Zacks Small-Cap Research

February 6, 2014

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# Zecotek Photonics (V.ZMS)

## V.ZMS: 3D Display Opportunity Looks Promising

| | |
|---|---|
| **Current Recommendation** | **Outperform** |
| Prior Recommendation | N/A |
| Date of Last Change | 10/02/2013 |
| Current Price (02/05/2014) | $0.82 |
| **Target Price** | **$4.00** |

## OUTLOOK

Zecotek is the only company in the world to own all key elements for a high performance PET scanner. Technology is protected by large patent portfolio. ZMS.V is well positioned to capitalize on growth of PET market. Their LFS scintillation crystals look to be superior to any other crystals on the market and with PET scanner performance tied to performance of crystals, demand for LFS crystals could be substantial. Major distributor just signed and initial orders received. Crystals also to be used in high profile Large Hadron Collider. ZMS.V is plaintiff in lawsuit claiming patent infringement - potential award could be substantial and provides potential add'l upside value.
Based on our DCF model, ZMS.V is valued at $4.00/share.

## SUMMARY DATA

| | |
|---|---|
| **52-Week High** | **$0.94** |
| **52-Week Low** | **$0.22** |
| **One-Year Return (%)** | **139** |
| **Beta** | **N/A** |
| **Average Daily Volume (sh)** | **283,118** |
| **Shares Outstanding (mil)** | **87** |
| **Market Capitalization ($mil)** | **71** |
| **Short Interest Ratio (days)** | **N/A** |
| **Institutional Ownership (%)** | **N/A** |
| **Insider Ownership (%)** | **N/A** |
| **Annual Cash Dividend** | **N/A** |
| **Dividend Yield (%)** | **N/A** |
| **5-Yr. Historical Growth Rates** | |
| **Sales (%)** | **N/A** |
| **Earnings Per Share (%)** | **N/A** |
| **Dividend (%)** | **N/A** |
| **P/E using TTM EPS** | **N/A** |
| **P/E using 2014 Estimate** | **N/A** |
| **P/E using 2015 Estimate** | **82.0** |
| **Zacks Rank** | **N/A** |

| | |
|---|---|
| **Risk Level** | **N/A** |
| **Type of Stock** | **Large-Growth** |
| **Industry** | **Med Products** |

## ZACKS ESTIMATES

**Revenue**
(in '000 of $)

| | Q1 (Oct) | Q2 (Jan) | Q3 (Apr) | Q4 (Jul) | Year (Jul) |
|---|---|---|---|---|---|
| 2013 | 0 A | 14 A | 0 A | 26 A | 40 A |
| 2014 | 8 A | 127 E | 391 E | 1030 E | 1556 E |
| 2015 | | | | | 6355 E |
| 2016 | | | | | 11995 E |

**Earnings per Share**

| | Q1 (Oct) | Q2 (Jan) | Q3 (Apr) | Q4 (Jul) | Year (Jul) |
|---|---|---|---|---|---|
| 2013 | -$0.01 A | -$0.01 A | -$0.01 A | -$0.05 A | -$0.09 A |
| 2014 | -$0.01 A | -$0.01 E | -$0.00 E | -$0.00 E | -$0.03 E |
| 2015 | | | | | $0.01 E |
| 2016 | | | | | $0.06 E |

Zacks Projected EPS Growth Rate - Next 5 Years % **N/A**

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## WHAT'S NEW…

**Fiscal Q1 2014 Financials**
Zecotek filed their financials for their fiscal 2014 first quarter. Revenue was just $9k and clearly did not reflect the initial $500k initial order from Hamamatsu for the scintillation crystals which was placed near the end of July. We now model contribution from this order in Q2 and for the $1.5M follow-on order from Hamamatsu, which was announced in November, to be recognized throughout the remainder of the current fiscal year.

Q1 net income and EPS were ($1.05)M and ($0.01), in-line with our ($1.05)M and ($0.01) estimates. We have made only minor adjustments to our model following Q1 results, mostly reflecting revenue from the initial Hamamatsu order being pushed back by one quarter.

**3D Display Technology Could Be Commercialized Ahead of Our Initial Expectations**
When we initiated coverage of Zecotek only just a few months ago, our expectations were that the company had somewhat back-burnered any substantial near-term focus on commercializing their 3D display technology as they dedicated all energy on their Imaging products. Since then, however, management appears to have made material progress in discussions with potential partners, in developing a feasible pathway towards further development of the technology and, potentially, commercialization in the not-too-distant future.

The company recently announced that they have been in discussions with major electronics companies to develop an OLED/LED-based, flat screen, glasses-free, 3D HD television. While the company has not specifically identified the potential partners that they are in discussions with, "major electronics companies" likely indicates these are brand-name, major TV manufacturers.

Relative to the recent progress on moving the Display business forward, Zecotek's CEO noted in their recent press release that, " We have overcome the main technical barriers required to meet the consumer preference for flat screen form factors and HD picture quality with available OLED/LED flat screen display technologies. Renewed discussions are now in progress and we feel confident about reaching a mutually rewarding business arrangement."

While it is still unclear how soon commercialization of the 3D display technology for the consumer market may materialize, we view the recent developments as materially positive and the progress more rapid than we had previously anticipated.

Zecotek is also moving forward on other fronts related to its 3D technology. This includes their 3D projection technology which they see applicable for applications where flat screens are not particularly important. This is mainly the non-consumer markets including for applications such as advertising and large venue displays. Of particular utility could be for 3D printing applications for commercial use.

In late January of this year Zecotek announced that they are now designing a 3D interface platform between 3D printers and their 3D display technology. This would allow someone to see a 3D image of an object prior to actually printing it on a 3D printer. The user would be able to view the object from all angles and make any desired adjustments before they printed it, affording time, cost and materials savings.

With the rapid growth in popularity of 3D printing, this could be another high-potential opportunity for Zecotek's 3D display technology. The company envisions initially subcontracting production of the 3D display units for the 3D printer application and then potentially partnering for wider distribution.

While we still do not model a contribution from the display-related businesses (consumer or commercial related markets), we believe the recent progress could provide a greater chance of upside to our outlook. We will be monitoring ongoing developments and update our model if and when appropriate.

**Maintaining Outperform Rating / $4.00 Price Target**
Based on our DCF model, we value ZMS.V at approximately $4.00/share. We see significant upside in the share price based on the current market value. We are maintaining our Outperform rating.

## SNAPSHOT

Zecotek Photonics Inc. (ZMS.V / ZMSPF) was founded in 2004 by Dr. A.Faouzi Zerrouk, a theoretical physicist with decades of research experience in varied fields of science and technology, and expertise in technology entrepreneurship, consulting and strategic planning. Zecotek develops high technology components including crystals, photo detectors, opto-electronics devices and three-dimensional displays for the medical, industrial and research industries. The company has three operating businesses; Zecotek Imaging, which develops high resolution imaging products and components for the medical and industrial fields, Zecotek Lasers, opto-electronics devices for the medical and optical data processing industries, and Zecotek Display, the company's proprietary display technology which provides 3-D multiple-views without glasses and is aimed at the medical, industrial and consumer markets. Zecotek and their technologies have received high acclaim over the past few years. This includes receiving the 2009 North America's "Best Enabling Technology" award from Frost & Sullivan for their Multi-Pixel Avalanche Photo Diode (MAPD) and Lutetium Fine Silicate (LFS) scintillation materials which are used in PET scanners.

While the company has yet to generate significant revenue, Zecotek is unique relative to most early-stage ventures as intrinsic value is perhaps more easily identifiable based on Zecotek's tangible assets, most notably the company's library of intellectual property, and defined end markets for their products. At the forefront of Zecotek's IP and product portfolio are technologies and components for the advanced medical imaging industry. Zecotek is the only company in the world to own all key elements (i.e. - scintillation crystals, solid-state MAPD photo detectors, and a data acquisition board and readout system) for a high performance positron emission tomography (PET) scanner.

The potential demand for Zecotek's LFS scintillation crystals looks to be very compelling. The performance of particular crystals has a direct effect on the performance of the PET scanners that they are used in and the properties of ZMS's crystals appear to superior to any others on the market. Significant quantities of these crystals are expected to be used in the Large Hadron Collider, the most powerful particle accelerator ever built, in a very high-profile experiment - which provides substantial validation for the performance of the crystals and which we think should benefit the commercial roll-out. With crystals accounting for approximately one-third of the cost of a PET scanner (which can cost up to $2 million) and only a small handful of competitors in the crystals space, Zecotek could have a big winner with their LFS crystals. Zecotek also believes that their crystals, which are being manufactured in China, can be more cost competitive than those from other suppliers and manufacturers, adding another catalyst to market penetration.

Specifically noteworthy to the potential of their intellectual property is a patent lawsuit that Zecotek brought against Saint-Gobain, a € 43 billion (revenue) French materials company, and Philips Healthcare, a behemoth in the medical device industry and one of the leading PET scanner manufacturers. The lawsuit alleges that Saint-Gobain infringed on a Zecotek-owned patent covering their LFS scintillation crystals and accuses Philips of using these crystals in their PET scanners. The lawsuit was brought in February 2012 and a Markman hearing was held in July 2013. The company and their lawyers believe that they have a strong case. If victorious, this could result in a potentially significant damages award for Zecotek.

In mid-July of this year the company announced an agreement with Hamamatsu Photonics to commercialize some of Zecotek's existing technologies as well as to collaborate on new and upgraded products. Hamamatsu is the world's leading supplier of optoelectronics components used in PET scanners and counts the major PET manufacturers as key customers. Hamamatsu is expected to be a key partner in selling Zecotek's high-potential LFS crystals (as well as other products). At the end of July Hamamatsu placed an initial order worth $500k for the crystals and in November placed their second order, worth another $1.5 million.

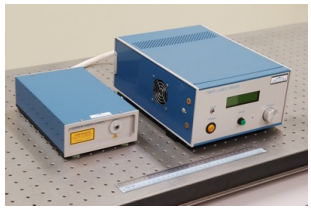
## BACKGROUND

**Three Operating Businesses, Current Main Focus is Imaging Systems**
The company has three operating businesses; Zecotek Imaging, which develops high resolution imaging products and components for the medical field (includes LFS crystals, the company's current focus), Zecotek Lasers, laser systems for the medical and industrial fields, and Zecotek Display, the company's proprietary display technology which provides 3-D viewing without glasses and is aimed at the medical, industrial and consumer markets.



