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The world leader in serving science

Thermo CIDTEC Camera Product Line

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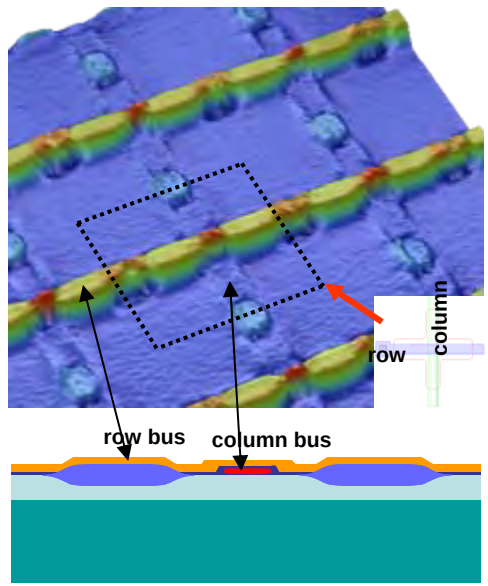
CID Technology

- What is a CID (Charge Injection Device)?
  - CID is a silicon imaging device with its pixel structure built in PMOS or QMOS (Quasi-PMOS / CMOS) that contains overlapping MOS capacitors per pixel
    - A surface-channel charge transfer device
  - CID converts photons to an electrical charge – done intra-pixel, unlike CCDs
  - Unique ability to clear individual pixel sites by measuring and injecting charge directly at pixel site

- Who is CIDTEC Cameras & Imagers?
  - GE Spin-off, CID Technologies, Inc. (CIDTEC) went private in 1987 was then purchased in 1995 by Thermo Electron.
  - Thermo Electron merged with Fisher Scientific in 2006 to form Thermo Fisher Scientific, Inc.
    - 2008 revenues: $10.5 billion
    - >30,000 employees worldwide

- Primary products based on CID imaging technology
  - Radiation hardened cameras
  - High dynamic range scientific cameras
  - Machine Vision Cameras
  - X-ray imaging



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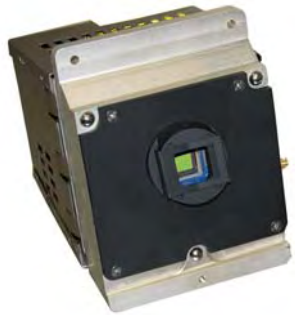
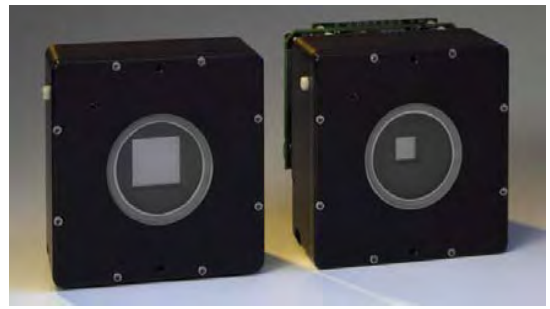
Key Products – Competitive advantage

- SpectraCAM Platform – ICP-OES
  - SpectraCAM86 ‘iCAP’ camera (540 by 540 imager)
  - SpectraCAM84 (1024 by 1024 imager)
  - Common 3 PC Board stack (ASP, TSP, CPU)
- SpectraCAM XDR – Scientific Imaging
  - CID820 (2048 by 2048 imager)
  - Preamp per pixel
  - 40X faster pixel rate
- CID8825D / CID8826D color and monochrome – radiation hardened cameras
- CID8722TE – Radiation oncology multi-leaf collimator control
- X-Ray Imaging Products
  - GdOx phosphor coatings
  - CID4150DX3 imager

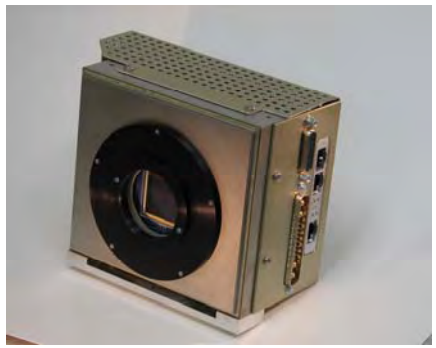
SpectraCAM™86 ‘iCAP’



