NSTX

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Some Halo Current Measurements in 2009

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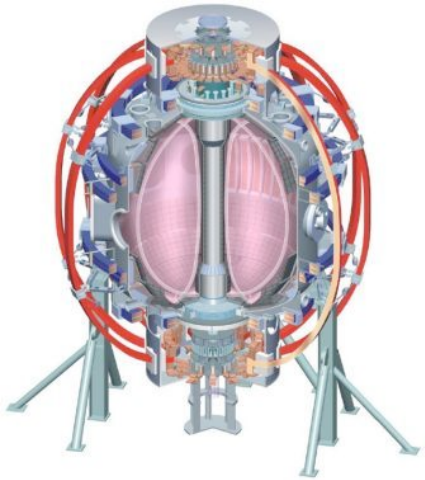
S.P. Gerhardt

Thanks to: E. Fredrickson, H. Takahashi, L. Guttadora

NSTX Results Review, 2009



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

Halo Current Detection in NSTX

3 Rogowskis on the Center Column (pre-2008)

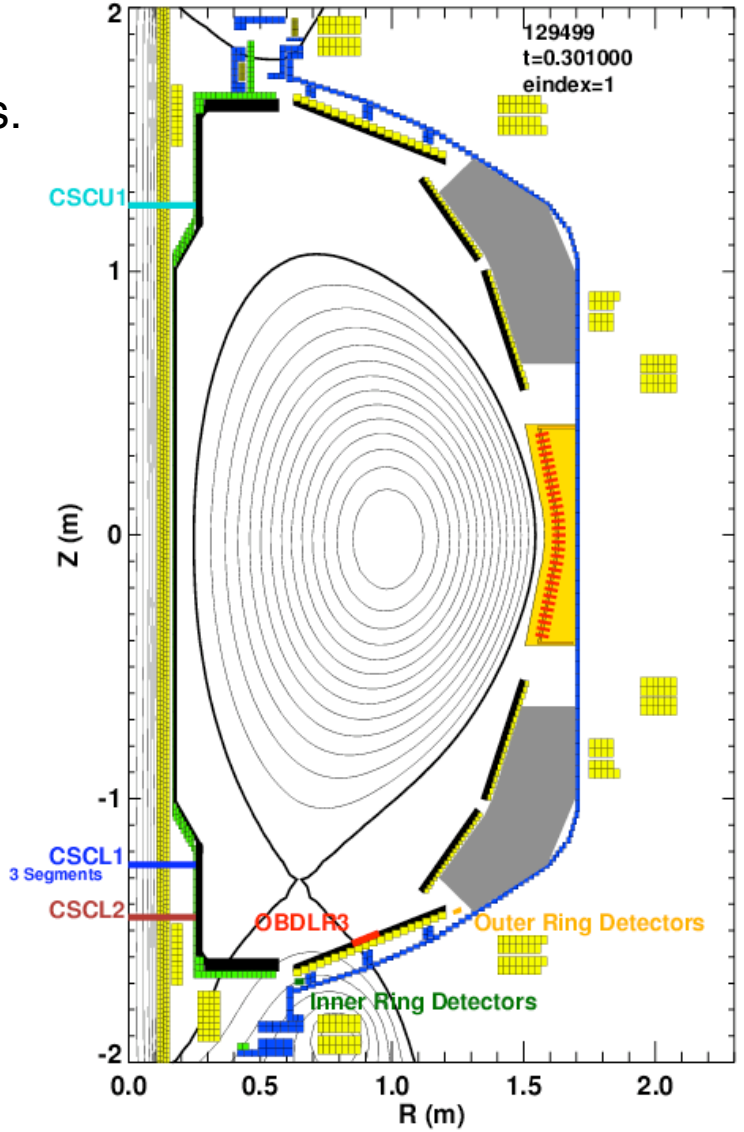
- One rogowski (CSCL1) broken into three segments.
- The other two (CSCL2 and CSCU1) continuous

Arrays of Toroidal Field Sensors (2008)

