

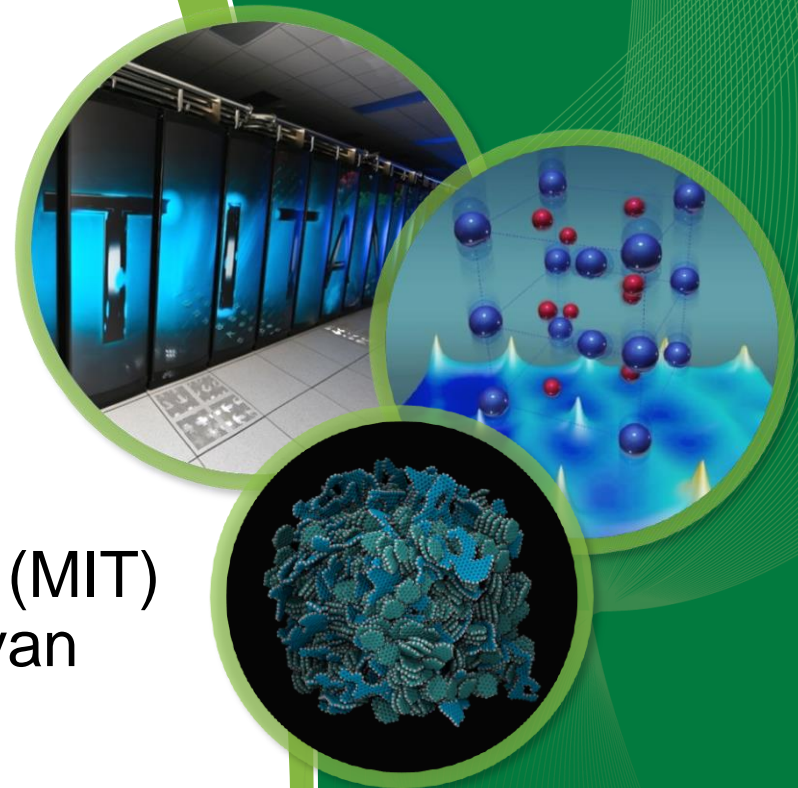
Initial Results from the NSTX-U InfraRed Video Bolometer (IRVB) ..using Alcator C-Mod

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w/ Byron Peterson (NIFS), G.G. van
Eden (DIFFER)

and NSTX-U collaborators

NSTX-U Monday Physics Meeting

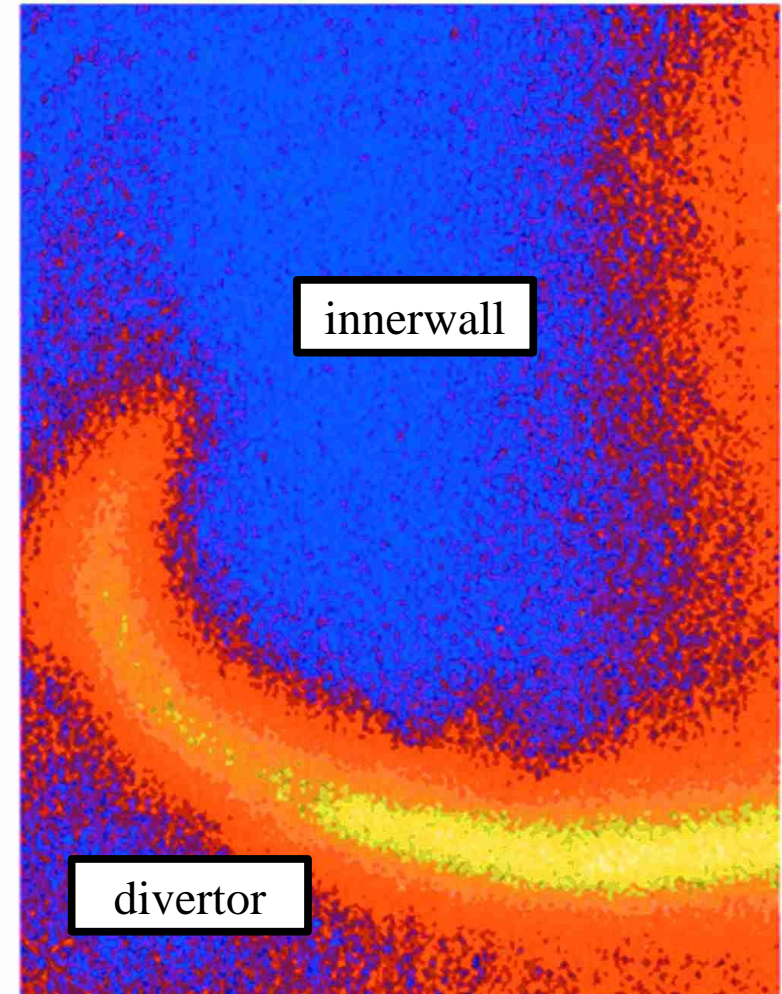
11/21/16



Infrared Imaging Bolometer Concept Pursued to Complement Planned Resistive Bolometry Tools

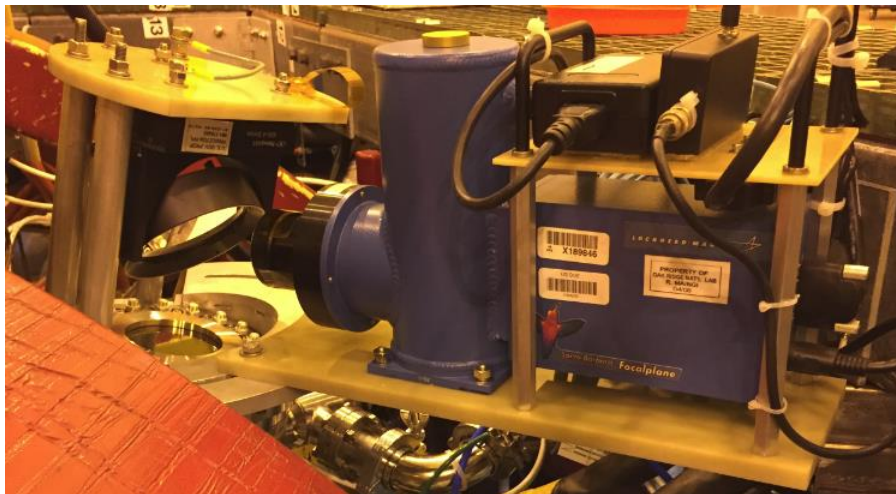
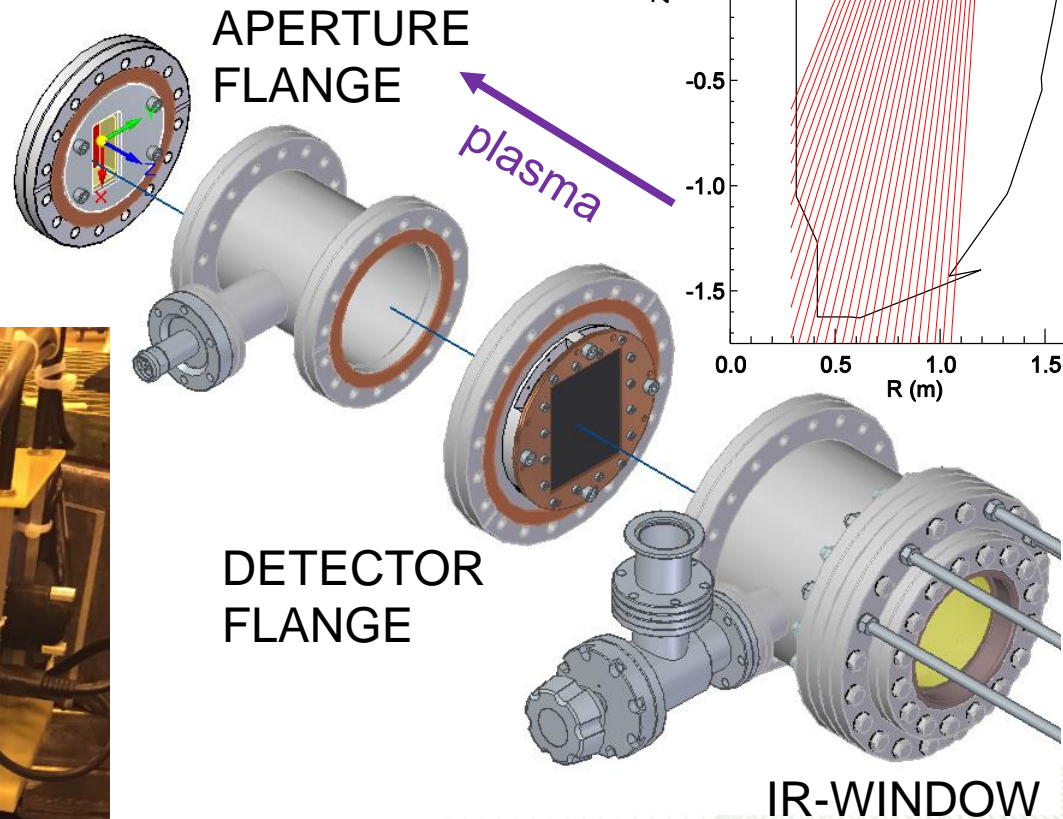
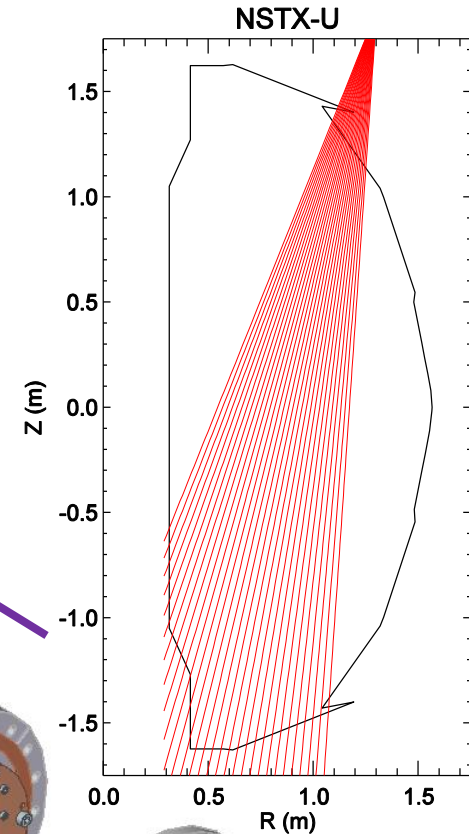
- bolometers measure radiated power through temperature rise
- resistive bolometers planned for next NSTX-U operations
 - 16 ch lower divertor system, and a 24 ch core system (FDR passed)
 - good for 1D, poloidal or tangential
- existing demonstrations of a 2D imaging concept on LHD, JT-60U and others
 - temperature rise from IR emission
- improve capabilities to measure fine-scale radiation patterns in the x-pt region, possibly asym. core