SpectraCAM™84

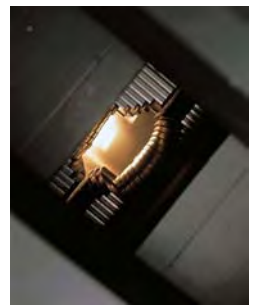


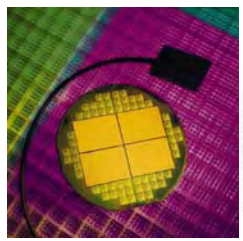
SpectraCAM™ XDR



ColorRAD Radiation hard

Monochrome Radiation hard Camera Multi-Leaf Collimator Control





X-Ray Imaging Products

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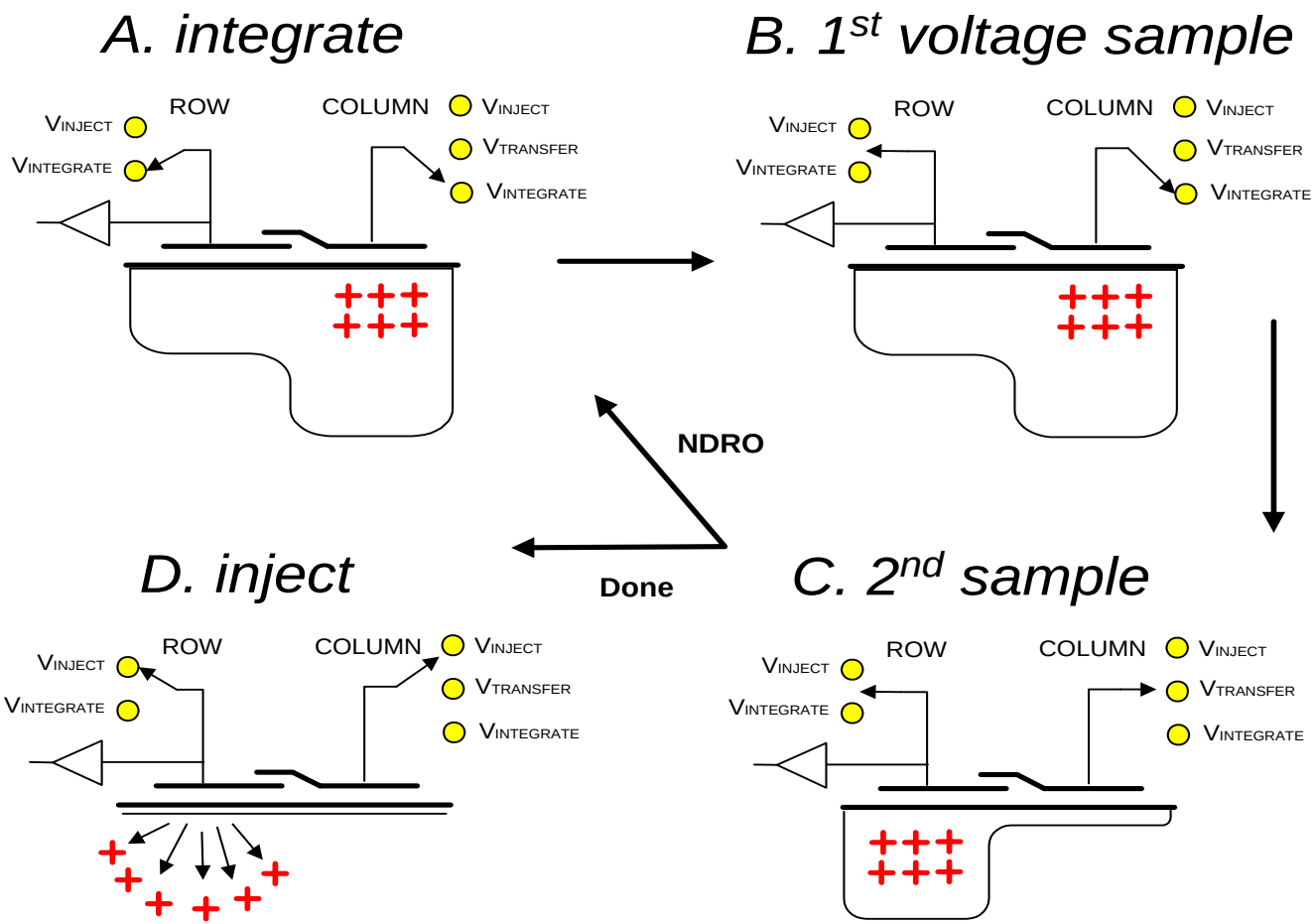
Traditional Passive CID Readout Process & Pixel Cross section



Radiation Hardened Solid State Cameras

Radiation Hardened - Gamma, Neutron, Proton, High Energy e^-

- RS-170, and CCIR monochrome video cameras
- Radiation tolerant operation to beyond 1 x 10^6 Rads total dose
- Sharp images even under severe light overloads
- Unpowered operation to beyond 20 Mrads
- Replaceable remote head 30 meters remote standard
- Excellent Imaging in fields greater than 750krads/Hr