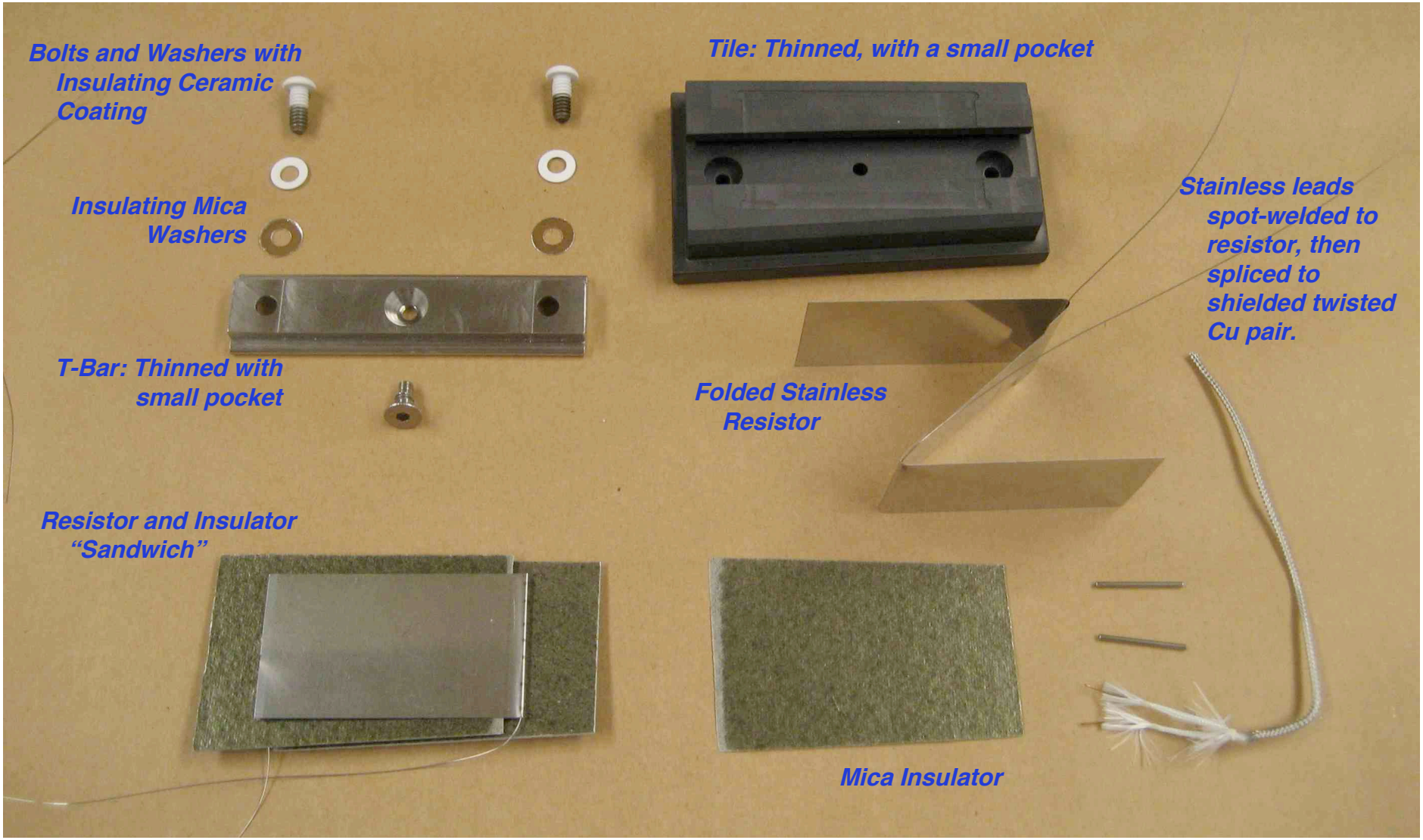
- Poloidal current flowing in vessel wall
- One array of 6 sensors near CHI gap (Inner Ring)
- One array of 6 sensors between OBD and SPP (Outer Ring)

Arrays of Instrumented Tiles (2009)

- 4 Tiles in row 3 of the outboard divertor (OBDLR3)
- 90º Toroidal Separation
- Highly localized measurements of the current