Experimental data from JT-60U



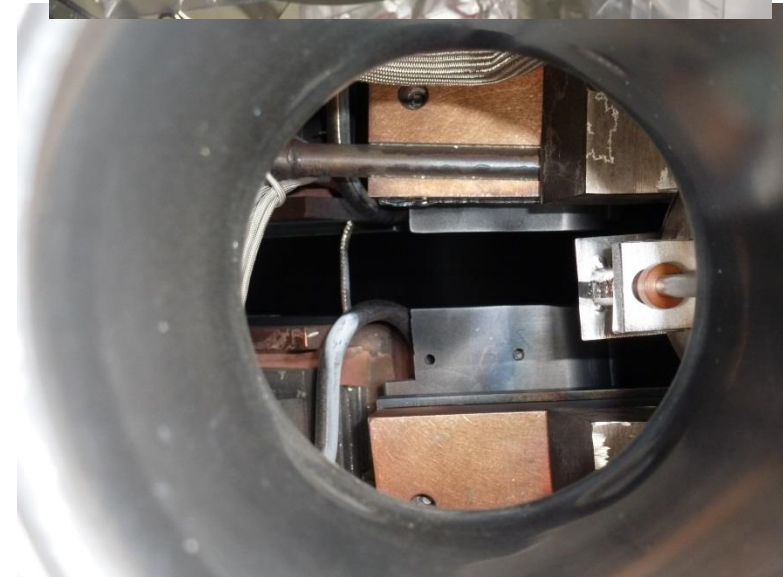
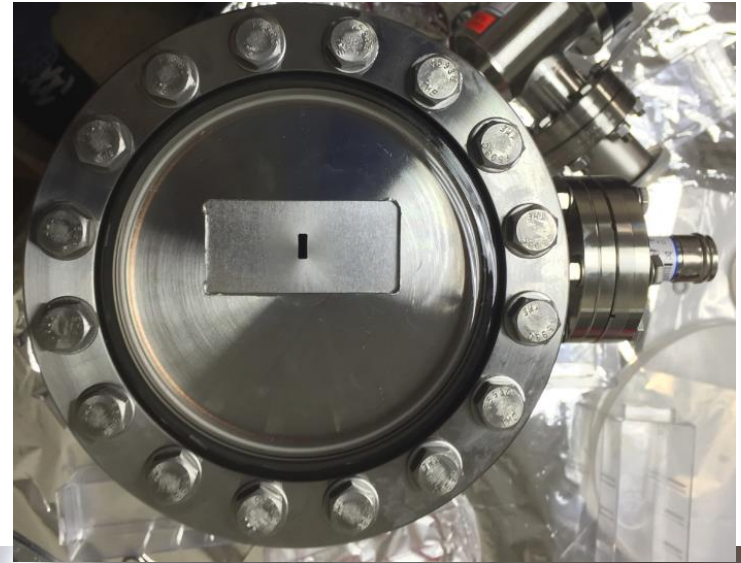
Original Design of IRVB for NSTX-U Divertor

- TIV on Bay-J Upper 'earmarked' for IRVB prior to pre-FY16 pump down
 - before 6/15, plan to test IRVB using ORNL upper divertor IR camera 128x128 1.6 kHz (LN₂ filled)
- system designed, built, installed operated but no plasma images
 - installed in May, camera gated off by TF in June
 - removed in early Aug.



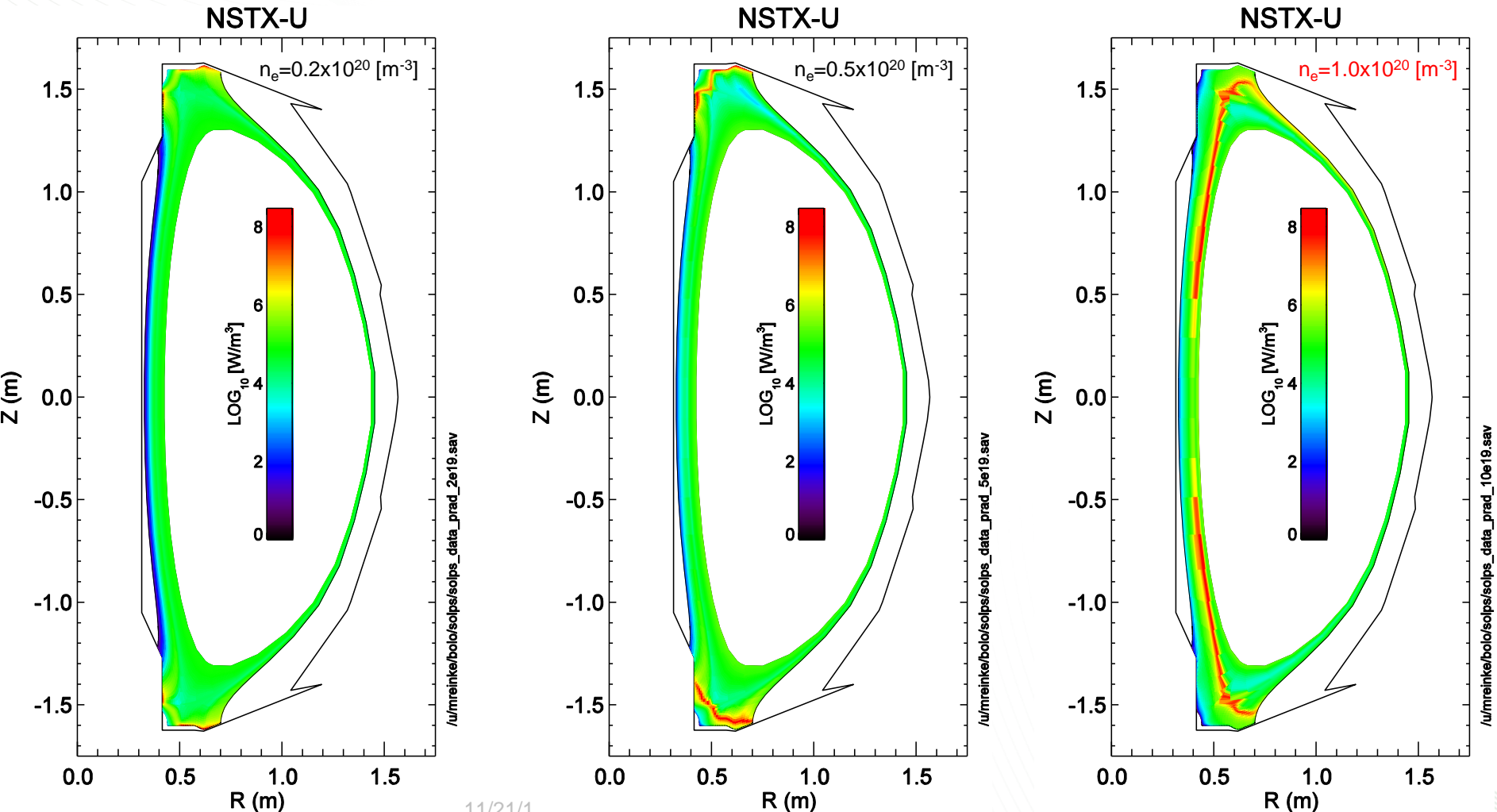
FY16 Prototype Limited to 1D Poloidal View

- viewed through window on Bay-J Upper TIV to examine in-vessel structures
 - upper primary passive plate limits view (damn you VDEs!)
 - gap is not aligned with center
- aperture flange required fixed offset to avoid being collimated
 - used holes in tiles as local ruler to estimate offset