Solid State Camera Features

- Intensifiers add extremely low light imaging capabilities, and high speed gating
- All CID camera's may be intensified
  - UV – GEN II UV
  - Visible

    Super GEN II, OMNI,

    GEN III, and XD-4, XR5
  - X-Ray detection,
  - Neutron detection
  - Solar-blind
  - Near-IR

*export restrictions may apply

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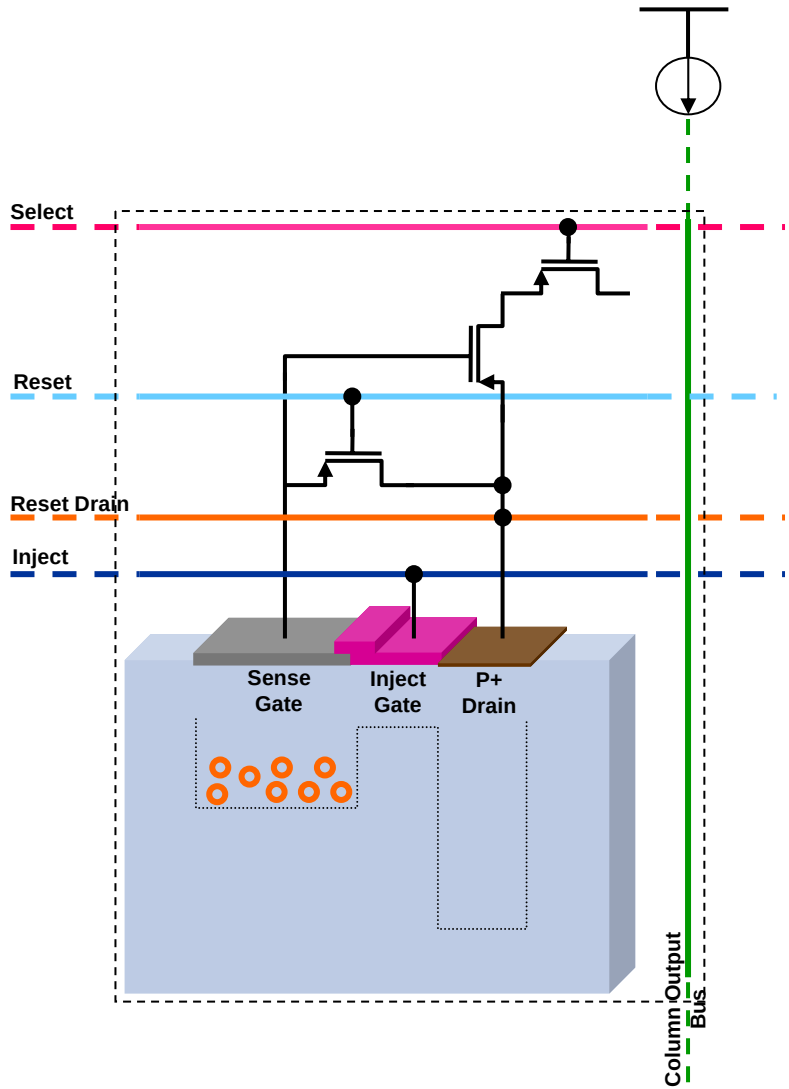
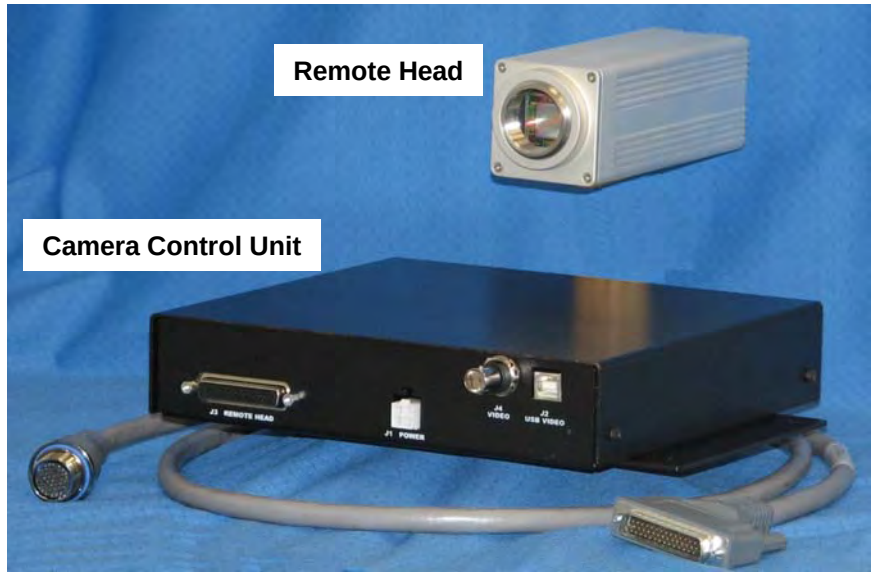
Rad Hard Active Pixel CID based Imager

