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Design and implementation of Dilation X-ray Imager for National Ignition Facility "DIXI"

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NIF

National Ignition Facility

Design and implementation of Dilation X-ray Imager For NIF “DIXI”

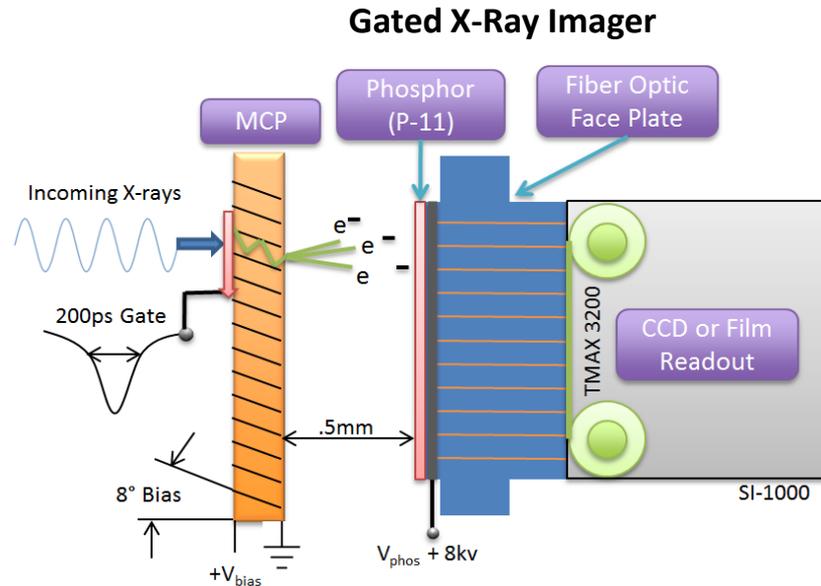
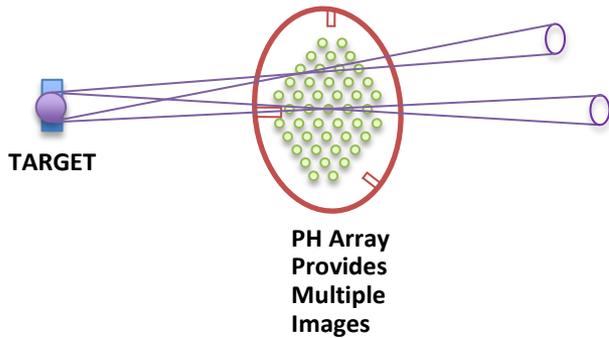
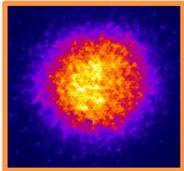
Jay Ayers, Perry Bell, Dave Bradley, Mark Chung Brian Felker,
Jonathan Hares, Terry Hilsabeck, Joe Kilkenny, Zach Lamb,
Sabrina Nagel, Jake Parker Ken Piston

8/20/13

Lawrence Livermore National Laboratory

Gated x-ray imaging is used to measure the symmetry and uniformity of the compressed core

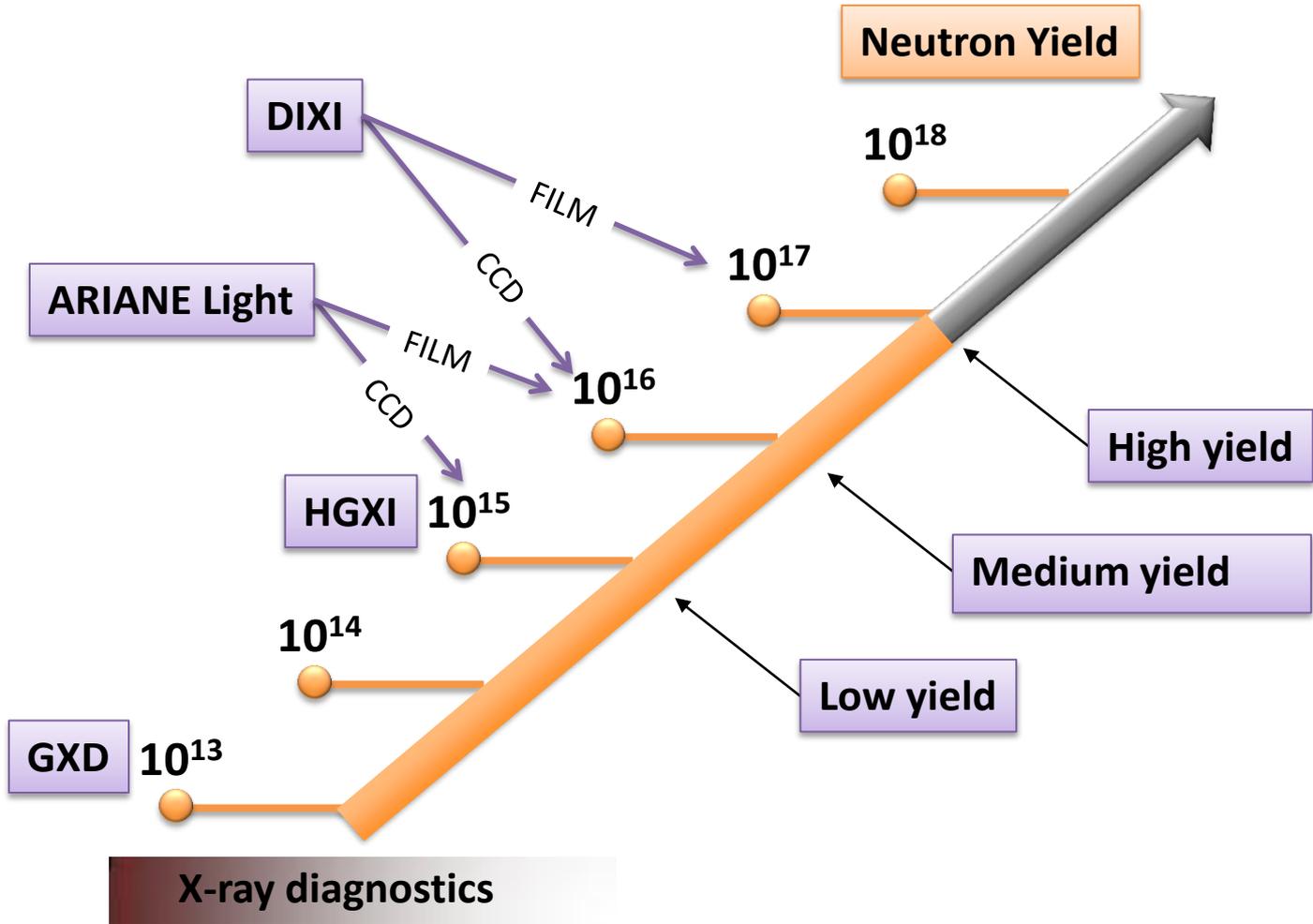
Sample Image



Existing gated x-ray detectors start to fail at target yields $\sim 10^{14}$ with CCD readout. As the yield/experimental needs change new improved time resolved x-ray imaging is required [DIXI]