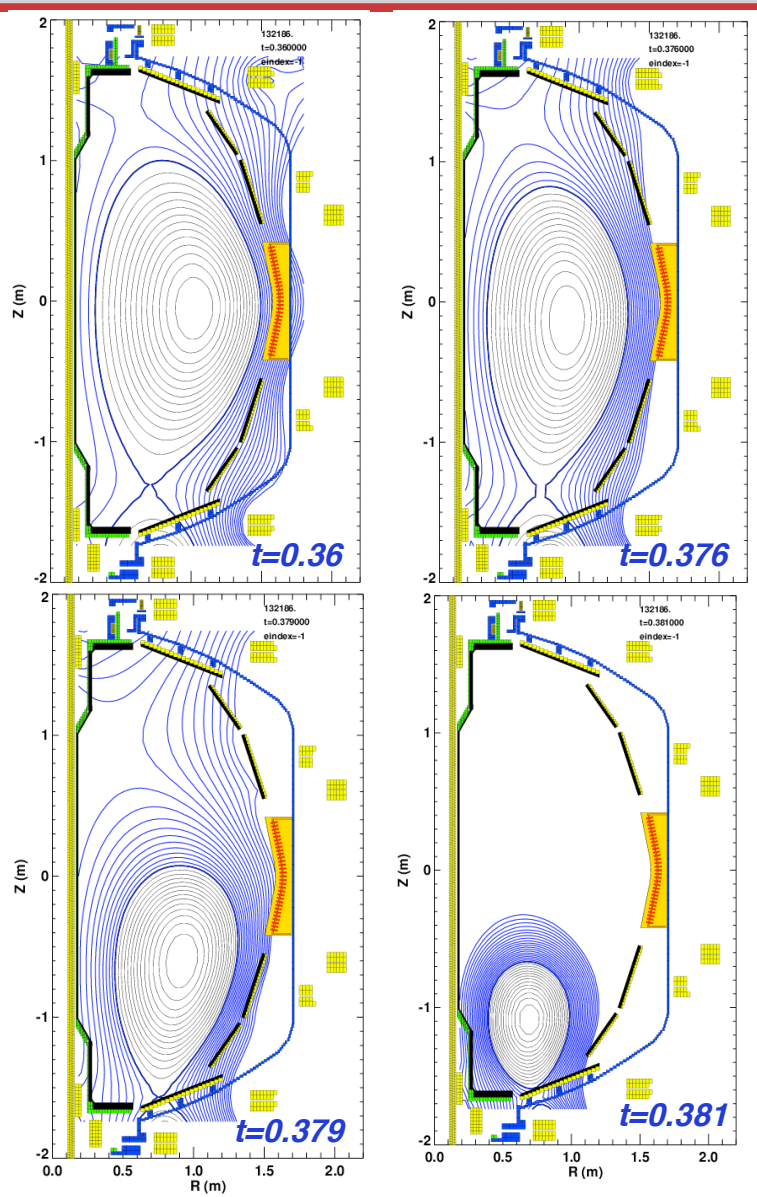


Novel Instrumented Tile Design Implemented For Four Tile #3s in the Lower Outboard Divertor