- **Zecotek Display Systems (ZDS)** is focused on a proprietary 3-D technology which provides unique, multi-dimensional viewing without requiring glasses. The display allows viewers sitting at different angles to see separate views. Zecotek completed system development and has a 32-inch pre-production model which they are exhibiting for demonstration. The system is not currently in production. Potential end markets include medical, video gaming, graphic design, and military, among others. We think the display systems business has significant potential given the huge and various markets interested in high quality 3-D technology and the unmet demand due to the fact that most currently commercialized technologies require glasses, which consumers find an annoyance. We believe Zecotek's display systems has significant potential. We had just recently viewed the business as sort of a back-burner opportunity as Zecotek focused on their LFS crystals and their MAPD but recent developments in the display business, including discussions with "major electronics" companies related to 3D flat screen HD televisions and potential opportunities in the 3D printer interface market, now have us believing Zecotek's display systems business may have more near-term potential than we had previously thought.

- **Zecotek Laser Systems (ZLS)** develops lasers and laser components for applications in the medical and industrial sectors as well as for research purposes. The company develops two main types of lasers; visible fiber lasers (VFL) and thin film lasers.



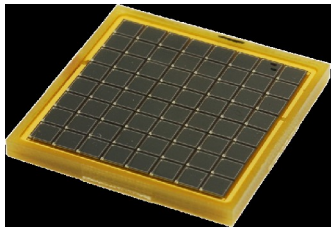
Their VFL lasers cover wavelengths in the green, blue and red spectral ranges and are manufactured using the company's proprietary fiber optical technology. Zecotek notes certain advantages of their lasers including; high beam quality and stability, compact design and high efficiency, adjustment-free operation, no water cooling, wavelength output in most of the visible spectrum, and broad continuous wavelength tuneability. The tuneability within wide spectral ranges, along with relatively lower cost compared to conventional lasers are specifically noteworthy benefits. Their VFL lasers are sold to various industries and for a variety of applications, these include; medical (DNA sequencing, flow cytometry, ophthalmology, dermatology, urology), printing, material processing (laser writing, lithography), and research (spectrsocopy, fluorescent analysis), among others. Zecotek continues development of additional VFL lasers which will further increase the range of tuneability. Zecotek's VFL lasers are currently used by the National Cancer Institute, a division of the U.S. National Institutes of Health (NIH).

Zecotek's thin film lasers are still under development. The company is partnered with the Advanced Materials and Process Engineering Lab at the University of British Columbia in development of thin film waveguide structures for the next generation of diode-pumped solid-state (DPSS) lasers.

- **Zecotek Imaging Systems (ZIS)** develops and manufactures components for advanced imaging products, mainly for the medical industry, including PET and MRI scanners. The ZIS business is where most of Zecotek's current attention is focused and includes their LFS scintillation crystals, MAPD, and integrated PET/MRI assemblies. As the products from the ZIS business, most importantly the LFS scintillation crystals, aggregate the majority of Zecotek's near-term opportunity, this is where we dedicate most of our discussion. In 2009 Zecotek received the Frost and Sullivan award for "Best Enabling Technology" for its MAPD and LFS scintillation materials.

The main components of PET scanners which have to do with capturing the images are crystals and photo-detectors. During a PET procedure a patient is injected with an imaging agent. As the agent decays it emits a positron, and eventually produces photons, which are detected by scintillation crystals. These crystals create a burst of light which are then captured by the photo detectors which multiply the signal, allowing for it to be detected. Millions of these events can occur in a single scan which are then reconstructed with computer algorithms to produce single images. The majority of PET scanners sold today also have CT capability which

provides for enhanced resolution and greater localization of lesions, which is particularly desirable for oncology applications. Hybrid PET/MRI scanners, which provide even better visualization of soft tissue and have lower radiation than PET/CT, have recently evolved as a major area of growth for PET manufacturers with Siemens introducing the first fully-integrated PET/MRI scanner in the U.S. in 2011.



Zecotek's **MAPD** have been developed to replace photo multiplier tubes, which are the most commonly used photo detector in PET scanners and gamma cameras. Photo multipliers are a type of vacuum tube, but unlike most vacuum tubes, photo multipliers are not obsolete. Photo multiplier tubes are very sensitive detectors of light with high gain, low noise and very fast response, which has made them ideal for applications such as in advanced medical imaging cameras. They do have some drawbacks, however, including they are relatively large, expensive, and require very high voltage. Another meaningful disadvantage is that strong magnetic fields can impede the performance of photo multiplier tubes. Therefore a combination PET/MRI machine can not easily be constructed using photo multiplier tubes as MRI (magnetic resonance imaging) produces strong magnetic fields. Zecotek and the University of Washington have collaborated in designs for a PET/MRI scanner using the company's newest generation MAPD's.

Zecotek's MAPD have been developed to have all the benefits of photo multiplier tubes (high sensitivity, high gain, low noise, fast response) without the drawbacks. Zecotek's MAPD uses relatively low voltage and the solid-state design makes them much more compact than photo multiplier tubes. It also is not affected by magnetic fields. Zecotek's MAPD target markets encompass all those currently served by photo multiplier tubes which, along with medical technology, includes high energy physics, astronomy, pharmaceutical research, security, defense, and environmental monitoring.

Due to the drawbacks of PMT and advantages of solid-state photo detectors, PET manufacturers have a significant interest in building their scanners with this better technology. The initial solid-state detectors were built with technologies called silicon photo multipliers (SiPM) and multi-pixel photon counters (MPPC), technologies which were invented and patented by scientists who now work for Zecotek. Zecotek improved on these technologies which resulted in the MAPD technology. The MAPD overcomes certain limitations of SiPM and improves overall performance. PMT suppliers have moved towards offering PET manufacturers solid-state technology but in the form of SiPM and MPPC. Zecotek believes their MAPD technology is the optimum solution for the PET manufacturers as well as high-energy physics such as calorimeters and part of the Large Hadron Collider machine in CERN. Zecotek has authored a white paper on their MAPD which references studies that have been conducted which have shown the high performance of their MAPD technology.

Hamamatsu Photonics, which Zecotek recently signed a distribution agreement with (discussed below), is the world's largest supplier of PET photo detectors.

Hamamatsu's capabilities extend much further than just manufacturing and distribution, however. The company is deeply engaged in PET-related research and development as well, which also extends into the relationship with Zecotek. Zecotek has several variants of MAPDs and the two companies will collaborate on improvements of Zecotek's photo detectors and modules with Hamamatsu in the lead role. Hamamatsu will also largely be responsible for funding joint R&D and product development. Both companies will retain ownership of their patents and IP.




*SOURCE: hamamatsu.com*

Hamamatsu is very much on the cutting edge of medical imaging technology innovation and founded the Hamamatsu Medical Imaging Center (picture) where they conduct medical imaging and conduct R&D and clinical trials. Hamamatsu has developed their own photo detectors which are used in TOF-PET/CT scanners. Therefore, Zecotek's agreement with Hamamatsu which includes collaborative efforts on product innovations is much more compelling than just from a distribution standpoint, particularly given Zecotek's large and potentially very appealing patent portfolio.

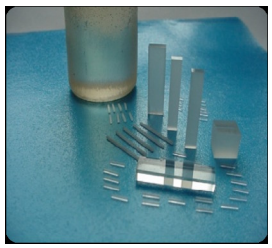
***MAPD Used by CERN…***

Zecotek notes that their MAPD has undergone testing by a number of institutions including the European Organization for Nuclear Research (CERN), a world-renowned institution run by 20 European member states which (per CERN website) uses "the world's largest and most complex scientific instruments to study the basic

constituents of matter - the fundamental particles." CERN has used Zecotek's MAPD photo detectors in several projects and experiments over the last few years all with positive results. CERN has chosen Zecotek's MAPD as an alternative to photo multiplier tubes. The most recent project, dubbed COMPASS, was announced in December 2012 whereby Zecotek's MAPD-3N (i.e. - the third generation MAPD) photo detector is being used in an electromagnetic calorimeter at CERN's Super Proton Synchroton accelerator in Switzerland. Given the strict criteria set by CERN engineers relative to selection of photo detectors, the fact that CERN continues to come to Zecotek for their MAPD for use in their experiments is a clear vote of confidence in the technology. And as CERN is a world leader in scientific research, this vote of confidence carries potentially significant influence and one which commercial manufacturer's of PET systems and other instruments may likely heed. And as we discuss below, CERN is also using Zecotek's LFS crystals in a revolution experiment to clarify the existence of the Higgs Boson.

Zecotek initially partnered with the National NanoFab Center (NNFC), a South Korean nanotechnology company, to manufacture their MAPD photo detectors for the commercial market. In December 2012 Zecotek announced that NNFC has completed the major steps towards upgrading their MAPD to current industry standards and indicated they were close to being able to deliver initial commercial units. With the recently penned agreement with Hamamatsu, manufacturing of the MAPD will now transfer over to Hamamatsu. This transfer to Hamamatsu is now ongoing. Zecotek and Hamamatsu will be jointly involved in selecting the versions of MAPDs that will be suitable for CERN and those for commercial production. Commercial sales could commence in early 2014.

**LFS Scintillation Crystals**



Scintillation means flash of light or luminescence. Scintillation materials are designed to absorb the energy of an incoming particle and then re-emit the energy as light. In applications that use scintillation materials, the more light produced by the material, the better. The company's proprietary and patented LFS scintillation crystals have been designed to provide for certain critical advantages over other commonly used scintillation crystals including high light yields and ultra fast decay times. As the performance of PET cameras is directly effected by the properties of the scintillation crystals used in the scanner, higher light yields and faster decay times means better quality pictures. Important to understand is that there can be significant performance differences between makes and models of PET scanners and the most important link in the components of a scanner that dictate performance is the quality and performance of the crystals. The crystals typically account for about one-third of the total cost of a scanner (PET/CT scanners can cost as much as $2 million) and each scanner requires as many as 30k of these crystals.

The desired properties of scintillators include high light output, high density, high atomic number, short decay time, fast speed, low cost, and hardness, with high light output and short decay time among the most important characteristics. Today, the three most commonly used scintillation materials in PET and gamma cameras are bismuth germanate (BGO), lutetium oxyorthosilicate (LSO) and gadolinium oxyorthosilicate (GSO). BGO has been the most widely used material in legacy PET scanners but since the discovery of LSO, which has certain advantages over BGO, LSO (and LYSO, a related material) has become the scintillation material of choice for new PET scanners (since ~2005).