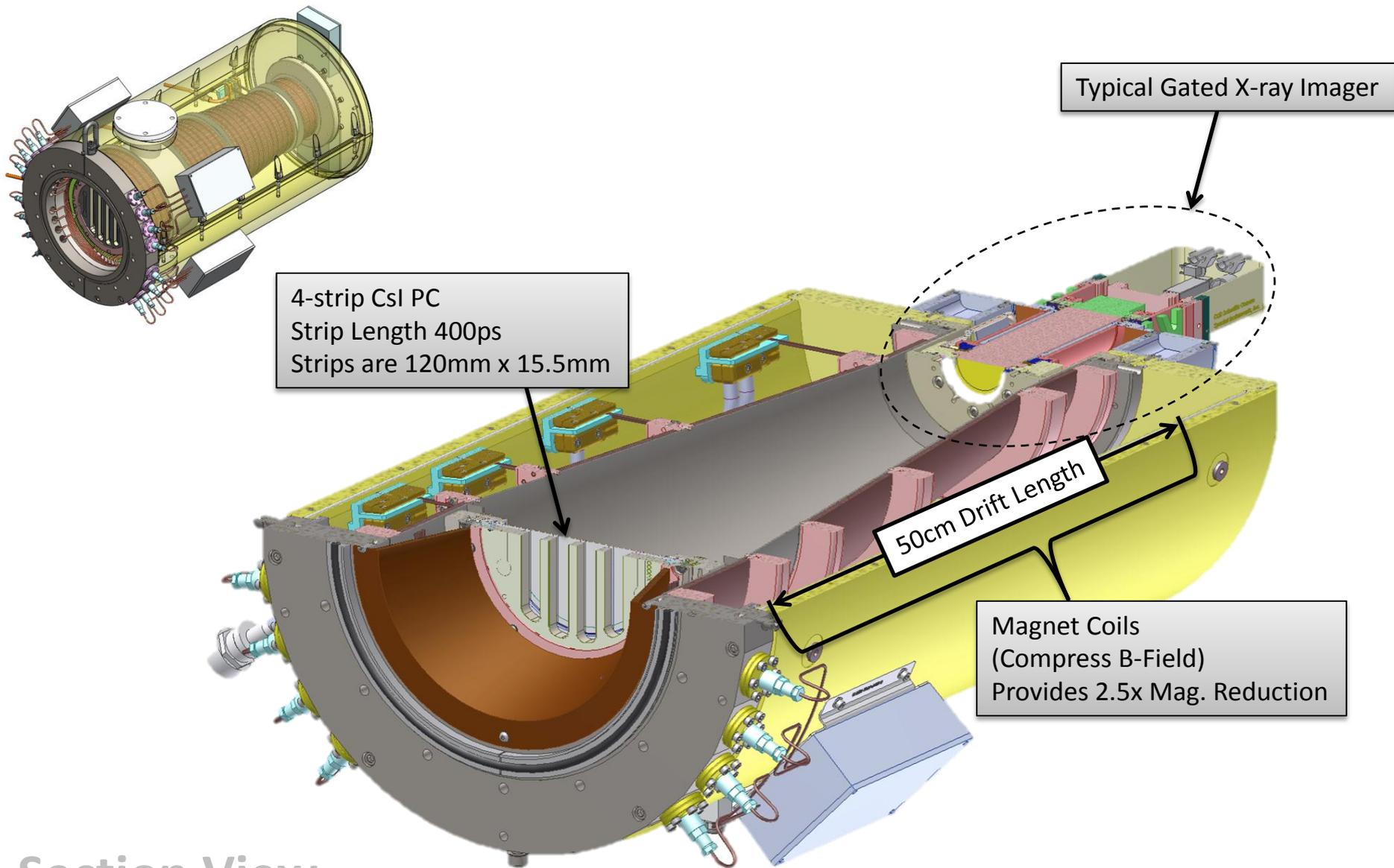
The goal is to make similar measurements with improved temporal resolution

Low yield experiment designs will allow us to use a phased approach to implementing x-ray imaging



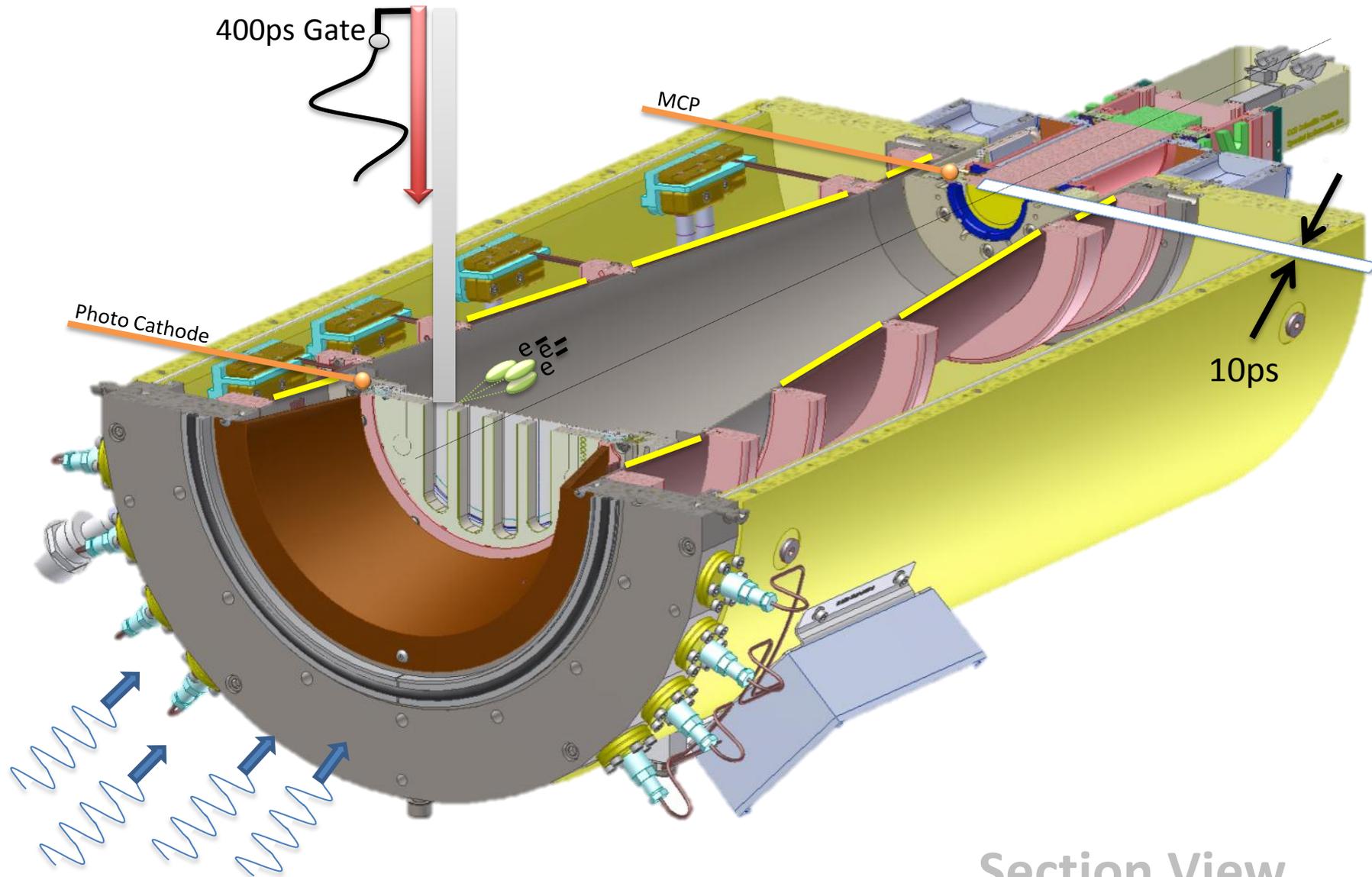
Phased hardening plan prepares for imaging in a high neutron environment

DIXI Overview



Section View

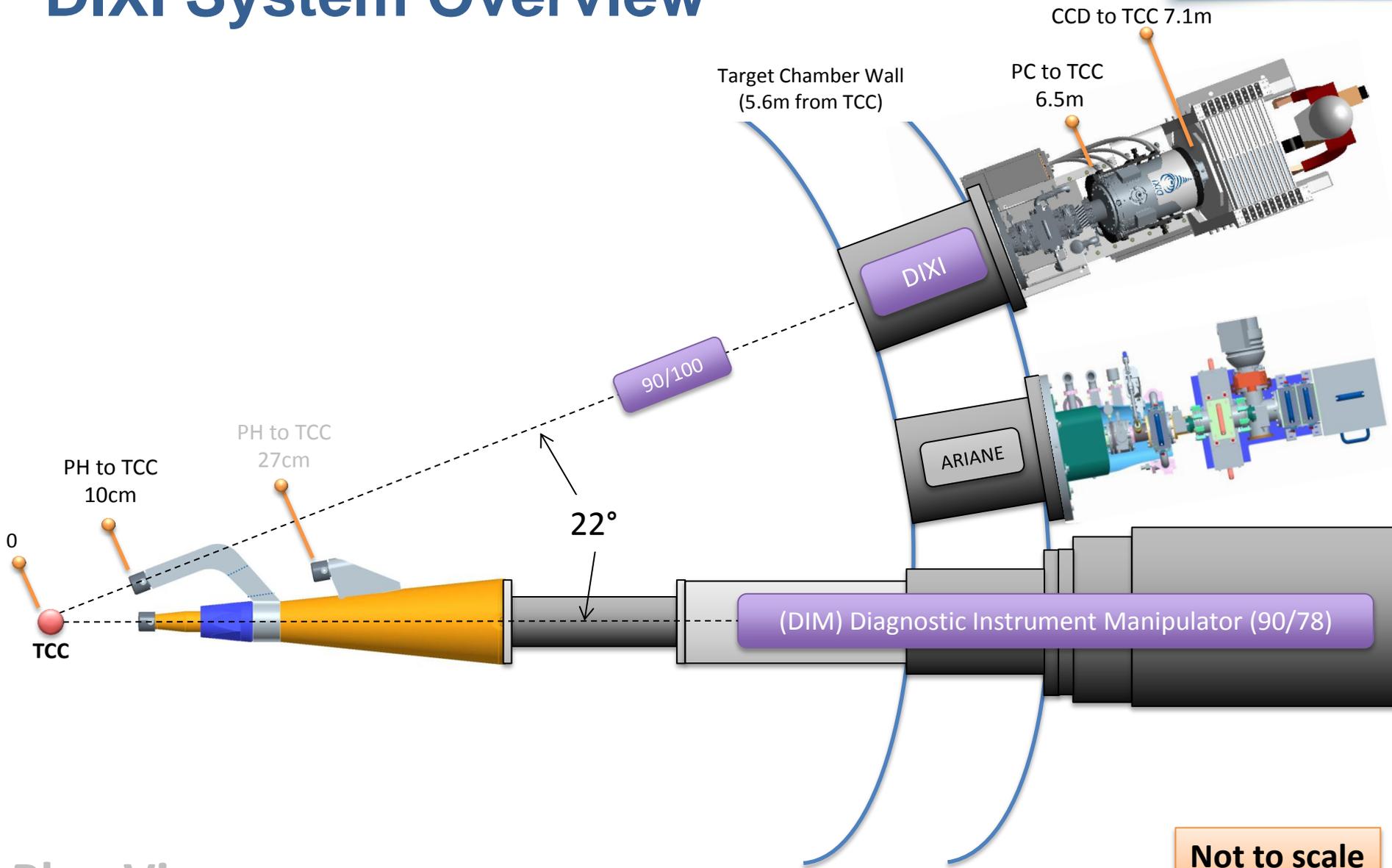
How does DIXI work?



