NSTX

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Some NSTX Halo Current Results

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Thanks to Larry Guttadora, Eric Fredrickson, Hiro Takahashi, Bob Kaita, Henry Kugel, Adam McLean

Late 2010 / Early 2011 Results Review

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Colorado Sch Mines
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INEL
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Nova Photonics
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Think Tank, Inc.
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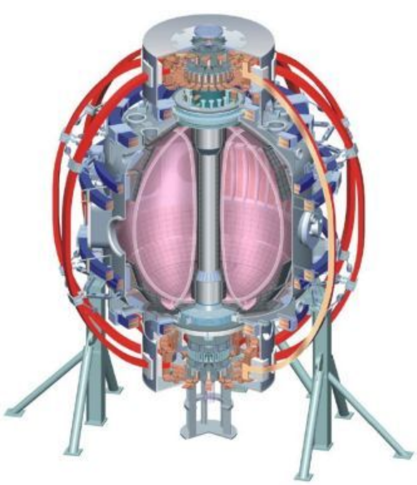

Culham Sci Ctr
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ENEA, Frascati
CEA, Cadarache
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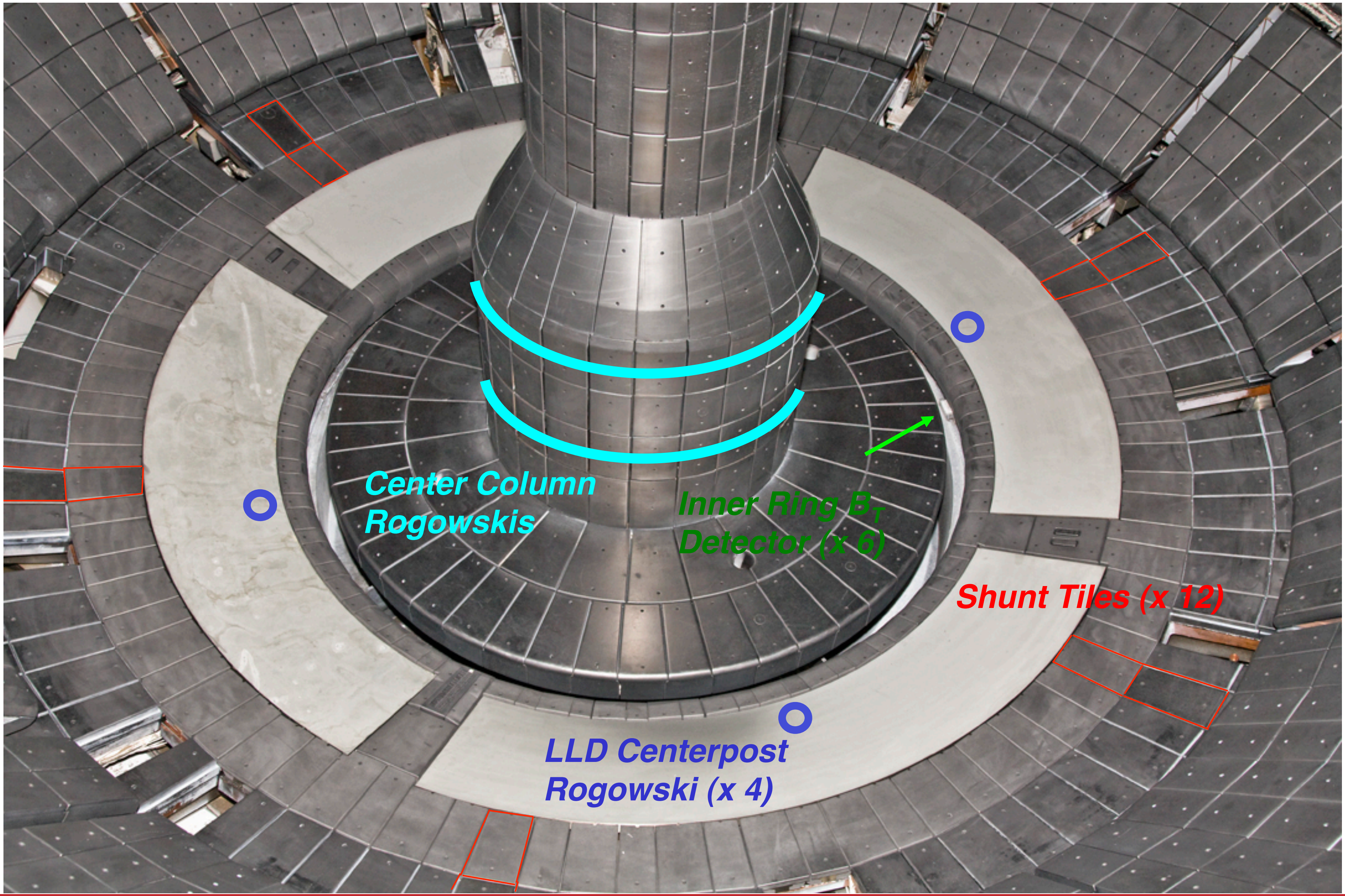
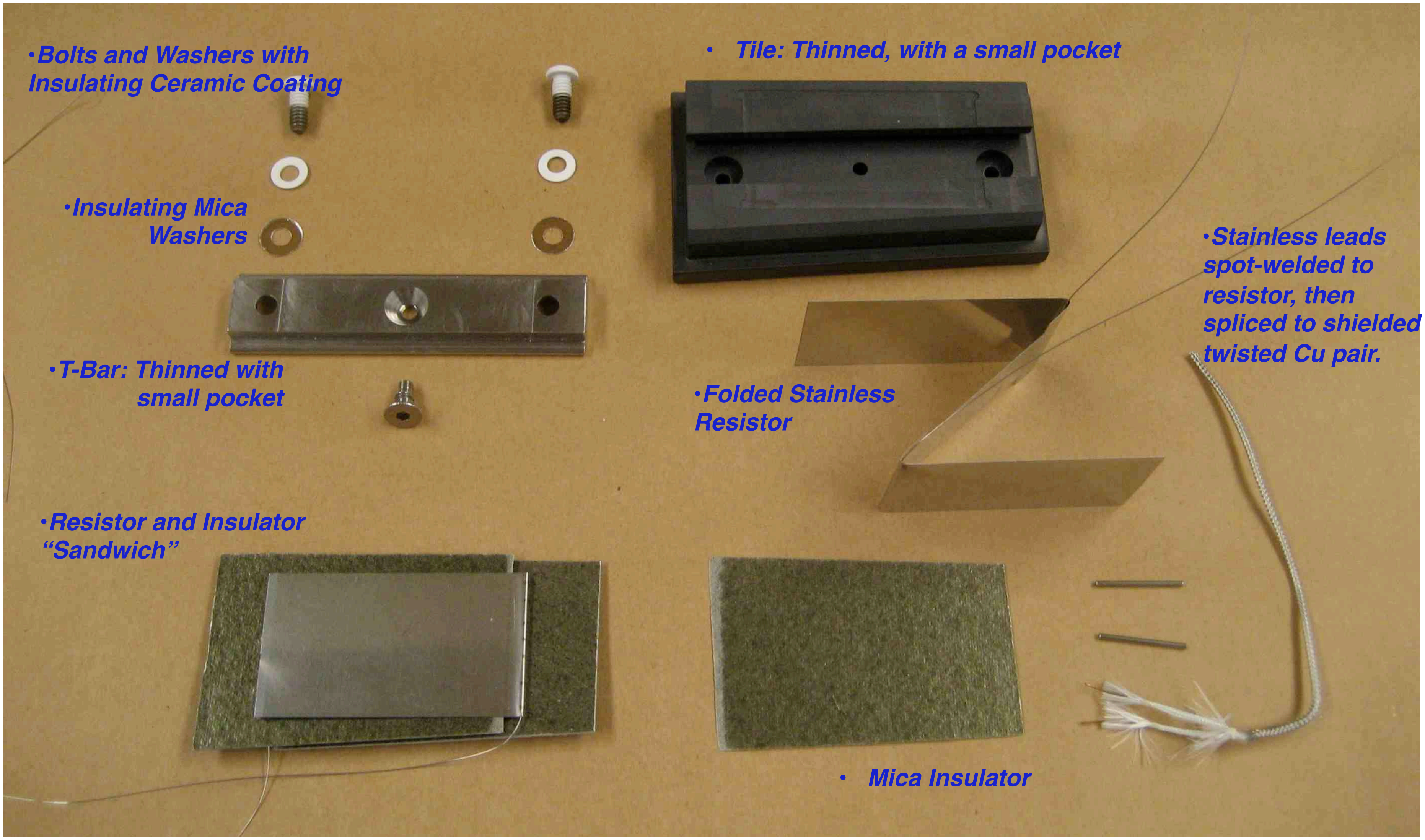
ASCR, Czech Rep
U Quebec

