Overview of NIF Framing Cameras

2026 NIF and JLF User Group Meeting

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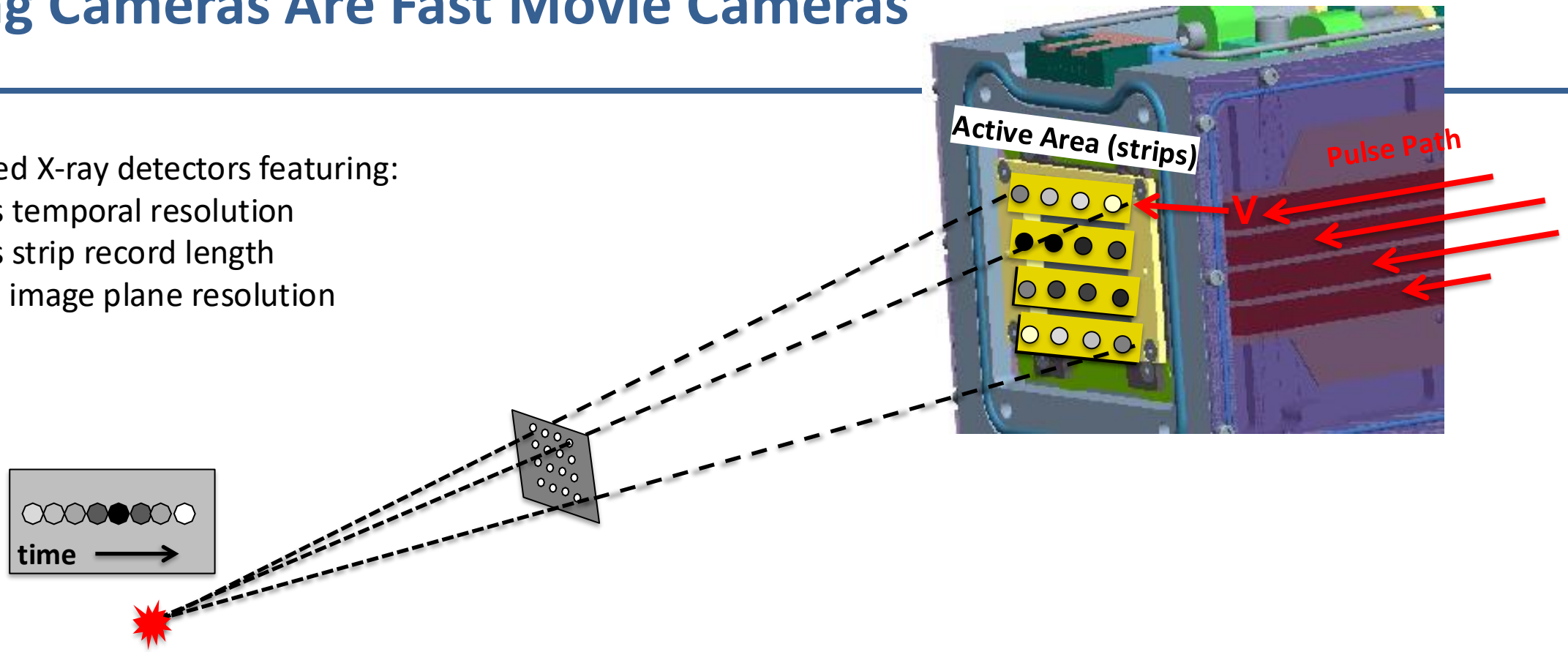
Framing Cameras Are Fast Movie Cameras

Time-gated X-ray detectors featuring:

- 100 ps temporal resolution
- 250 ps strip record length
- 50 um image plane resolution



Paired with imaging snouts (pinhole arrays, Crystal Backlighter Imager, …), spectrometers (Super Snout, ISS), etc…

