XP 938 Dust mobilization from ITER-scale castellations

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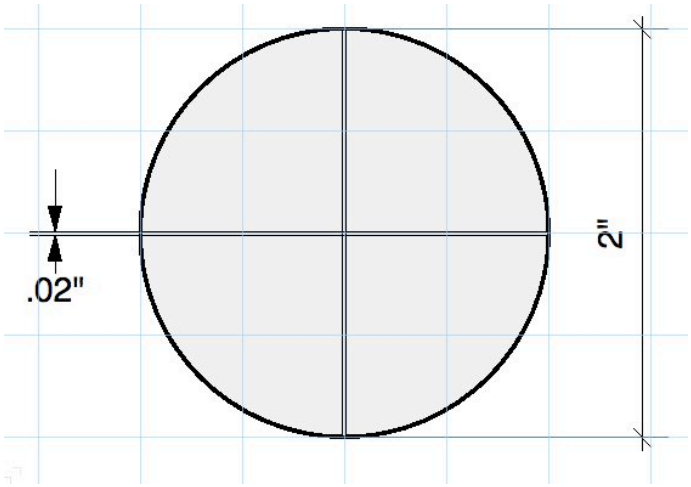
Motivation:

- Dust on ITER will fall down the gaps between tile castellations.
- The question is whether it is then permanently 'buried' or could be mobilized by a disruption.
- If the latter it needs to be included in safety assessments of the dust inventory and could contaminate the succeeding plasmas.

Plan:

- Make up a castellation mockup with gaps that are the same dimensions as the ITER castellations. Fabricate probe from boron nitride (an insulator) to avoid issues with induced JXB forces.
- Load it with 'dust' (carbon particles scraped from ATJ tile) and mount it on the Bay J sample probe assembly.
- Insert it and land some disruptions close by.
- Weigh and photograph before and after to assess how much dust is lost.



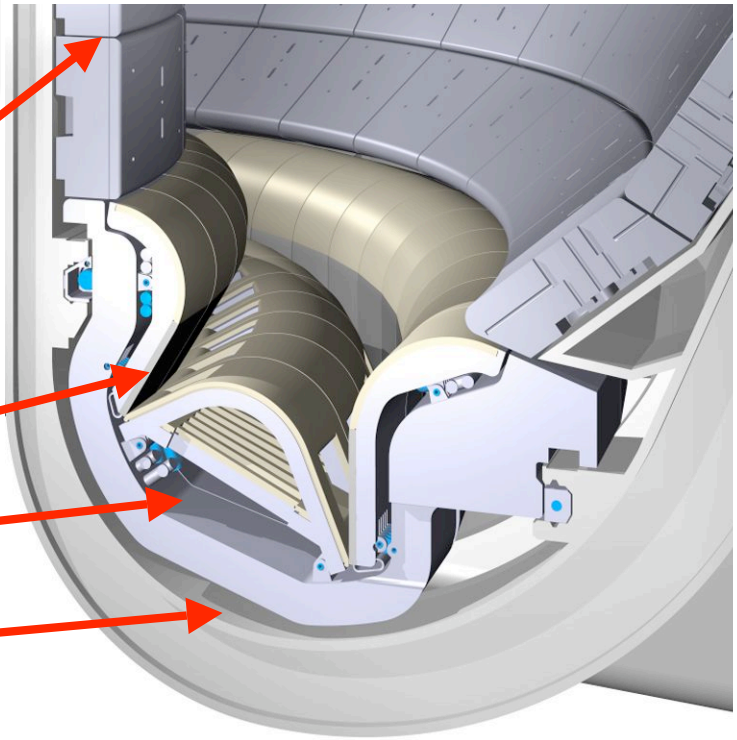
Top of sample probe with 0.5 mm wide gaps in 'castellations' of 8 mm depth (as in tungsten PFCs in ITER).

- XP938 was run with carbon dust for 3 shots on 14 August.

Potential dust locations in ITER

Dust typically accumulates at the bottom of a tokamak (TFTR diagnostic pipes, JET subdivertor…).