High light output and short decay time (decay time is a measure of how long until a crystal emits light after absorption of a photon) were not a common combination in scintillation crystals until LSO was discovered, which performs relatively well (compared to BGO and GSO) on both measures. Another scintillation material, NaI(Tl), has very high light output but low density and a low atomic number, which means it is relatively inefficient at absorbing photons (i.e. - low stopping power). Despite the shortcomings of NaI(Tl), it has been the dominant scintillator material for more than 50 years and remains the material of choice in single-photon emission computed tomography (SPECT)[1]. Meanwhile LSO seems to have combined the best of BGO (i.e. - high density and atomic number) and NaI(Tl) (i.e. - high light yield) which has recently made it the scintillation material of choice for the major PET manufacturers.

***LFS's Advantages Trump Competition…***

The performance of Zecotek's LFS scintillation crystals, however, looks to even trump that of LSO. With a very high light yield (up to twice that of LSO, although slightly less than NaI(IT)), comparable density and atomic number to LSO (and much higher than NaI(Tl)), and the fastest decay times of all the common scintillation

[1] Saeterstol, Jostein. Characterization of Scintillation Crystals for Positron Emission Tomography. University of Bergen. June 2010

materials, Zecotek's scintillators appear to be the most competitive and highest performance material. In addition to superior performance over competing scintillation materials, Zecotek's LFS crystals are also lower cost. And with the photo detector and scintillation material typically accounting for approximately 60% - 65% of a PET scanner's cost, lower cost and better performing scintillation crystals are significant advantages.

Below is a chart from a white paper authored by Zecotek comparing the characteristics of each scinitillation material. We have verified the performances listed in this chart for the competing materials to other published data in the public domain which agree with Zecotek's findings. The LFS data was taken from trials performed by the University of Washington, CERN, and the Institute for Theoretical and Experimental Physics ) Moscow, Russia.

**LFS scintillation crystals: Industry product comparison**

| Parameter \ Crystal* | Tl:NaI | BGO | LSO | GSO | LYSO | LFS-3 | LFS-7 | LFS-8 |
|---|---|---|---|---|---|---|---|---|
| Density, g/cm³ | 3.67 | 7.13 | 7.4 | 6.71 | 7.1 | **7.35** | **7.4** | **7.4** |
| Effective at. number | 51 | 74 | 66 | 57 | 66 | **64** | **64** | **64** |
| Attenuation length, cm | 2.6 | 1.11 | 1.14 | 1.38 | 1.12 | **1.15** | **1.12** | **1.14** |
| Decay constant, ns | 230 | 300 | 40 | 30–60 | 41 | **25–33** | **30–35** | **12–25** |
| Max emission, nm | 415 | 480 | 420 | 430 | 420 | **425** | **412–416** | **422** |
| Light yield (NaI:Tl=100%) | 100 | 7–12 | 40–75 | 20 | 70–80 | **80–85** | **80–85** | **80–85** |
| Refractive index | 1.85 | 2.15 | 1.82 | 1.85 | 1.81 | **1.81** | **1.81** | **1.81** |
| Energy resolution $^{137}$Cs, % | 8 | 12–14 | 10–14 | 9.5 | 8.0 | **8** | **8** | **7** |
| Absorbed γ-ray irradiation dose, rad (rad. hardness, %/cm)† | 10 (?) | $10^{2-3}$ (?) | $10^{6}$ (7) | $10^{8-9}$ (6) | $10^{8}$ (7) | **$10^{8}$ (2)** | **$10^{8}$ (7)** | **$10^{8}$ (7)** |
| Hygroscopicity | strong | No | No | No | No | **No** | **No** | **No** |
| Hardness, Moh | 2 | 4.5 | 5.8 | 5.7 | 5.8 | **5.8** | **5.8** | **5.8** |
| Cleavage | (100) | none | none | (100) | none | **none** | **none** | **none** |
| Boule size, mm | Ø400x600 | Ø100x250 | Ø75x200 | Ø75x150 | Ø75x150 | **Ø90x250** | **Ø90x250** | **Ø50x200** |

* The chemical composition of the competing crystals: BGO — $Bi_4Ge_3O_{12}$, LSO — $Ce:Lu_2SiO_5$, GSO — $Ce:Gd_2SiO_5$; LYSO — $Ce:Lu_{1.8}Y_{0.2}SiO_5$.

† Induced optical transmission loss after exposure to radiation is a more realistic and quantifiable measure of the radiation hardness than the absorbed radiation dose.

*SOURCE:Zecotek*

Similar to the OEM PET manufacturer market, the market for medical imaging crystals is largely highly concentrated between only a few major suppliers. In general BGO crystals are not considered competitive in terms of performance to LYSO and LSO crystals. Zecotek's LFS crystals would compete against LYSO and LSO crystals, the major manufacturers of which are Saint-Gobain and Crystal Photonics. A third manufacturer, CTI Molecular Imaging, had been a long-term JV of Siemens' and was eventually acquired by the PET OEM in 2005, which afforded Siemens the ability to source their crystals through their wholly-owned supply chain.

***LFS Crystals Validation Supported By Use In High Profile Experiments…***

The LFS crystals have been used in trials since 2007 including by The Paul Sherrer Institute (Switzerland) in a PET program focused on increasing performance of PET scanners, Shinshu University (Japan) in trials for their next-gen PET imaging program focused on improving resolution of 3-D imaging in cancer, and trials by the University of Washington and CERN. The various studies over the recent years have aided in the validation of the performance of the LFS crystals.

Employment of the crystals has since evolved to the late stages of validation and is now at a point where they are being utilized as components in scanners and other instruments. This includes being used in development

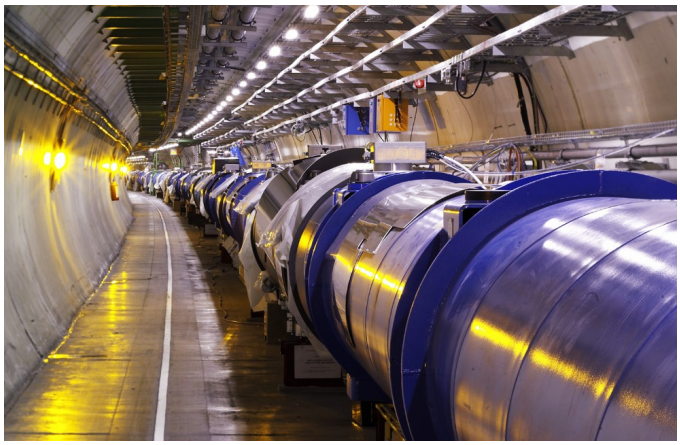
of a new PET system by NuCare Medical Systems, a South Korean nuclear imaging company and in a trial PET scanning device by a (undisclosed) Japanese OEM PET manufacturer.

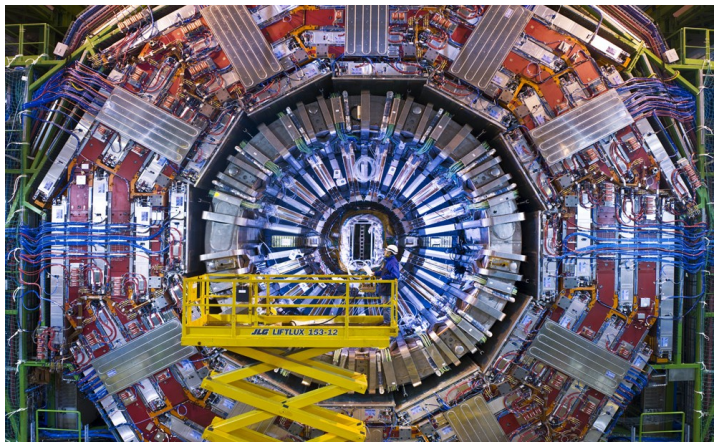
Scientific applications of the LFS crystals has also evolved beyond just validation of the material and moved to utilization of the crystals for scientific discovery purposes. In May 2013 Zecotek announced that CERN will be using the LFS crystal material in experiments to clarify the existence of Higgs boson - which is considered a very high-profile project in scientific communities.

Higgs boson is an elementary particle and discovery of it would confirm the Standard Model of particle physics - which in the field of physics would be considered a monumental accomplishment - in fact the Large Hadron Collider (built by CERN from 1998 - 2008), the most powerful particle accelerator ever built, was constructed largely to prove or disprove the existence of Higgs boson.

In March 2013 CERN physicists announced that the Large Hadron Collider had tentatively confirmed the existence of Higgs boson. Formal confirmation still needs to be made through additional experiments, however. The Large Hadron Collider is now being rebuilt in order to be able to operate at higher temperatures. The rebuilding process is expected to take about two years with experiments expected to resume in early 2015. Higher temperatures will require extremely hard crystals - which is one of the reasons that CERN has chosen Zecotek's LFS crystals. Zecotek's LFS-8 crystals will be used by CERN. Zecotek's MAPD may also be used by CERN. Zecotek is now working with CERN to determine the optimum size configurations to be used in the Higgs boson confirmation experiments. Use by CERN in this project should provide significant validation of the properties and performance of the LFS crystals and almost certainly provide Zecotek and Hamamatsu with a valuable and very credible marketing message to the commercial marketplace (Zecotek's LFS-3 crystals will be sold commercially and used in the MAPD product).

## Large Hadron Collider





*SOURCE: boston.com*

The other potentially very valuable benefit to Zecotek is that the Collider rebuild may require significant quantities of crystals and photo detectors. While it's too early to speculate on specific quantities that CERN may order from Zecotek, we think that it's reasonable that it could be in the several million dollars to potentially tens of millions of dollars worth of product.

***Now On The Cusp of Full Commercialization…***

The next link in the chain of evolution of the LFS crystals is expected to be full-blown commercialization. In mid-July 2013 Zecotek announced a partnership with Hamamatsu Photonics to commercialize the company's imaging products including their photo detectors, LFS crystals and integrator detector modules. Tokyo-based Hamamatsu has approximately $1 billion in annual sales, is the leading supplier of optoelectronic components used in PET scanners and counts major OEM PET manufacturers as customers, including Philips and GE. Hamamatsu also has a long-standing relationship with CERN - in fact we think the relationship between Zecotek and Hamamatsu may have been facilitated by an introduction through CERN.

Under this exclusive commercialization and joint development agreement, Hamamatsu will handle marketing and distribution of most of Zecotek's imaging products including their LFS crystals and solid-state MAPD photo detectors. Hamamatsu will also manufacture the MAPD and IDM products. Zecotek received its first order from

Hamamatsu in late July. We view the relationship with Hamamatsu as a significant positive development for Zecotek as while Zecotek had already established compelling products (particularly the LFS crystals), substantial distribution and customer relationships (particularly with the PET OEM's) had been the missing piece of the puzzle until now. Hamamatsu also brings R&D and product development resources and will largely be funding these activities for ongoing improvement of Zecotek's existing products as well as potentially bringing new products to market. Hamamatsu's relationships, marketing muscle and distribution reach should be an ideal fit for Zecotek's products. Hamamatsu placed a $500k order for Zecotek's LFS scintillation crystals which are slated for use in third party PET scanners as well as for in-house use by Hamamatsu.