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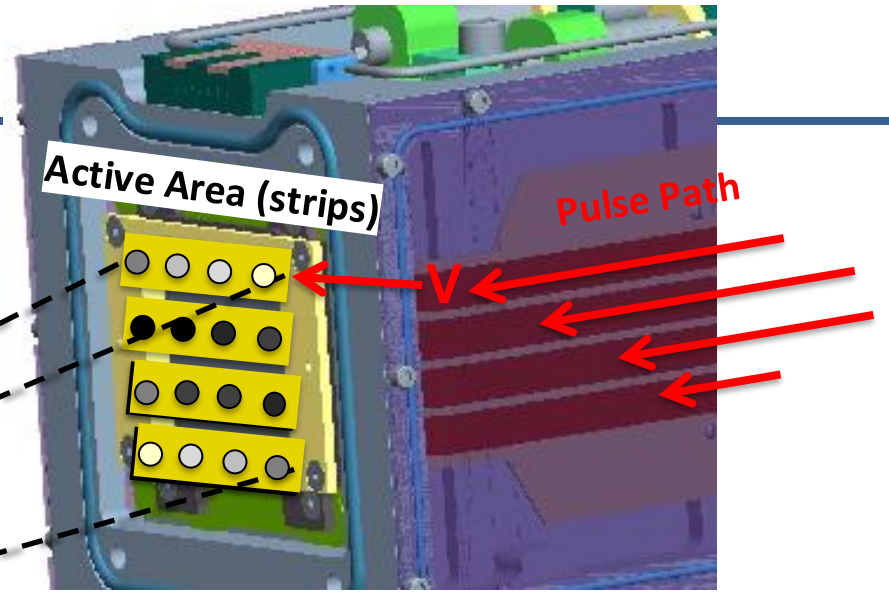
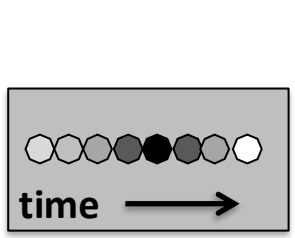
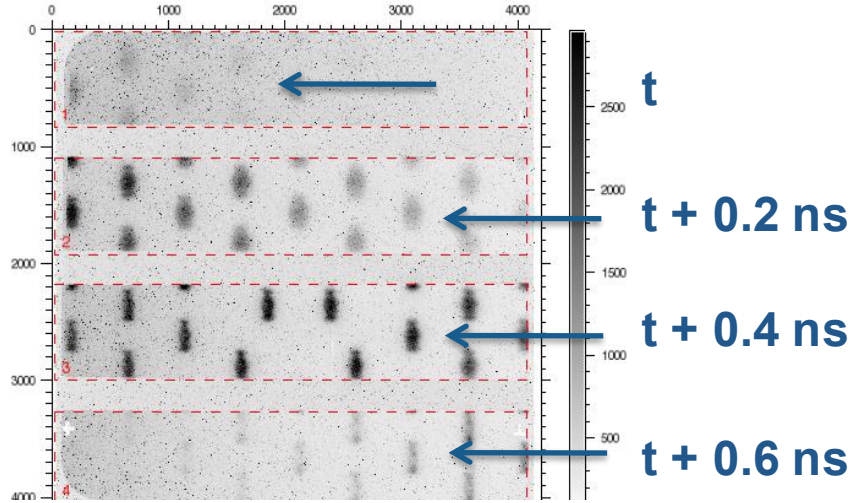