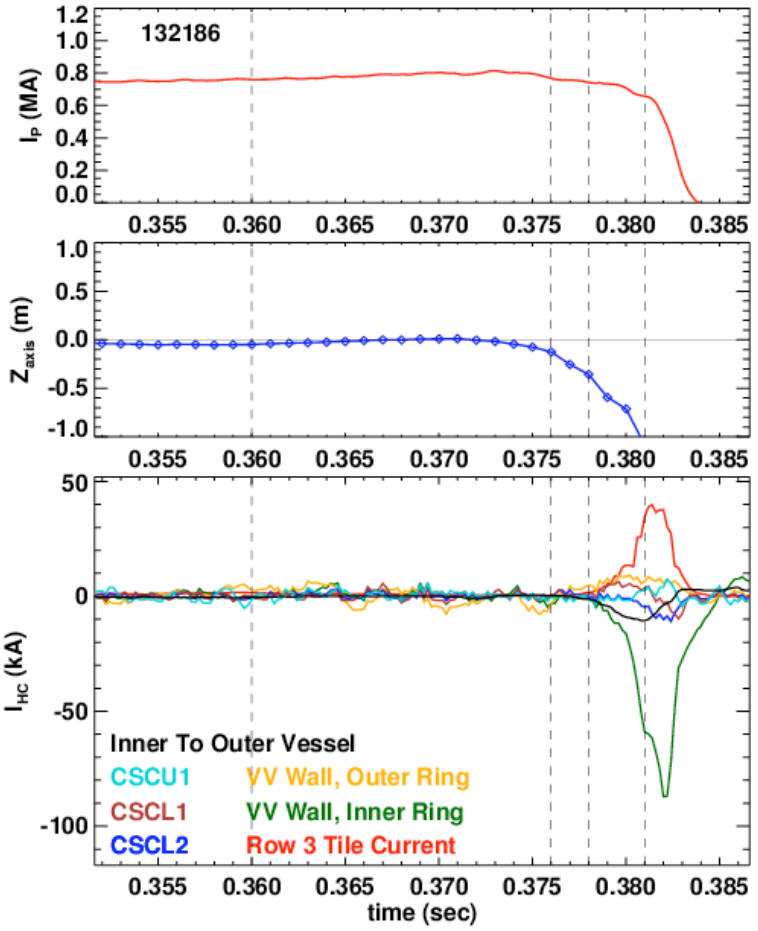


Design by S. Gerhardt, L. Guttadora, E. Fredrickson, and H. Takahashi

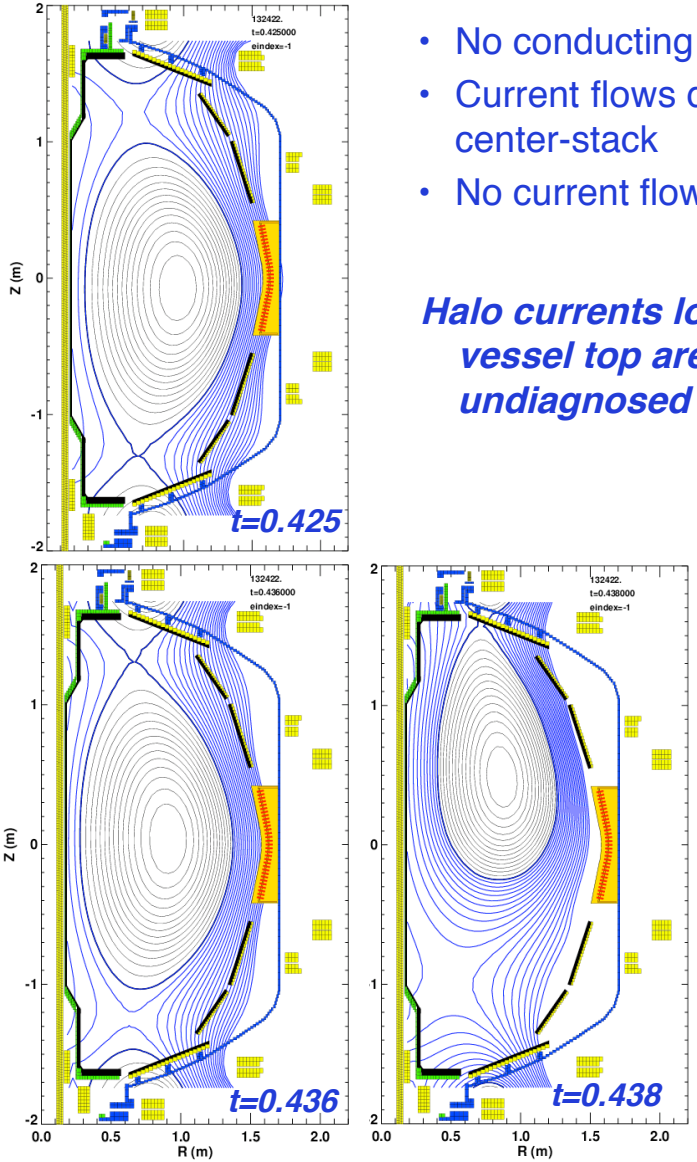
Example #1: Currents Flowing Out of OBD Row #3 (132186)



- Currents flow into the OBD near the CHI gap, and out of the OBD near tile #3
- Row-3 currents peak before the Inner-Ring currents
- Essentially no currents on the center-stack.

