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CdZnTe Detector Technology for Emerging Applications in Synchrotrons

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Agenda

- CdZnTe Technology
- Redlen Technologies
- CZT for Synchrotron Applications
- Fine Pixel Pitch (FPP) Custom Sensor Offering
- Conclusions and Outlook



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TECHNOLOGIES

CdZnTe Technology

CdZnTe Semiconductor Radiation Detectors

- Cadmium Zinc Telluride (CZT)
 - Optimal X-ray and Gamma ray detection at room temp
 - High resolution / High sensitivity / Low radiation dose
 - Available today in volume production
- Two main types
 - Low-flux process (5 to 15 mm thickness, spectroscopic) optimized for electron transport
 - High-flux process (2 to 2.5 mm thick, photon counting), optimized for balanced electron and hole transport
- Redlen has solved the CZT high-flux problem
 - Proprietary “Traveling Heater Method” (THM) growth
 - 24 years of R&D and production scaling
 - High yields, high performance, consistent quality

CZT Boule



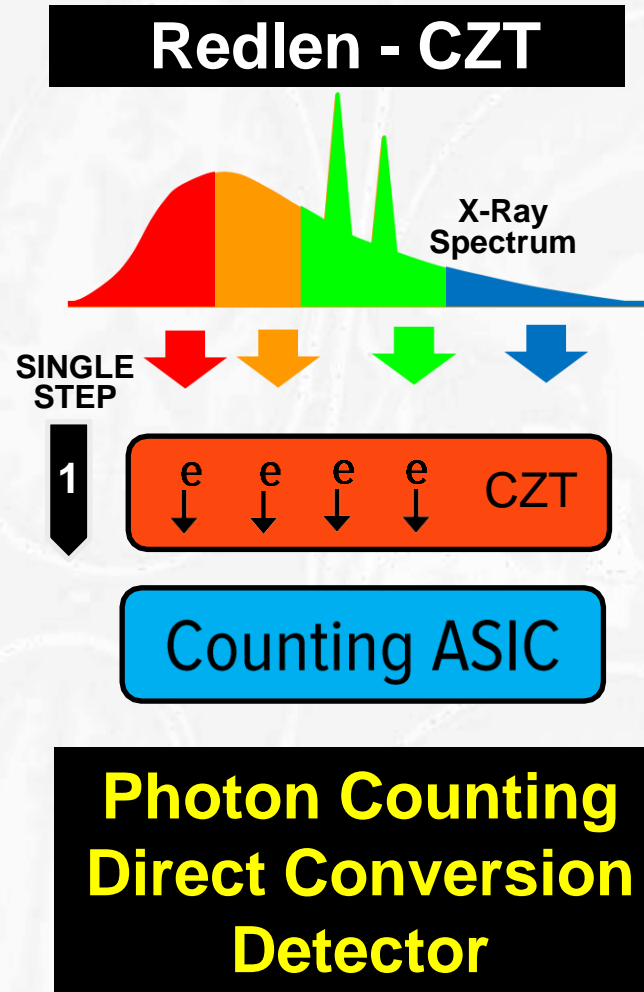
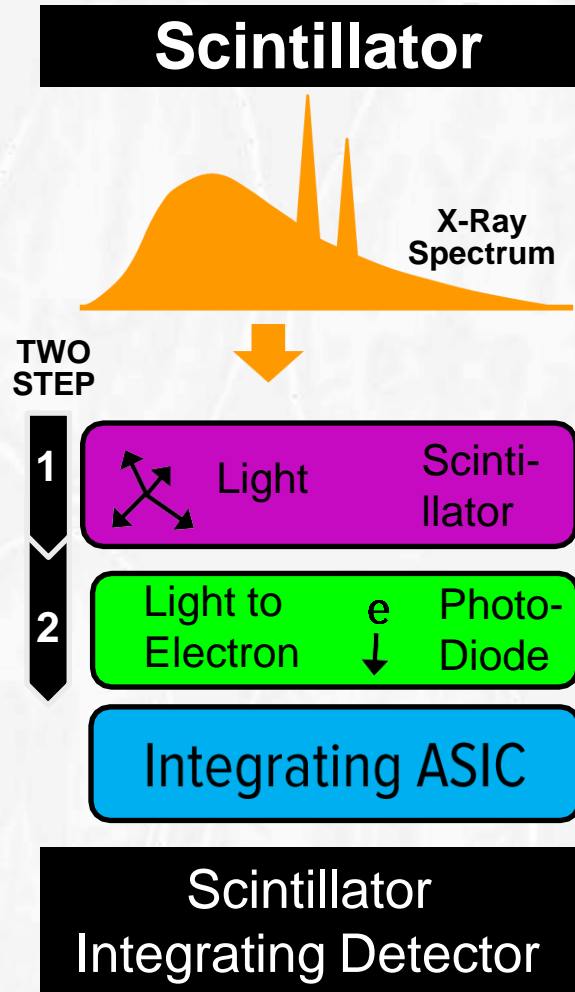
CZT Sensor Wafer