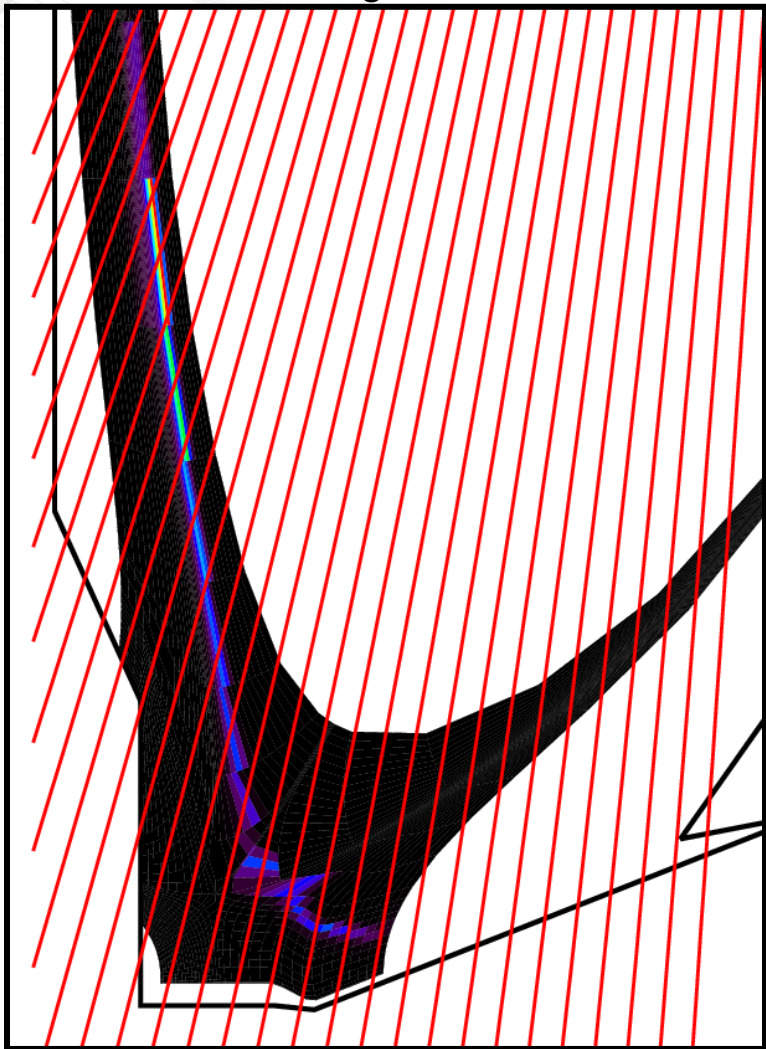
Signal Scoping Using SOLPS Simulations

- density scan at 10 MW to access different divertor regimes
- results show movement of narrow radiation features

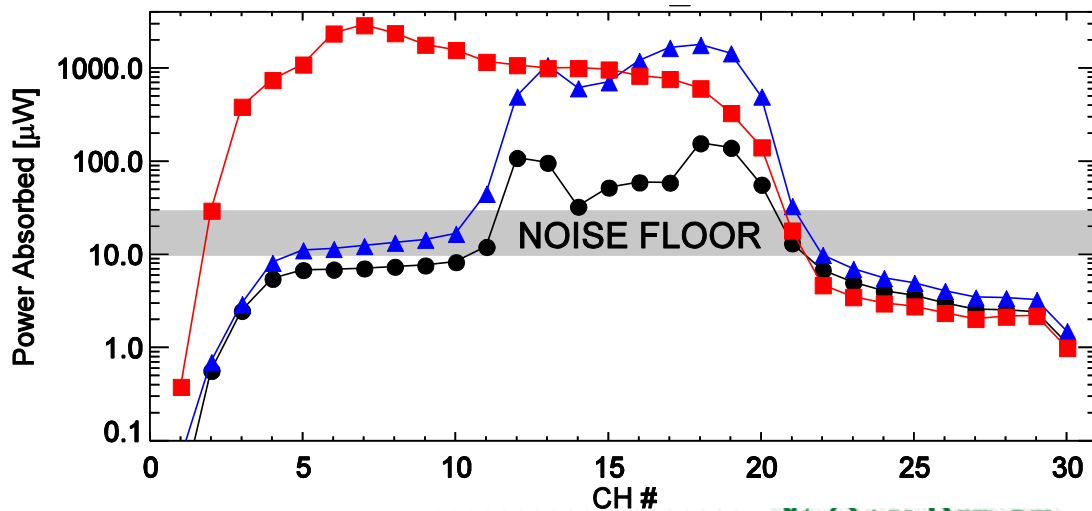
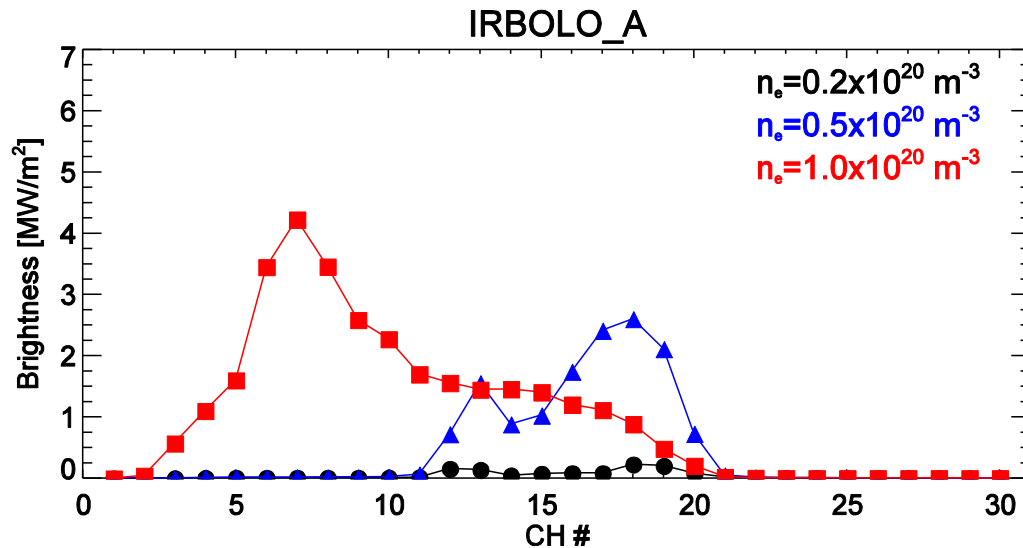


Good Signal to Noise from Divertor Radiation

→ increasing CH#

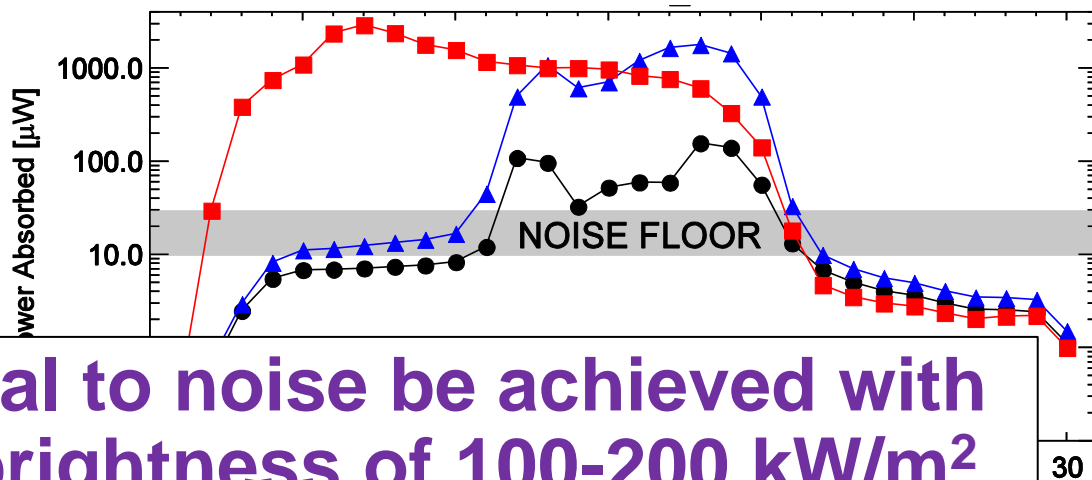
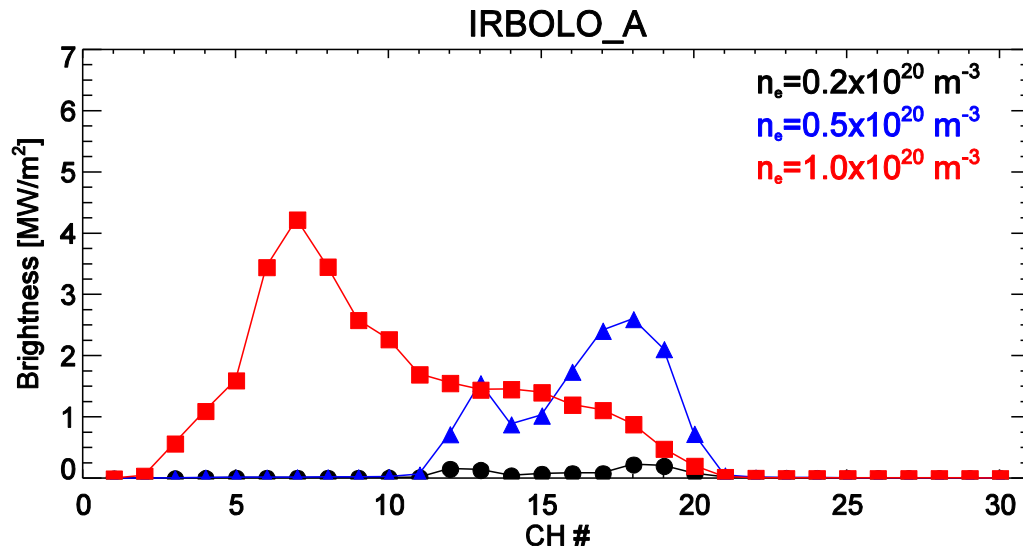
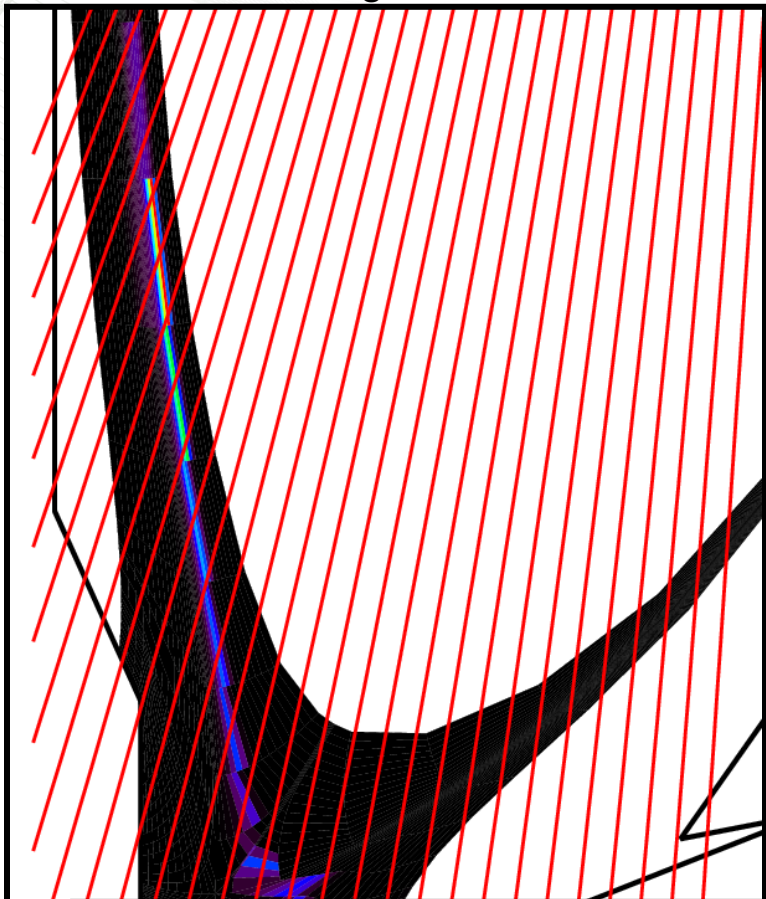