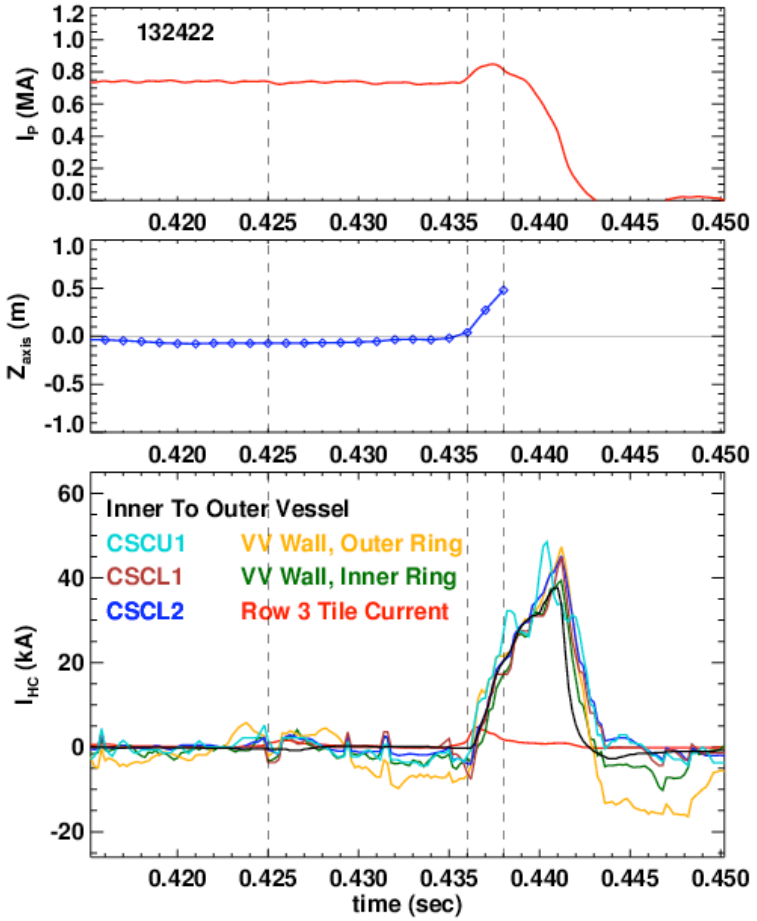


Example #2 Upward VDE (132422)

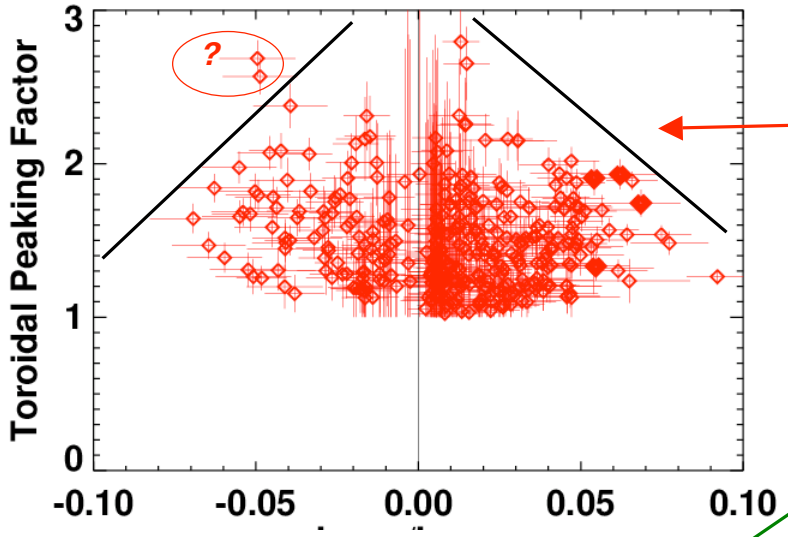


- No conducting path between machine top and bottom.
- Current flows down the outer vessel, along the machine bottom, and up the center-stack
- No current flow through row #3 tiles