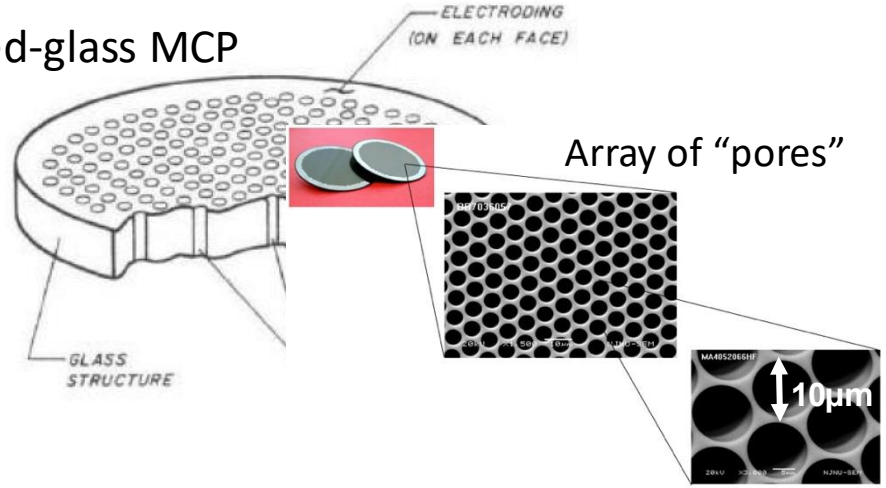


Imploding capsule recorded on framing camera

Paired with imaging snouts (pinhole arrays, Crystal Backlighter Imager, …), spectrometers (Super Snout, ISS), etc…

Framing Cameras Use MicroChannel Plates as Their Primary Active Detection Element

Leaded-glass MCP



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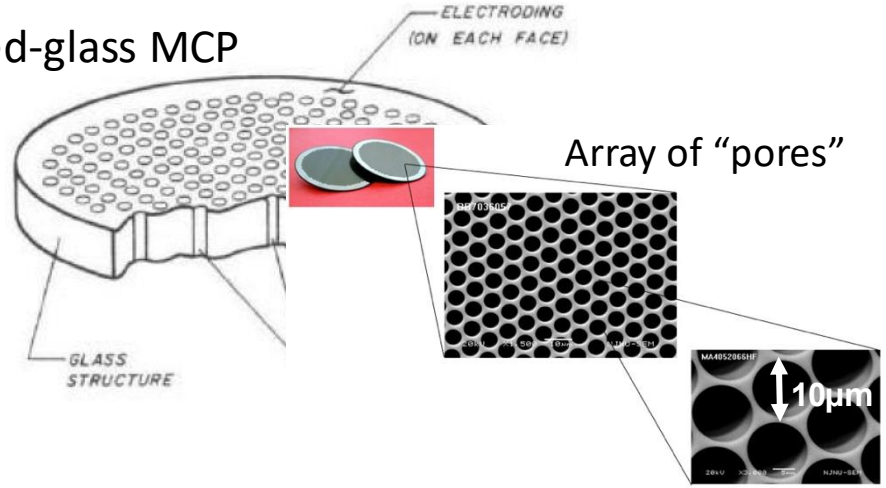
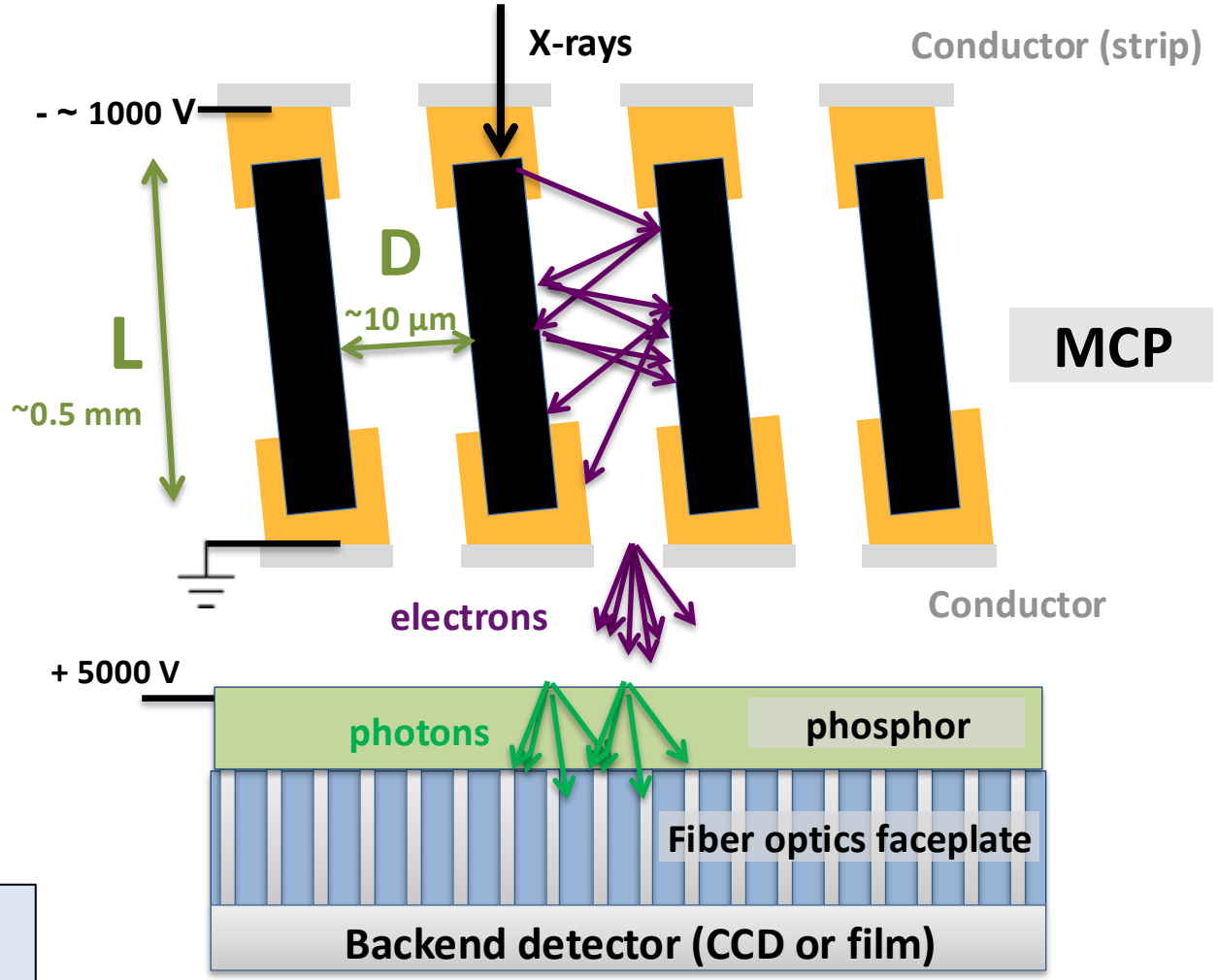