$n_e = 1.0 \times 10^{20} \text{ m}^{-3}$



Good Signal to Noise from Divertor Radiation

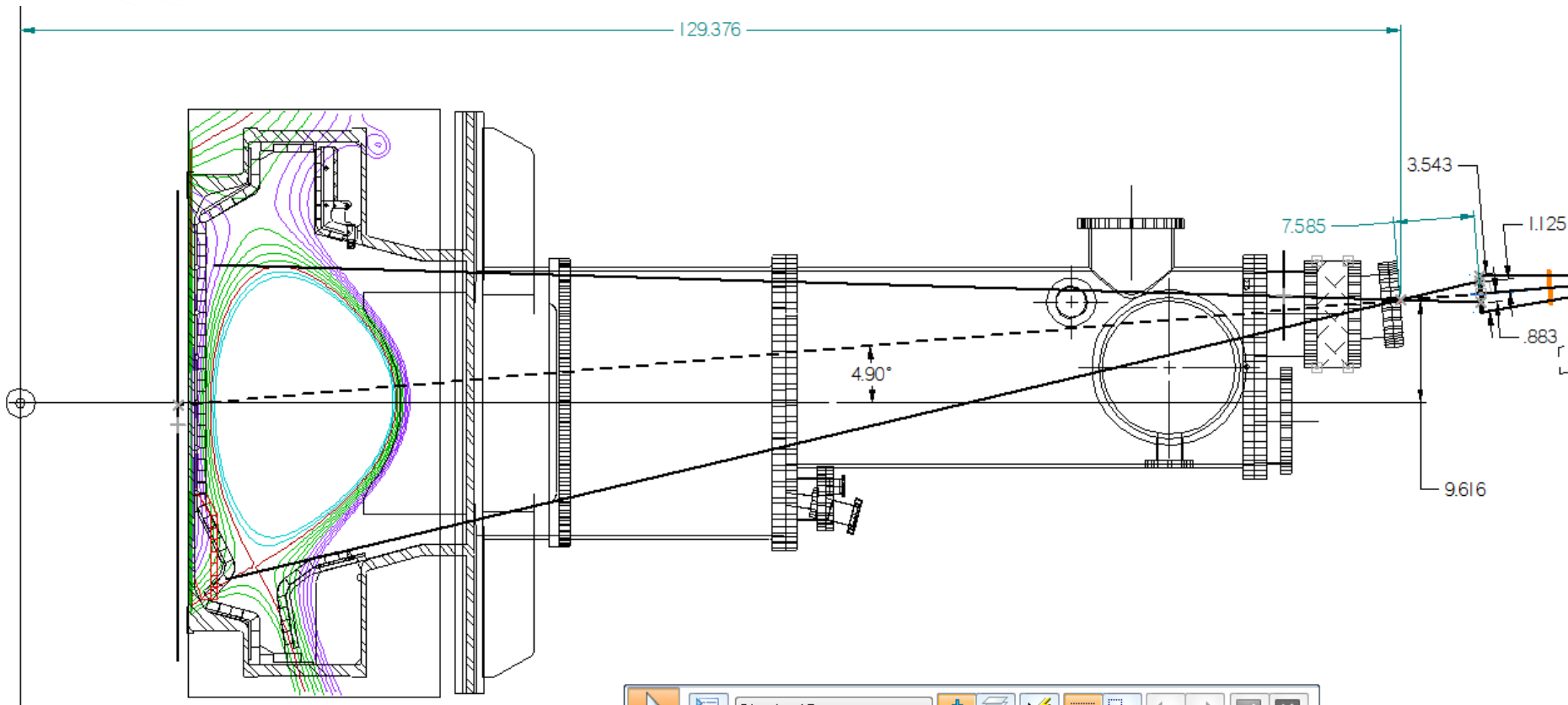
→ increasing CH#



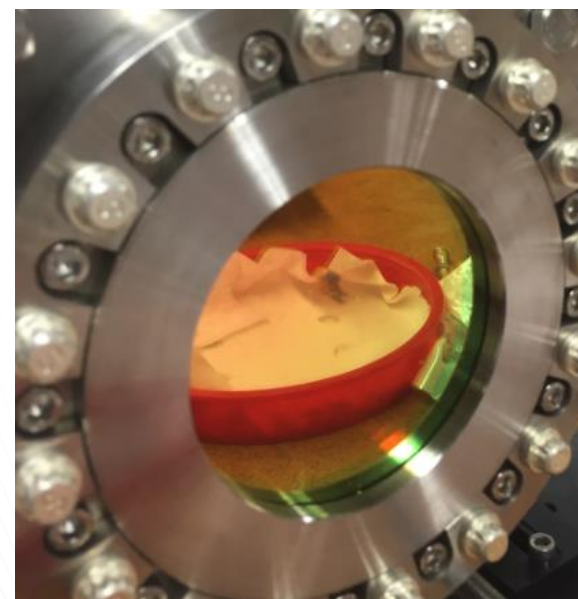
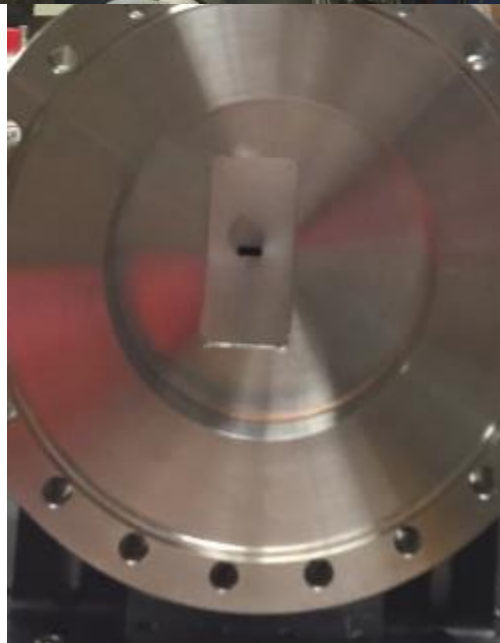
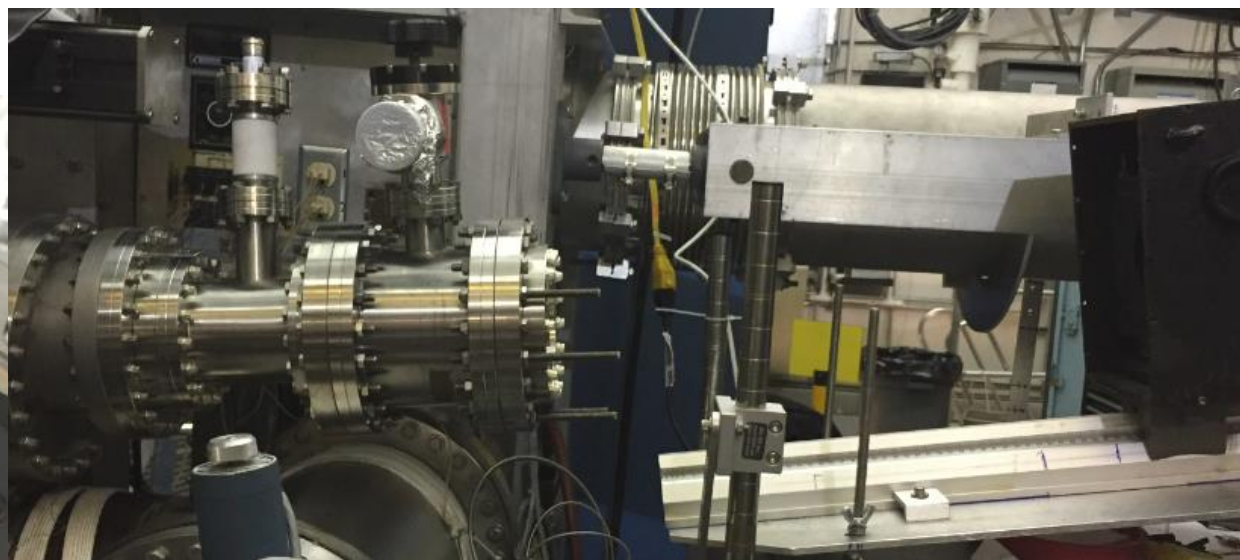
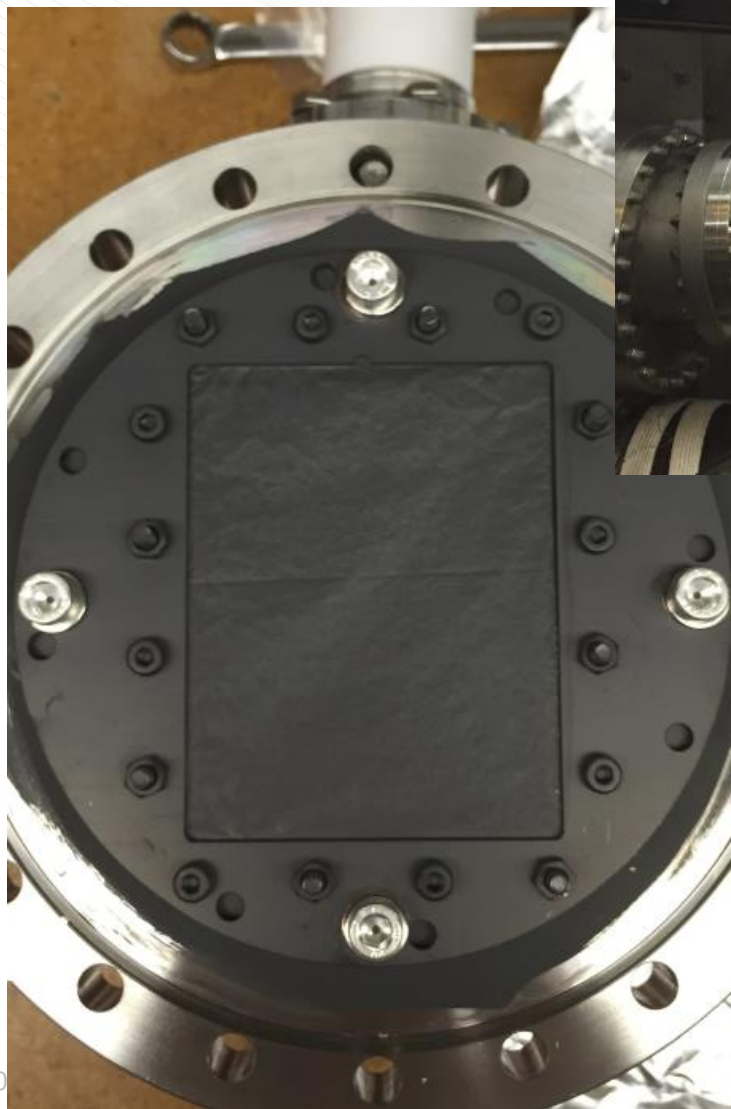
Could decent signal to noise be achieved with a line-integrated brightness of 100-200 kW/m²

Layouts Indicated Alcator C-Mod Could Provide This Initial Demonstration

- use the SC7000 IR camera used for inner divertor heat flux
- C-Mod core P_{RAD} ranges from 0.1-3.0 MW (various regimes)
 - ~1 m³ volume, ~40 cm path length, 40-1200 kW/m² brightness