- Active Pixel CID structure adds an amplifier inside each pixel
- Advantages of Active Pixel architecture
  - Low noise performance
    - Improved raw dynamic range
  - Improved sensitivity to light
    - Reduced sense node capacitance
  - Improved conversion gain
- 0.8μm technology
- NTSC, PAL, RS-170, CCIR formats
- CMYG color filter array
- Parallel row processing
  - Reduce row-row variation in radiation
- 2 rows can be processed simultaneously for color operation
- On-chip CDS
  - Reduce ktc and reset noise



CID Based Radiation Hardened Color Camera

- 8825D / 8826D Color Camera system
  - World's only true commercially available rad-hard solid state camera!
  - NTSC or PAL version image sensor
  - Two piece camera system with up to 150 meter remote head operation.
  - Dose rate tolerance of up to 300 kilo-rad/hour
  - Radiation hardened to at least 3 x 10^6 rads (30 kilo-gray) with no degradation in performance
    - Has been tested to 14 Mega-rad (140 kilo-gray) with noticeable degradation in video image, but imager and camera still operational
  - Improved sensitivity
    - 10 lux for full saturation – 20X improvement over passive pixel color sensor
    - SNR=54dB
  - Digital USB2.0 output



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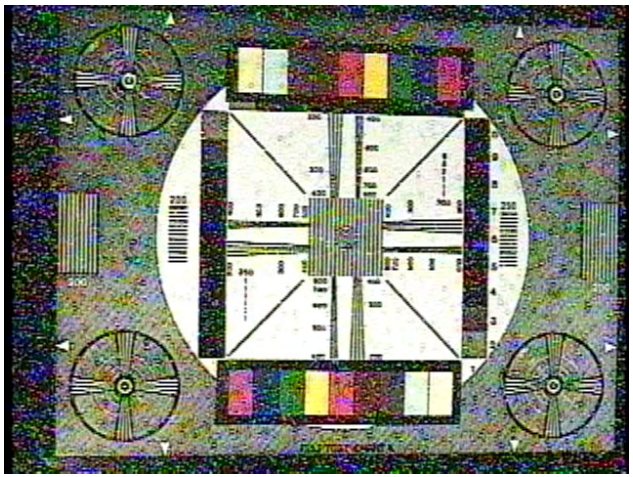
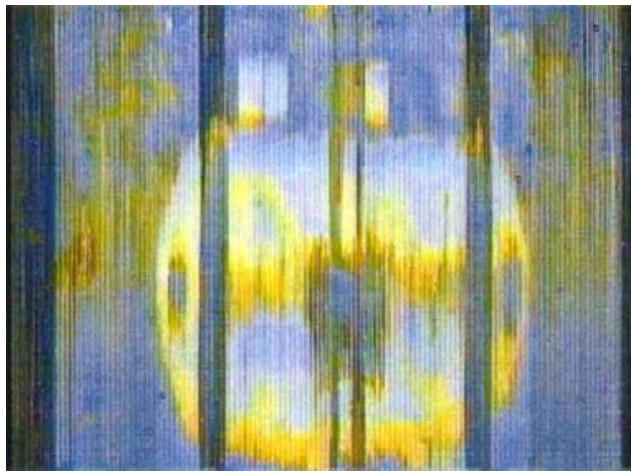
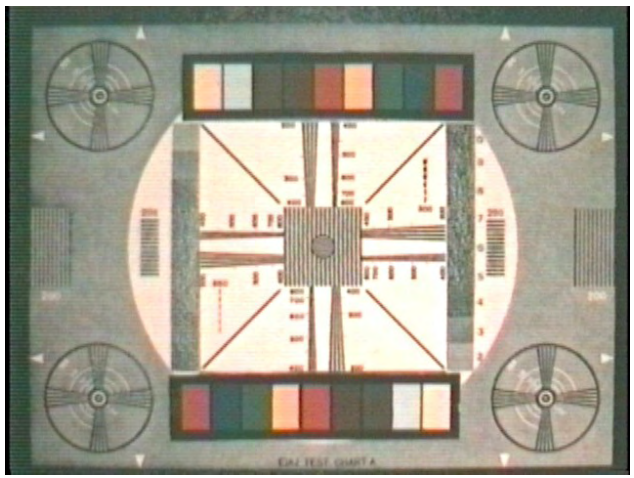
Comparison of CCD and CID based cameras in radiation