CZT Detector Module



CZT's Value Proposition for X-Ray Imaging

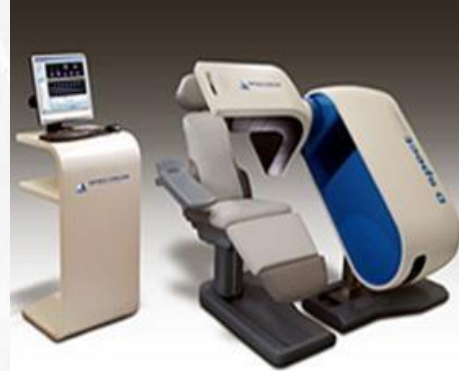


- ### CZT Benefits
1. Small Pixels = Better Image Resolution
 2. Better Efficiency = Up to 80% less radiation
 3. Elimination of electronic noise
 4. Equal contribution of lower energy quanta
 5. Energy Bins = More Data / Photon (10x) = Better Materials Identification

Medical, Security, NDT & Science CZT Applications



Photon Counting CT



NM Cardio



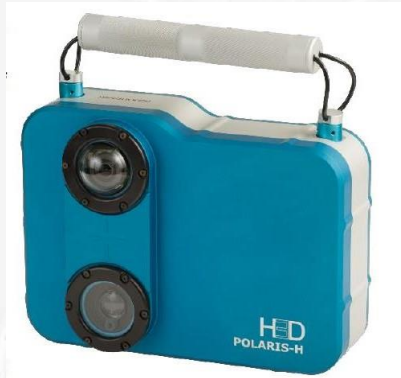
SPECT / CT



Synchrotrons



Baggage Scanning



Radiation ID



NDT



Space
Science



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Redlen Technologies

About Redlen: CZT Detector System Foundry



- Founded in 2000, Victoria, BC, Canada
 - 200+ staff, 15+ PhDs, 40,000 sq-ft production facility
- Vertically integrated company - Crystal growth, sensor fab, module development and assembly, test and validation
- Core competency: High flux CZT sensors
- Canon Inc. acquired Redlen, Sept 2021
- Redlen is now a wholly-owned subsidiary of Canon Inc
- Canon is committed to supporting global adoption and high-volume supply of premium quality CZT

Canon buys B.C. company set to transform CT scanning business in US\$335-million deal