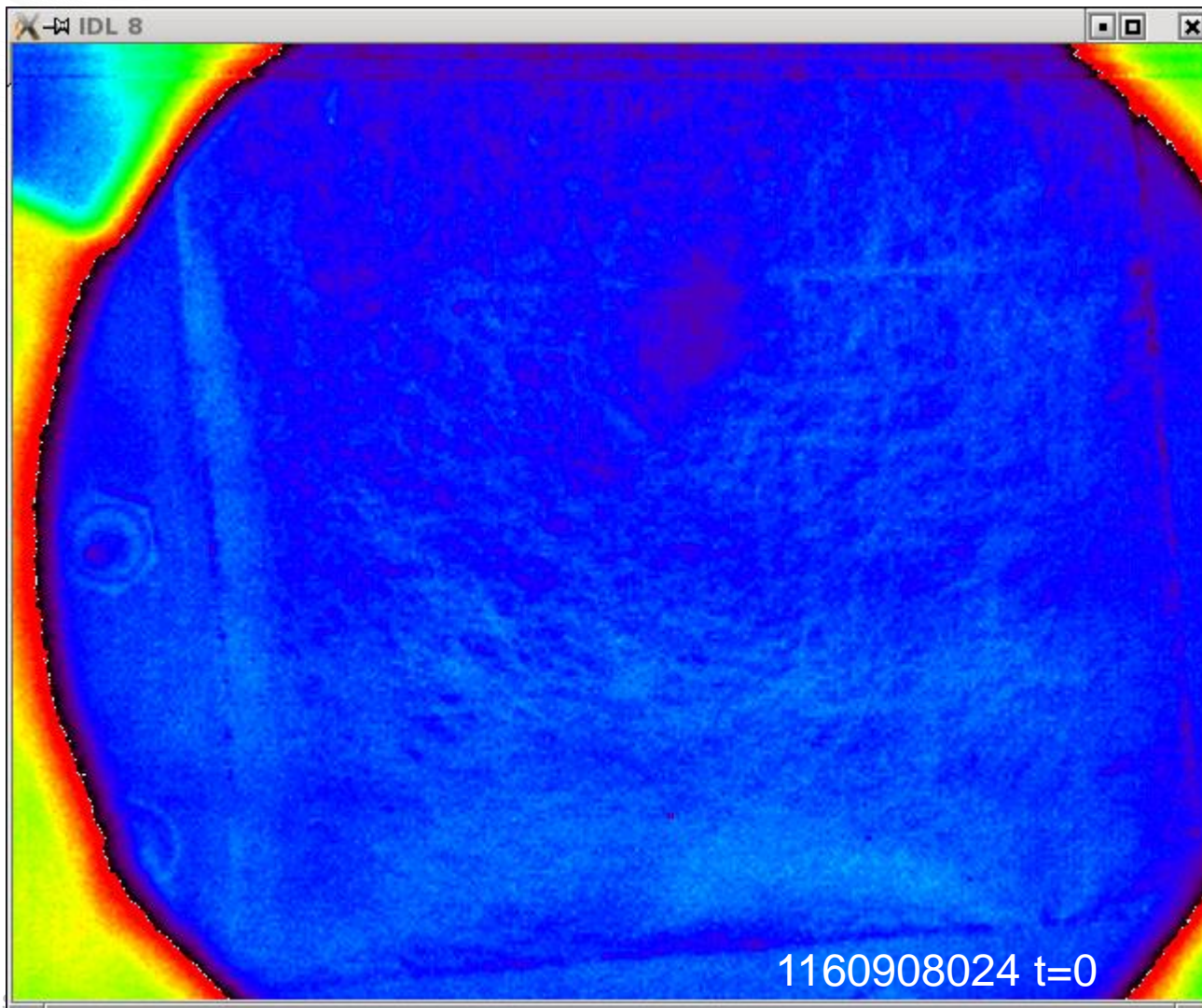


IRVB Rebuilt at C-Mod and Installed 9/06/16



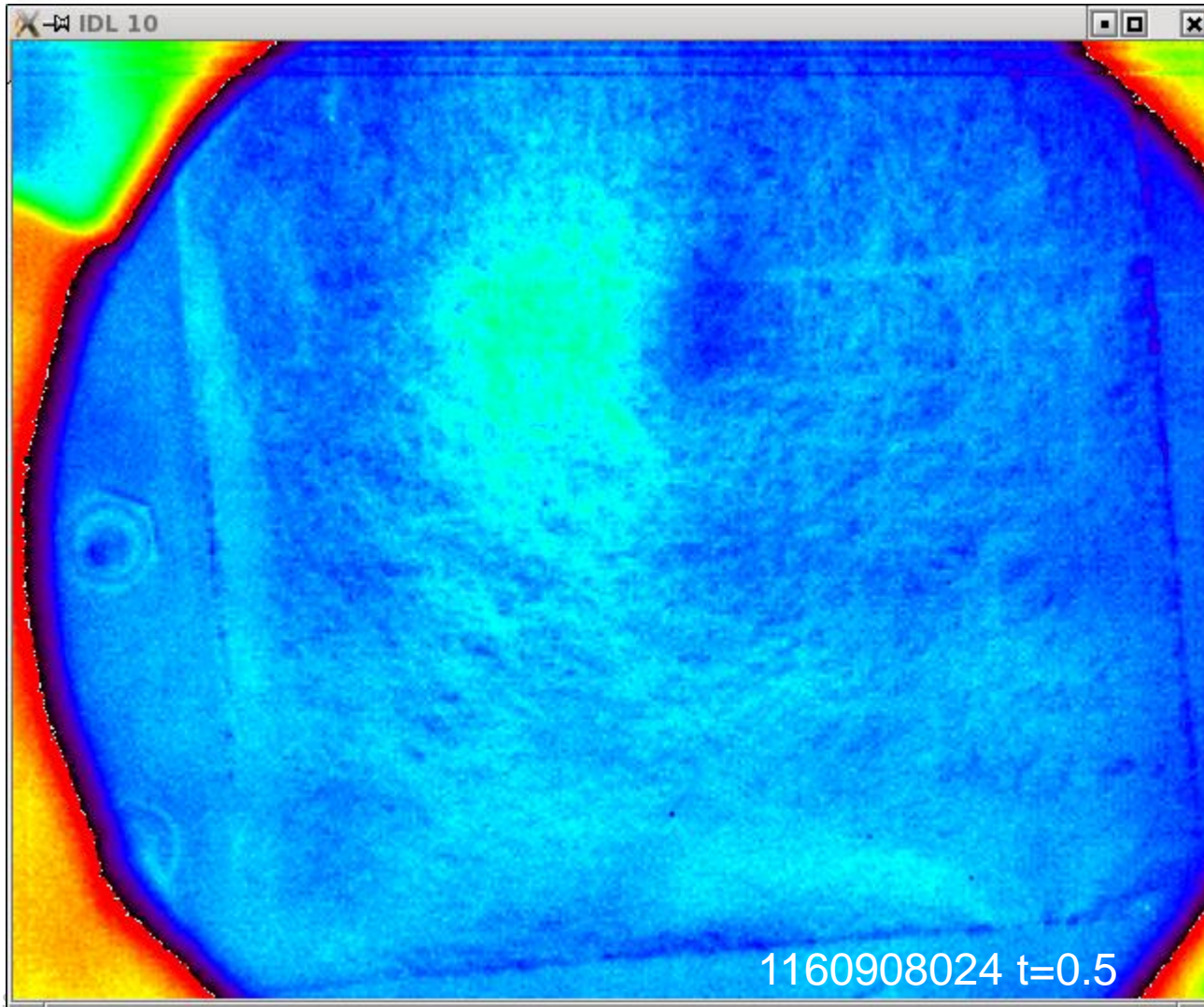
IRVB Operated on 1160908, 1160909

- 380 Hz full-frame on 1160908, 1 kHz slice on 1160909



