Pixelated ceramic scintillators for large-area high-resolution X-ray and gamma-ray detectors

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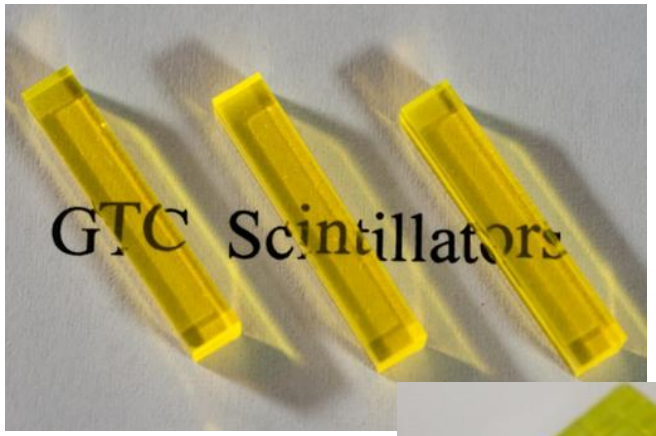
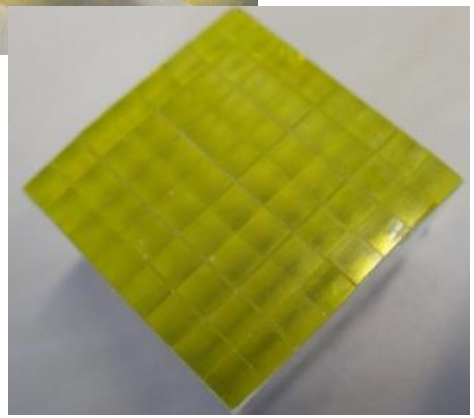
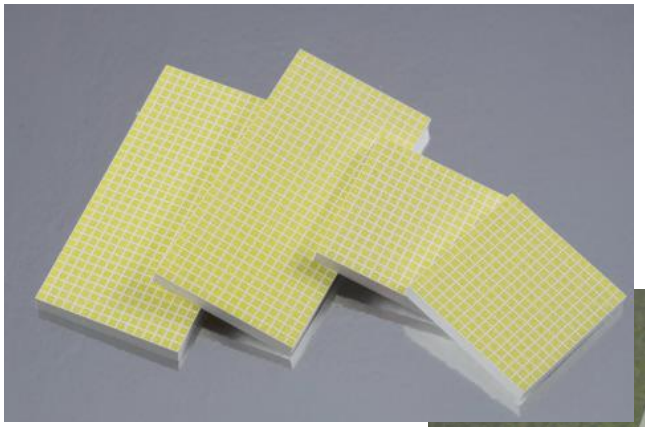
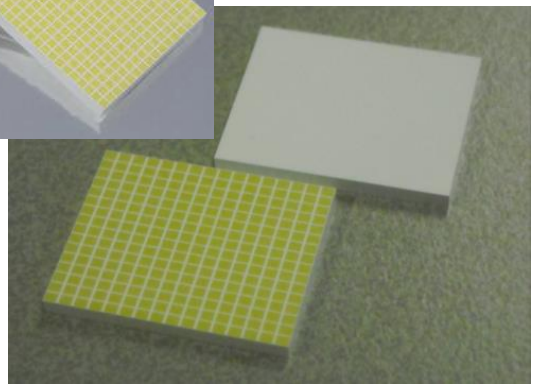
Production Capabilities at Philips GTC Detection