Incoming X-rays (20° off axis)

Section View

DIXI System Overview



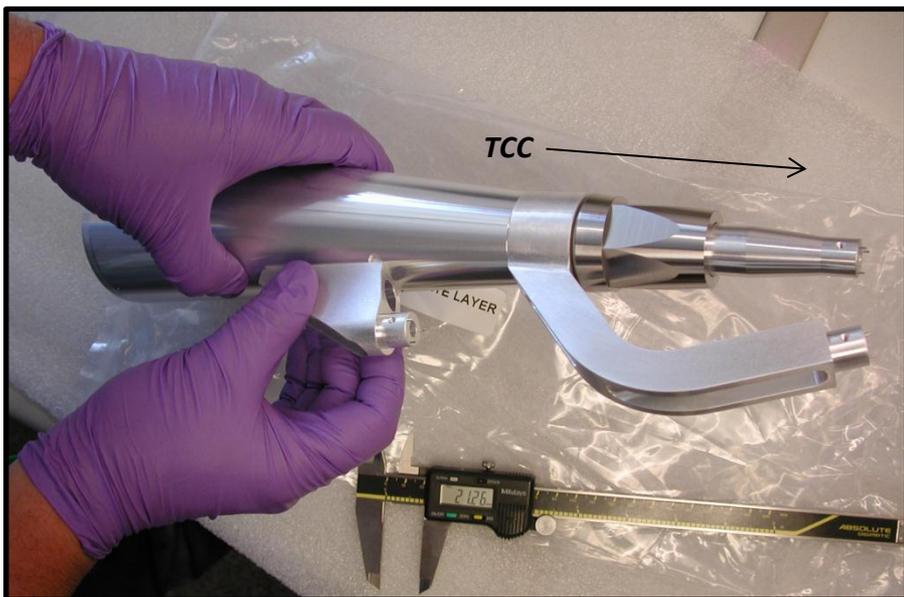
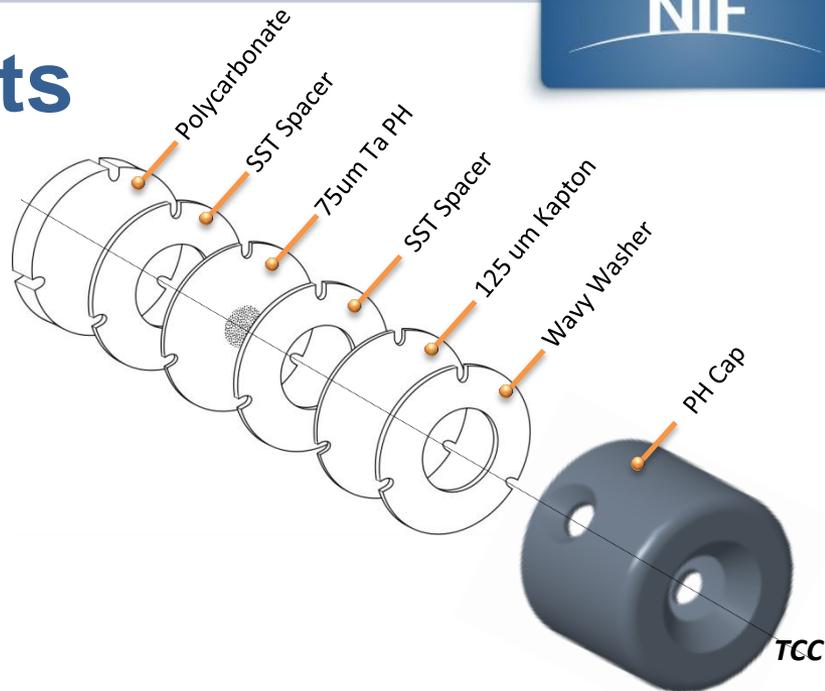
Plan View

Not to scale

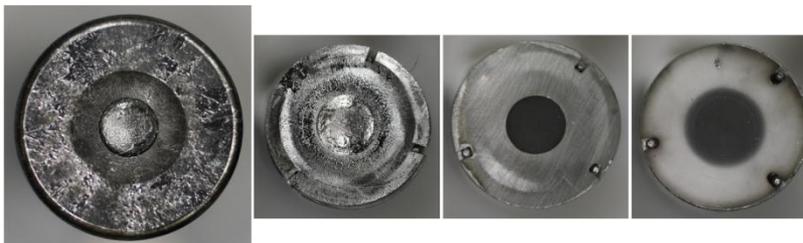
DIXI Imaging Components

- **Imaging Hardware Required For DIXI Operations**

- **DIXI PH** (Not standard, no collimators needed)
- **DIXI Cone HW** (Al6061-T6 and 304 SST)
- **DIM** (Diagnostic Instrument Manipulator)