- Gaps between blanket modules
- Gaps between tile castellations
- Under divertor dome
- Under divertor cassette



Macrobrush

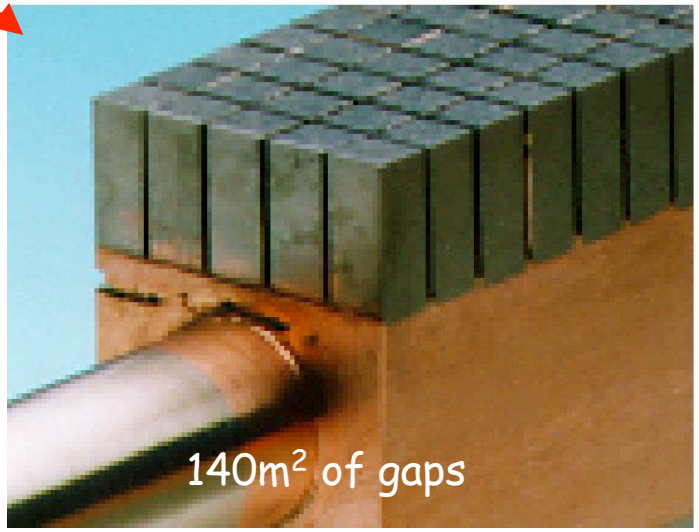


Illustration only

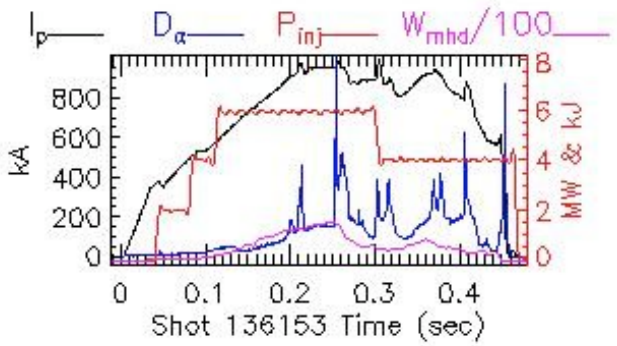
- Could be carbon, tungsten, beryllium or mixed materials.
- 'Dust' is defined as particles < 100 μm (larger particles will not transport to the environment in accident scenarios).
- Typical count median diameter in present tokamaks is few microns.
- Fractal-nanoscale particles reported in ELM simulators.

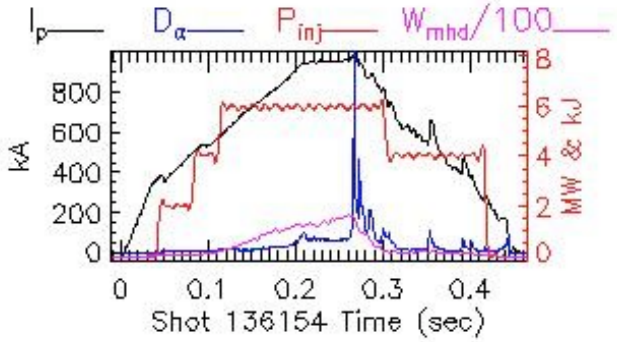
Operators Log:

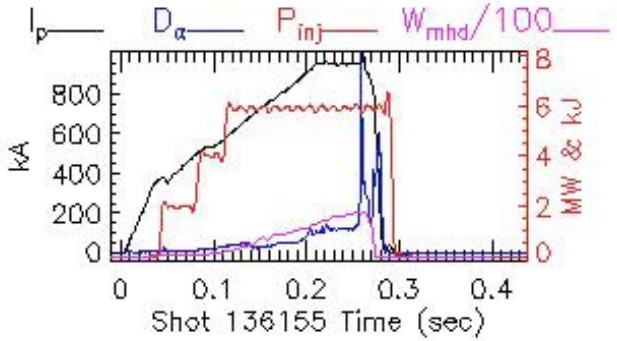
136153 XP# 938 PHYS OPS
Aug 14 2009 04:26PM MUELLER
900 kA LSN with shift down at 250ms to make disruption - disrupted too late and in wrong direction