While Hamamatsu will manufacture Zecotek's MAPD photo detectors, Beijing Opto-Electronics Technology (BOET) is manufacturing the LFS crystals. In November 2011 Zecotek penned a deal with BOET, a leading photonics company focused on growing, cutting, polishing and large-scale production of crystals. BOET has extensive experience in scintillation crystal production and being based in China has the advantage of easy access to a plethora of rare earth and other materials used in crystal production. BOET is partly owned by the Chinese government and will also be able to provide the crystals at what will likely be significantly lower cost than if produced elsewhere.

**Integrated Detector Module**
Zecotek is also working on an Integrated Detector Module (IDM) which combines their LFS crystals, an array of their MAPD photo detectors and a readout system into a single assembly for use in PET and gamma scanners. The IDM allows PET manufacturers to forego having to purchase the three components separately. The components of the IDM represent approximately 75% of the total cost of a PET scanner.

Given that the IDM has the potential to reduce the cost of building a PET scanner with potentially less maintenance required (compared to separate components), this offers a much more affordable option for less well-heeled manufacturers, particularly those that service lower-income markets. Zecotek envisions the initial market for their IDM as small PET manufacturers in emerging countries.

In January 2013 the company announced that they had completed the design concept of the IDM. The IDM will also be manufactured by Hamamatsu, which will also be directly involved in ongoing R&D related to ongoing improvements of the product. The IDM has already been validated in prototyped machines. Additional functionality and added value will be incorporated into the IDM including a data acquisition board. The next step prior to commercialization will be to optimize components to reduce input costs and to facilitate full-scale production and manufacturing.

**Patent Portfolio**
Zecotek has a large patent portfolio, covering all of the company's major products including lasers, displays, LFS crystals, photo detectors, and other PET component technologies. Zecotek is the only company to own all key elements for a high-end PET scanner. As of July 2013 Zecotek owned or controlled over 50 patents.

While the carrying value of the patent portfolio is relatively minimal, the true tangible value could be substantial, particular relative to ZMS.V's current book and market values of about ($2.7) million and $60 million, respectively. Insight into the value of the '060 patent covering the LFS crystals may be unearthed at the conclusion of the ongoing lawsuit (below) - the value of this patent alone could potentially dwarf current market value of the company.

Zecotek is looking to monetize their patent portfolio in several ways. One is developing and commercializing products built from their IP. The other - although not a strategic move - is defending their patents in court and seeking damages. The third is through a recent relationship with Intellectual Ventures, a leading IP firm involved in patent strategy and monetization - which includes patent purchasing, licensing, building and partnering.

Below is Zecotek's patent portfolio from their most recent public filings;

| Key Technology | Patent/App. No | Date Filed | Jurisdiction | Status |
|---|---|---|---|---|
| Visible fibre lasers | 12/182,951 | 30-07-08 | PCT, US, CA | Pending |
| | 2006119198 | 02-06-06 | RU | Granted |
| Solid-state lasers | 12/851,427 | 05-08-10 | PCT, US | Pending |
| | 12/881,033 | 13-09-10 | US | Pending |
| 3D displays | 7,944,465 | 27-02-06 | US, CA, AU | Granted |
| | 13/108,249 | 16-05-11 | US | Pending |
| | 11/769,672 | 27-06-07 | US | Granted |
| | PCT/IB2007/003309 | 07-11-07 | PCT, CN, EA, EP, IN, JP, KR | Pending |
| | 201070065 | 07-11-07 | EA | N. of Allowance |
| | EP 2177041 | 07-11-07 | EP | Granted |
| | 61/586,809 | 01-15-12 | US | Pending |
| | 13/546,877 | 11-07-12 | US | Pending |
| LFS scintillation crystals | 7,132,060 | 21-07-05 | US | Granted |
| | 2242545 | 04-11-03 | RU | Granted |
| | PCT/RU2004/000094 | 12-03-04 | PCT, AU, CA, CN, EA, DE, FR, GB, IN, JP, NL | Granted |
| | 1493/KOLNP/2006 | 12-03-04 | IN | Pending |
| Semiconductor photo-detectors (MAPD) | 2316848 | 01-06-06 | RU | Granted |
| | PCT/RU2007/000287 | 31-05-07 | PCT, AU, CA, EP, IN, JP, KR, MY | Pending |
| | 200808979-9 | 31-05-07 | SG | Granted |
| | 200780024920.5 | 31-05-07 | CN | N. of Allowance |
| | 12/034,603 | 20-02-08 | US | Pending |
| | 13/609,136 | 10-09-12 | US | Pending |
| PET imaging technologies | 7,956,331 | 27-10-08 | US | Granted |
| | 13/232,944 | 14-09-11 | PCT, US | Pending |
| | PCT/US2009/062108* | 26-10-09 | PCT | Pending |
| | 12/544,174* | 19-08-09 | US | Pending |
| | 8,003,948 B2* | 03-11-08 | US | Granted |
| | PCT/US2008/082273* | 03-11-08 | PCT, AU, CA, EP, JP, KR, CN, EA, IN | Pending |
| | PCT/US2009/061600* | 22-10-09 | PCT, US | Pending |
| | 13/125,962* | 10/26/2009 | US | Granted |

* Zecotek, as principal financier and development partner of imaging components with the University of Washington, has the exclusive license rights for improved data-processing electronics for new generation PET scanning devices.

## Zecotek vs. Saint-Gobain / Philips lawsuit

***Zecotek Believes They Have Strong Case in LFS Crystals Patent Infringement Lawsuit…***

In February 2012 Zecotek announced that they brought a lawsuit against Saint-Gobain Corporation and Philips alleging infringement of Zecotek's patent (7,132,060) covering the substances and chemical formulations to grow their LFS crystals. Zecotek was granted the patent in November 2006. See this link on the U.S Patent and Trademark office website for the full description and claims of the patent: http://1.usa.gov/1bcxsYP.

The lawsuit, which was originally filed in U.S. Federal District Court in Los Angeles and is now being heard in the U.S. District Court in Ohio, claims that Saint-Gobain's currently commercialized LYSO (lutetium yttrium orthosilicate) crystals infringe Zecotek's patent and that Philips is also liable because they use these Saint-Gobain crystals in their commercialized PET scanners. BOET is co-plaintiff with Zecotek in the lawsuit. Zecotek has retained the law firms of Graybeal Jackson LLP and Godfrey LLP to represent them. Zecotek is in good hands with both firms highly respected and having significant patent law experience. In July 2013 Susman Godfrey, for the fourth straight year, was named the nation's number one (~17k law firm associates were surveyed) litigation boutique in Vault's annual Practice Area Rankings.

In early July 2013 a Markman hearing was held. The Markman hearing allows the judge in a patent infringement case to examine evidence from both parties and to determine the interpretation of the language of the patent in question. A date for results of the Markman hearing were not set, although we think this may come in the very near term. The result will not determine the outcome of the lawsuit but it may provide some insight into Zecotek's ultimate chances for success.

***Similar Lawsuits Could Offer Insight…***

Zecotek's action is not the first crystals related patent infringement lawsuit. In fact, crystals-related patent lawsuits have become almost commonplace. There is an ongoing lawsuit brought by Crystal Photonics, Inc.

(CPI), developer of LYSO crystals, against Siemens Medical. The suit claims that Siemens infringed on a patent issued to CPI in 2006 ("Method of Enhancing Performance of Cerium Doped Lutetium Orthosilicate Crystals and Crystals Produced Thereby") to enhance the performance of Siemens' LSO crystals which were incorporated into various products (including PET scanners) that the company sold. CPI argues the Siemens used CPI's patented technique of exposing crystals to oxygen diffusing treatments to improve their crystals which thereby improved the performance of the Siemens products. CPI is seeking an undisclosed amount of damages ("adequate to compensate CPI for Siemens Medical's acts of infringement, such damages to be determined by a jury"). Similar to Zecotek's lawsuit against St. Gobain, CPI is also claiming willful infringement which, if the court agrees, provides for the potential of trebling of damages.

Another lawsuit similar to Zecotek's was that of Siemens brought against St. Gobain in 2007 in U.S. District Court in Delaware. In that action Siemens claimed that St. Gobain infringed on their scintillator crystal detector patent ("Lutetium Orthosilicate Single Crystal Scintillator Detector"). The patent was filed in 1989. Siemens manufactured LSO crystals covered by this patent which used only the element lutetium and had relatively superior performance properties (high light output, fast decay time, etc.) to other crystals on the market at the time. Siemens claimed that St. Gobain infringed on the patent by manufacturing their LYSO crystals which also used lutetium but substituted 10% of the lutetium with another element, yttrium (10% Y LYSO crystals), in an effort to avoid patent infringement. St. Gobain's 10% Y LYSO crystals were used in two specific Philips PET scanners models ("Gemini TF" and "Gemini Raptor"). "TF" stands for "time-of-flight" which is a technology used in high-end scanners which provides for much better resolution.

Siemens admitted evidence at the trial which showed a large similarity in scintillation properties of the two crystals. The jury ruled that St. Gobain's 10% Y LYSO crystals violated the doctrine of equivalents as the performance achieved substantially the same result as Siemens' crystals. St. Gobain argued that Siemens had not demonstrated clear and convincing evidence of equivalence of the two crystals and, given that St. Gobain's crystals are patented (and therefore it's not obvious that they were equivalent to Siemens' crystals), Siemens should be required to do so. The court disagreed. Clear and convincing evidence is a higher burden or proof than preponderance of the evidence, the latter which is typical practice.

The jury ruled in favor of Siemens on the issue of equivalence and awarded them $52.3 million in lost profits damages. Siemens had also sought willful infringement which the jury did not grant. The amount of lost profits damages was calculated based on the number of PET scanners sold that used the 10% Y LYSO crystals prior to the expiration of the patent (October 2008) as well as related lost service contracts. The jury award was based on 79 scanners (at ~$580k per scanner) plus 28 service contracts (at ~$344k per contract) for scanners located in the U.S. less $3 million. In post trial motions the court ruled that Siemens did not provide sufficient evidence that 79 scanners were sold with the infringing crystals and reduced the award to $44.9 million, representing 61 scanners. The court noted that while there was evidence that 79 scanners were manufactured with these crystals, there was only sufficient proof that 61 had been sold prior to the expiration of the patent.