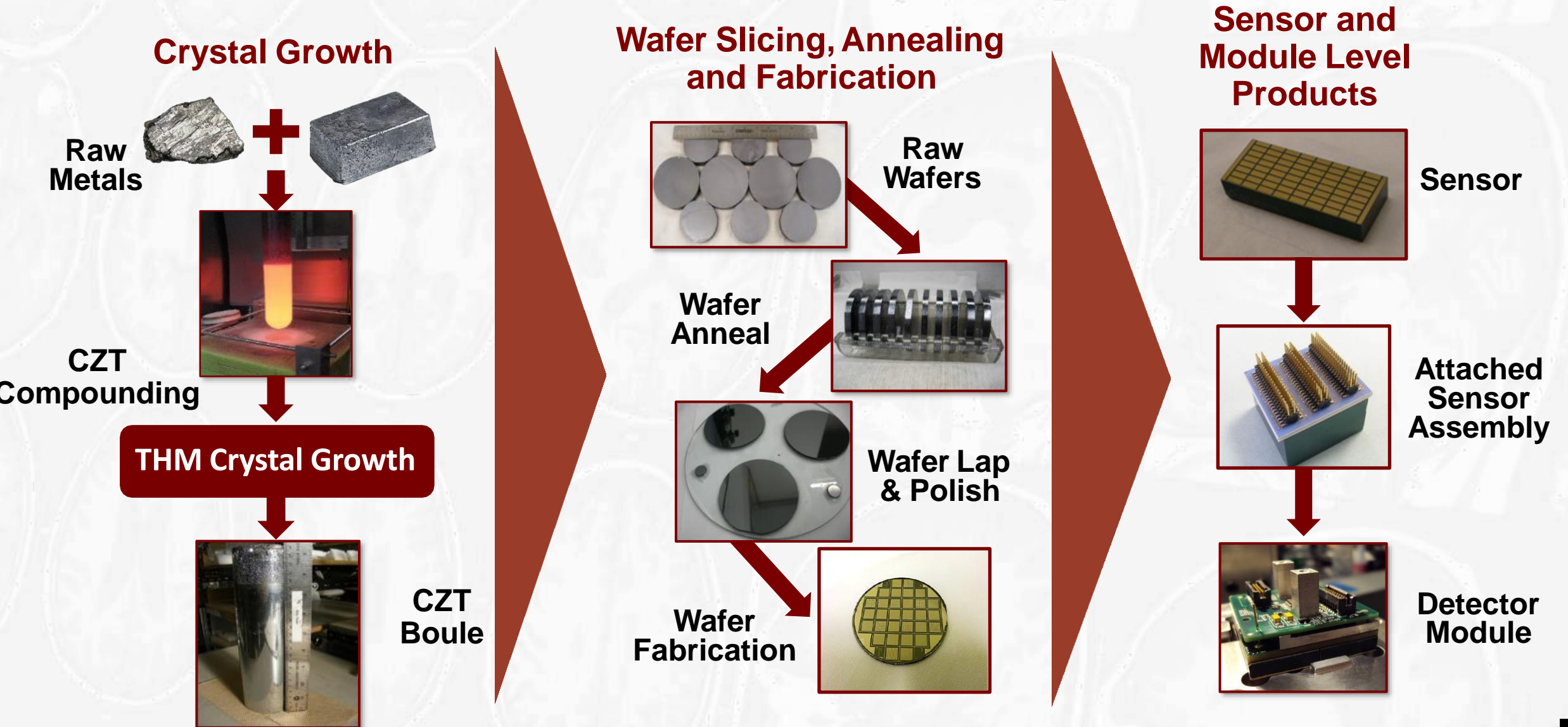
SEAN SILCOFF > TECHNOLOGY REPORTER
PUBLISHED SEPTEMBER 9, 2021



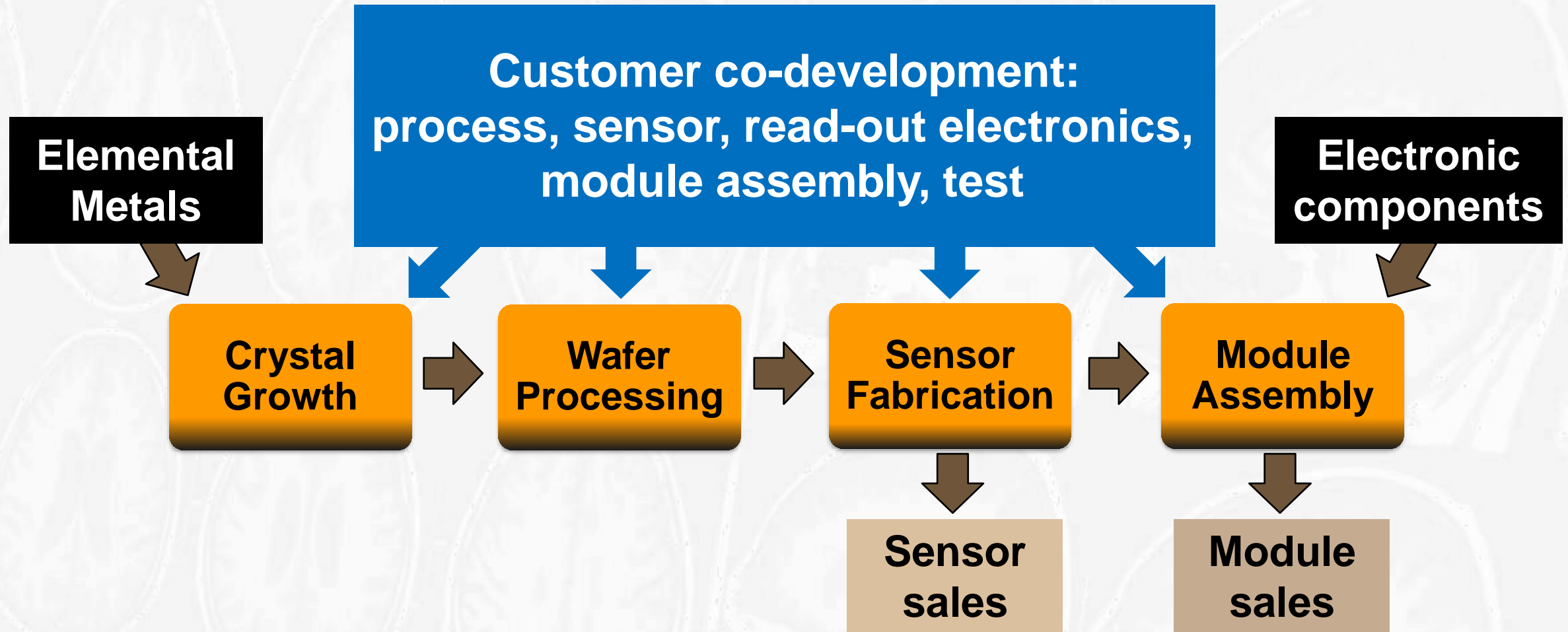
Canon

Delighting You Always

CZT Manufacturing Process



Redlen's detector system foundry





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Synchrotron Applications

Statement of Problem

- 4th gen Synchrotron Light Source upgrade is taking place and will last for the next ten years
 - Very high photon flux (x10-100)
 - Moderate to high photon energies (above 25keV hard X-ray)
- Key requirements for next generation detectors
 - Flux: 10^{10} cps/pixel
 - Pixel pitch size: $\leq 100\mu\text{m}$
 - Frame rate: 100 kHz
 - Sensitive Energy range: 25 keV for high-Z
 - Large active area: up to 16M pixels or more
 - Highly modifiable detector assemblies

Redlen CZT

- Redlen High-Flux CZT is proving to be one of the most suitable detector material for this purpose
 - Very high photon flux (up to 10^{12} cps/mm²)
 - Moderate to high photon energies (30 – 200 keV)
 - Lower dark current and lower noise
 - Better spectral stability
 - Lower afterglow
- Looking forward to collaboration with science research community and detector industry players
 - Proven material for a variety of ASICs including Medipix3, Timepix4 and more for successful system deployments
 - More custom development programs are in progress (under NDA)