Halo currents local to the vessel top are undiagnosed in NSTX

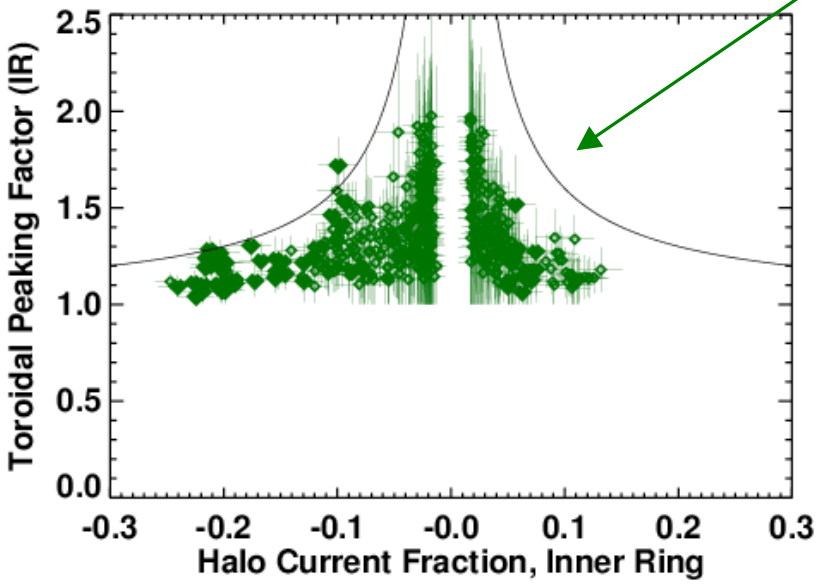


Have Reasonable Measurements of HCF vs. TPF at Three Different Locations

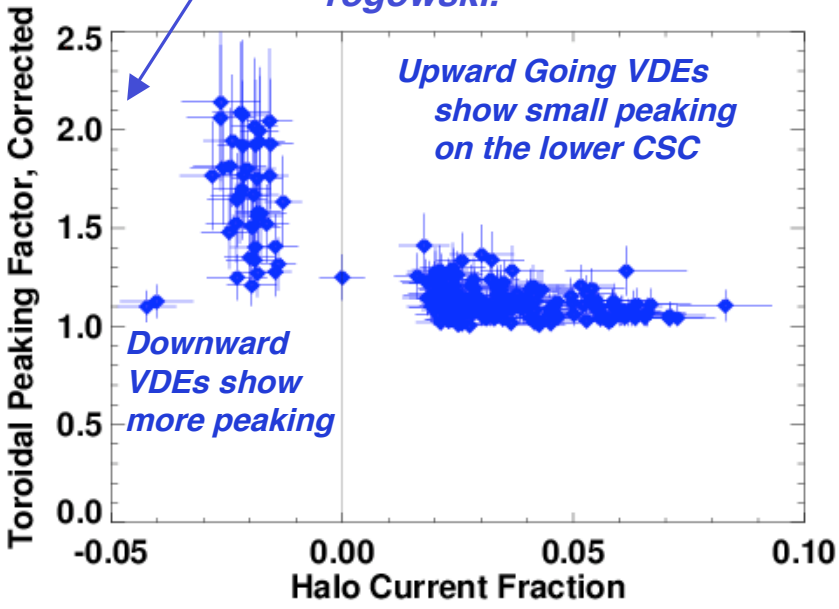


- *Row 3 of Outboard Divertor*
  - *New for 2009*
  - *For Positive I_{HC}, HCF*

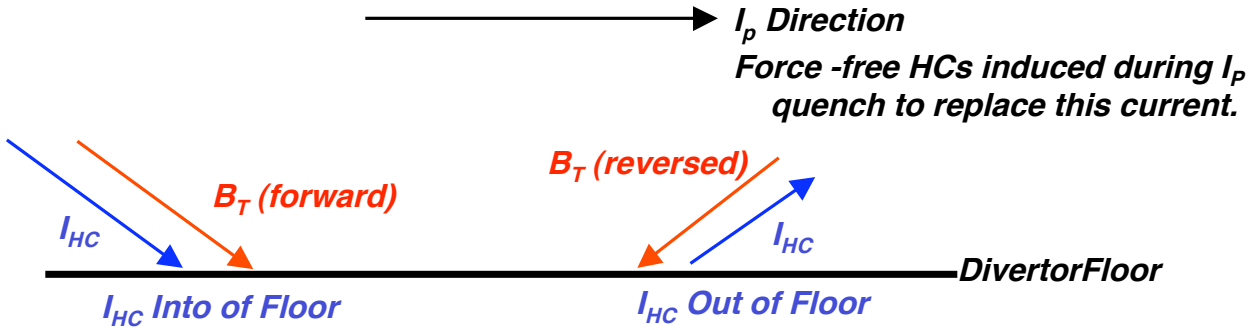
- *Vacuum Vessel Near CHI Gap*
  - *2008 & 2009 Data*