Diagnostic Distribution

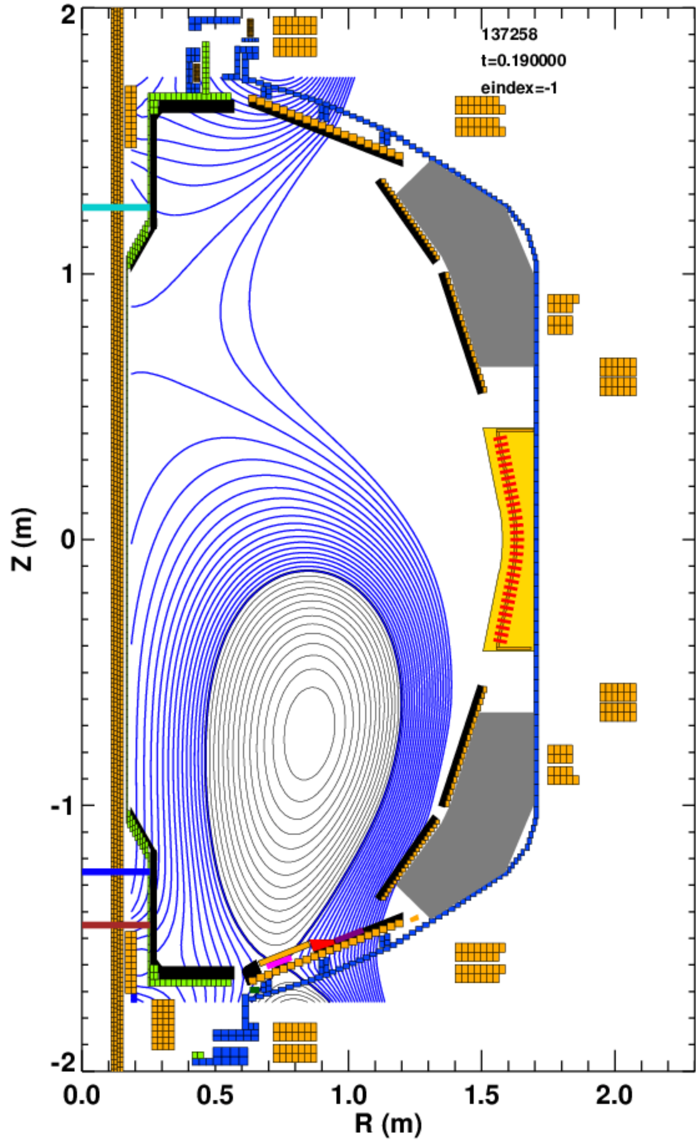


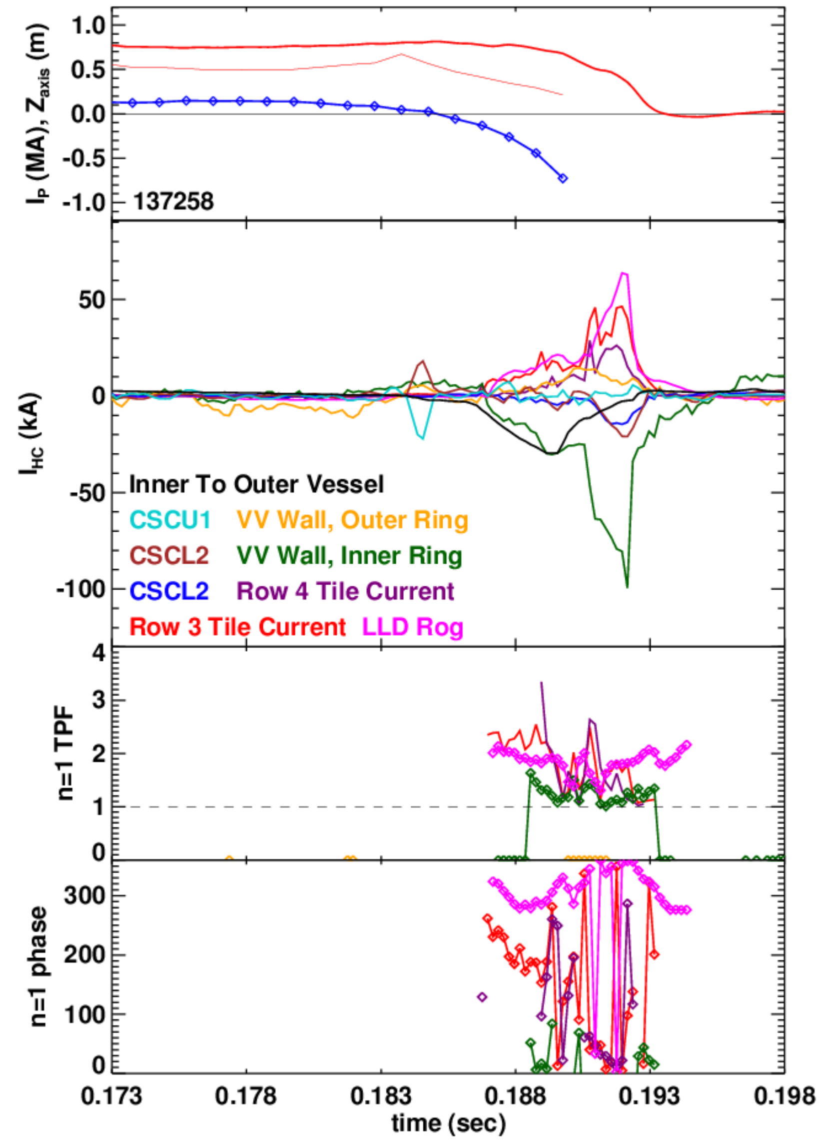
Compact Current Shunts Fit Directly Beneath Tiles