136154 XP# 938 PHYS OPS
Aug 14 2009 04:27PM MUELLER
again with big DRSEP (-20) and Z axis shift (-20) - Ramped down

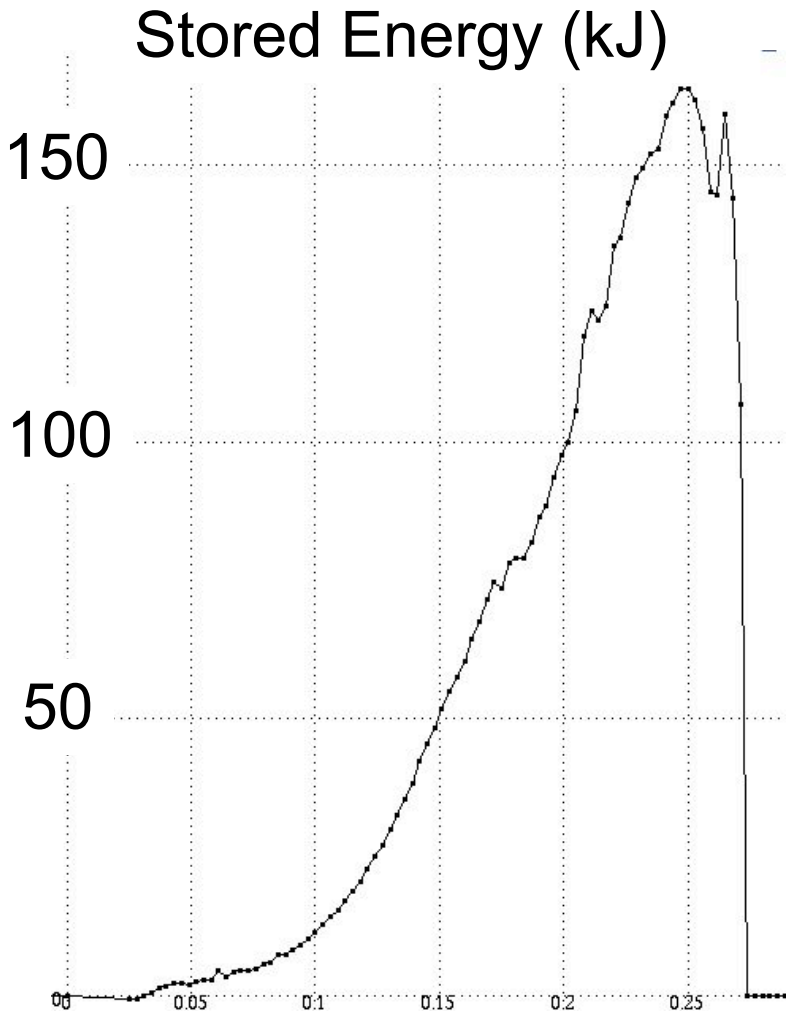
136155 XP# 938 PHYS OPS
Aug 14 2009 04:27PM MUELLER
Take PF3L out of isoflux control and request opposite sign current at 250ms
Finally a good fast disruption