St. Gobain appealed in federal court but the verdict was upheld. The appeals court ruled in February 2011 and also asked the trial court to consider additional damages for the 18 scanners that were not part of the award given that manufacturing these scanners (whether they were sold or not) infringed the patent. The Federal Appeals Court concluded that, " The district court's judgment entered in favor of Siemens is affirmed. However, we vacate the damages award and remand for the court to consider a reasonable royalty for the additional 18 infringing scanners, to be added to the $44,937,545 in lost profits for the 61 scanners that were sold." The case eventually went to the U.S. Supreme Court which upheld the federal appeals court decision. In November 2012 The district court made a final judgment of $51.6 million.

Key for the plaintiff to claim lost profits damages was to support the supposition that had their patent not been infringed upon, that it would have made the sales that St. Gobain did make. The Federal Circuit uses a four-factor test, called the Panduit test, which the plaintiff must demonstrate in order to prove lost profits. This encompasses 1) demand for the patented product 2) absence of acceptable non-infringing substitutes 3) manufacturing and marketing capability to exploit the demand and 4) the amount of the profit it would have made.

The dearth of PET manufacturers (market largely consists of only Siemens, GE and Philips), the fact that the performance of crystals is a key factor in demand of PET scanners, that Siemens' crystals were considered superior to crystals used in GE scanners (which use BGO crystals), and that Philips was only able to compete in the "high-end" PET scanner market due to the use of the 10% Y LYSO crystals was deemed sufficient support for passing the Panduit test. Key for Siemens was to demonstrate to the court that this was really a two supplier market for high end PET scanners - Siemens and Philips and since GE only sold lower performance

scanners, that they did not compete in the same space and therefore theirs were not an acceptable alternative to the high end scanners.

***Potential Implications for Zecotek's Lawsuit…***

Assuming the case goes to trial, we think it is reasonable to assume Zecotek will cite the Siemens case as a precedent. St. Gobain is the defendant in both lawsuits and Philips is accused of using the crystals in their Gemini scanners in both suits. There are also some other obvious and significant similarities between the Siemens vs. St Gobain lawsuit and Zecotek's lawsuit against St. Gobain. Both claim that a crystals-related patent was infringed upon and that these crystals were used in PET scanners which were then sold. The crystals named in both lawsuits are St. Gobain's "PreLude 420" crystals (the Zecotek suit notes the infringing crystals are not limited to the PreLude 420 crystals). The crystals in both lawsuits both fit into the high-end category, both may be considered the highest performing at their particular and respective times and were used in Philips' "Gemini TF" and/or "Gemini Raptor" scanners (the Zecotek suit notes that use of the infringing crystals is not limited to these scanners). There still is only three major PET scanner manufacturers and the quality of the crystals used in PET scanners remains perhaps the most important characteristic of the quality of the scanner. Perhaps these also provide a reasonable position for Zecotek's claim to pass the Panduit test, assuming it is applied. In addition, both lawsuits claim willful infringement by the defendant.

While all the details of the lawsuit have not been made public, it is probably reasonable to assume Zecotek will take a similar position as did Siemens in regard to calculating damages. There is no publicly available information on the number of scanners sold that use the PreLude 420 crystals - and Zecotek's lawsuit implies they may believe St. Gobain has manufactured other crystals that infringe on their patent. An article written by AlphaEdge in March 2012 related to the Zecotek lawsuit estimates the number of scanners sold using the infringed crystals since the granting of Zecotek's patent in November 2006 at about 300. AlphaEdge basis their estimate on a June 2011 Philips press release which cited that 260 of its Gemini scanners were sold since 2006 and adds an estimated 40 scanners to this to account for those sold after the June 2011 press release (up to the March 2012 publication of AlphaEdge's article). We think that that's not an unreasonable estimate.

Another not unreasonable estimate methodology is to use some of the testimony from the Siemens lawsuit. The number of scanners sold that used the infringing crystals was not known. Records showed 49 sales through May 2008 - to come to the 61 number, St. Gobain's damages expert extrapolated, based on past performance, to estimate the total number that was sold through September 2008 (the extrapolation averages 3 scanners sold per month). If we use a 3 scanner/month average to estimate the number of scanners that may have infringed Zecotek's patent from November 2006 to the present, this equals approximately 243 - in the ballpark with AlphaEdge's estimate (which through the current date would now be slightly higher than 300). In addition, Siemens' damages were eventually based on 79 scanners, 18 more than allegedly sold, as the appeals court ruled that just manufacturing the scanners infringed the patent. As such, it would not be unreasonable to assume that Zecotek would have a fair argument to claim similar infringement - potentially meaning the 243 number is low.

Assuming a per scanner basis is used to calculate damages, the other part of the equation to figure the damages is the per scanner loss of profit. In the Siemens case this was approximately $653k ($51.6MM / 79 scanners) per scanner. Zecotek's case is different however, as instead of lost profits from scanners, it is based on lost profits on the crystals - the margin from which, on a per scanner basis, may be significantly different than for each scanner.

Timing for conclusion of the lawsuit is a complete unknown. It's still possible that the two sides could settle prior to trial. And if it does go to trial, it's possible that it could be drawn out for sometime given the potential for appeals by either side. Clearly the lawsuit will be of significant interest to investors as the outcome could, if in Zecotek's favor, could provide significant upside value to the company.

We also note that Philips, which holds significant share of the OEM PET market, is a potential future customer for Zecotek's products - LFS crystals, MAPD, IDM, and potentially future products. While complete speculation on our part, we think there may be an interest for both Zecotek and Philips to come to terms of an agreement and settle the lawsuit in exchange for (at the very least) to allow for good relations and potentially enter into a supply/purchase agreement.

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## MARKETS

***PET Systems Growth Fueled By Areas Zecotek Expects To Exploit…***

In January 2012 Bio-Tech Systems Inc. a healthcare market research firm specializing in medical imaging, published a report on forecasted growth of PET systems sales in both the U.S. and internationally[2]. The report noted that while U.S. sales volumes had been declining from about 2005 through 2009 due largely to uncertainties over reimbursement, that sales have since picked up. Worldwide, Bio-Tech estimates PET scanner sales to grow at a CAGR of just over 10% from 2012 to 2018 with much of this driven by increasing demand for hybrid PET/MRI machines, which they forecast to grow at a CAGR of 16% worldwide and 21% in the U.S.

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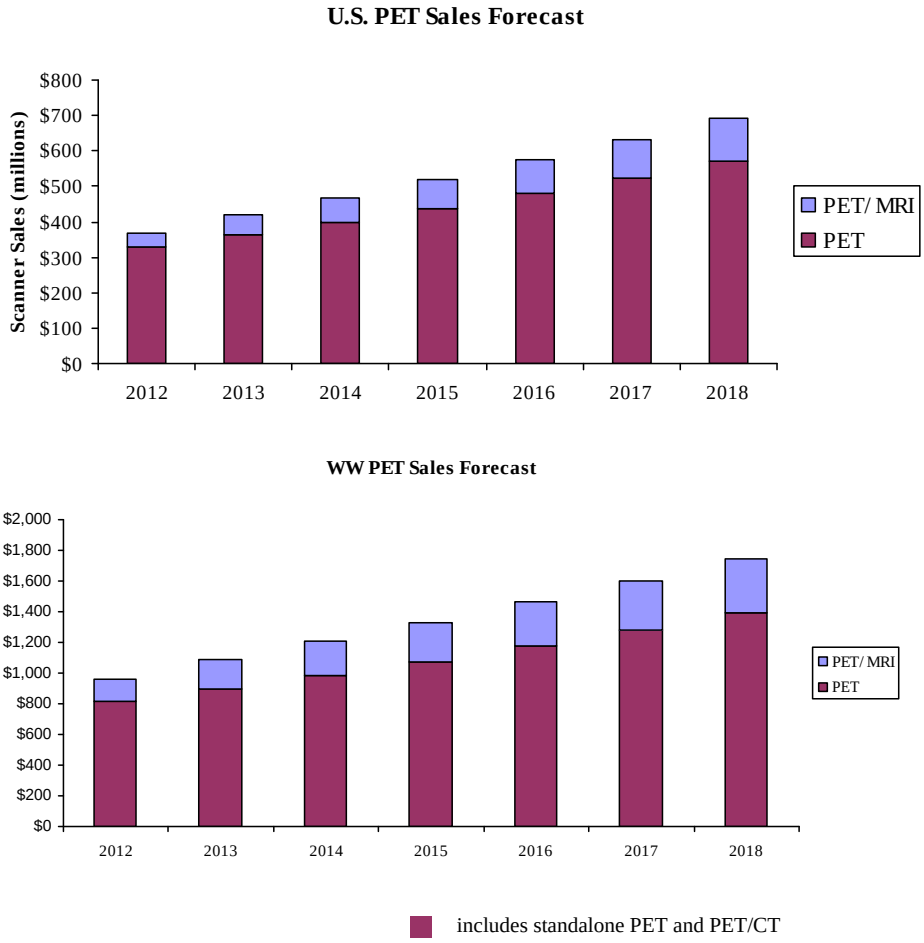


Bio-Tech Systems forecasts total U.S. PET and PET/MRI scanner sales to increase from about $368 million in 2012 to $690 million in 2018. Worldwide, they project this to go from $962 million in 2012 to $1.75 billion in 2018. Of particular interest, in relation to Zecotek, is that Bio-Tech Systems expects much of this forecasted growth to be fueled by increasing demand for higher resolution imaging, burgeoning interest in PET/MRI systems, and lower priced scanners with higher-end imaging capabilities. All of these are the sectors of the market that Zecotek expects to exploit. The competitive advantages of their LFS crystals (very high performance at potentially more competitive prices) and MAPD photo detectors (lower price, equal to or better performance than PMT and legacy solid-state detectors, and can be used with PET/MRI) potentially put them in an ideal position relative to where the bulk of the market growth is expected to come from over the next several years.

Visiongain, another life sciences market research firm, also recently published a report on the nuclear medicine industry. The authors of the report, titled, "Nuclear Medicine Imaging Devices: Global Market Prospects 2012-2022", note that developed markets such as the U.S. and U.K. are already highly saturated and growth in these

[2] Burns, M. Report 340:Market For PET Radiopharmaceuticals and PET Imaging. Bio-Tech Systems Inc. Dec 10, 2010.

markets will mostly come from upgrading stand-alone PET and SPECT systems with hybrid units (i.e. - with adding CT or MRI). This again, suggests potentially increasing demand for the likes of Zecotek's MAPD photo detector which, unlike PMT's, can be used side-by-side with MRI.