Design by Stefan Gerhardt, Larry Guttadora, Eric Fredrickson, and Hiro Takahashi

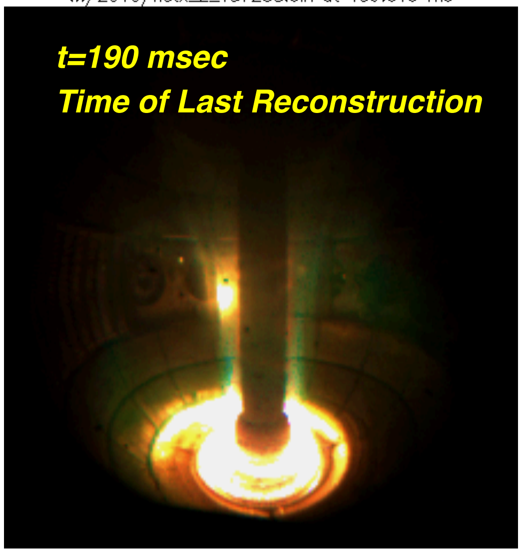
Example: Downward VDE
Largest Currents For Inner Ring Detectors (137258)



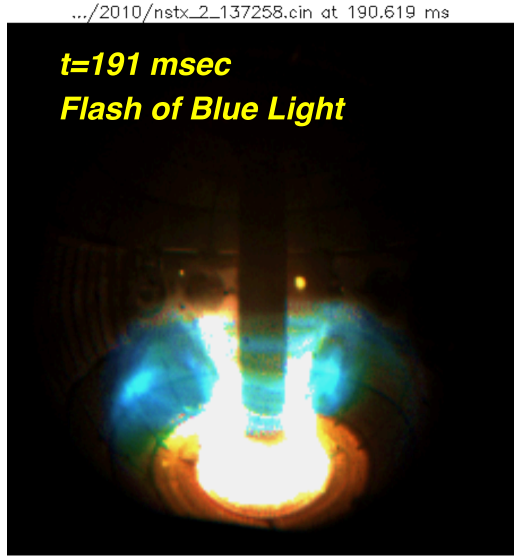


Halo Widths Can Be Quite Large (137258), and Plasma Shorts-Out the CHI Gap

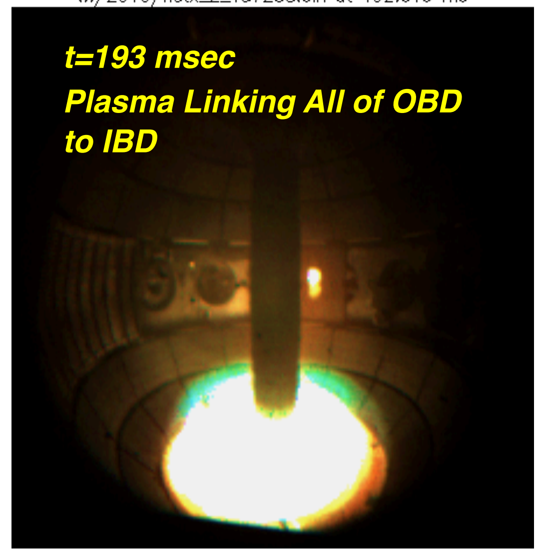
.../2010/nstx_2_137258.cin at 189.619 ms



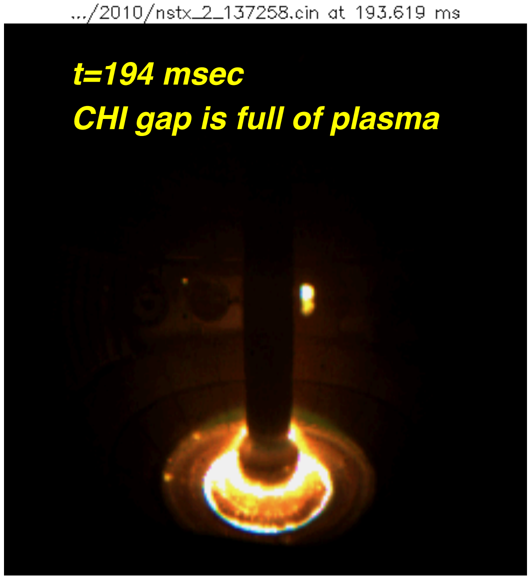
.../2010/nstx_2_137258.cin at 190.619 ms