Generators Tubes Components









- Anti-Scatter Grids for X-ray and CT
- Scintillators: GOS and garnet ceramics

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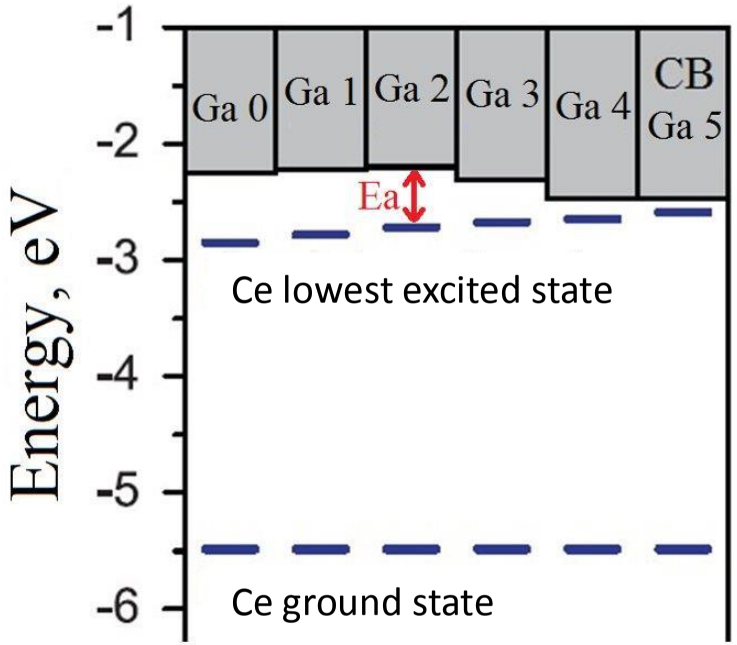
Advantage of garnet ceramic scintillators

Material compositions that are not accessible by crystal growth

Reduced cost price:
avoid expensive crystal growth

Tailoring of material composition
to meet application requirements

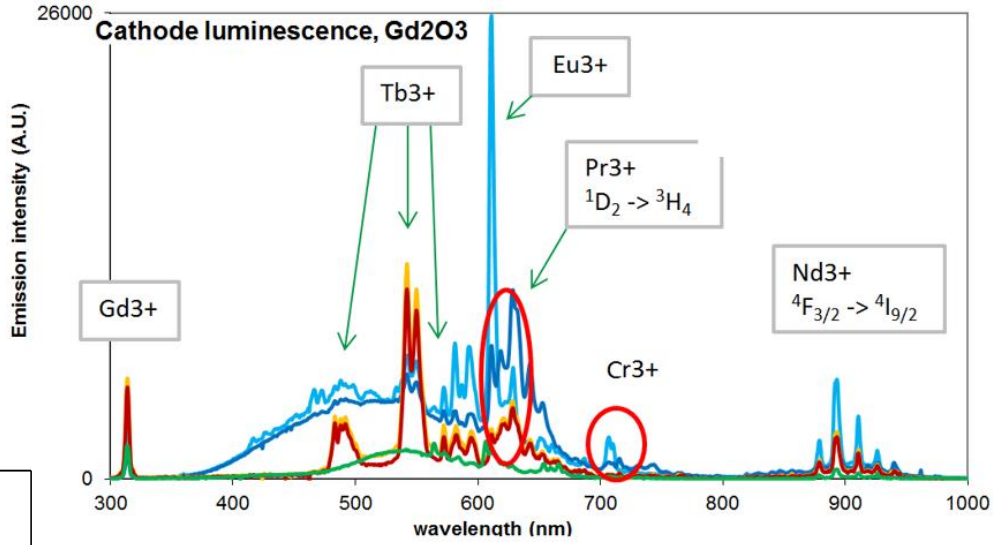
Band gap engineering for garnets:
- band gap (avoid quenching)
- light output (40-60 ph/keV)
- decay time (40-150 ns)
- afterglow adjusted for CT