Visiongain also expects emerging markets such as China and India to offer more opportunity for growth due to the relative lack of nuclear medicine facilities and increased healthcare spending in those parts of the world. Visiongain notes that healthcare investment in emerging countries is expected to double over the next seven years. Zecotek has noted that they have a particularly strong focus in emerging markets. Emerging markets are the initial territories that they expect to target with their IDM product and the company has plans to identify and work with a strategic partner in India to manufacture PET scanners incorporating their components.

The high cost of the scanners from the major OEM's have largely precluded significant purchases from many of the emerging countries. This, however, offers a real potential opportunity for Zecotek as these developing countries, which largely have nationalized healthcare systems, are now looking to manufacture their own PET machines. With Zecotek owning all the major technology necessary to build a PET scanner and with lower-cost components, demand from emerging markets could be a real boon for the company.

***Medical Imaging Market Dominated By "Big 3"…***
The general medical imaging market is dominated by three manufacturers; GE, Siemens and Philips with approximate market share of 22%, 20% and 17%, respectively. Other players (market share) include Toshiba (9%), Hitachi (4%) and Shimadzu (2%).

Siemens and Philips have been the pioneers in advancements in PET/MRI scanners and in development of high-end scanners in general. Siemens, following its acquisition of CTI Molecular Imaging in 2005, sources its crystals through its internal supply chain and as such, there may be limited opportunity for Zecotek to sell crystals to Siemens, at least in the near-term. As Philips is named as co-defendant in Zecotek's lawsuit against St. Gobain, we do not see a likely customer relationship until the conclusion of the lawsuit or, potentially, earlier in the event Zecotek and Philips agree to a settlement. GE's scanners still use BGO crystals, which may be considered inferior to LSO (used by Siemens) and LYSO (used by Philips). As such, GE may be highly interested in upgrading to higher performing crystals and, therefore, we view GE as a likely near-term customer for ZMS's crystals. GE and potentially the other smaller PET OEM's (combined which accounts for ~40% of the total market), would therefore be Zecotek's major target customers for their LFS crystals in the near-term.

With the crystals and photo detector of a PET scanner each accounting for approximately one-third of the cost of the machine and estimating that Zecotek's target market encompasses roughly 40% of the PET OEMs, we estimate the size of their current total market at about $290 million and estimated to grow to approximately $470 million in 2018. While not an enormous market size, it's important to keep in mind that the PET component and OEM markets are highly concentrated which provides for the potential for Zecotek to acquire significant market share in short-order, particularly if their components are considered higher performance and at least (or more) cost competitive than other suppliers'. And with Zecotek being the only company in the world to own all key elements (i.e. - scintillation crystals, solid-state MAPD photo detectors, and a data acquisition board and readout system) for a high performance PET scanner, just a small initial foothold into the PET OEM supply chain could potentially quickly turn into large and very valuable supply agreements over the long term.

***Other Markets Offer Future Opportunity, Particularly For Their 3D Technology…***
And while the PET component market is Zecotek's near-term focus, their other products target other customers, industries and applications which would significantly expand the size of their overall end markets. As an example 3-D imaging for the consumer market has massive appeal and an enormous potential market size (maybe as many as 1 billion potential customers) - the market has barely been penetrated, however, given that most currently commercialized 3-D technologies require glasses, which consumers find an annoyance. Zecotek also believes their technology could be ideal for the 3D printer market. These products are in earlier stages of development, however, and may not be substantially advanced until the company has reasonable resources to do so.

We do note, however, that Zecotek has made recent progress in moving its display-related business closer towards eventual commercialization. The company recently announced that they have been in discussions with major electronics companies to develop an OLED/LED-based, flat screen, glasses-free, 3D HD television. While the company has not specifically identified the potential partners that they are in discussions with, "major electronics companies" likely indicates these are brand-name, major TV manufacturers. Zecotek's CEO noted in their recent press release that, "We have overcome the main technical barriers required to meet the consumer preference for flat screen form factors and HD picture quality with available OLED/LED flat screen display

technologies. Renewed discussions are now in progress and we feel confident about reaching a mutually rewarding business arrangement."

While it is still unclear how soon commercialization of the 3D display technology for the consumer market may materialize, we view the recent developments as materially positive and the progress more rapid than we had previously anticipated.

Zecotek is also moving forward on other fronts related to its 3D technology. This includes their 3D projection technology which they see applicable for applications where flat screens are not particularly important. This is mainly the non-consumer markets including for applications such as advertising and large venue displays. Of particular utility could be for 3D printing applications for commercial use.

In late January of this year Zecotek announced that they are now designing a 3D interface platform between 3D printers and their 3D display technology. This would allow someone to see a 3D image of an object prior to actually printing it on a 3D printer. The user would be able to view the object from all angles and make any desired adjustments before they printed it, affording time, cost and materials savings.

With the rapid growth in popularity of 3D printing, this could be another high-potential opportunity for Zecotek's 3D display technology. The company envisions initially subcontracting production of the 3D display units for the 3D printer application and then potentially partnering for wider distribution.

While we still do not model a contribution from the display-related businesses (consumer or commercial related markets), we believe the recent progress could provide a greater chance of upside to our outlook. We will be monitoring ongoing developments and update our model if appropriate.

## FINANCIALS

**Balance Sheet / Cash Flow**
As of the most recent reporting period (ending 10/31/2013) the company had $2.5M in cash and equivalents and no debt.

Cash used in operating activities averaged approximately $804k/quarter in fiscal 2013 and was $1.06M in the most recent quarter. Capex has been relatively immaterial.

**Recent Financial Performance**
Zecotek has generated immaterial revenue since inception through their most recent reporting period. However, that is expected to change starting with the $500k order from Hamamatsu announced in July and the $1.5 million order announced in November.

Zecotek generated net losses averaging approximately $5 million/year in fiscal 2011 and 2012. Net loss, excluding a $3.0 million non-cash share compensation expense (related to the joint collaboration agreement with IDMC) was approximately $4.0 million in fiscal 2013. We expect financial performance, including revenue, net loss and cash flow to significantly improve, initially catalyzed by the now commercialized LFS crystals.

## INVESTMENT SUMMARY

✧**Validation of LFS Scintillation Crystals**
Validation of the crystals is essential for there to be meaningful commercial demand for them. We think there is no question that the LFS crystals have been sufficiently validated. Characteristics and performance of the LFS crystals has been proven not only by internal and third party testing but, perhaps just as importantly, through CERN choosing them in prior experiments and for use in the Large Hadron Collider to verify the existence of Higgs boson.

Scientific testing has indicated that Zecotek's scintillators are the most competitive and highest performing material of any crystals on the market. Selection by CERN, a world leader in scientific research which uses "the world's largest and most complex scientific instruments", offers a very credible vote of confidence in the performance and characteristics of the crystals.

✧**Hamamatsu Relationship Is Major Positive For Zecotek**

We view the relationship with Hamamatsu as a significant positive development for Zecotek as while Zecotek had already established compelling products (particularly the LFS crystals), substantial distribution and customer relationships (particularly with the PET OEM's) had been the missing piece of the puzzle until now. As the leading supplier of optoelectronic components used in PET scanners with approximately $1 billion in annual sales and counting the major PET OEM's, Hamamatsu provides major distribution muscle. The agreement with Hamamatsu not only relieves any distribution-related concerns, it also provides additional and potentially very valuable R&D and product development expertise and resources. Hamamatsu is very much on the cutting edge of medical imaging technology innovation and will largely fund ongoing improvement of Zecotek's products, which we think can be a real benefit to Zecotek.

The Hamamatsu relationship has already started generating revenue for Zecotek, commencing with the $500k order which was announced in July and the $1.5 million order announced in November. And while there is little visibility relative to near-to-mid term commercial demand for Zecotek's products, at the very least these initial orders provide evidence that there is likely viable and real interest in the crystals. We think it is reasonable, given the performance characteristics of the crystals and Hamamatsu's distribution reach, that penetration of the worldwide PET scanner market could reach mid-to-high single digits or better by the end of fiscal 2015.

Hamamatsu will also act as Zecotek's distributor for any purchases by CERN. The Large Hadron Collider rebuild will require significant quantities of crystals and photo detectors. While the amount is still very much an unknown, as is the potential share of the business that Zecotek may receive, we think the potential revenue opportunity to Zecoteck could be between several million dollars to as high as tens of millions of dollars. We note that, given the ambiguity of when CERN may make purchases or the amount of any purchases, that we have not included a contribution from CERN related revenue in our financial model. We will update this when there is more visibility.

✧**PET Market Growing**

Independent sources estimate PET scanner and related component sales to increase meaningfully over the next several years, driven largely by growth in demand for higher resolution imaging, hybrid PET/MRI capability, lower-priced units with higher-end imaging, upgrading of existing systems, and burgeoning spending on healthcare in emerging markets which includes manufacturing lower-cost PET scanners within these developing countries. Zecotek is well positioned to capitalize on all of these growth catalysts.

✧**Lawsuit Somewhat of a Wildcard**

Prior crystals-related patent infringement lawsuits, particularly the 2007 Siemens vs. St. Gobain case, may provide some insight into the strength of Zecotek's case and potential awards. But, given that the suit is still in a relatively early stage with only limited information made public, we currently view the eventual outcome as somewhat of a wildcard with potential awards to Zecotek ranging from $0 to several hundred million dollars. As the case progresses and more information is made public, we would expect an opportunity to arise to make a more educated guess as to the chances of a ruling in Zecotek's favor as well as narrowing the range of potential awarded damages.

The lawsuit may also afford olive-branch value for Zecotek in terms of cultivating potentially valuable trade relations with Philips. In addition to, or perhaps in lieu of a damages award against Philips, the lawsuit potentially offers the opportunity for a settlement agreement in return for a supply/purchase agreement with Philips for Zecotek's PET components.

Despite the current ambiguity relative to the eventual outcome, we do believe that ZMS.V's current market capitalization should account for and assign real value to the lawsuit, even in this relatively early stage. All else equal, we would also expect changes in market capitalization to be positively correlated with interim outcomes from the lawsuit proceedings.