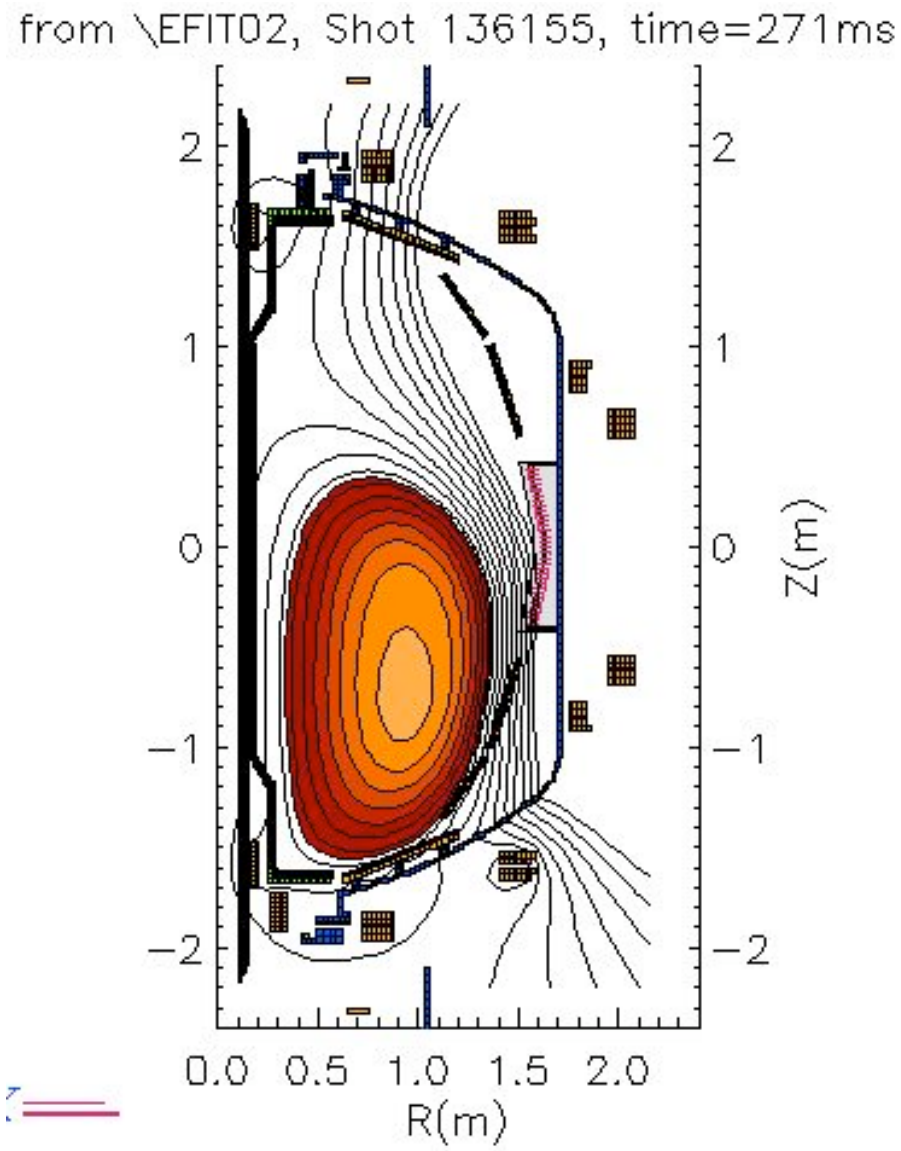






136155 Disruption:



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EUROPA$ dwscope -def auser7:[dm1]efit02.dat