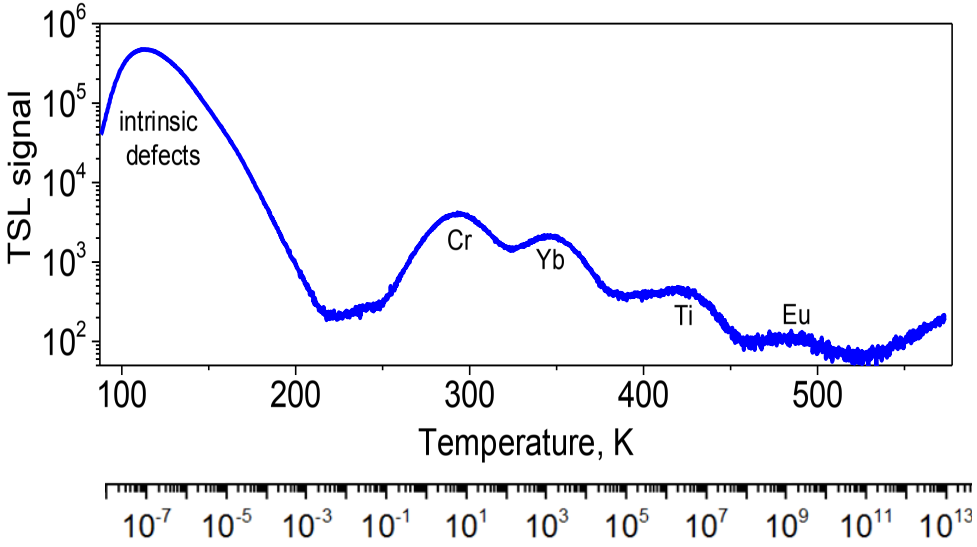
Defect engineering

Adapting and optimizing scintillating properties

- Quality control of raw materials
- Final check of ceramics properties
- Translation of defect physics into application parameters



CL (cathode luminescence) showing impurities in raw material



TSL (thermally stimulated luminescence) showing quality check on ceramics.
Time scale for carrier emission added.
(In cooperation with Peter the Great St. Petersburg Polytechnic University)

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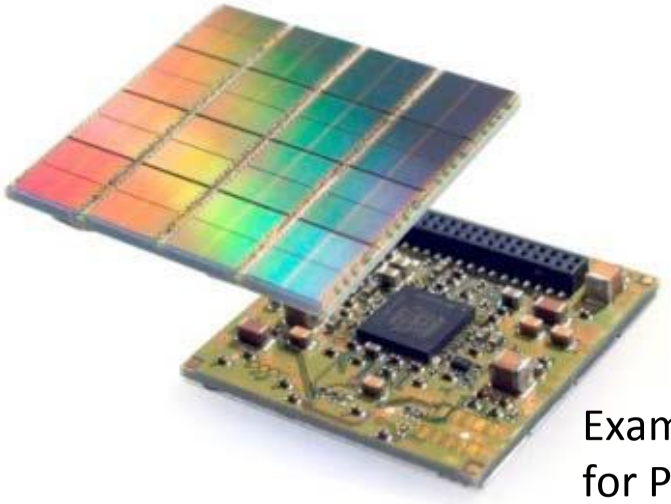
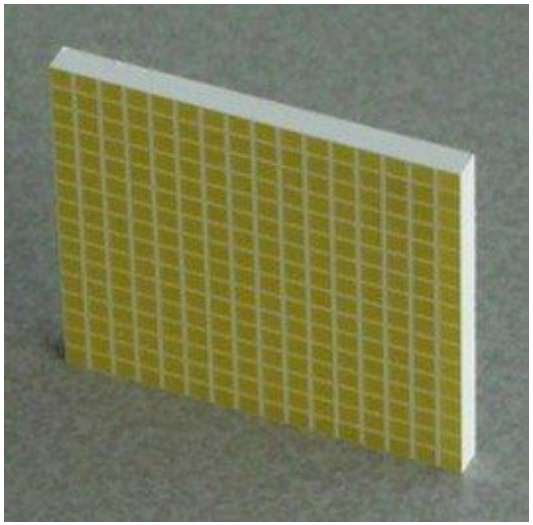
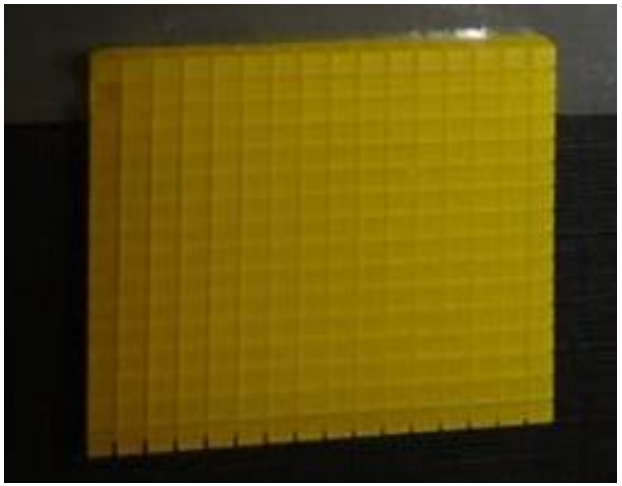
Garnet & GOS scintillator arrays