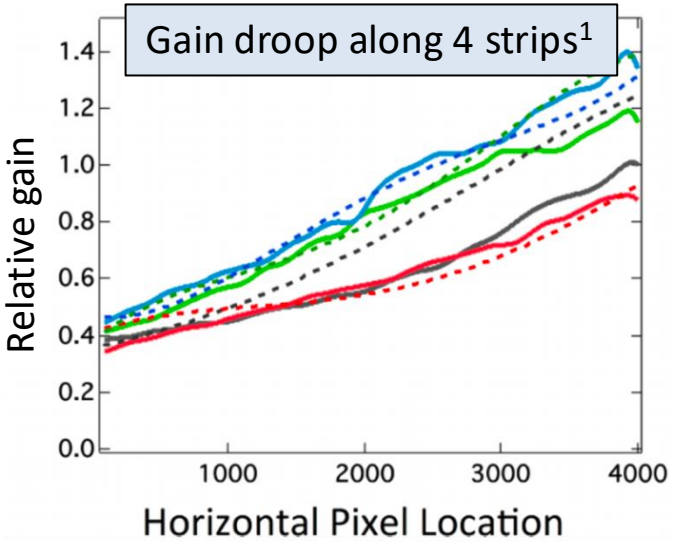
Conductors coated on top and bottom support a voltage difference:

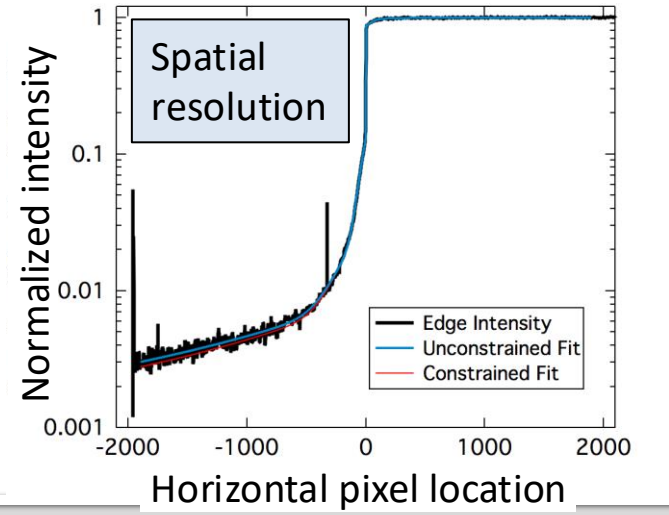
- Creating electric field in each pore
- Accelerates electrons down the pore
- Secondary electrons are produced at each impact (dynode)

Electron cascade → $\text{Gain} \propto V_{\text{MCP}}^{\gamma}$ $\gamma = \frac{L}{4D}$

Individual Framing Camera Properties Are Hard to Predict or to Characterize

- Photon detection and signal amplification occur throughout the MCP
- Variability in the MCP and its coating, HV pulses and their coupling onto strips
- Actual use conditions are hard to reproduce during calibration
- We calibrate:
  - Pulse velocity across microstrip
  - Gate (gain) width
  - Gain variation with voltage on MCP
  - Strip-to-strip gain
  - Relative Droop
  - DC Sensitivity
  - …