✧**Another Wildcard: Could Zecotek Be An Acquisition Target?**

While we will refrain from proposing that Zecotek is or should be an acquisition target, we think there are real reasons that a potential acquirer may be interested in buying the company. The LFS crystals look to be the

most desirable crystals on the market and are sufficiently validated, the IP is fully-owned by Zecotek, competition is limited to legacy crystals from a small handful of companies, PET scanner performance can only as good as the performance of the crystals which sets definitive lines between the value of different crystals, and sourcing and distribution agreements are already in place and functioning. This could mean that market share penetration of the LFS crystals could be quick, deep, and lucrative. Zecotek is also the only company with technology to make all the major components of a PET scanner with a large and potentially very valuable patent portfolio. Add the fact that ZMS.V trades at a meager market capitalization of about $60 million and a potentially significant damages award from the lawsuit, and all this makes it a potentially attractive acquisition target from, perhaps, the likes of a PET OEM or even possibly Hamamatsu - either of which would easily have the financial resources to take ZMS.V out at even a hefty premium. Similar to the potential for a favorable outcome of the lawsuit, we believe valuation of Zecotek should account for the (not unlikely) possibility of Zecotek being acquired at a premium - which offers option-like upside.

✧**Technology Portfolio Targets More Than Medical Imaging**

Our research report focuses almost exclusively on Zecotek's opportunity within the medical image space although there are real potential opportunities in other areas as well. The scintillation technology is suited to other industries including astronomy, pharmaceutical research and security and for applications such as radiation detection, calorimetry and gas exploration.

As Zecotek has had to conserve resources and focus their efforts on the near-term opportunities from their Imaging business, they have yet to fully develop and exploit the potential from their Laser and Display segments, both of which could offer additional and significant upside value. Assuming commercial success with their Imaging products, we would expect Zecotek to look to reinvest and further develop their other business lines and to target other applications for their Imaging technology. Their Display business, in particular, looks to have promising opportunities, in both the consumer (3D TVs) as well as the commercial (advertising, 3D printer interface, etc) markets - with potential commercialization happening in the not-too-distant future. This could provide upside to our outlook as we have yet to model a contribution from these other business.

✧**Patent Portfolio**

Zecotek's large patent portfolio (50 patents as of July 2013) covers all of the company's major products including lasers, displays, LFS crystals, photo detectors, and other PET component technologies. While the carrying value of the patent portfolio is relatively minimal, the true tangible value could be substantial, particular relative to ZMS.V's current book and market values of about ($2.7) million and $60 million, respectively. Insight into the value of the '060 patent covering the LFS crystals may be unearthed at the conclusion of the ongoing lawsuit - the value of this patent alone could potentially dwarf current market value of the company.

## VALUATION / RECOMMENDATION

Given the very early stage of commercialization of the LFS crystals via Hamamatsu, only general timelines relative to introduction of the MAPD and IDM, and substantial unknowns regarding potential purchases (timing and amounts) from CERN, we submit that our current financial model is based on general assumptions and is highly subject to change as more information becomes available.

Specific terms of the distribution agreement with Hamamatsu have not been released. For simplicity, we assume that Zecotek receives a percentage of Hamamatsu's gross profits on sales.

Our PET related revenue forecasts are based on general estimates of penetration rates of what we view as Zecotek's aggregate target market size (as explained in "Markets" section we estimate this at $290MM growing to $470MM in 2018). Our revenue estimates assume Zecotek captures approximately mid-single digit market share through about 2015 and reaches very low double-digit share by around 2016 - 2017. Our 10- year DCF valuation model assume low 20% market share by the year 2023. Again, our estimates are very general-assumption based, are subject to change as more information becomes available and do not incorporate any contribution from CERN. We also think there is a case that could be made, particularly given the compelling competitive characteristics of the LFS crystals and that we have yet to include any contribution from CERN, that our current estimates could be conservative (potentially significantly so).

There is also a wide range of potential outcomes from the ongoing lawsuit. While we think it is fruitless to incorporate an estimated (i.e. - complete guess at this time) award from the lawsuit, we do think the lawsuit provides potential upside market value to Zecotek that should be reflected in our valuation of the company. Our

discount rate in our DCF valuation considers some of the potential upside value from both a favorable ruling from the lawsuit as well as the possibility that Zecotek may become an acquisition target.

**DCF values ZMS.V @ $4.00/share**

As it is now, we model approximately $1.6 million in revenue (which includes the initial $2 million orders from Hamamatsu) in fiscal 2014 growing to $12 million in fiscal 2016 and to almost $39 million in 2023. As indicated earlier our current model only reflects commercial PET scanner related sales and does not incorporate any contribution from CERN related revenue - this will be updated if and when appropriate. We have also not included any contribution from Zecotek's other business lines - which is also subject to being updated, if and when warranted.

We use an 6% discount rate, which we think is appropriate given the potential upside from the lawsuit and that ZMS.V could be considered an attractive acquisition target. Our terminal growth rate is 2%. Based on our DCF model ZMS.V is valued at approximately $4.00/share. We are initiating coverage of Zecotek with an Outperform rating.

## FINANCIAL MODEL

Zecotek Photonics Inc.

| | 2013 A | Q1A | Q2E | Q3E | Q4E | 2014 E | 2015 E | 2016 E | 2017 E |
|---|---|---|---|---|---|---|---|---|---|
| Total Revenues | $39.6 | $8.2 | $127.4 | $391.2 | $1,029.6 | $1,556.3 | $6,354.6 | $11,995.2 | $16,447.5 |
| *YOY Growth* | *8.4%* | - | *829.5%* | - | *3872.8%* | *3828.5%* | *308.3%* | *88.8%* | *37.1%* |
| SG&A | $3,209.0 | $716.4 | $765.0 | $988.0 | $1,068.0 | $3,537.4 | $4,330.0 | $5,850.0 | $6,908.0 |
| *% SG&A* | *8100.3%* | *8784.8%* | *600.7%* | *252.5%* | *103.7%* | *227.3%* | *68.1%* | *48.8%* | *42.0%* |
| R&D | $929.5 | $236.5 | $225.0 | $225.0 | $225.0 | $911.5 | $755.0 | $650.0 | $700.0 |
| *% R&D* | *2346.3%* | *2900.4%* | *176.7%* | *57.5%* | *21.9%* | *58.6%* | *11.9%* | *5.4%* | *4.3%* |
| Collaboration costs | $2,966.7 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| Operating Income | ($7,065.6) | ($944.8) | ($862.6) | ($821.8) | ($263.4) | ($2,892.6) | $1,269.6 | $5,495.2 | $8,839.6 |
| *Operating Margin* | *-17835.2%* | - | - | - | - | | *20.0%* | *45.8%* | *53.7%* |
| Total Other Income (Expense) | $27.4 | ($101.6) | $0.0 | $0.0 | $0.0 | ($101.6) | $0.0 | $0.0 | $0.0 |
| Pre-Tax Income | ($7,038.2) | ($1,046.4) | ($862.6) | ($821.8) | ($263.4) | ($2,994.2) | $1,269.6 | $5,495.2 | $8,839.6 |
| Tax expense (benefit) | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 | $0.0 |
| *Tax Rate* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* | *0.0%* |
| Net Income | ($7,038.2) | ($1,046.4) | ($862.6) | ($821.8) | ($263.4) | ($2,994.2) | $1,269.6 | $5,495.2 | $8,839.6 |
| *YOY Growth* | *36.0%* | *19.1%* | *3.3%* | *-12.6%* | *-94.0%* | *-57.5%* | *-142.4%* | *332.8%* | *60.9%* |
| *Net Margin* | *-17766.1%* | - | - | - | - | | *20.0%* | *45.8%* | *53.7%* |
| EPS | ($0.09) | ($0.01) | ($0.01) | ($0.01) | ($0.00) | ($0.03) | $0.01 | $0.06 | $0.09 |
| *YOY Growth* | *25.1%* | *-4.8%* | *-17.1%* | *-29.5%* | *-94.8%* | *-65.2%* | *-140.6%* | *319.6%* | *54.6%* |
| Diluted Shares O/S | 74,461 | 86,842 | 91,500 | 92,500 | 93,000 | 90,961 | 95,000 | 98,000 | 102,000 |

*Brian Marckx, CFA*

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## LEADERSHIP

### Management

**Dr. A. Faouzi Zerrouk**
***Chairman, President, CEO and Founder***
Dr. Zerrouk is Chairman, President and CEO of Zecotek Photonics Inc. In 1989, he established the first foreign partnered, private, business oriented photonics research Lab in the Ex-Soviet Union (Novosibirsk, Siberia). He duplicated the same model in three prestigious research institutes in Moscow. Dr. Zerrouk acted as a technology transfer advisor, working closely with the Ministry of Science and Technology during the transition period to the Russian federation. He worked on Research and Development strategies for the new economy with prominent members of the Russian Academy of Science and coordinated many government projects in joint relations between Russia and countries like China, Germany, USA, Malaysia, and Saudi Arabia. Dr. Zerrouk was Chairman and CEO of various companies in Europe and Asia.
Dr. Zerrouk is a Canadian citizen. He received his PhD in Theoretical Physics, in 1987 from the University of Sussex, England. Through 1987–1993, he held research and faculty positions at various centers. Amongst them, the Clarendon Laboratory, University of Oxford, England, (Atomic & Laser physics); Siberian Academy of Sciences (TOKAMAK and Laser fusion research); the Institute of Thermal Processes, Moscow (high-power gas dynamic lasers). At the Institute of General Physics, Moscow, Dr. Zerrouk worked with the group of the Nobel Laureate Academician Prokhorov where he co-developed RGB and UV micro-chipset lasers with large market applications. He also established commercially driven private R&D labs based in Russia, in the fields of crystals & lasers, holographic, 3D displays, new materials, nanostructures, optical networks and communication subsystems. Dr. Zerrouk is the principal founder of Zecotek Holdings technologies. He served as the Executive Chairman, President and CEO since inception.

**Michael Minder**
***Interim CFO, Executive VP of Finance, Investor Relations***
Mr. Minder is a seasoned finance professional with over 15 years of international banking experience. He held senior leadership roles in Asset and Wealth Management for Credit Suisse Group in both Switzerland and North America, managing assets of high net worth accounts.
In 1998 he left the Credit Suisse Group to form his own firm providing international investment banking and investor relations advisory services to numerous U.S., Canadian, and European listed companies.

**Azman Ariffin**
***Executive VP, Operations and GM Zecotek Imaging Systems***
Mr. Azman , a Singapore citizen, holds a Masters Degree in Engineering Business Management from Warwick University and has more than 25 years experience in the field of Manufacturing and Operations. Prior to joining Zecotek in 2006, he held a senior position in a Government Statutory Board. From 2001 to 2004, Mr. Azman was the General Manager for the South East Asian operations of Unified Technologies, a private Canadian company working in the field of photonics. Mr. Azman received his early training in the field of optical fabrication from a Singapore Government Training Centre and received further training in the United States of America. He held various positions in product development and manufacturing. From 1990 to 2000, Mr. Azman was Senior Commercial Advisor for an international middle-Eastern-based high tech company.