Adaptable for different sensors and applications

- Development of advanced (low-cost and large-area) array manufacturing technologies ongoing, especially additive manufacturing
- Application-specific geometry possible
- Optical coupling to different sensors
- Arrays: up to 100mm x 100 mm
- Pixel sizes: > 500µm







Example: Garnet array adapted for CT-like applications.

Example: Sensor module of Philips Digital Photon Counter (PDPC) for PET-type applications

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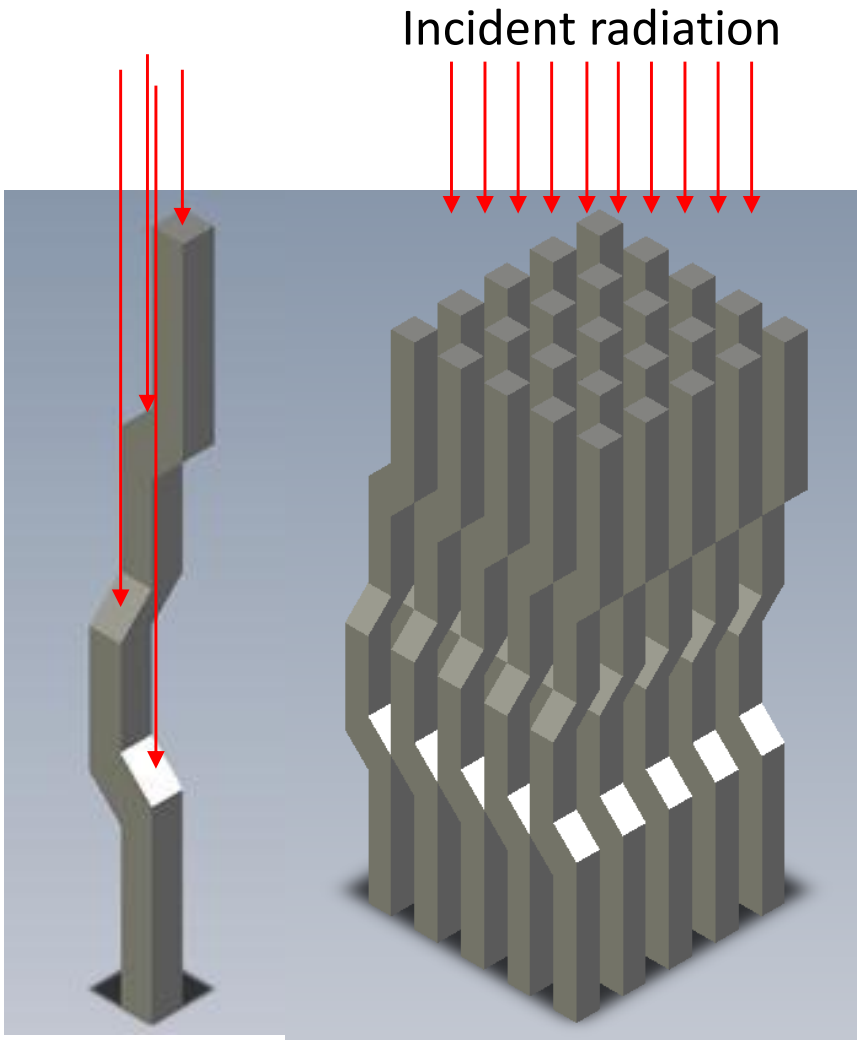
Technology options under investigation (1)