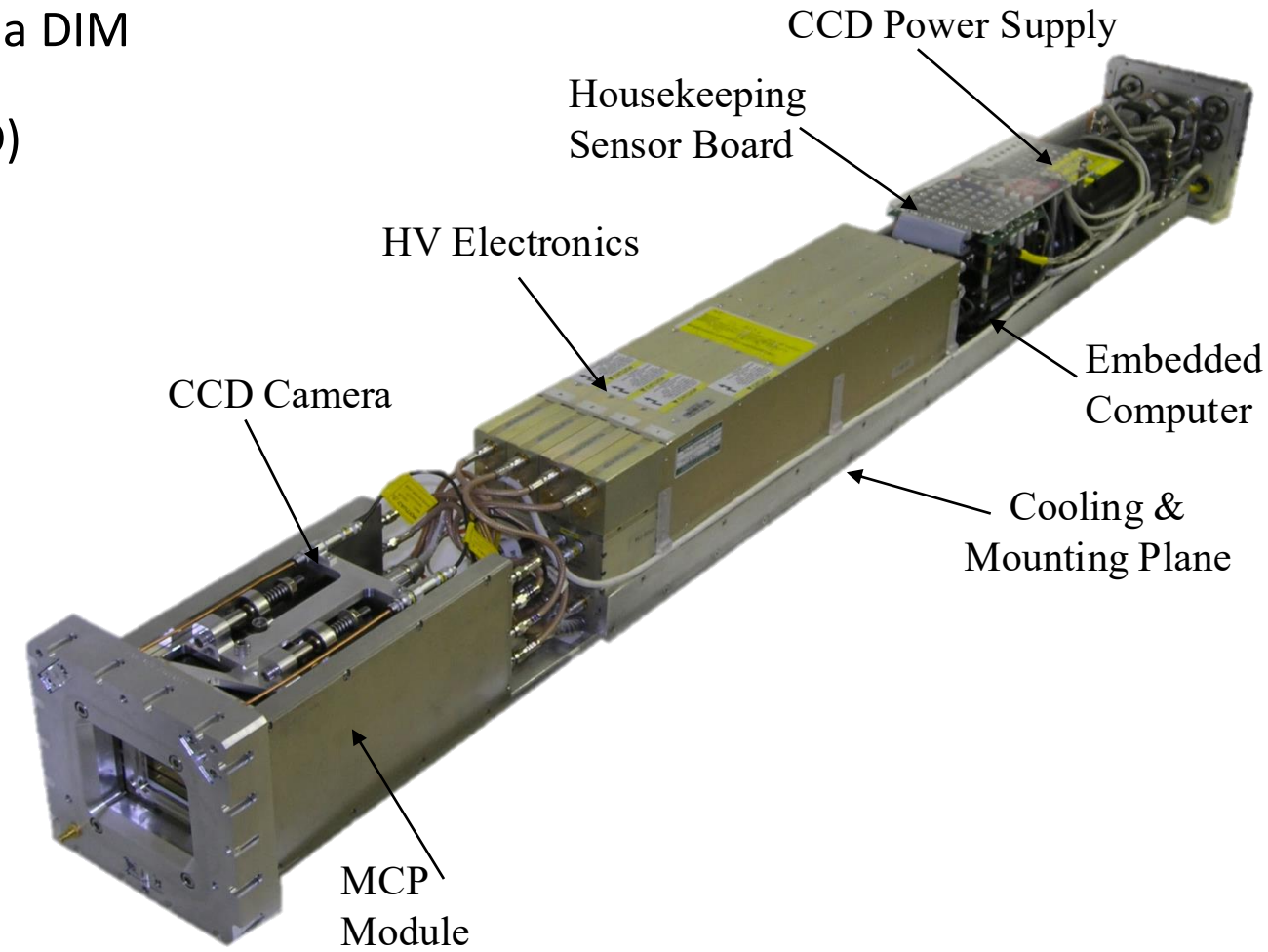




[1] Benedetti, Rev. Sci. Instrum. 87, 023511 (2016)

We Have Several Types of Framing Cameras on NIF

- Packaged inside an airbox, inserted and aligned *via* a DIM
- Hardened (HGXD) and non-hardened versions (GXD)
  - Film backend vs CCD backend
  - Recently, CMOS backend (HGXD-3)
- 4-strip and 2-strip (HGXD only) versions
- "-200" vs "-600" on some cameras
  - Controls integration time by shaping of HV pulse
  - Actual integration time is ~100 ps vs ~250 ps resp.



Framing Cameras Are Configured Through Shot Setup Tool (SST)

https://nifit.llnl.gov/sst/

TC090-078		
DIM Configuration (090,078)	TC090-078	Approved
ARIANE (090,089)	TC090-089	Approved (Secondary)
DISC DIM (090,078)	TC090-078	Not Used
DIXI (090,100)	TC090-100	Approved (Secondary)
GXD DIM (090,078)	TC090-078	Not Used
HGXD DIM (090,078)	TC090-078	Approved (Secondary)

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GXD DIM (090,078)	TC090-078	
HGXD DIM (090,078)	TC090-078	

TC090-078	
DIM Configuration (090,078) TC090-078	Approved
Description	
Comment	
Template Applied	NONE
Priority	Primary
Aimpoint Coordinates	Cartesian
x (mm)	0
y (mm)	0
z (mm)	0
DLP Nickname	HGXD6F IMPORT
Active	YES
DIM Configuration	AAA10-115328 : HGXD2-H-640-25.4-1X