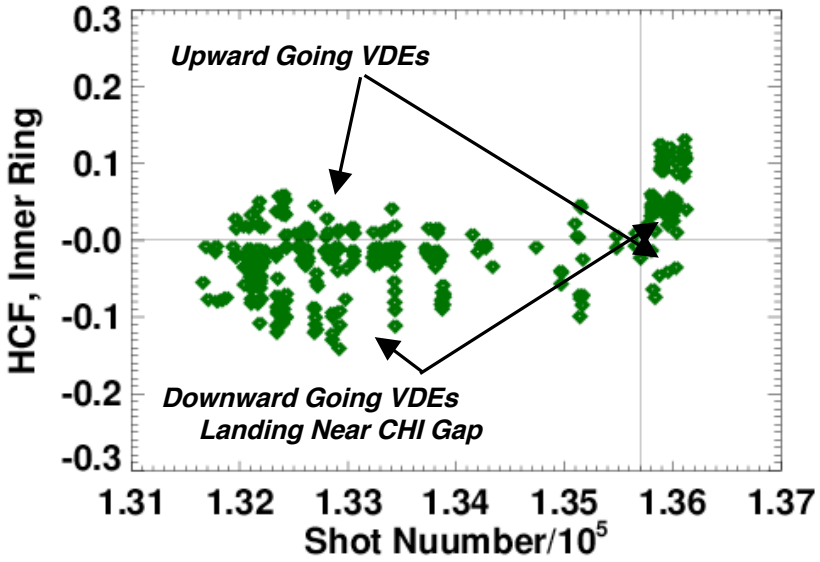
- *Lower Center Stack Casing*
  - *Correction to account for poor TPF sensitivity of segmented CSC rogowski.*



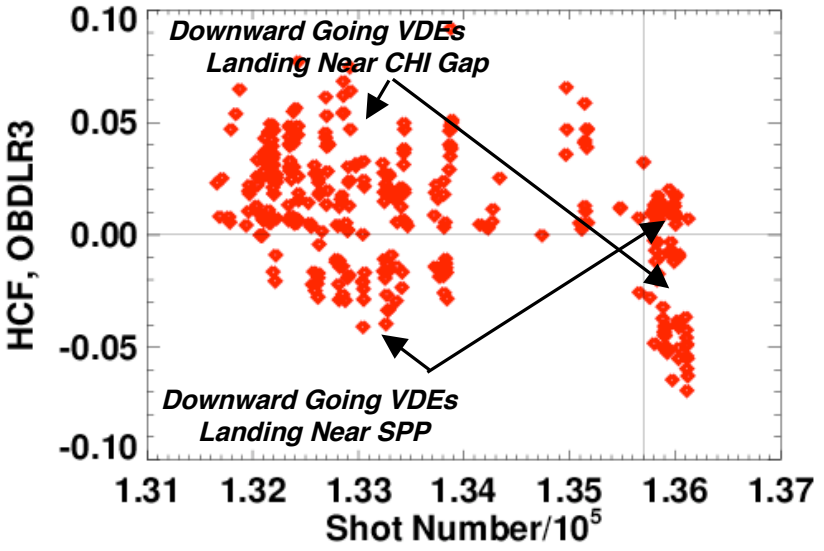
Axisymmetric Halo Current Directions Changed After B_T was Flipped (~135702)