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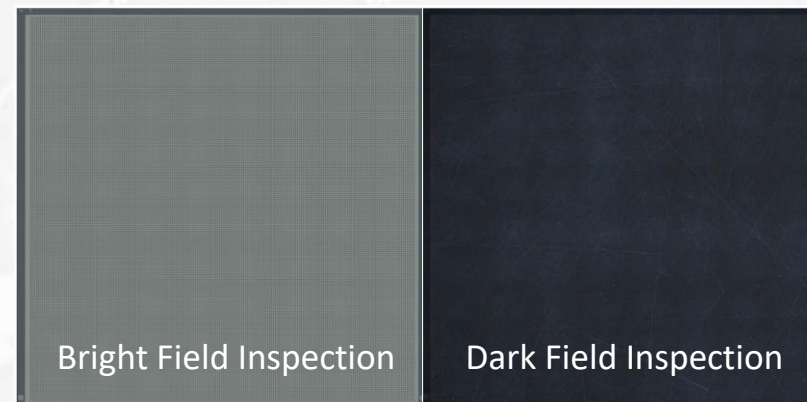
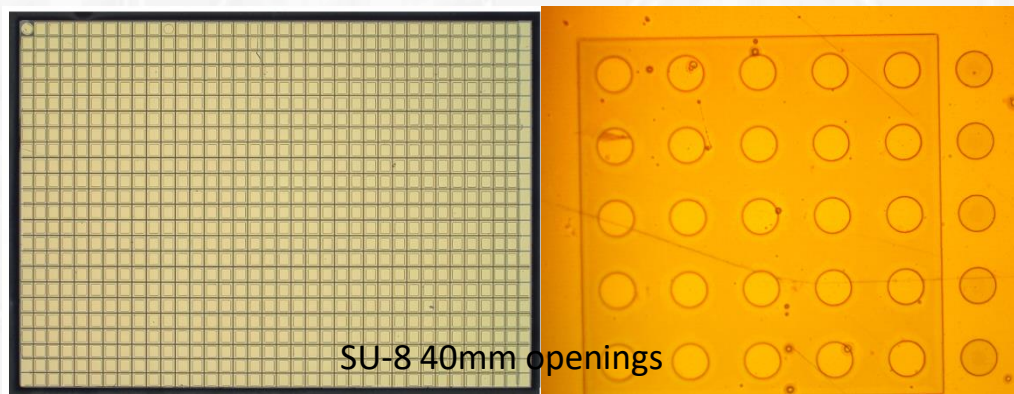
Fine Pixel Pitch (FPP) Custom Sensor Offering

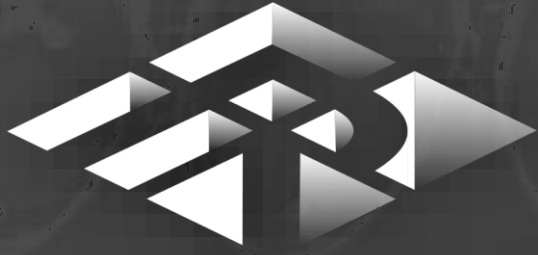
Overview

- Canon acquisition has enabled Redlen to improve production capabilities of FPP sensors to an acceptable quality level and scalability according to initial feedbacks
- Canon has blessed Redlen to do everything we can to service this market in the years to come
- Such program will provide opportunities to both science communities and industrial players to gain access to Redlen's photon counting CZT at prototype and massive production volume
 - CZT foundry only - focusing on sensor fabrications
 - ASIC and module developments are Redlen's off limits

Description

- Key Highlights
 - HF CZT
 - Pixel Pitch < 250 μ m
 - Max X or Y Dimension: 40mm
 - Sensor Thickness: 2mm
 - Contact Metallization:
 - Single metal (Pt), or
 - Bi-Metal (Pt/Au)
 - Street Width > 20 μ m
 - Guard-ring: Optional
 - Passivation: SU-8
 - Edge Gap: > 50 μ m
 - Visual inspection only:
 - Anode defective pixel %: TBD
 - Cathode delamination %: TBD





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Conclusions and Outlook

Conclusions

- CZT – a mature, enabling, available technology
 - Yield and quality have achieved levels enabling volume applications in Synchrotrons
 - Redlen continues to invest further its global leadership in commercial supply of CZT
 - Expanding advanced production capability, improving quality, driving cost reduction
- High-Flux CZT is the next-generation high performance detector material for Synchrotrons
 - Superior detector performance in high energy and high photon flux imaging
 - Redlen's fine pixel pitch sensor program is available today
 - Proven with a wide range of state-of-the-art ASICs

Outlook

- Redlen is enhancing CZT technology to meet increasing challenging market applications
 - Supporting customer development and production of CZT based cameras in multiple light sources
 - Improving processes to increase X-Y dimensions and reduce sensor thickness
 - Development of novel metal stack and passivation solutions
 - Development of smaller street width and edge gap to reduce dead area

Thank You! Let's work together

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