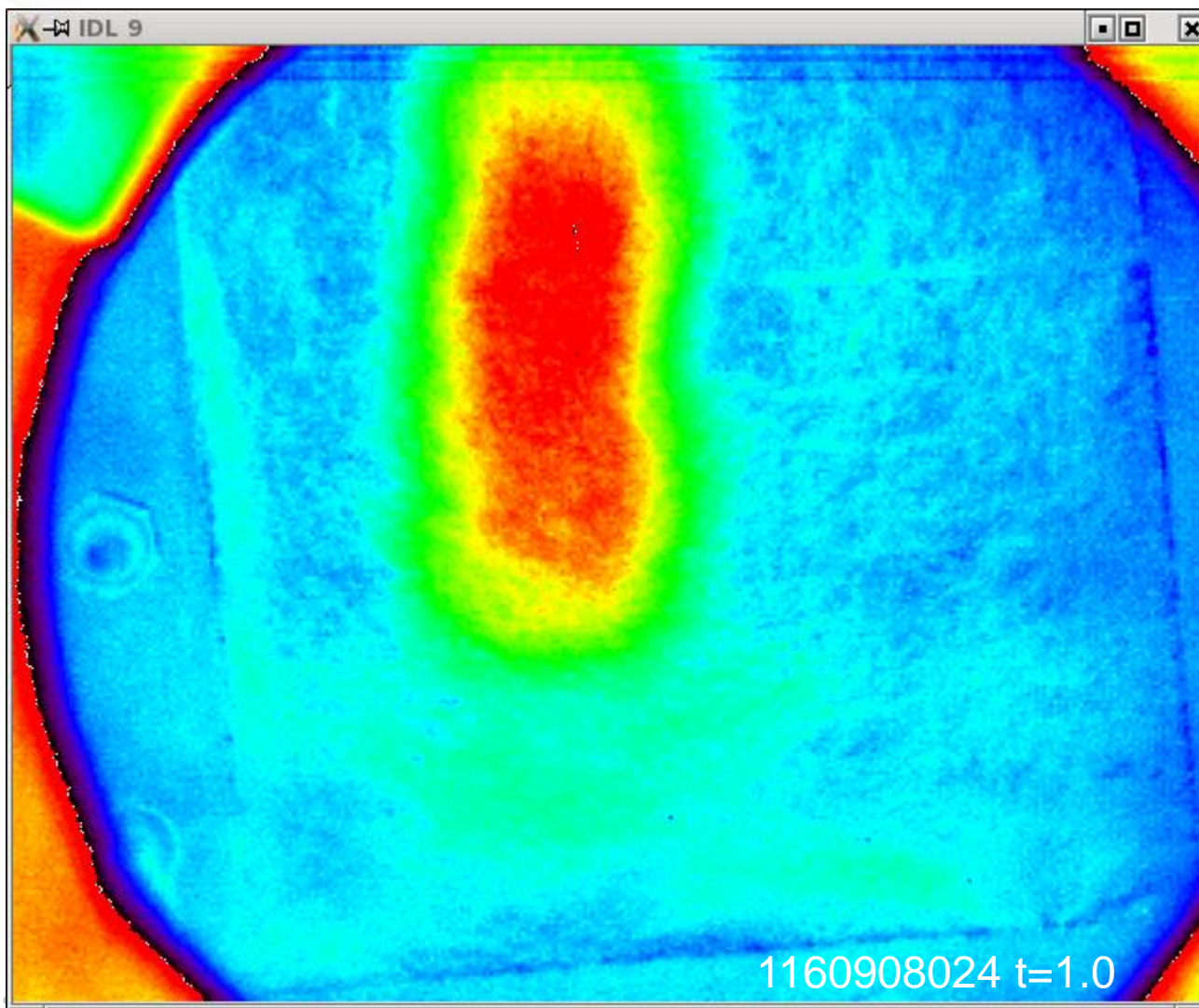
IRVB Operated on 1160908, 1160909

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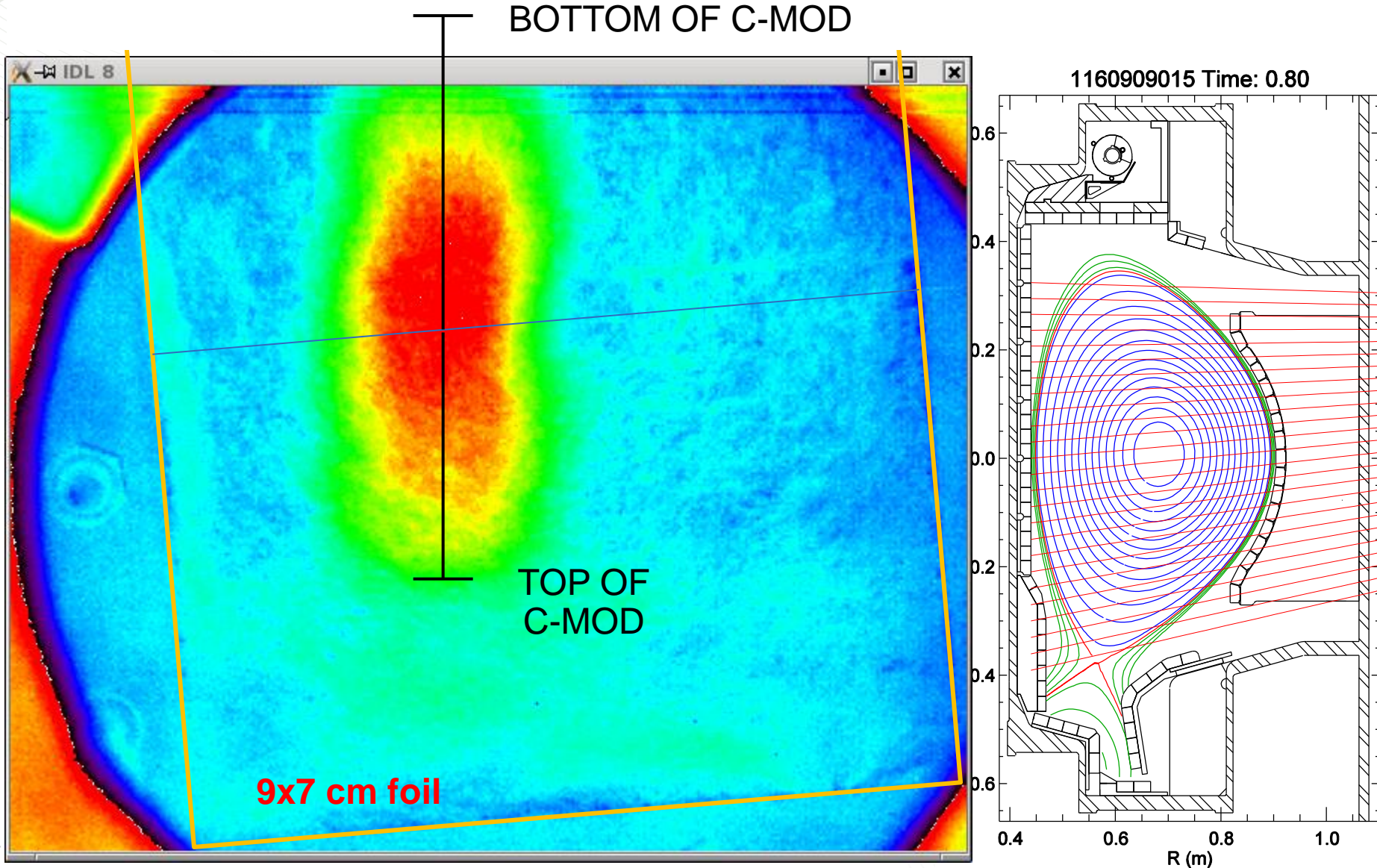