\EFIT02::WMHD/1000.
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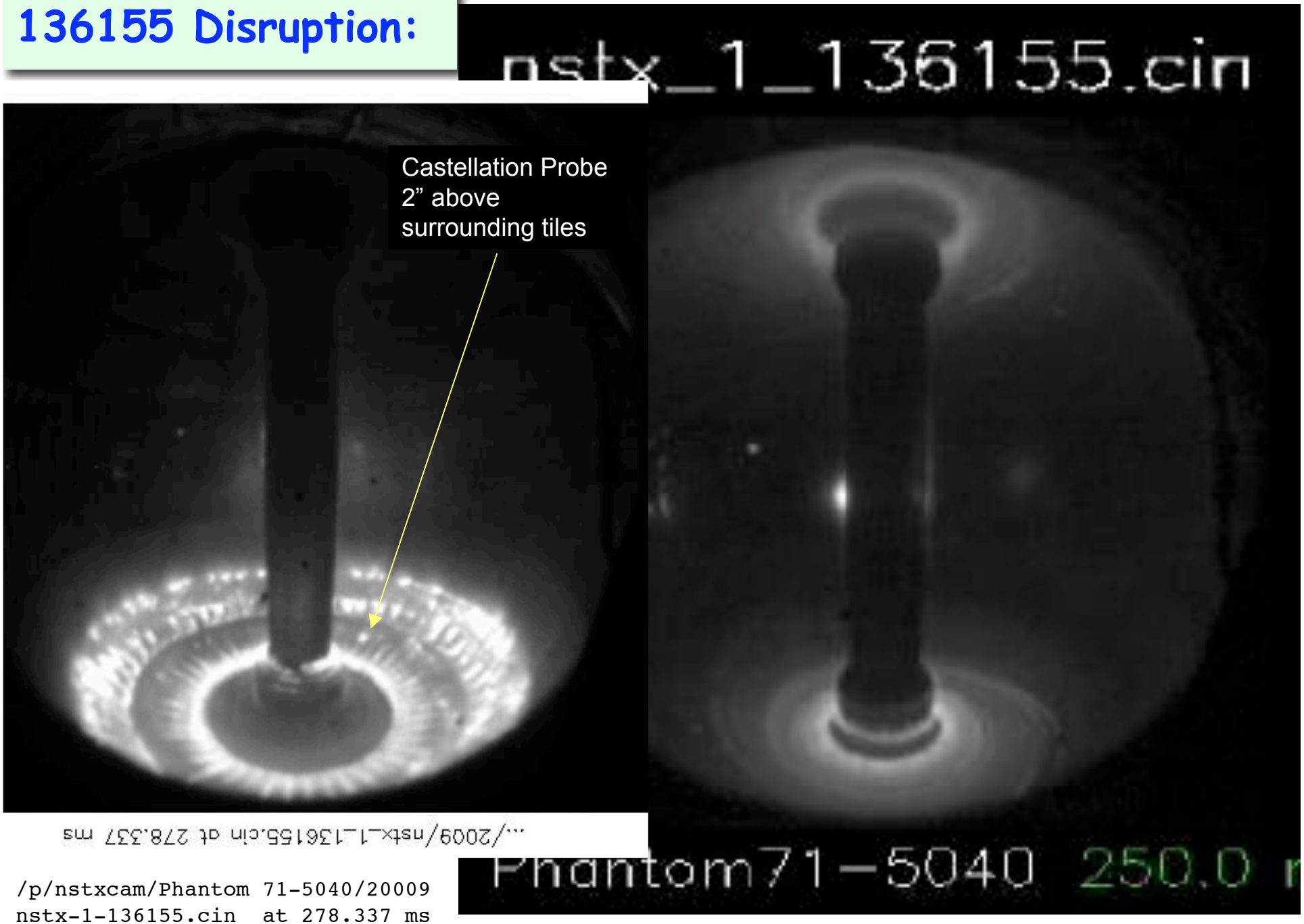
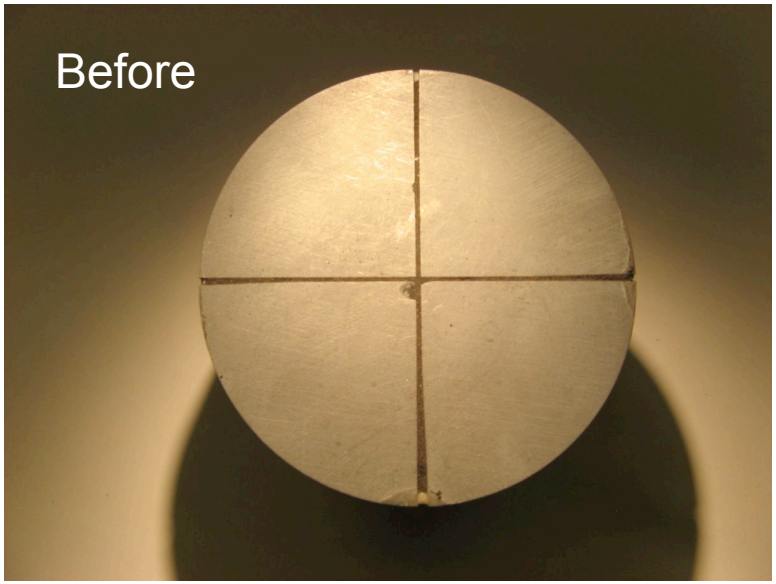
136155 Disruption:

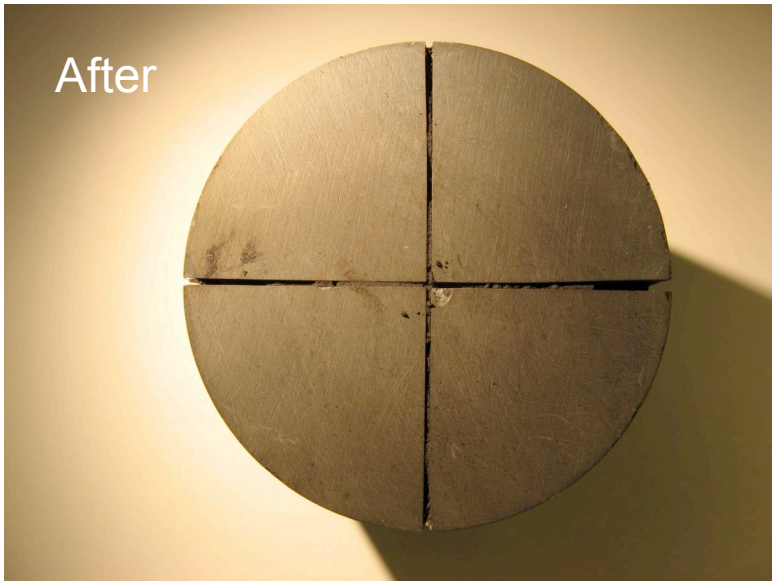


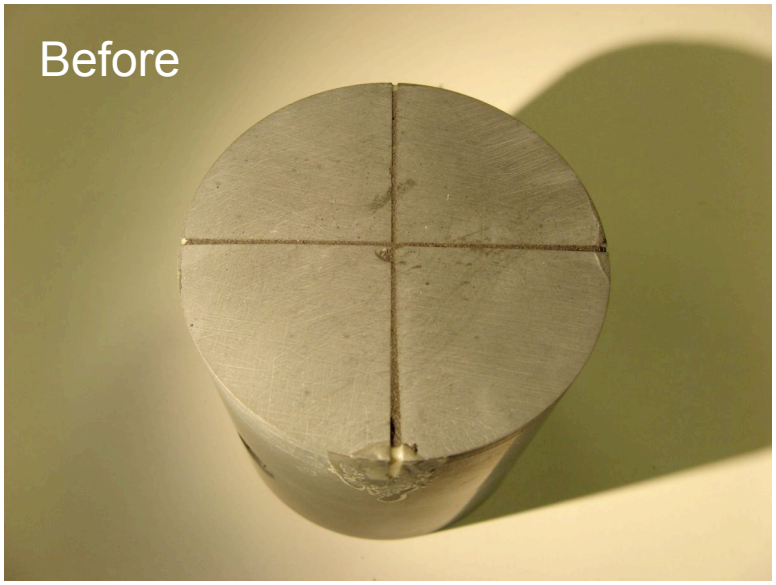
/p/nstxcam/Phantom 71-5040/20009
nstx-1-136155.cin at 278.337 ms
viewed from Bay B midplane