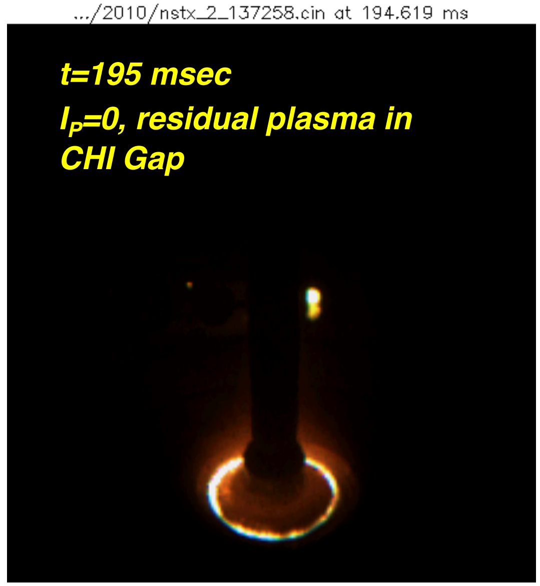
.../2010/nstx_2_137258.cin at 192.619 ms



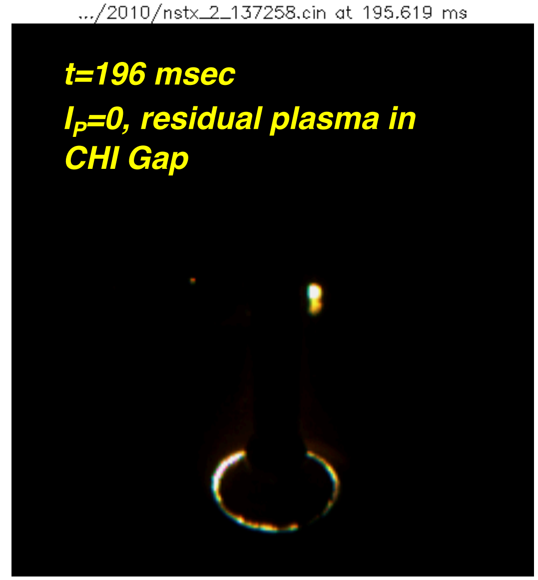
.../2010/nstx_2_137258.cin at 193.619 ms



.../2010/nstx_2_137258.cin at 194.619 ms



.../2010/nstx_2_137258.cin at 195.619 ms



Raw Data Shows Rotation of Halo Current Pattern

Isolation amplifiers for shunt tile have ~100 kHz bandwidth.

Each signal is digitized twice:

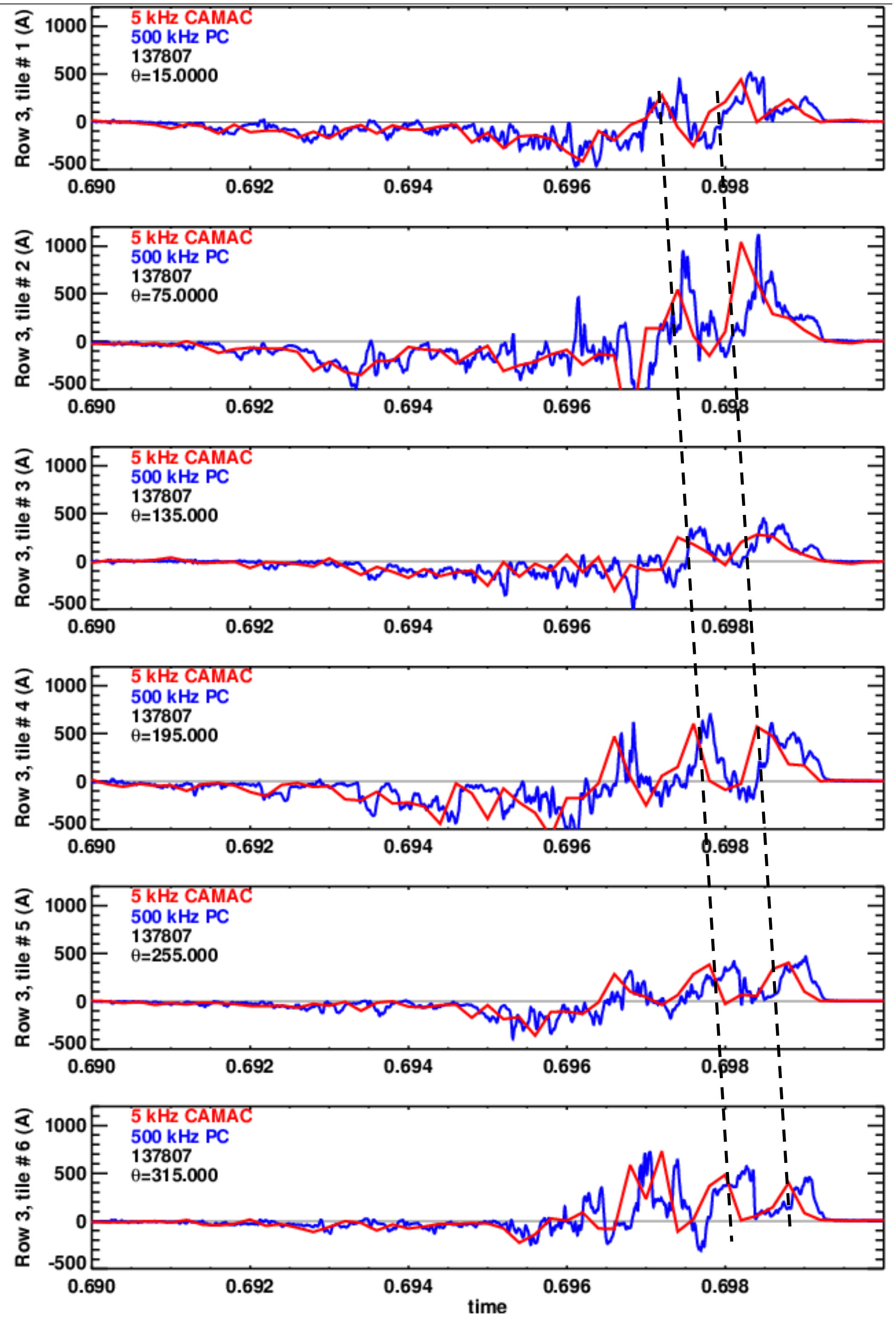
CAMAC at 5 kHz

National Instruments PCI digitizers at 500 kHz

Features only 1-2 samples wide in CAMAC are cleanly resolved with faster rate.

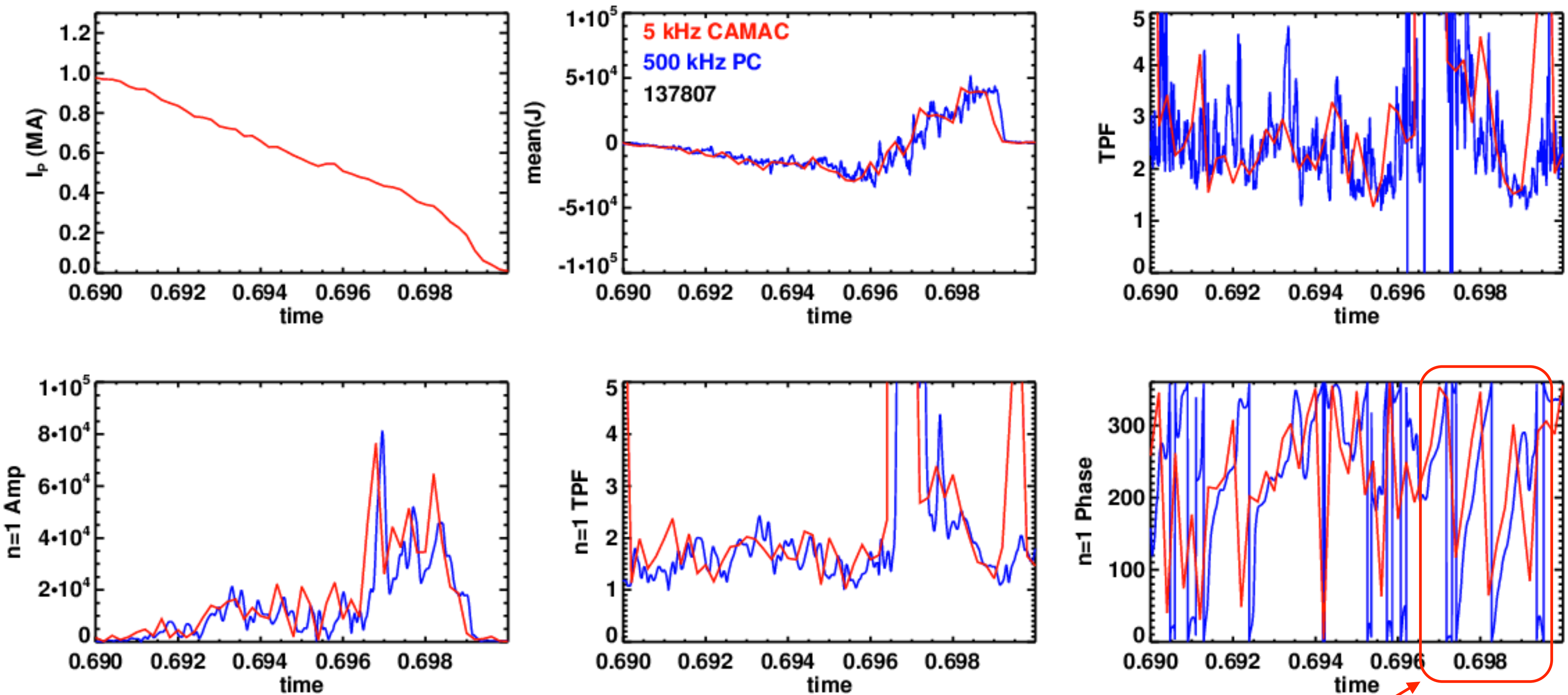
Synchronization delay between CAMAC and PCI