← where the camera should be pointed to

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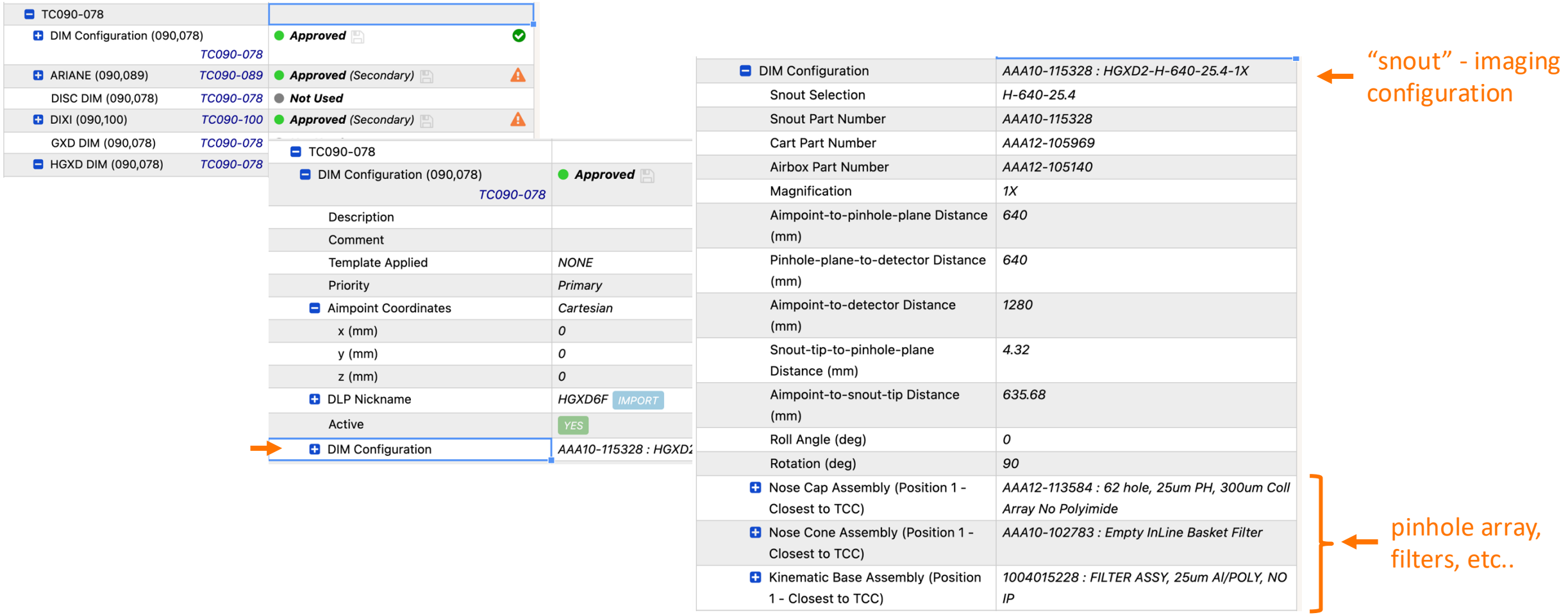

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HGXD DIM (090,078)	TC090-078	Approved (Secondary)
Priority		Secondary
Description		
Comment		
Template Applied		NONE
Nickname		HGXD6F IMPORT
Timing		

Timing	
Trigger Delay rel Tzero (ns)	16.38
Configuration	
Flange Filter	24um Al Polyimide
Detector	
Pulse Forming Width (ps)	200
Strip #1	
Timing Delay (ps) (in 25 ps increments)	0
Backbias (volts) (in 50V increments)	100
Strip #2	
Strip #3	
Strip #4	
Film	TMAX 400 with P11 phosphor 35mm FILM

← select trigger delay

← select ≥ 0 delay relative to global delay

← select MCP bias
+50 V → ~1/3 gain

Framing Camera Data is Recorded in NIF's Archive Viewer

https://nifit.llnl.gov/viewer/main.action

- GXD
  - TC090-124
    - FRAMING_CAMERA_TIMING 1
    - DIAGNOSTIC_IMAGE 1
    - FRAMING_CAMERA_PULSER 1
- HGXD
  - TC000-000
    - DROOP_CORR_IMAGE 1
    - FRAMING_CAMERA_TIMING 1
    - EXPOSURE_IMAGE 1
    - FRAMING_CAMERA_PULSER 1
    - PDS_IMAGE 6
  - TC090-078
    - DROOP_CORR_IMAGE 1
    - FRAMING_CAMERA_TIMING 1
    - PINHOLE_EXTRACTED_IMG 1
    - EXPOSURE_IMAGE 1
    - FRAMING_CAMERA_PULSER 1
    - PDS_IMAGE 6

MONITOR_T1	Time for center of first strip relative to TCC T0	13.9
MONITOR_T2	Time for center of second strip relative to TCC T0	14.16
MONITOR_T3	Time for center of third strip relative to TCC T0	0
MONITOR_T4	Time for center of fourth strip relative to TCC T0	0

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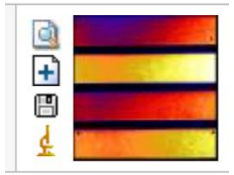
MONITOR_T4	Time for center of fourth strip relative to TCC T0	0

SHOT_IMAGE	Shot image	
PRESHOT_IMAGES	Preshot images	

subtract this from shot_image!