Low-cost manufacturing of large-area structured ceramic scintillators

- High resolution pixelated scintillator array
- Pixel size: > 50µm
- Can be made with 3D printing
- Good separation of pillars -> light guide
- 100% fill factor for perpendicular direction through “twisting”



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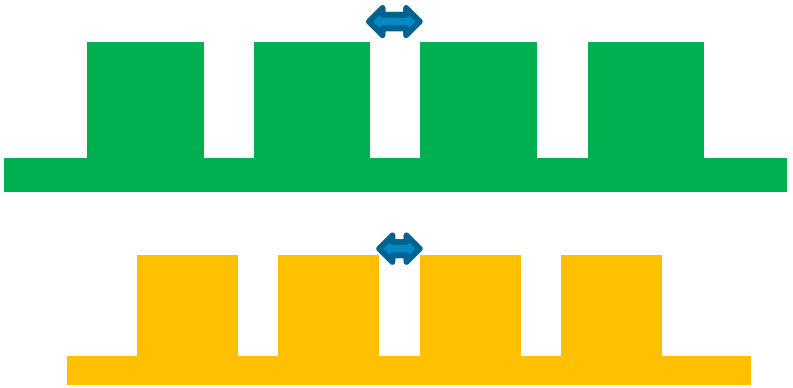
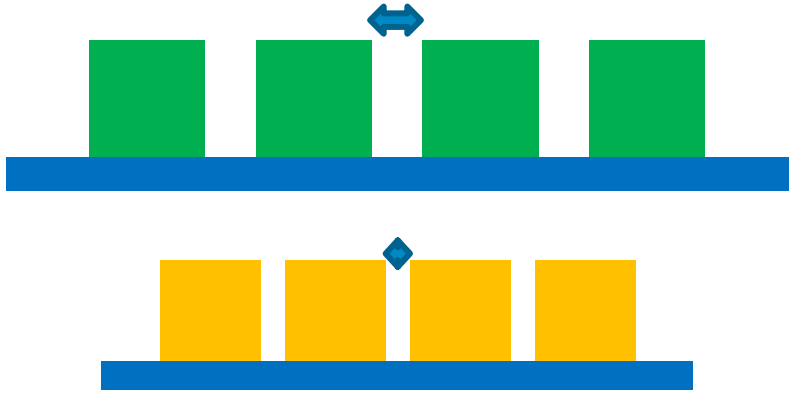
Technology options under investigation (2)

Low cost manufacturing of large-area structured ceramic scintillators

- Changing shrinkage of substrate layer and pixel during sintering allows for very narrow gaps between pixels which are difficult to make with 3D printing alone.



Example 1: substrate layer has equal shrinkage as pixel layer.



Example 2: substrate layer has higher shrinkage as pixel layer.

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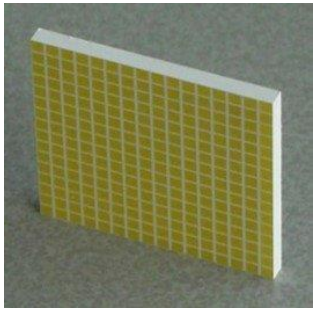
Summary

Ceramic scintillators



Advantages:

- fine-tuned material composition
- advanced 3D shapes possible over large areas
- low cost price: avoid expensive crystal growth

Partnering in projects on

- Ceramic scintillator material development
- Additive manufacturing, e.g. 3D printing, of structured ceramic material
- Encapsulation and packaging of ceramic scintillator array
- Detector assembly, integration of scintillator arrays with other components including photosensors, read-out electronics and image data processing
- X-ray and gamma-ray imaging in different applications domains, such as medical, high-energy physics, security, spectrometry, non-destructive testing, and astronomy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