Actual test shot images



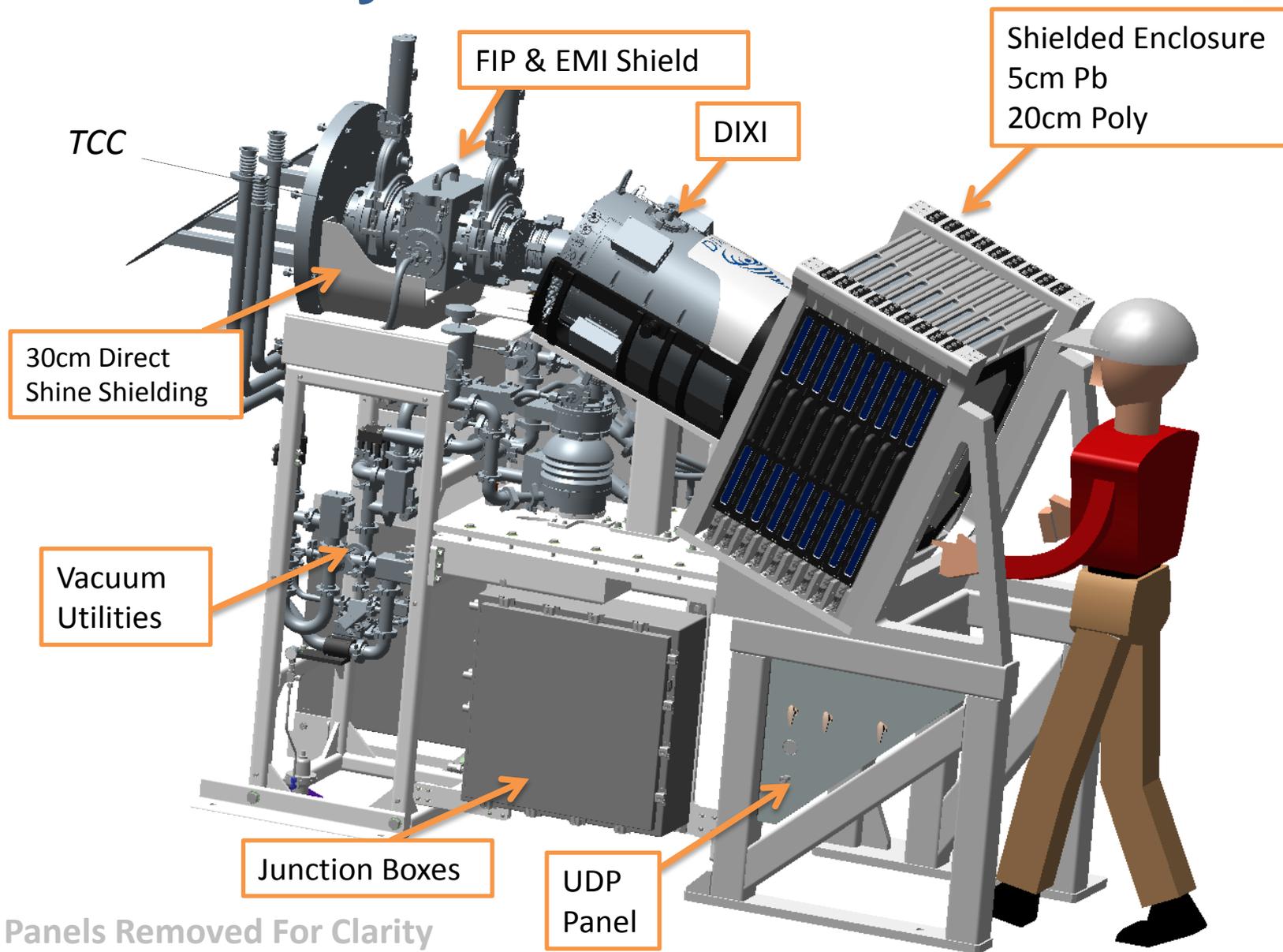
Complete build

Pinhole plate

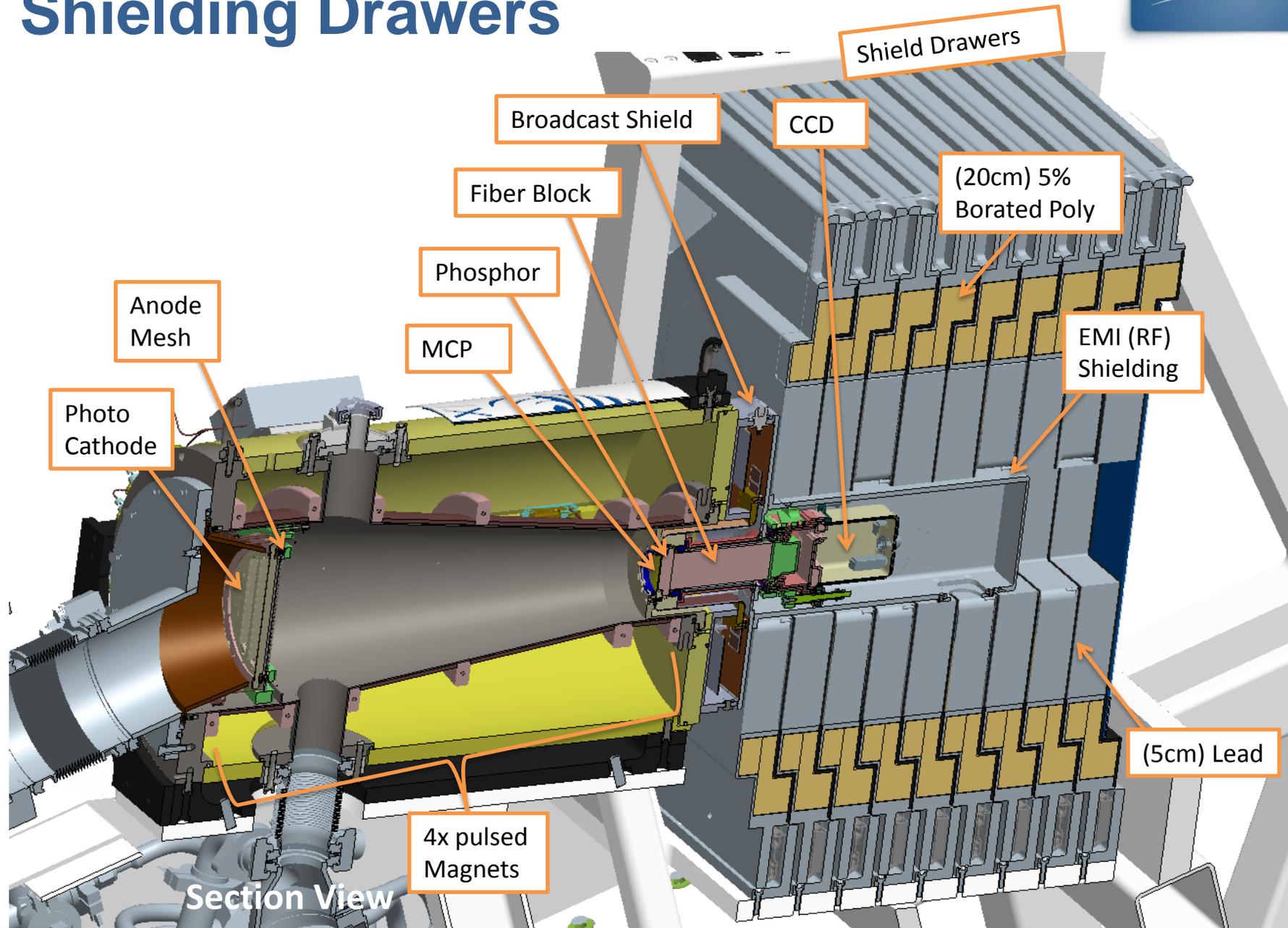
Spacer

Polycarbonate

DIXI Subsystem Overview



Shielding Drawers



Drawer Assembly

- DIXI Assembly

- MIC6

- Dimensionally stable
- Reduced fab costs

- 5cm Pb

- Taped or painted

- 20cm 5% borated poly

- 2 pcs (more readily available)

- Poly and Pb fully encased (10% fire load)