Propagation of structures is observed.



Fourier Analysis Confirms That the Halo Current Pattern Is Indeed Rotating

$$I\left(I_0(t), I_1(t), \phi_1(t)\right) = I_0(t) + I_1(t)\cos\left(\theta - \phi_1(t)\right)$$



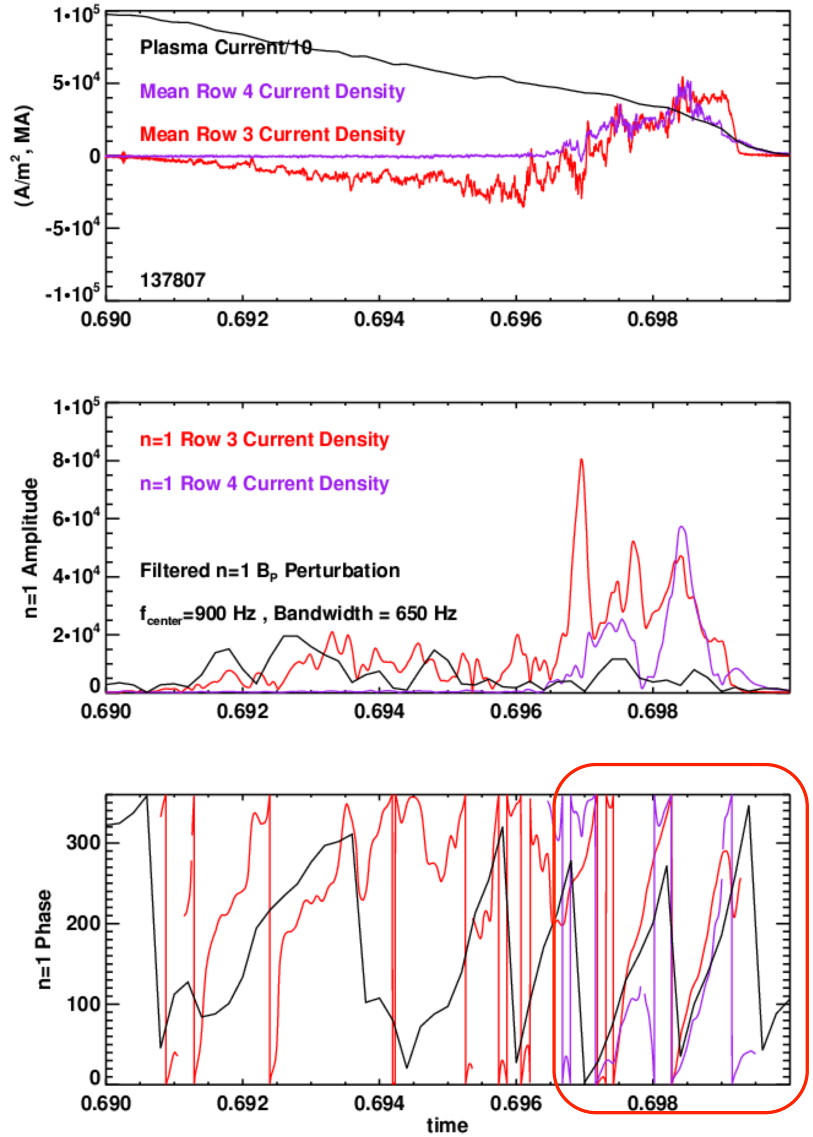
Rotation is in "positive" direction-> clockwise when viewed from above.

Opposite to both the plasma current and flat-top rotation direction.