Commercial CCD camera, t=0 hr, 300 Gy/hr

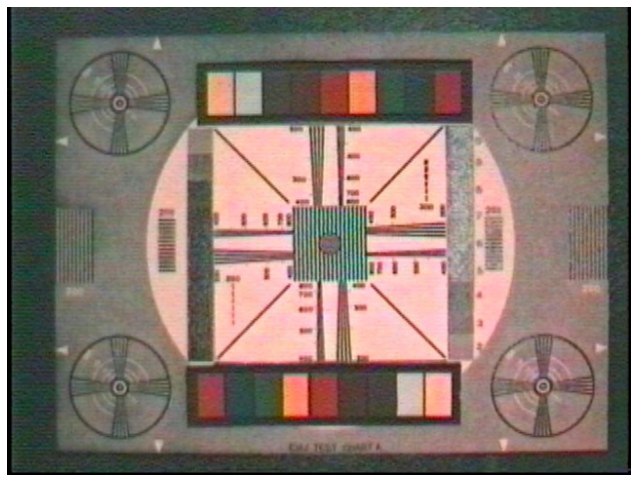


Commercial CCD camera, t=1 hr, 300 Gy/hr





Rad. Hard CID camera, t=0 hr, 300 Gy/hr



Rad. Hard CID camera, t=45 hr, 300 Gy/hr (1,500 KRad T.D)

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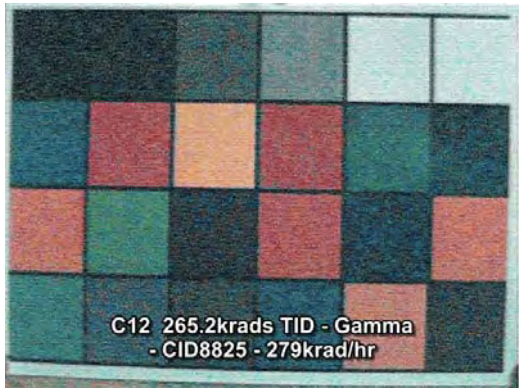
ColorRAD camera radiation performance