- Control of combustible materials



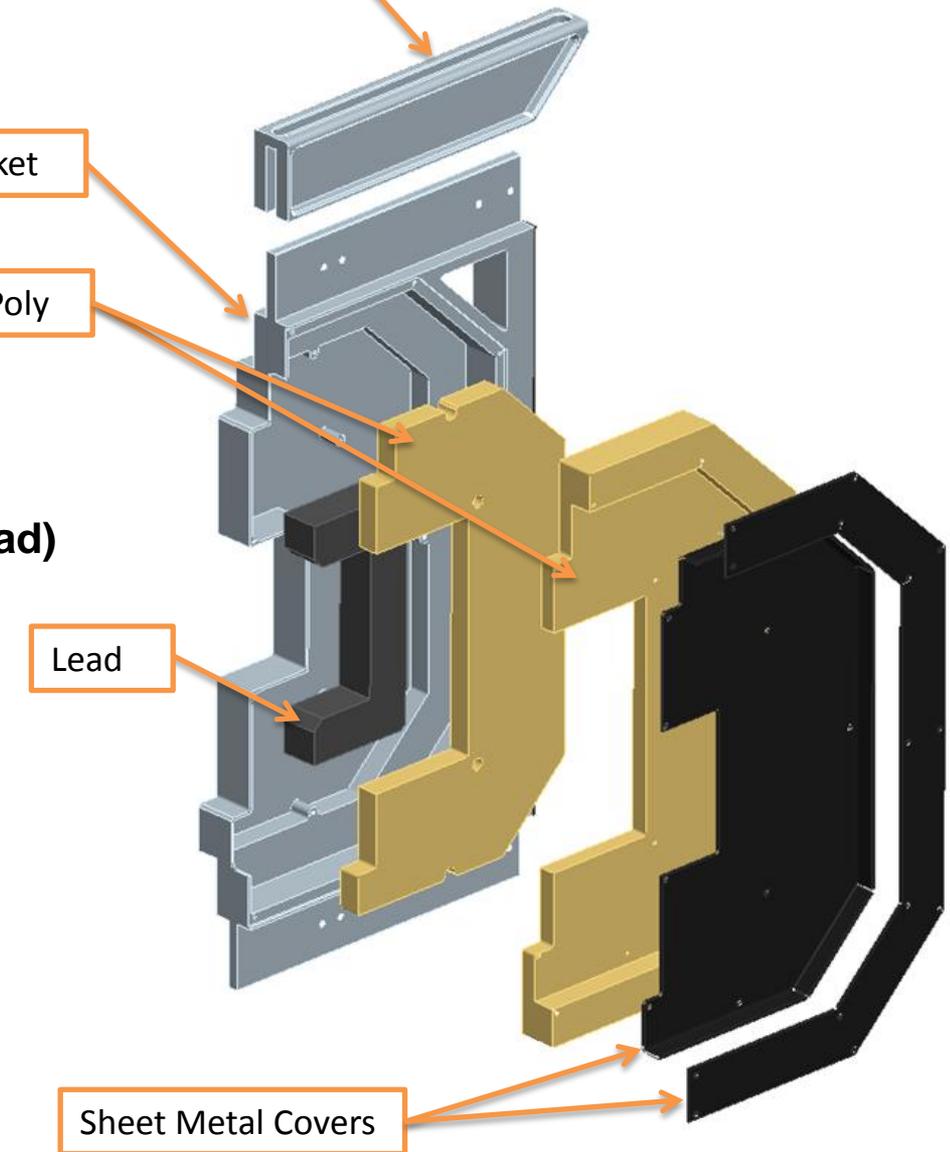
Shielding Casket

5% Borated Poly

Cam Follower Track

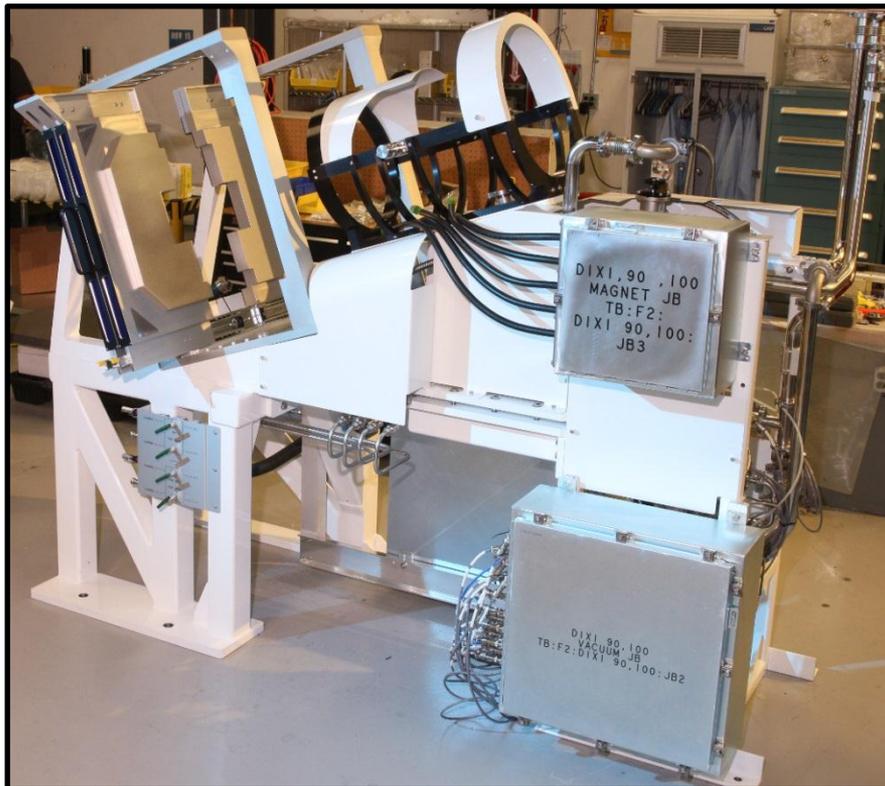
Lead

Sheet Metal Covers



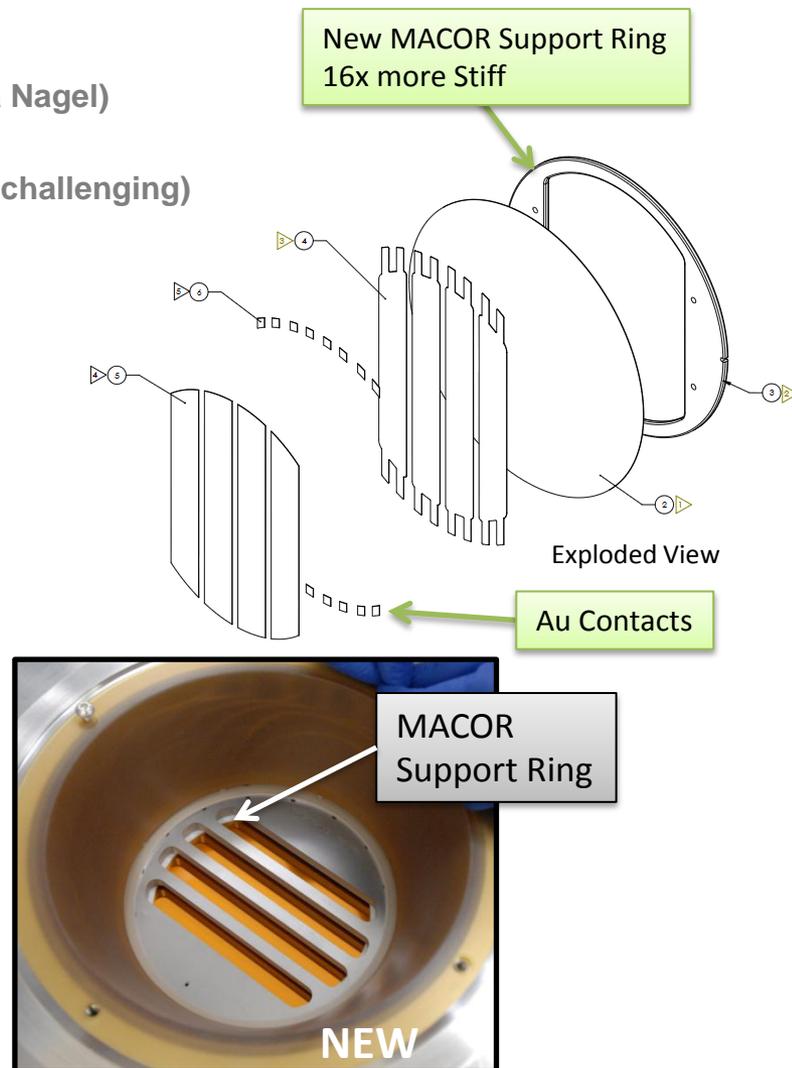
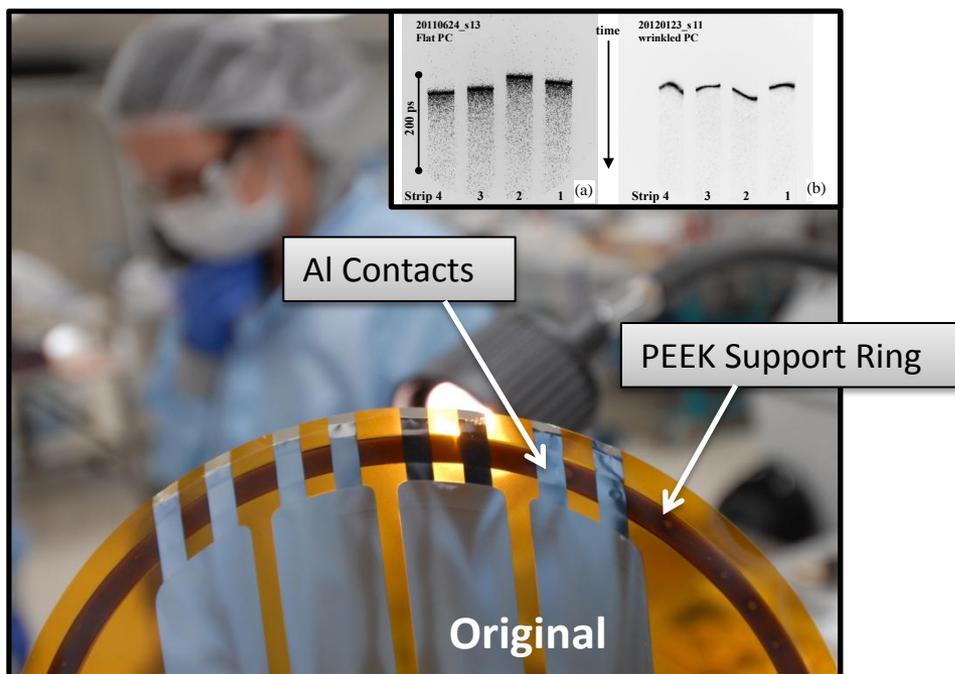
Current Status, DIXI

- DIXI infrastructure 90% completed
- Extensive testing of Instrument at JLF since June 2011
- Utilities installation in the NIF completed
- Hardware Installation in the NIF 50% completed
- Ready For Shots January 2014



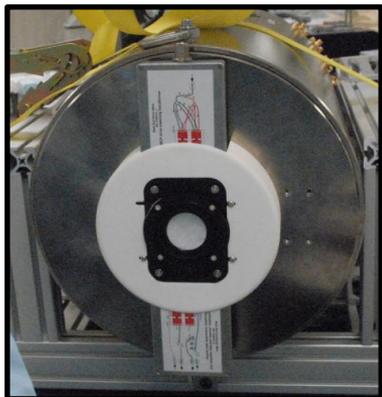
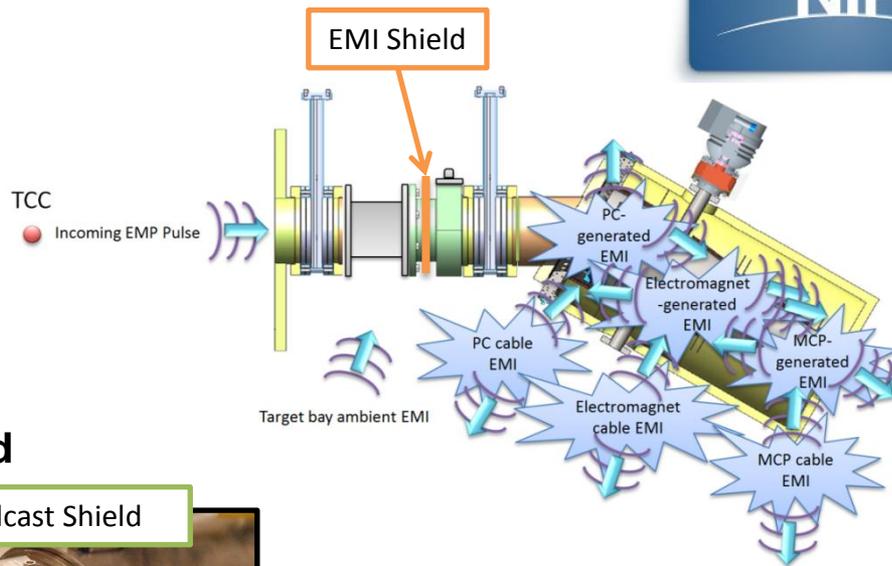
Challenges And Improvements

