

## high energy x-ray imaging enhancement via custom x-ray screens

*Advances in custom screen design & production offer significant enhancement of performance in high energy X-ray imaging. Such improvements are vital to precise operation in very demanding applications.*

### Background

Most commonly used X-ray systems such as might be found in dentistry or security applications operate at X-ray energies between 60 and 120KvP.

However, the prime function at these systems is to image soft tissue for diagnosis or evaluate the contents of suitcases or similar packages which have low X-ray absorption characteristics.

However, when radiation is being used to treat disease (particularly cancer) or if a thick metal structure or even something as complex as an aircraft engine is being imaged, the X-ray energies required for penetration of the structures are significantly higher. Energies in these applications range from approx. 0.5MvP up to 25MvP or more – approximately 10 to 50 times greater than the more common applications.

Such high energies present a range of technical problems:

- ◆ how to “stop” or absorb the X-ray to create an image with a structure sufficiently thin to allow light transmission
- ◆ how to capture such signals as available & distinguish them from the X-ray noise
- ◆ how to do all this with the precision that might be required in a medical situation

These are only a few of the compromises that must be addressed in order to achieve a high performance, high quality scintillator.

Further the scintillator has to be robust in a highly radiative environment and markets (the industrial market in particular) demand custom sizes of substantial area to image very large structures.

High energy X-ray imaging therefore presents some of the greatest demands on scintillators and imaging systems of all imaging applications.

### The Applied Scintillation Technologies Solution

Applied Scintillation Technologies (AST) has a long experience of addressing the most complex radiation imaging and detection required by medical and industrial imaging.

In generating a range of custom solutions for high-energy X-ray imaging AST sought the optimal solution using its extensive knowledge of imaging, phosphor materials and scintillator construction.

In particular, AST:

- ◆ collaborated in developing very large particle size, high density phosphors to maximise X-ray absorption and efficiency while minimising light scatter
- ◆ developed techniques for the custom deposition of screens in thick, large area, highly absorbing layers
- ◆ evaluated alternative reflector and substrate combinations to enhance output and lifetime in highly radiative environments

This culminated in production of a unique X-ray screen product with key benefits to the market place:

- ◆ highest absorption commercially available X-ray screens
- ◆ high efficiency vs. resolution compromise providing best signal:noise ratio (as high as 50 times better) for enhanced image quality
- ◆ unique non-burn long-lifetime screens
- ◆ largest area commercially available custom size X-ray screens for industrial & medical imaging



Radiation therapy utilising AST Medex Portal screen

## Features of the AST Product

AST, as with other X-ray screen manufacturers, most commonly uses terbium doped gadolinium oxysulphide ( $Gd_2O_2S:Tb$ ) phosphor – the phosphor being dense (and therefore highly X-ray absorbing), efficient and robust. However, AST, rather than producing a routine product, seeks to arrive at the optimal solution using its expertise in manufacturing process development – matched to customer requirement.

There are a number of key features of the AST high-energy screens which allow the benefits listed.

◆ **particle size**

AST utilises  $Gd_2O_2S:Tb$  particles which are 2 – 3 times larger than conventional screens. This increases efficiency of the material and X-ray absorption while minimising emitted light scatter.

◆ **substrate**

At high energies X-rays interact with matter in a complex combination of process as shown. Taking advantage of this, AST can mount the X-ray screen on a suitable metal (such as brass) which will produce high-energy photoelectrons.

The AST screen utilises this additional source to maximise the efficiency of the imaging process.

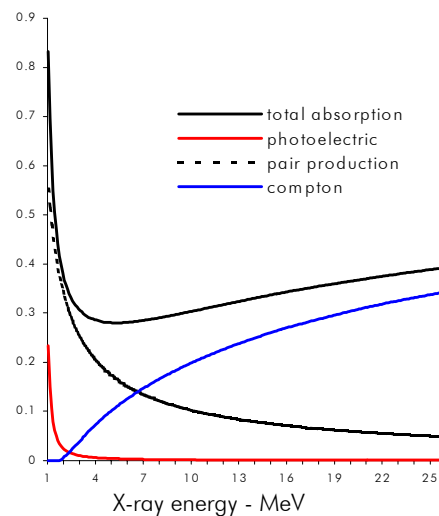
◆ **reflector**

Recognising the high radiation doses suffered by X-ray screens in such applications and the demands for long product lifetime, AST developed a mounting system based on high quality photographic card. This increases efficiency by reflecting scatter light but unlike conventional polymer based reflectors, suffers minimal radiation burn

◆ **other phosphor options**

AST has expertise in a wide range of materials which provide alternative features and benefits and can be customised to individual requirements. For example, utilising the same host material –  $Gd_2O_2S$  – AST can manufacture screens with alternative dopants including praseodymium (Pr) and Europium (Eu). Thus while maintaining the same X-ray absorption characteristics, AST can change the decay time from ms to  $\mu s$  regime (Pr) or the emission colour from green to red (Eu).

$Gd_2O_2S$  – MeV X-ray absorption processes



Comparative performance data showing benefits of optimisation in AST's screen

	Kodak Lanex	MedeX Portal
phosphor	$Gd_2O_2S:Tb$	$Gd_2O_2S:Tb$
particle size	7 – 10 $\mu m$	25 $\mu m$ median
coating weight	137mg/cm <sup>2</sup>	up to 400mg/cm <sup>2</sup>
packing density	4.5g/cm <sup>3</sup>	4.3g/cm <sup>3</sup>
sizes	<17" x 17"	up to 0.75 x 1.0m
reflector	plastic	plastic
MTF @1lp/mm	0.21	0.18
rel signal:noise	0.16	1.0
rel light out	0.41	1.0
rel absorption	0.34	1.0

Data for equivalent screens mounted on brass substrate – X-ray energy 6MeV

Applied Scintillation Technologies has the knowledge and expertise based on years of experience to partner you in the development of custom products for X-ray imaging & detection. Resolution, sensitivity, speed & colour of response are a few of the parameters that can be influenced in the production of a customised product that more closely relates to your customer need.

- ◆ A customised product is often a more cost effective solution
- ◆ Formulations can be developed to meet your specific requirements
- ◆ Exceed your initial expectations through partnership development
- ◆ An ISO9002 company – quality assurance is guaranteed through every delivery
- ◆ Product differentiation can provide unique product positioning versus competitors
- ◆ Enjoy continued product development and technical support through partnership

APPLIED SCINTILLATION TECHNOLOGIES LTD  
 8 ROYDONBURY INDUSTRIAL ESTATE  
 HORSECROFT ROAD  
 HARLOW CM19 5BZ UNITED KINGDOM  
 TEL +44 [0] 1279 641234 FAX +44 [0] 1279 413679  
 e-mail sales@appscintech.com



[www.appscintech.com](http://www.appscintech.com)