0 rads total dose

0 rad flux rate

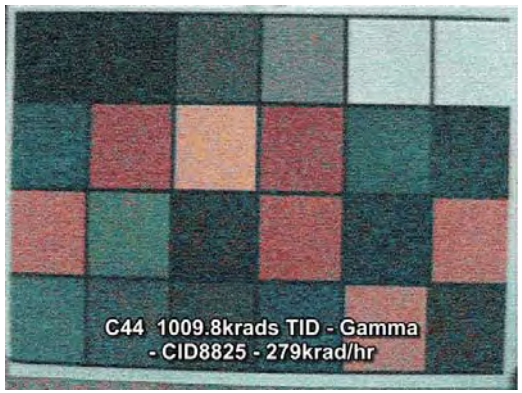


265 krads total dose

279 krads flux rate

520 rads total dose

279 krad flux rate



1.0 Mrads total dose

279 krads flux rate

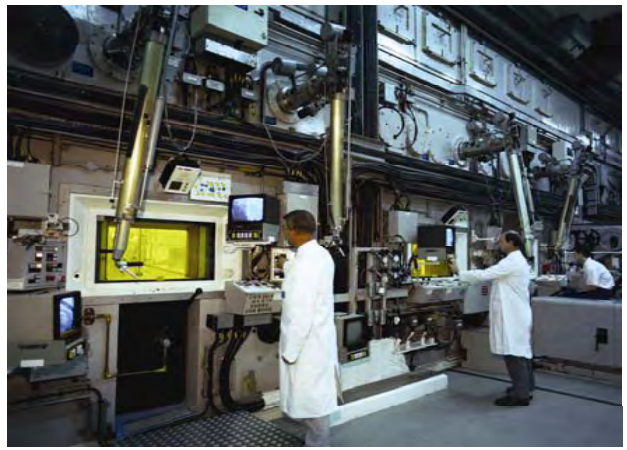
2.0 Mrads total dose

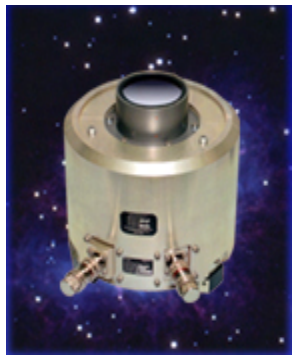
279 krads flux rate

3.0 Mrads total dose

279 krads flux rate

We Excel in Accelerators and radiation applications





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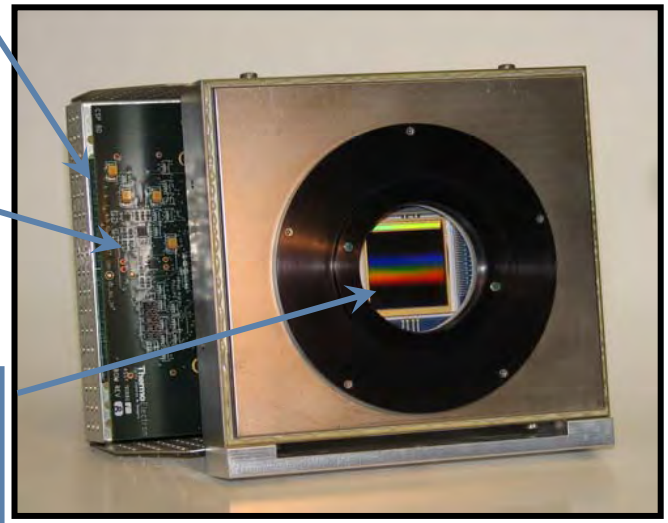
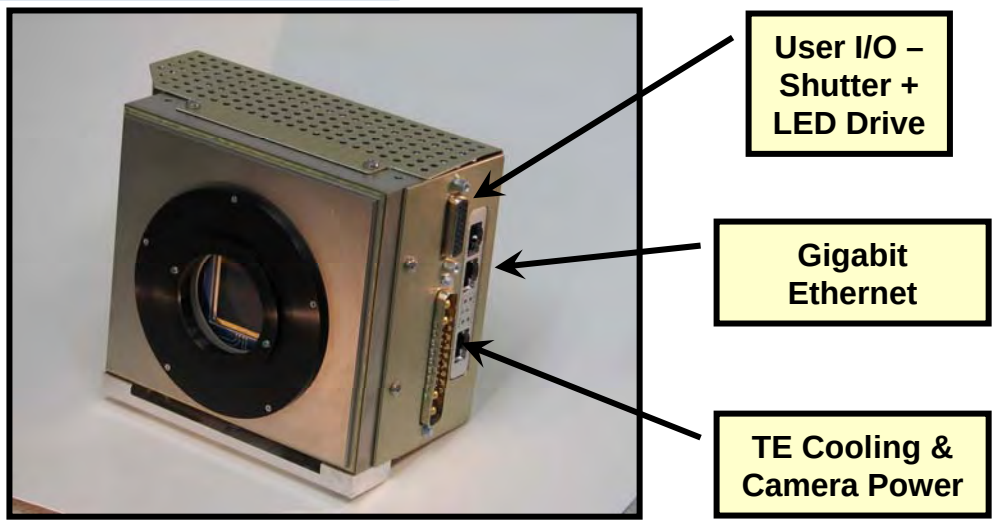
Scientific Imaging - SpectraCAM XDR:

A CID Camera Designed to Provide Unprecedented Dynamic Range

- CID820 preamplifier per pixel (PPP)
  - 2048 h x 2048 v format
  - 12 μm x 12 μm pixels
  - 24.6 mm x 24.6 mm photoactive area
  - Low noise (<35 electrons rms)
  - UV – NIR wavelength response
- Signal processing
  - 2.08 MHz pixel rate
  - Correlated sample & hold
  - Nondestructive read
  - Windowing
  - True random access
  - Selected pixel reset (clear of photon-generated charge)
- Run-time SW/firmware licenses
  - Extreme DR (10^6 – 10^8)
  - Random access integration
  - Time resolved spectroscopy
- Thermo electrically cooled (-45C)