- Photo cathode flatness and electrical contacts
- EMI design and testing
- Pinhole design
- Magnetic field warp correction (See Paper Presented By Sabrina Nagel)
- Improved spatial resolution (Increased magnetic field)
- Development of calibration and characterization plan (Timing is challenging)



EMI/EMP Protection

- Extensive EMI measurements performed
 - Need to protect DIXI from outside EMI sources
 - Prevent DIXI from broadcasting
- Design Solutions Implemented And Tested

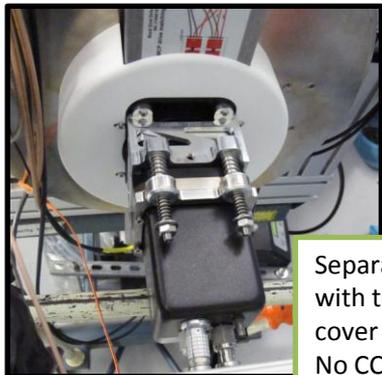


Before →



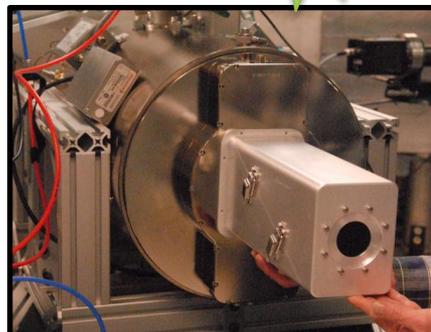
10x Reduction

→ Inside

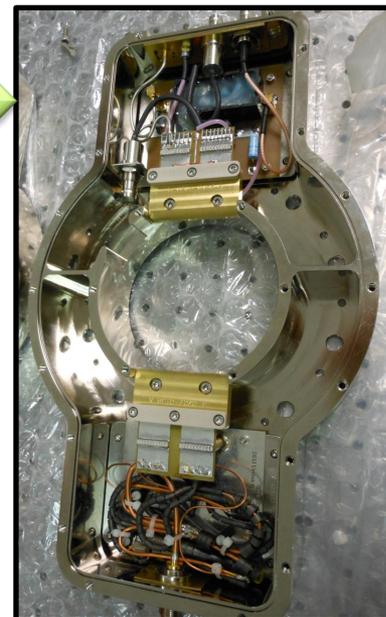


Separate drive boxes with temp. safety cover over strip lines. No CCD EMI protect

After



CCD EMI Protection + Added Light Tightness



Summary & Questions



NIF

National Ignition Facility

DIXI will have sufficient signal for NIF

	Filter transmission at 8 keV	Gate width (ps)	MCP Bias (V)	CCD Pixel/Resol ution Element	Counts/ Pixel	Counts/ Event	Events/Re solution Element
DIXI (Comet)	0.82	5	100	655	6000	50,000	79
GXD (Comet)	0.98	200	50		2000	8000 (*)	
ARIANE (Comet)	N/A	100	400	900	2000(**)	20000	90
ARIANE (NIF)	?	100	400	900	11000	20000	495
DIXI (NIF)	“	10	100	655	26431	50000	347

(**)assumption: GXD w\ 50V bias = ARIANE w\ 400V bias

(*) (DC -750, 5kV Phosphor Pulse)

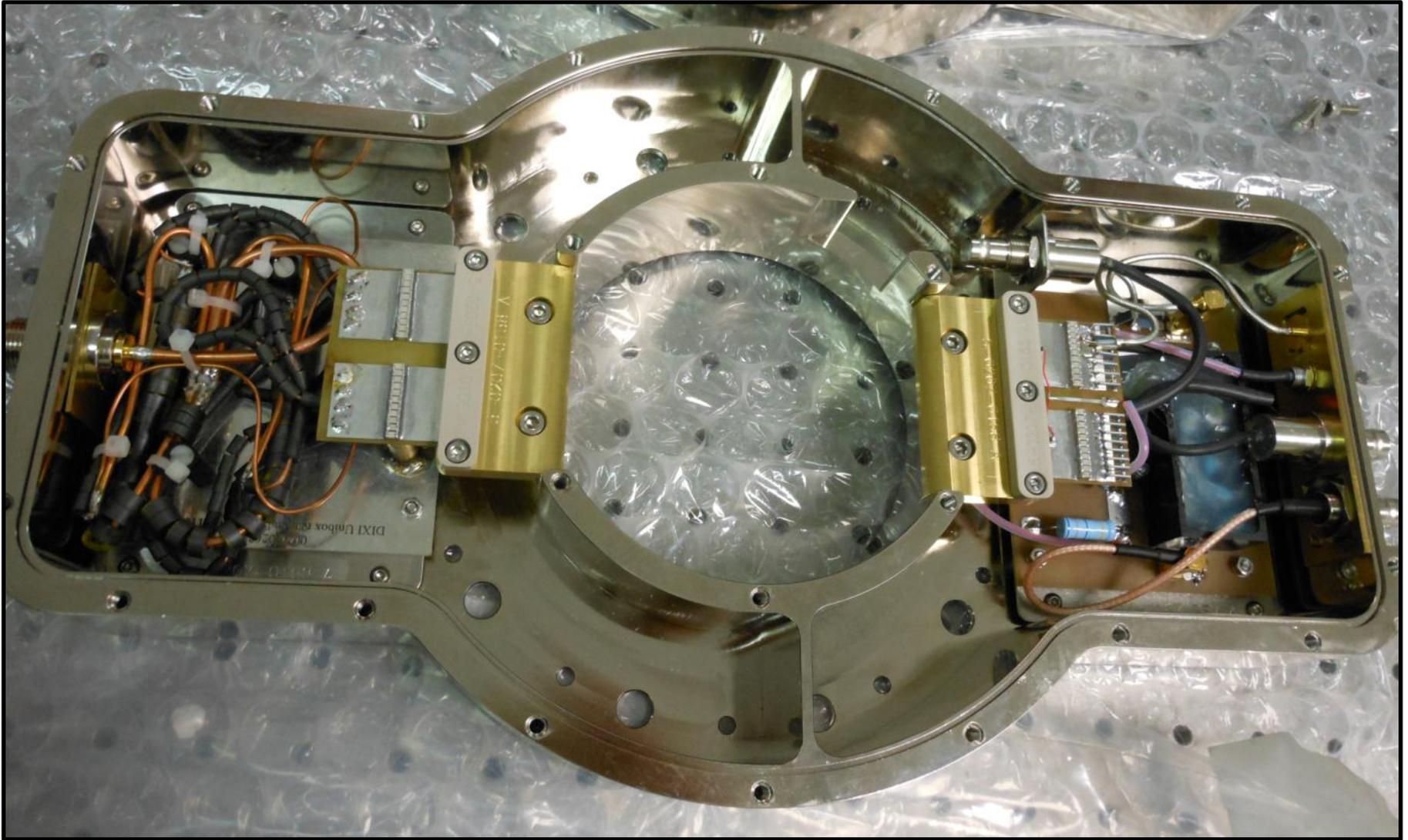
DIXI pinhole is 10 cm from TCC vs. 27 cm for ARIANE $\rightarrow \Omega(DIXI) = 7x\Omega(ARIANE)$