IRVB Operated on 1160908, 1160909

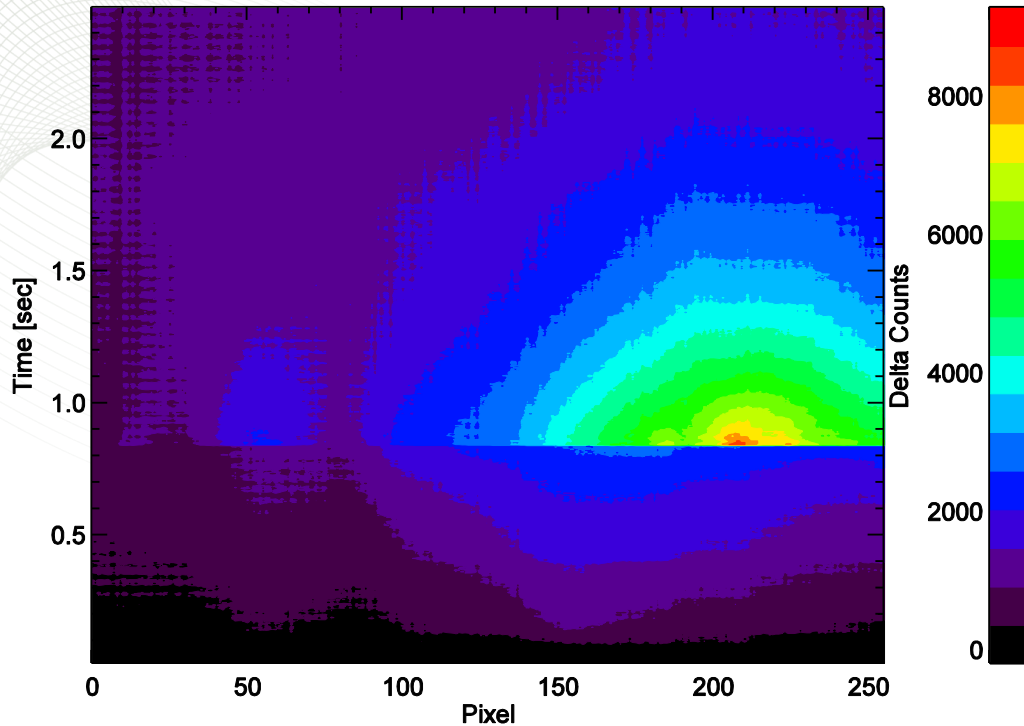
- 380 Hz full-frame on 1160908, 1 kHz slice on 1160909



Initial FOV Calculations Show Get the Core, but Just Miss the Lower Divertor

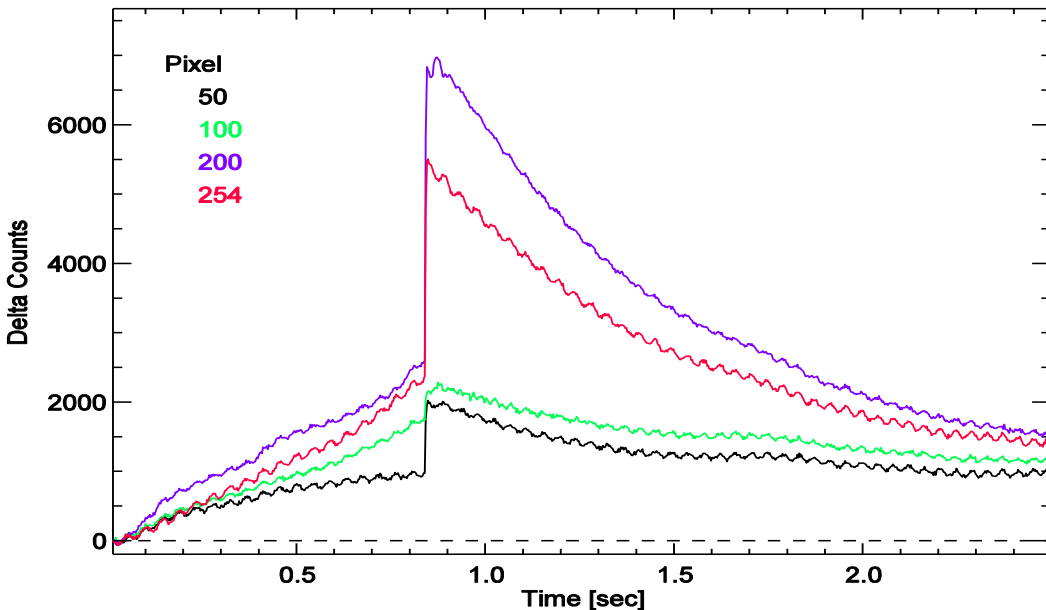


C-Mod IRVB 1160908014



Initial Observations

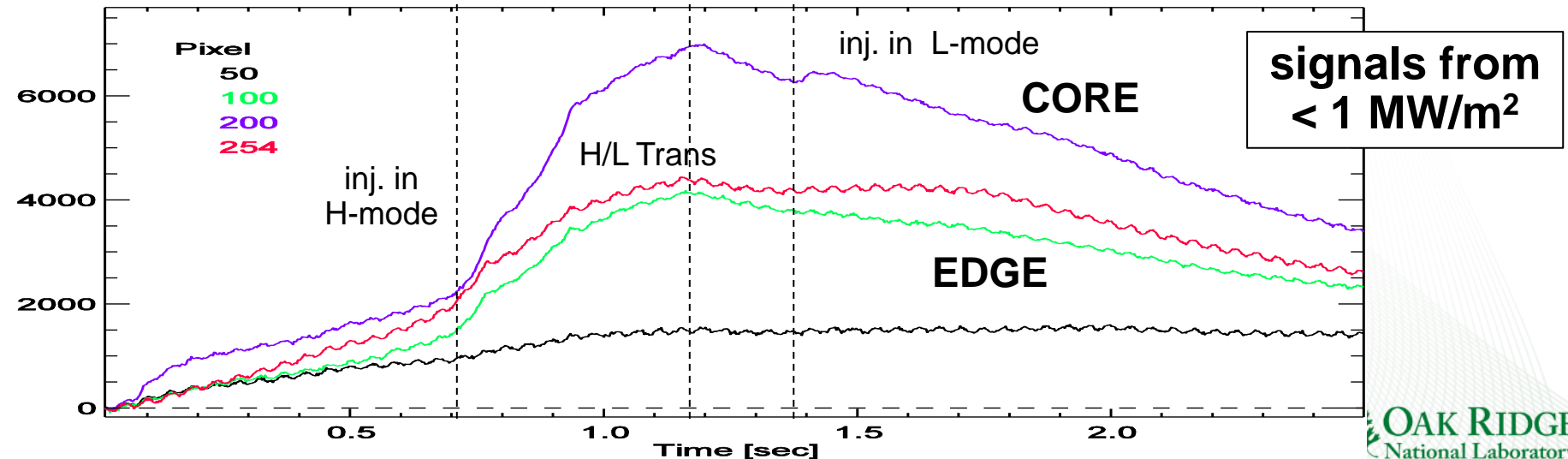
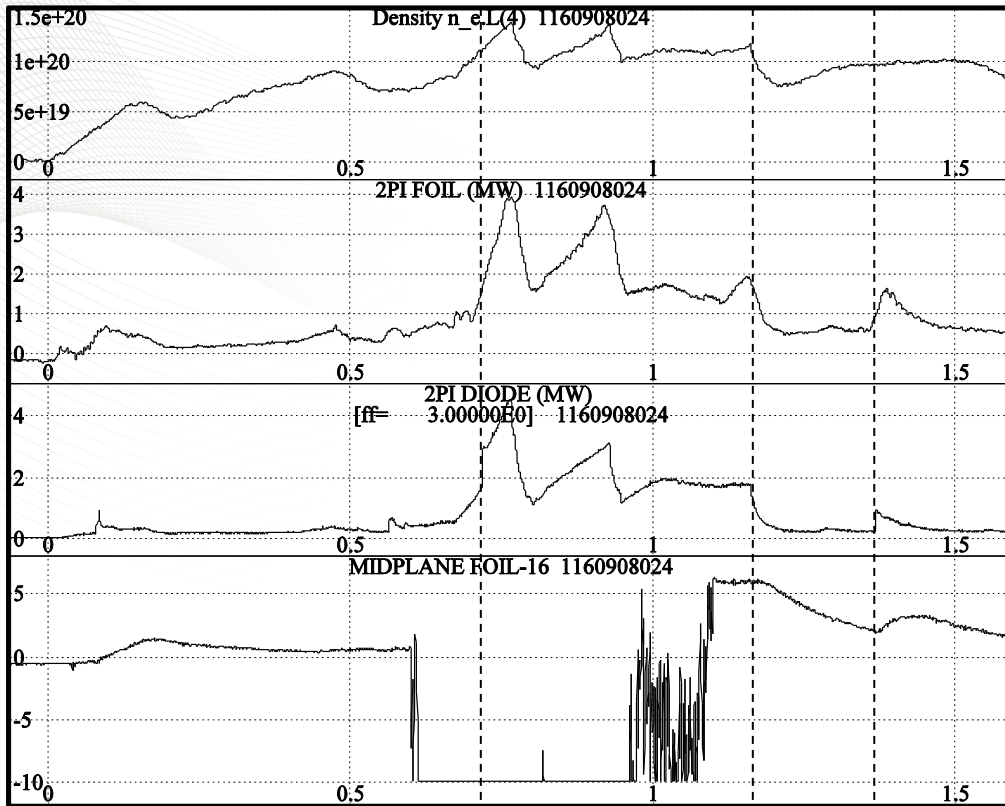
- averaging over 16 columns to raise SNR
- survives 1.3 MA disruptions just fine
 - worried about p_{NEUT}
- system has a very long time constant
 - locks in disruption radiated energy pulse
 - good for radiation asym.