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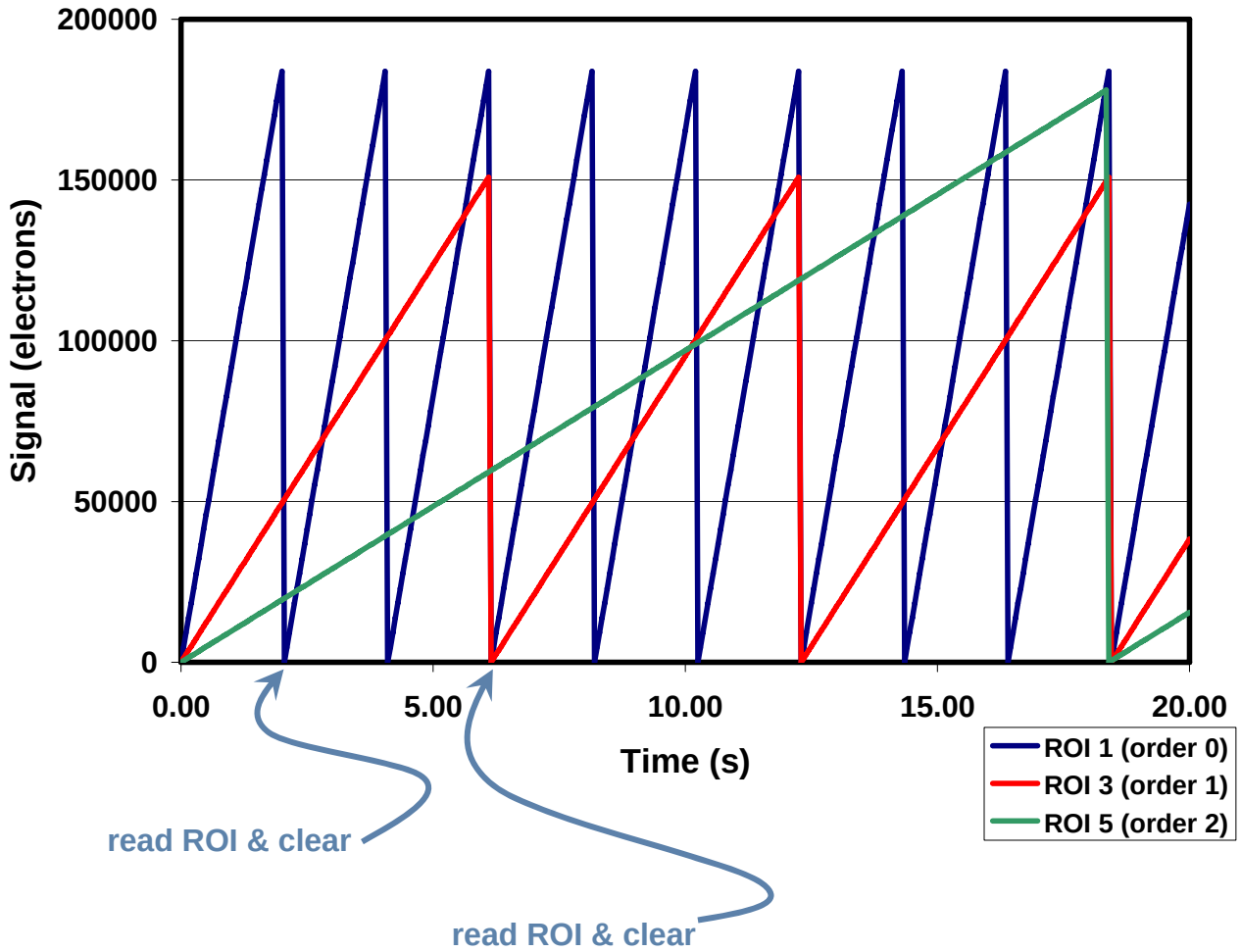
Critical Figures of Merit for the SpectraCAM XDR and Comparison Cameras