DIXI at COMET had 5 ps gate time, this will be increased to ~10 ps on NIF

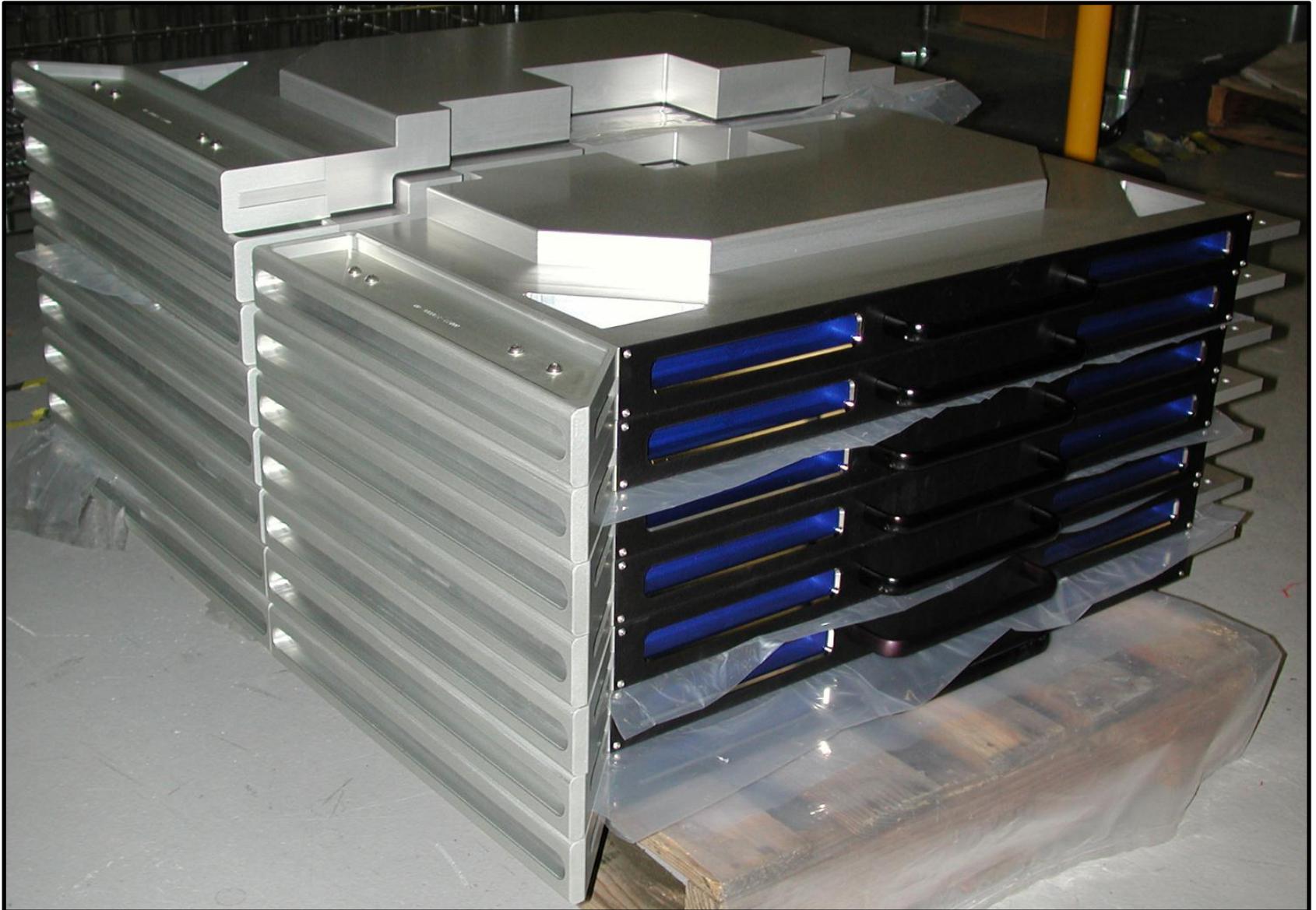
Estimate DIXI should measure ~ 350 events / resolution element in the peak on NIF