### Board of Directors

**Dr. A. Faouzi Zerrouk**
(bio above)

**Dr. Jalil Ali**
Dr. Jalil Ali received his PhD in plasma physics from Universiti Teknologi Malaysia (UTM), Malaysia in 1990. At present, he is a Professor of Photonics at the Institute of Advanced Photonics Science, Nanotechnology Research Alliance and the Physics Department, UTM. From 1987-2010, he has held numerous faculty and research positions including the Dean/Director, Bureau of Innovation and Consultancy. He was instrumental in establishing and forging University-Industry collaboration in Malaysia. He has authored/coauthored more than 300 technical papers published in international journal, three books and a number of book chapters. His area of interests are in photonics, optical solitons, fiber couplers, and nano waveguidesHe is currently the Head of Nanophotonics Research Group, UTM. Dr. Jalil Ali is a member of OSA, SPIE, and the Malaysian Institute of Physics.

**Erich Sager**
Erich Sager is a founding partner of Limetree Capital SA, a Swiss-based investment banking boutique. Mr. Sager also serves as Chairman and member of the Board of Directors at Calltrade Carrier Services AG, a European wholesale phone operator, since 2004. He is also a current Board member of Zecotek Medical Systems Inc. and Pulse Capital Corp.
Mr. Sager served for several years on the Board of Directors of BioMarin Pharmaceutical Inc. and as Chairman of LaMont Asset Management SA, a private investment management firm. Mr. Sager has held the position of Senior Vice President, Head of the Private Banking for Dresdner Bank (Switzerland) Ltd, Vice President, Private Banking, Head of the German Desk for Deutsche Bank (Switzerland) Ltd., and various positions at banks in Switzerland. Mr. Sager received a business degree from the School of Economics and Business Administration, Zurich, Switzerland.

**David Toyoda**
Mr. David Toyoda graduated from the University of British Columbia with a Bachelor of Law degree and a Bachelor of Commerce degree with honors. He was called to the Bar in 1993. Mr. Toyoda practices in the corporate and securities law area, focusing on companies that list on Canadian stock exchanges. Mr. Toyoda teaches in the areas of corporate governance and public financing at Simon Fraser University, Faculty of Business Administration and the TSX Venture Exchange. He has also coordinated courses for the Continuing Legal Education Society of

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British Columbia. He is the Past Chair of the Securities Law Subsection of the Canadian Bar Association (B.C. Branch) and was a member of the Securities Law Advisory Committee for the B.C. Securities Commission.

## Scientific Advisory Board

**Dr. A. Faouzi Zerrouk**
(bio above)

**Dr. Stephen Rowe**
Dr. Rowe holds a Ph.D. in Physics (Optical Imaging) from Imperial College, London University. He formerly served as Chief Technology Officer for Zecotek and, after retiring, has acted in an advisory role to the Company. Prior to Zecotek, Dr. Rowe was an innovation management consultant, based in Silicon Valley. In this capacity, Dr. Rowe assisted top management of high-tech companies and investors to develop solutions to complex problems in business planning and development, managing the product development process, patent strategy and due diligence. Previously, Dr. Rowe was Managing Director of the Innovation Management practice at PricewaterhouseCoopers (PwC). Before focusing on consulting, he worked in executive product and business development positions at Xerox, IBM, and ventures in Silicon Valley. He helped bring several products from concept to market including, scanners, copiers, imaging workstations, optical data links and the world's first laser printer.

**Dr. Thomas Tiedje**
Dr. Tiedje received his doctorate in Physics at the University of British Columbia (UBC), Vancouver , BC , Canada . At present, he is a Professor of Physics and Astronomy, and Electrical and Computer Engineering at UBC. In recognition of his important work, he was awarded a fellow of the American Physical Society and the Royal Society of Canada. Dr. Tiedje has conducted extensive research in the area of new semi-conductor materials. He presently heads the Molecular Beam Epitaxy (MBE) lab at UBC where advanced research is currently focused on the growth of epitaxial films and the fabrication of optoelectronic devices from compound semiconductors. Under Dr. Tiedje’s leadership the MBE lab has pioneered the use of diffuse light scattering for monitoring surface morphology and substrate temperature in real time.

**Dr. Thomas Lewellen**
Dr. Lewellen obtained his doctorate in Experimental Nuclear Physics from the University of Washington in Seattle , Washington . He currently holds the position of Director, Physics and Instrumentation Development as well as Professor of Radiology at the University of Washington and is also an Adjunct Professor of Electrical Engineering and Bioengineering. Dr. Lewellen is considered the leading researcher in the field of high resolution PET system development. He is conducting advanced research in the area of position-sensitive PET scanners. Moreover, Dr. Lewellen has been and is a principal investigator for many NIH grants in the areas of PET and SPECT development, simulations of imaging systems, and improvement of image quality. Dr. Lewellen's group at the University of Washington has also conducted contract research for several major corporations, including General Electric Medical Systems.
Additionally, Dr. Lewellen has undertaken consulting tasks for many commercial firms, including most of the major medical imaging companies. Dr. Lewellen has received various honours from the National Honors Physics Society, NASA, and the National Mathematical Honors Society among others. In 2005 he chaired the Nuclear Science Symposium (NSS) and Medical Imaging Conference (MIC) held in Puerto Rico.

**Dr. K.A. Abraham**
Dr. K.A. Abraham is a Consultant E.N.T. Surgeon who has been in private practice since 1984. He has held the position of Deputy Head at the E.N.T. Department of the Singapore General Hospital, and later was the first Head of the E.N.T. Department at Tan Tock Seng Hospital. He helped establish the E.N.T. Department at the National University Hospital and was a visiting Consultant at the University until 2002. Dr. K.A. Abraham received his MBBS from the University of Singapore (1969). He is a Fellow of The Royal College of Surgeons, Edinburgh (1973), a member of the Academy of Medicine, Singapore and is a past President of the Society of Otolaryngology in Singapore.

**Dr. Tiong-Ann Teoh**
Dr. Tiong-Ann Teoh is a recognized expert in Laparoscopic (keyhole) surgery and is currently the Consultant Colorectal Surgeon and General Surgeon at the Mount Elizabeth Medical Centre in Singapore. He received his MBBS (1985) and Master of Medicine (Surgery)(1990) from the National University of Singapore under the auspices of a Singapore Government Public Services Commission Merit Scholarship. He is a Fellow of the Royal College of Surgeons (Edinburgh)(1990) and the Academy of Medicine, Singapore (1994). Dr. Teoh is a Founding Member of Endoscopic & Laparoscopic Surgeons of Asia and also a Founding member of the Society of Colorectal Surgeons of Singapore. He is also a Member of the American Society of Colon & Rectal Surgeons and was previously a member of the Technologies Committee of this American Society.

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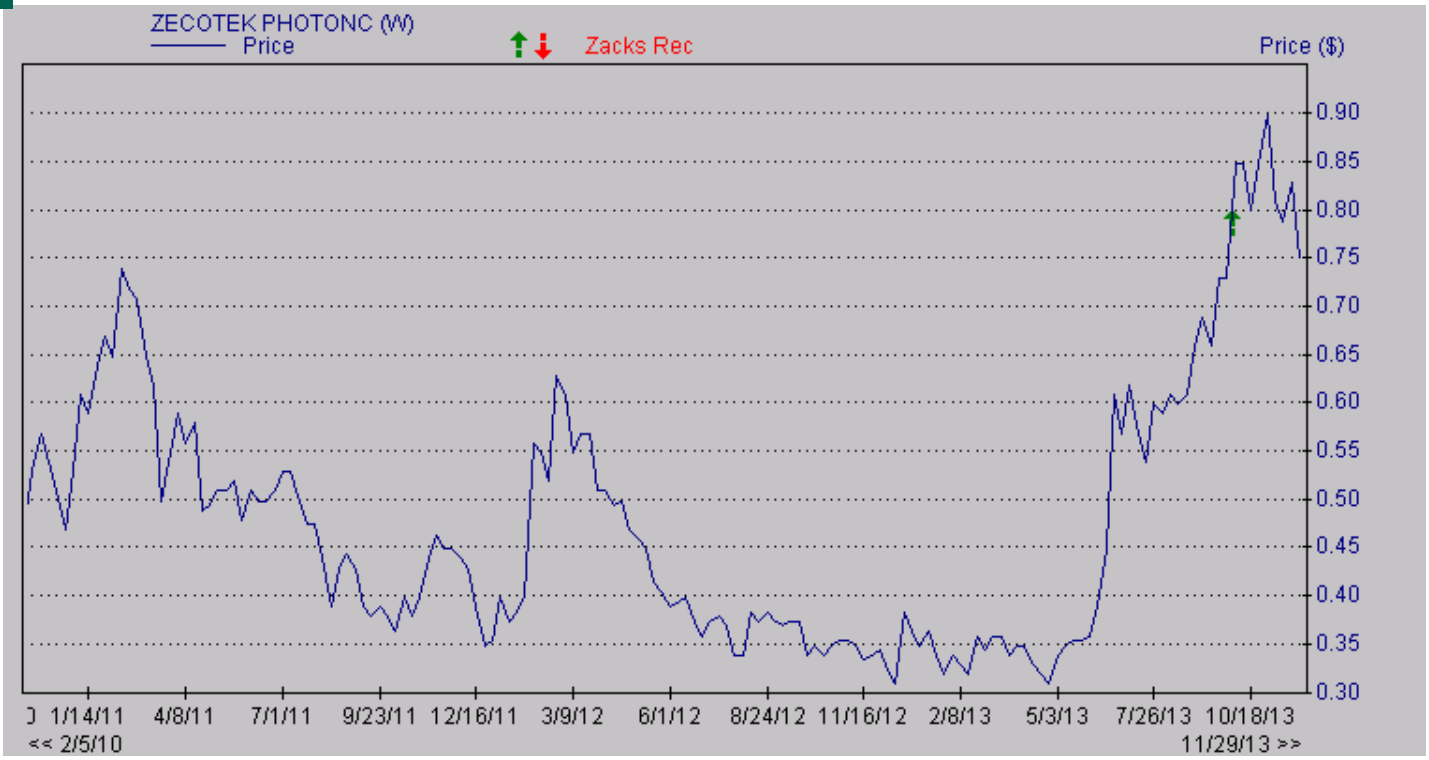


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