mechanical oscillations
apparent in data

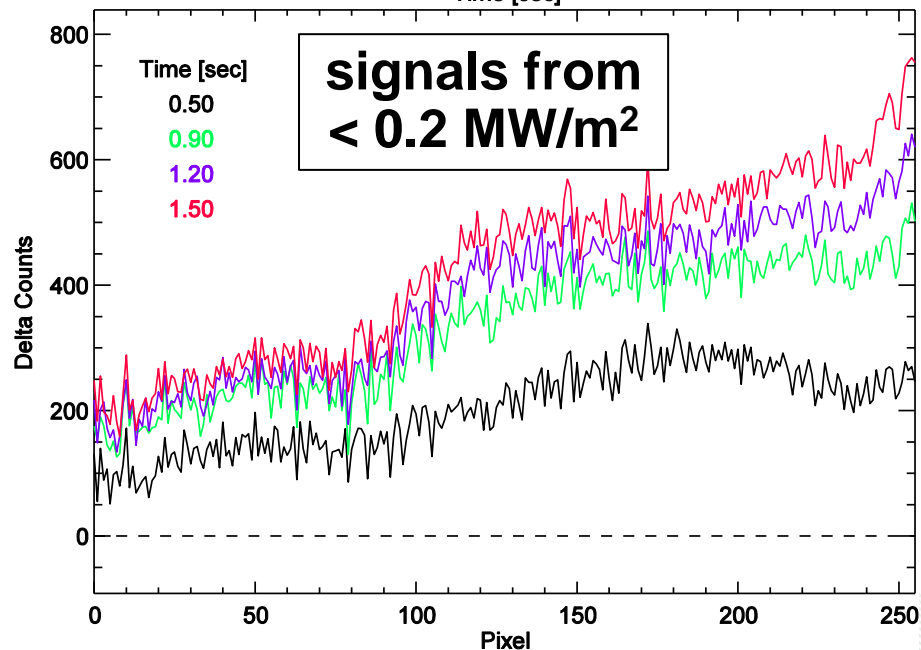
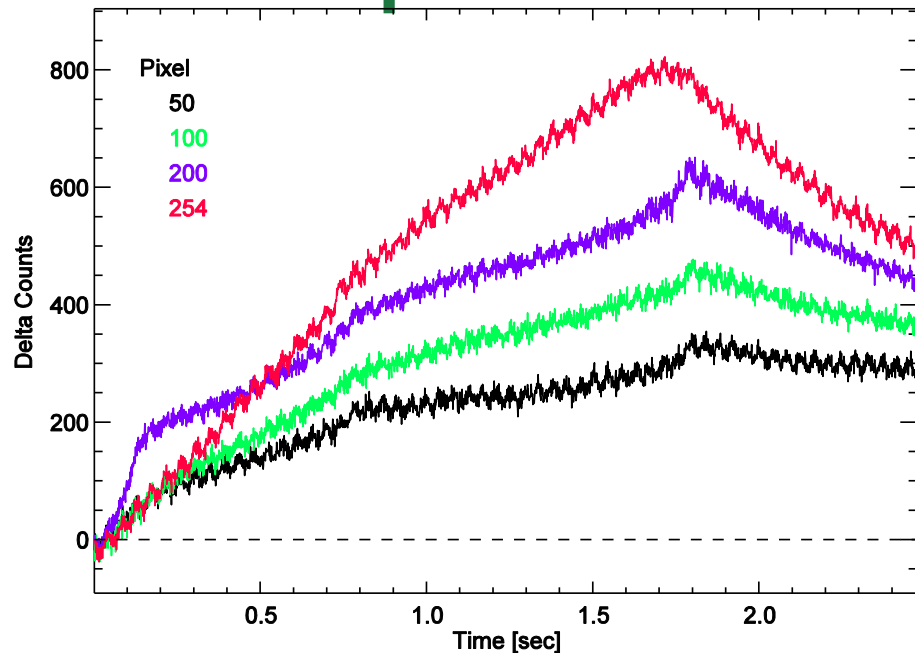
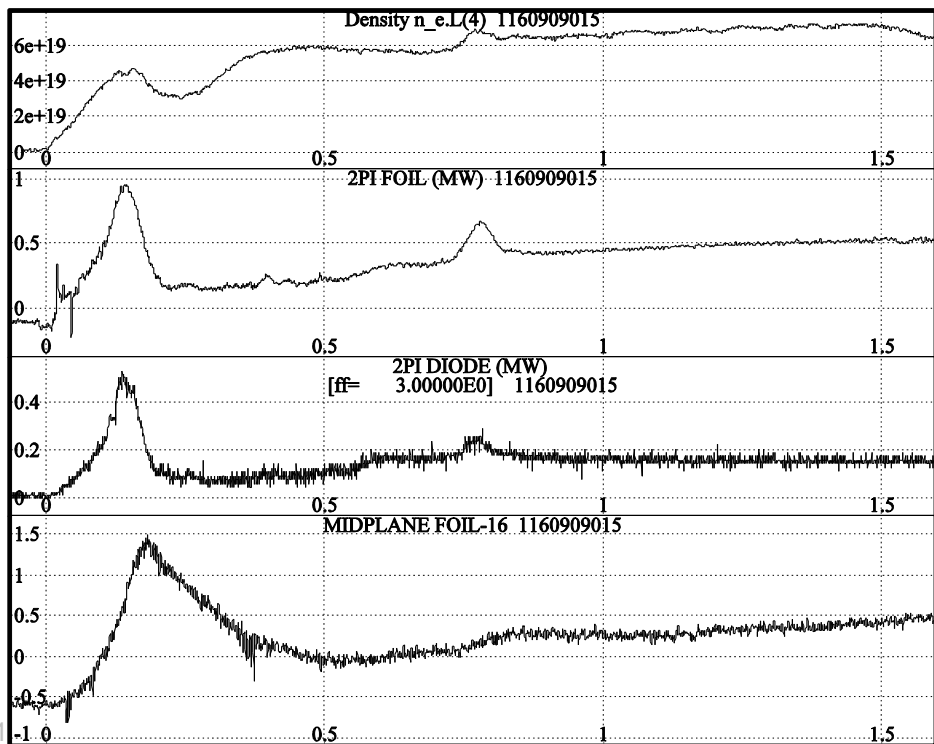
Initial Observations

- averaging over 16 columns to raise SNR
- survives 1.3 MA disruptions just fine
 - worried about p_{NEUT}
- system has a very long time constant
- not impacted by ICRF



Ohmic Phases for Res. Bolo. Comparison

- many 1160908 shots had W LBO into Ohmic
- pre-RF times on both days
- 1160909015 had no RF
- will stress the noise limits



Future Work for IRVB

- post FY16 ops, need to calibrate the IR camera w/ the IRVB
 - need to turn change in ‘counts’ into temperature for the IRVB configuration – can’t just use the same calibration
 - would like to test integrated system using laser (5 mW) to demonstrate a known power flux can be recovered vs. time
- IRVB is up at MIT for now and planning Dec. visit for calib.
 - IRVB hardware will return to PPPL, continued testing in outage
- data will be valuable in understanding the time resolution limits of IRVB, development on NSTX-U and elsewhere
 - if calibrations go well, likely get an RSI out of C-Mod data
- MAST-U interested in x-point region IRVB, and ORNL has started a boundary physics collaboration
- ‘Category-1’ from measurement innovations call into OFES for development of a new, segmented IRVB absorber