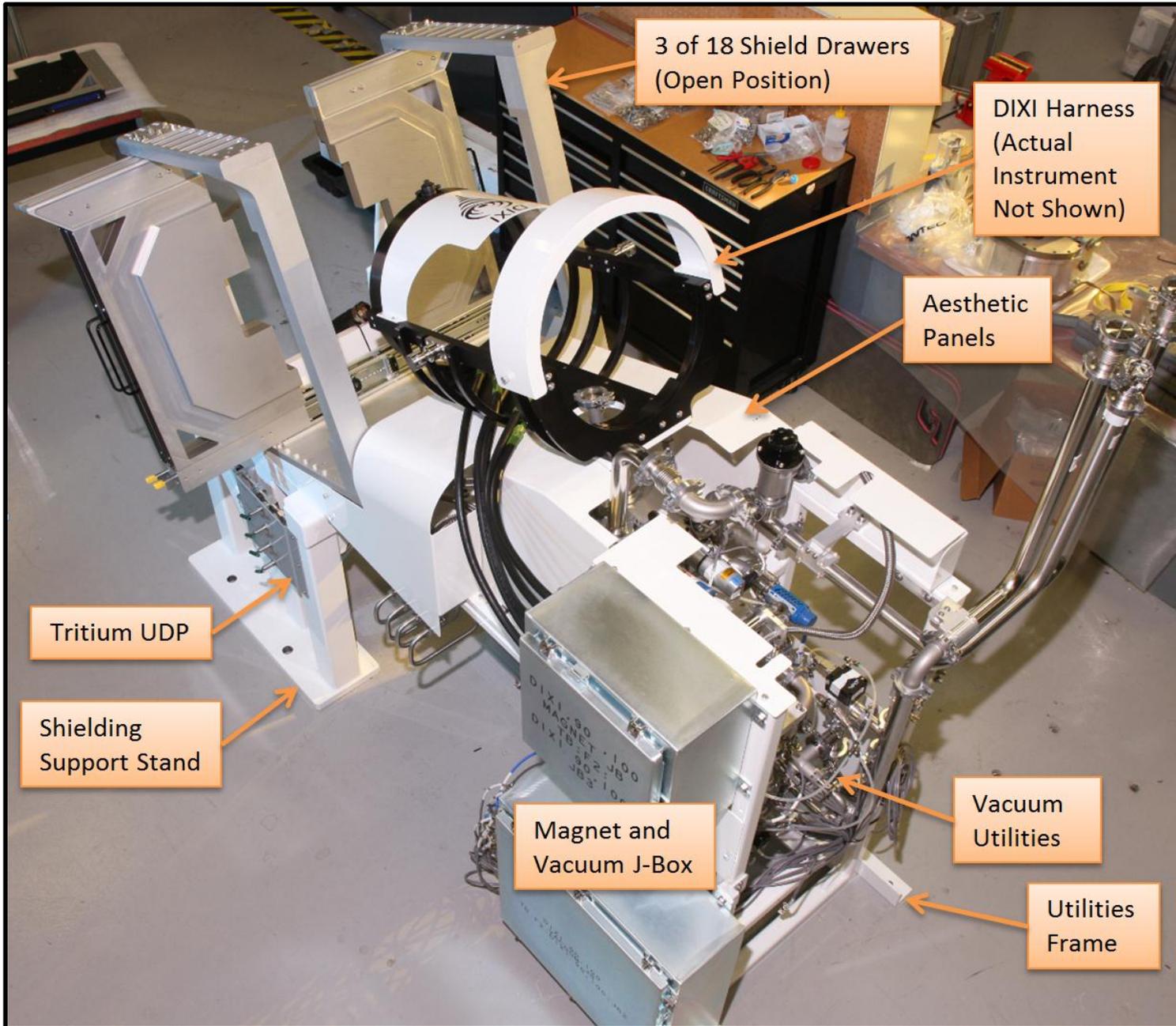


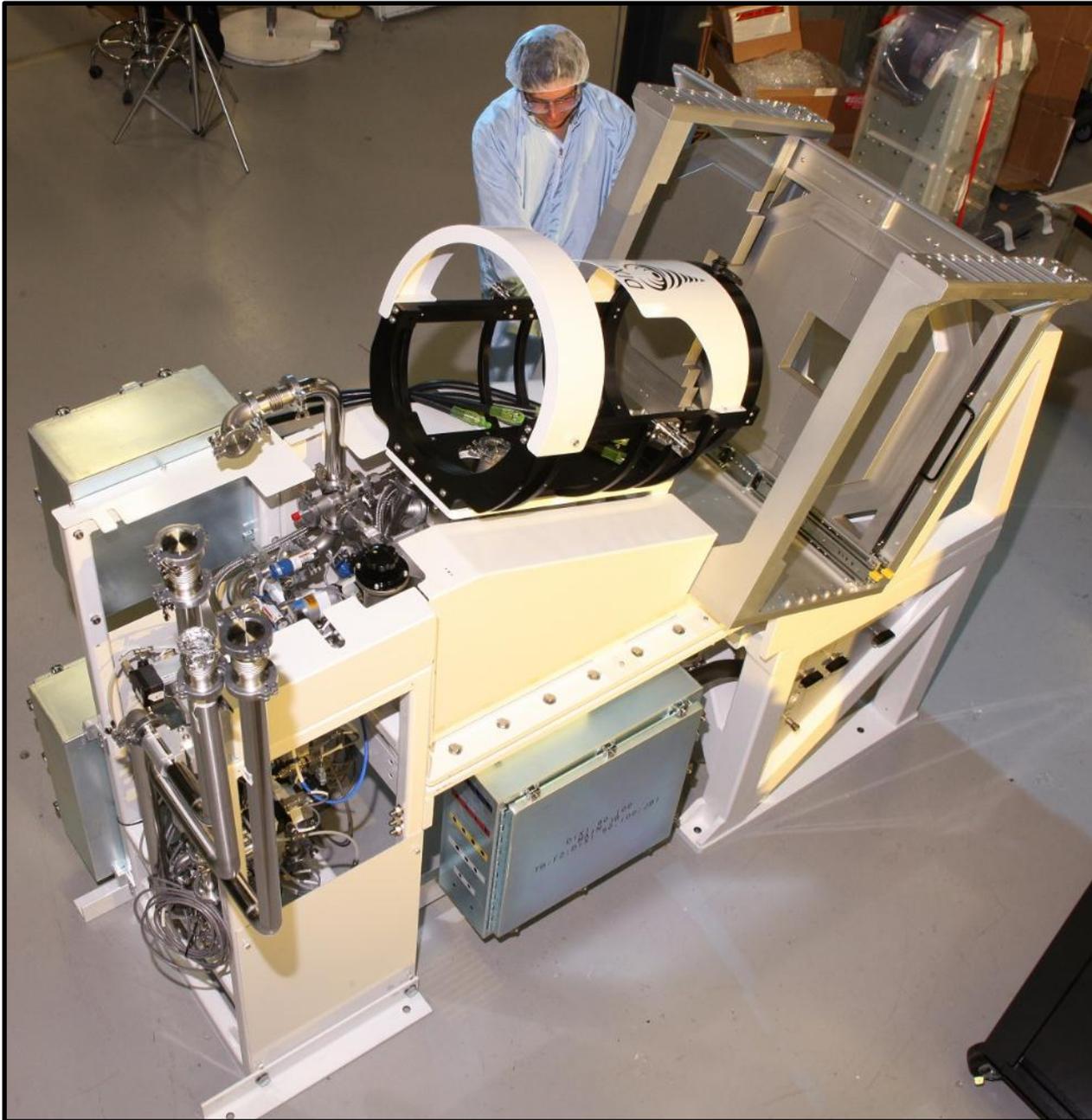
EMI Broad Cast Shield With Electronics



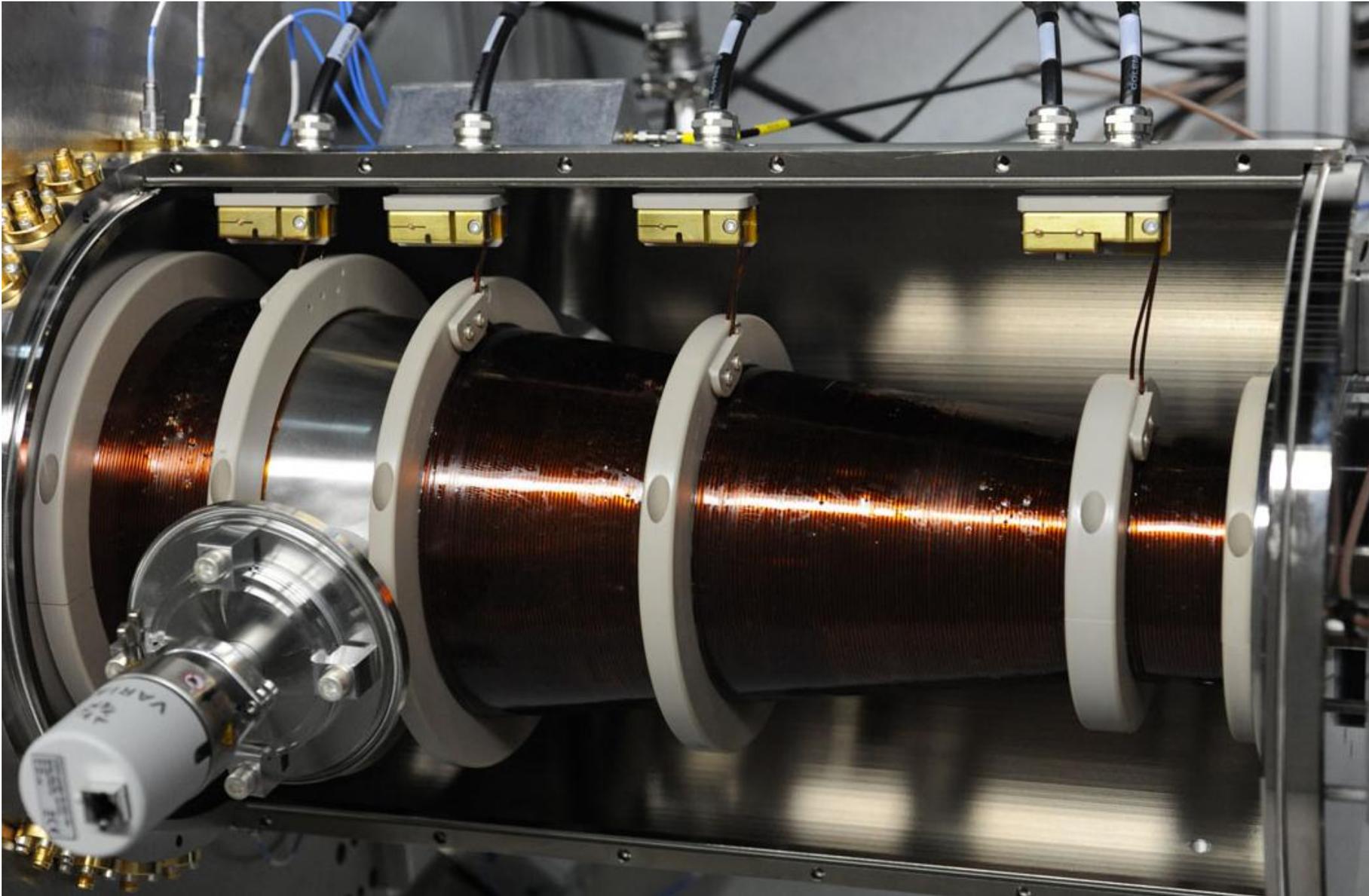
Assembled DIXI Shield Drawers





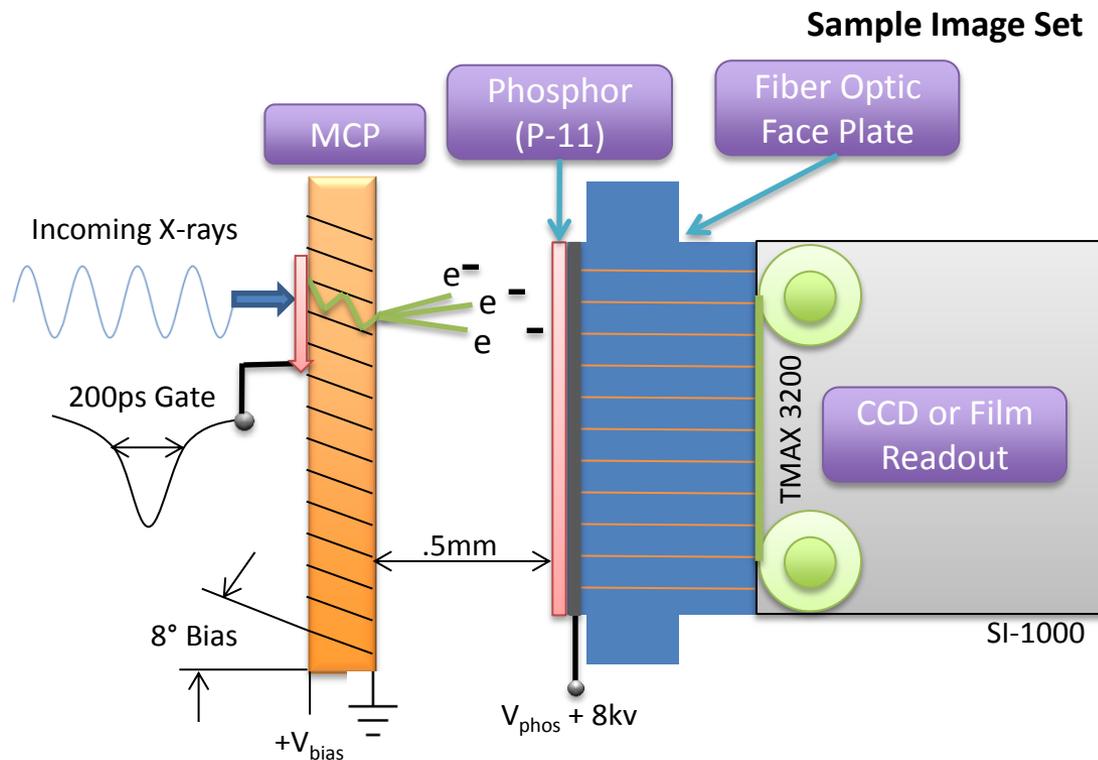
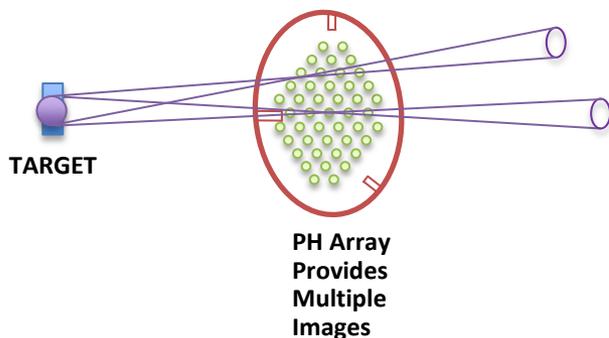
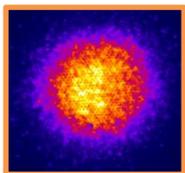






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