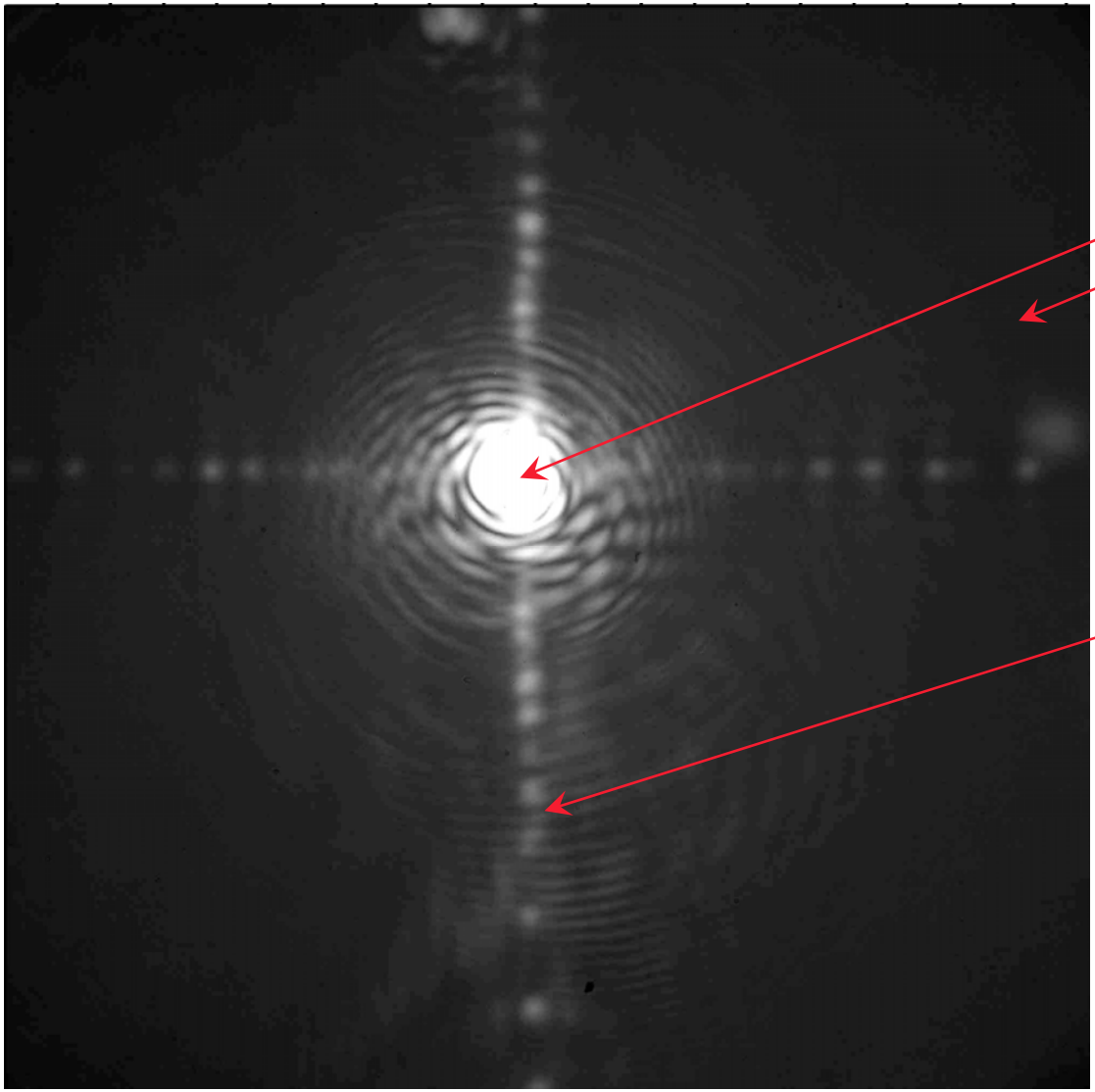
Parameter	CID820 SpectraCAM™ XDR	Kodak KAI-4020 Apogee	CID86 SpectraCAM 'iCAP'	CID38 'IRIS Intrepid'
Format	2048 x 2048	2048 x 2048	540 x 540	512 x 512
Pixel Size	12 μm x 12 μm	7.4 μm x 7.4 μm	27 μm x 27 μm	28 μm x 28 μm
Active Area	24 mm x 24 mm 6.0 cm^2	15 mm x 15 mm 2.3 cm^2	14 mm x 14 mm 2.1 cm^2	14 mm x 14 mm 2.1 cm^2
Full Well Capacity	235,000 e^-	40,000 e^-	535,000 e^-	512,000 e^-
Dark Noise (e rms)	**35**	25	136	205
Pixel Read Frequency	2.1 MHz	1 MHz	50 kHz	33 kHz
Simple Dynamic Range	77 dB	64 dB	71 dB	68 dB
Linear Dynamic Range	**10^6 – 10^7 full frame single exposure**	10^5 multiple exposures	10^5 – 10^7 subarrays only	10^5 – 10^6 subarrays only
Quantum Efficiency				
200 nm	17%	NA	36%	33%
300 nm	24%	NA	27%	27%
550 nm	38%	48% w/ lenslets	37%	41%

Representation of the Extreme DR Readout Mode

- Intensely illuminated regions readout & cleared
- Readout frequency determined by experimentally observed photon flux
  - ROI 1 readout and cleared at higher frequency.
  - ROI 3 and ROI 5 are readout and cleared at a lower frequency.
- Dynamic range not limited by detector full well capacity (as with CCDs)
- Dynamic range limited instead by the frequency at which ROIs may be read
  - 200 – 1000 Hz



SpectraCAM XDR – CID820 for High Dynamic Range Imaging



- CERN – Particle accelerator alignment
- Dynamic range = $10^{6.3}$
  - Central signal = 290,000 cps
  - Noise level = 0.13 cps
- CID820 with full frame 2048H by 2048V Image
- True simultaneous data acquisition for all 4.2 million pixels.
- Logarithmic scale
- Lens flare or internal reflections become apparent

This image of CERN's particle accelerator beam alignment exhibits 6.3 orders of magnitude in dynamic range. The signal on the center point is 290,000 counts per second whereas the noise level in the background is about 0.13 counts per second. The ratio of these 2 values is 6.3 orders of magnitude – about 2 orders of magnitude more dynamic range than one can hope to achieve with a scientific CCD camera. This does not represent the limits of the dynamic range capabilities of SpectraCAM XDR. Calculations indicate that the dynamic range could readily be pushed beyond 7 orders of magnitude.