Rotation frequency is ~1 kHz

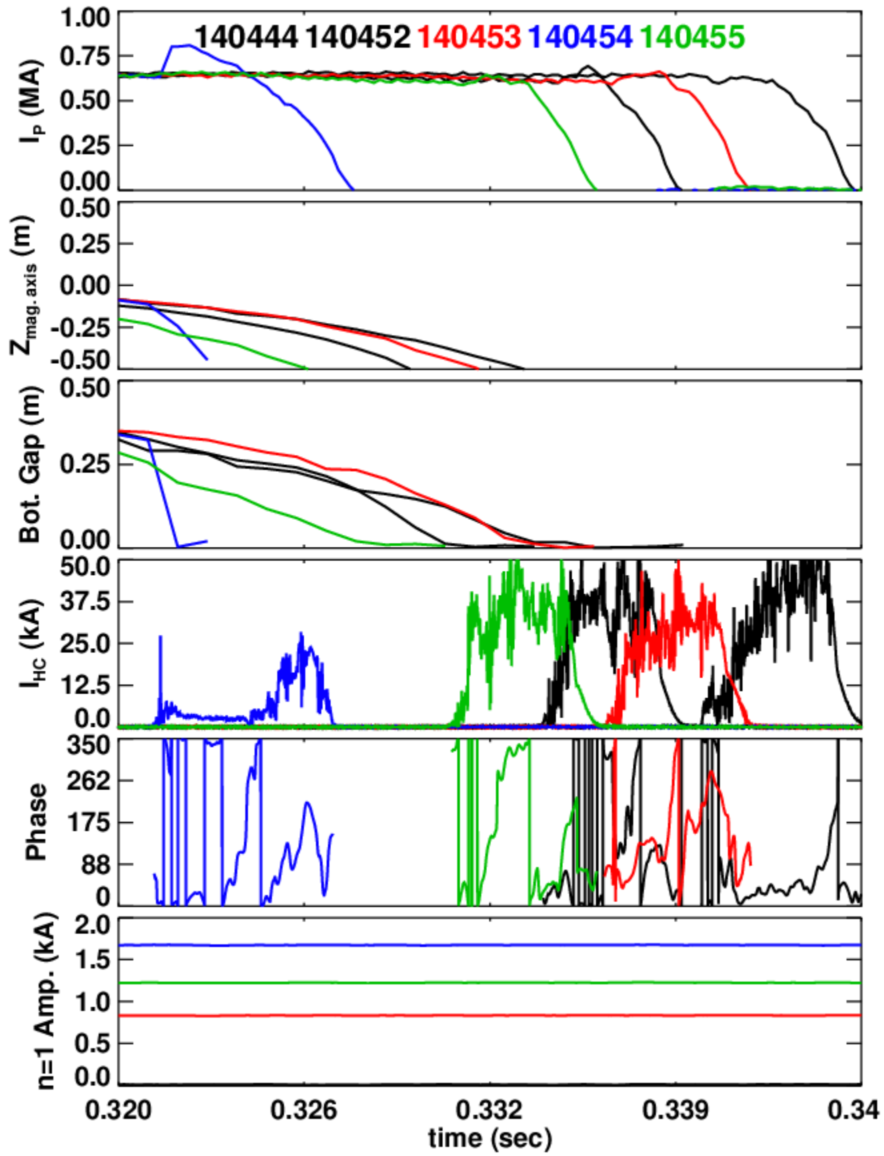
Magnetic Signature Seen To Rotate With n=1 Halo Current Perturbation

- NSTX has a significant array of in-vessel sensors for n=1 fields.
- Bandpass filter the B_P, n=1 perturbation, look at phase progression.
- Observe magnetic signature rotating with the halo current.
- Is it possible to to control the rotation with applied n=1 fields?



Large n=1 Fields Were Not Able to Change HC Toroidal Rotation

- Deliberate VDEs, driven down, NB heated L-mode.
- n=1 fields applied just as vertical drift is beginning.
  - Large enough to drive a locked mode disruption during the VDE for 140454.
- Halo current pattern rotates in all cases.
  - Not encouraging for HC rotation control with applied n=1 fields



Summary

- This is just a first look…lots of data to be analyzed.
- The CHI gap is full of plasma during many downward disruptions.
- n=1 halo current perturbation is observed to rotate toroidally:
  - In the counter-current direction,
  - at ~1 kHz type frequency,
  - for 1-2 turns (typically).
- Large applied n=1 fields were not able to lock the rotation.
- Physics is important for ITER, where mechanical resonances can come into play of multiple rotations occur.

Magnetic Signatures (n=1) Still Visible Despite Large Applied n=1 Fields