On Vessel Wall Near CHI Gap

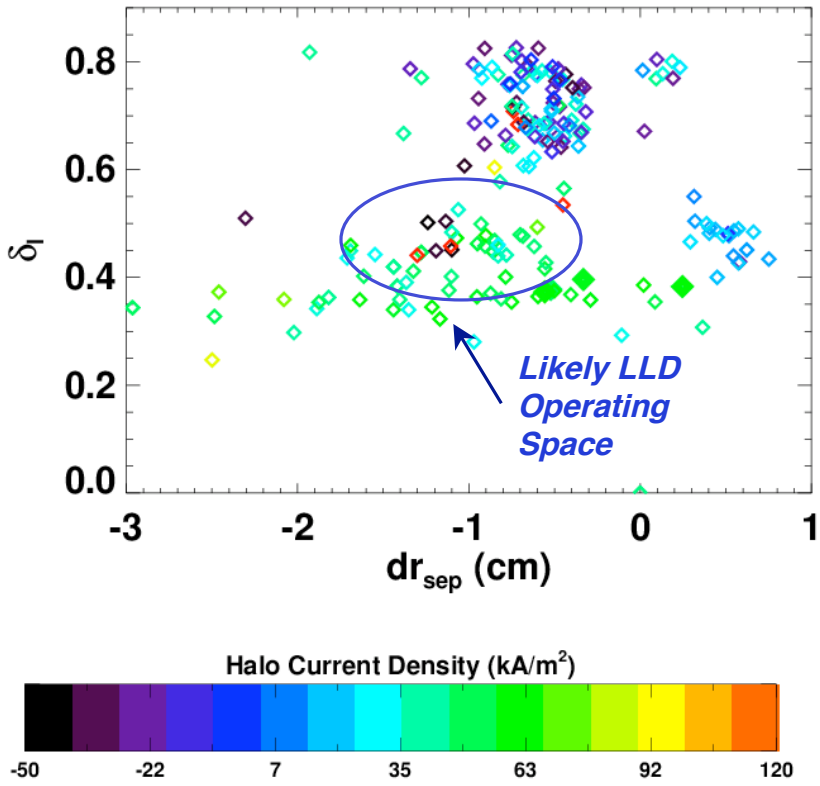


Shunt Tiles in Row #3 of Outboard Divertor

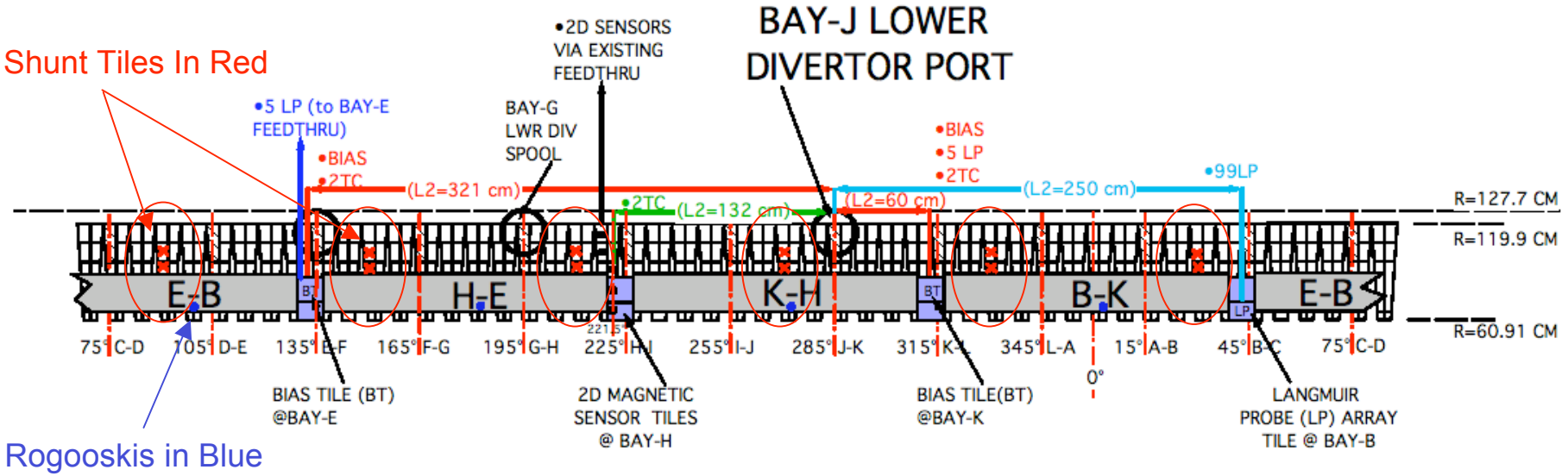


Preliminary Analysis Shows that Currents of 20-30 kA per LLD Segment Should Be Anticipated For Rare Events

- Current density measured from tiles in outboard divertor.
- LLD Area is ~1m^2, divided into four quadrants.
  - $A=2\pi R\delta R=2\pi\cdot 0.78\cdot 0.2=1m^2$
- Maximum halo current density in row 3 observed for the low-δ, $dr_{sep}<0$ cases.
  - These are exactly the conditions of the LLD baseline scenario.
- Halo currents of 20-30 kA/segment should be assumed for the rare worst case.
  - Caveat, need to carefully look at the data for these worst cases.
- Halo current measurements will be an important part of the LLD operational experience.



Substantial Upgrade to Capability For 2010



- ***Keep the Old Diagnostics***
  - ***Center stack casing rogowskis***
  - ***Lower vacuum vessel current measurements***
- ***Add Some New Ones***
  - ***Each LLD Segment has a Small Rogowski on its single point ground***
  - ***6 shunt tiles in row 3 of the lower outboard divertor***
  - ***6 shunt tiles in row 4 of the lower outboard divertor***