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- GXD
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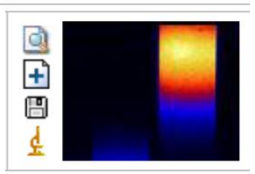
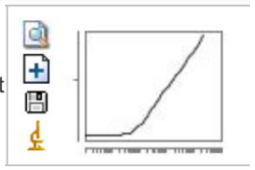
SHOT_IMAGE	Shot image	
PRESHOT_IMAGES	Preshot images	

subtract this from shot_image!

EXPOSURE_CORR_IMG	Corrected raw PDS image	
OPT_DENSITY_VS_EXP_WF	Optical density vs. Exposure plot	

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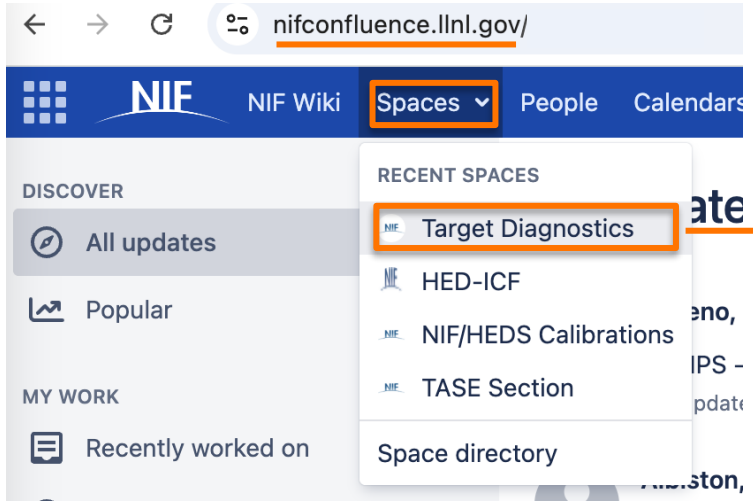
    - EXPOSURE_IMAGE 1
    - FRAMING_CAMERA_PULSER 1
    - PDS_IMAGE 6

Flat-fielded data only when calibration file is available!
Ask ahead of your shot if this is important for your experiment.

Useful User Resources

- Framing camera wiki page[1]
  - Answers 95 % of your questions (setup + data processing)
    - Gain
    - Orientation
    - Dimensions
    - …



- Calibration reports[2]

- Responsible scientists
  - Joe Holder (holder4@llnl.gov)
  - Clement Trosseille (trosseille1@llnl.gov)

[1] https://nifconfluence.llnl.gov/display/TD/X-ray+Framing+Cameras+%3A+GXD%2C+HGXD+and+ARIANE
[2] https://nifconfluence.llnl.gov/display/nhc/Calibration+and+Characterization+Reports

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Framing camera cheat sheet (NIF wiki)

Available GXD Framing Cameras at NIF							
	Camera	# strips	Add'l INFO	Gain Rel	Pulse Vel (mm/ns)	UV-measured gate width (ps)@(bias V)	Actual Interstrip Timing (vs req.)
CCD	RGXD1F-200	4	No ERASER	8*	140	109 (50V) 107 (150V)	0/5/15/8 (co-timed)
	RGXD1F-600	4	No ERASER	256 (32x of -200 config)	140	240 (150V)	
	GXD3F &RGXD3F	4	No ERASER	1.2	142	115 (50V) 90 (300V)	
	RGXD4F-200	4	No ERASER	1.4	137	100 (100V)	
	RGXD4F -600 extended integration	4	No ERASER	22 (16x of -200 config)	139	228 (100V)	