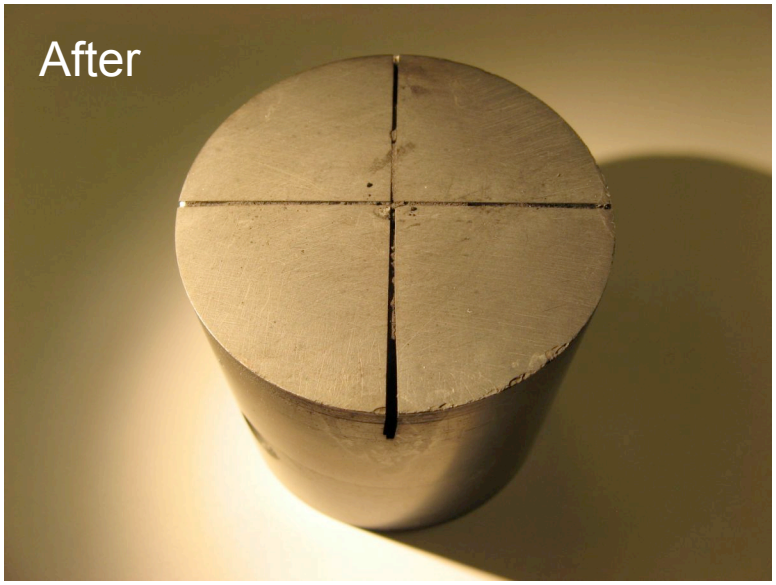
No IR data this shot unfortunately

Castellation probe loaded with dust

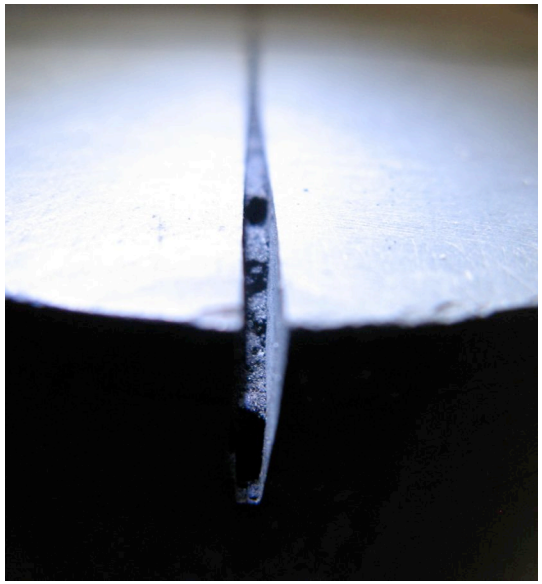






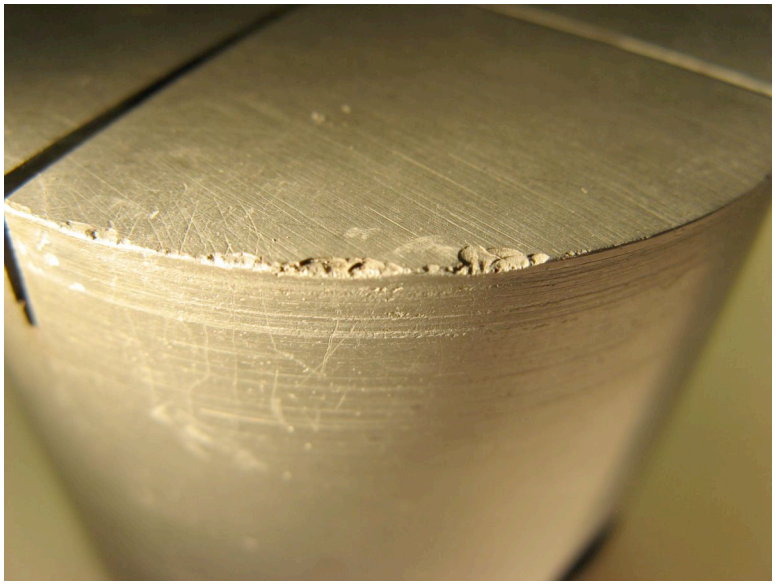


Castellation probe after disruption



- Fortafix 'plug' blown out of one gap.
- Significant particle loss from damaged areas
- Modest loss (~ 0.5 mm depth) from undamaged gaps.
- Evidence of strong heating on leading edge of probe ->

  (protruded 2" above surrounding tiles)



Mass Loss Results:

Probe + dust before exposure	200.4512 g
Probe + dust after exposure	200.3044 g
Initial weight of dust	0.140 g (after correction for lost fortafix & chips)
Final weight of dust	0.123 g
Dust mobilized	0.016 g or 12%

Conclusions:

- Some dust in castellation gaps is mobilizable.
- For one NSTX disruption, dust is lost from a gap depth is similar to gap width.
- Dust at ends of gaps or surface imperfections is much more mobilizable.