EAST Erosion/deposition Experiment

W. R. Wampler,
Sandia National Laboratories, Albuquerque, NM

Gong Xianzu
ASIPP, Hefei, China

Richard Pitts, Sophie Carpentier-Chouchana
ITER Organization, France

Peter Stangeby
UTIAS, Canada

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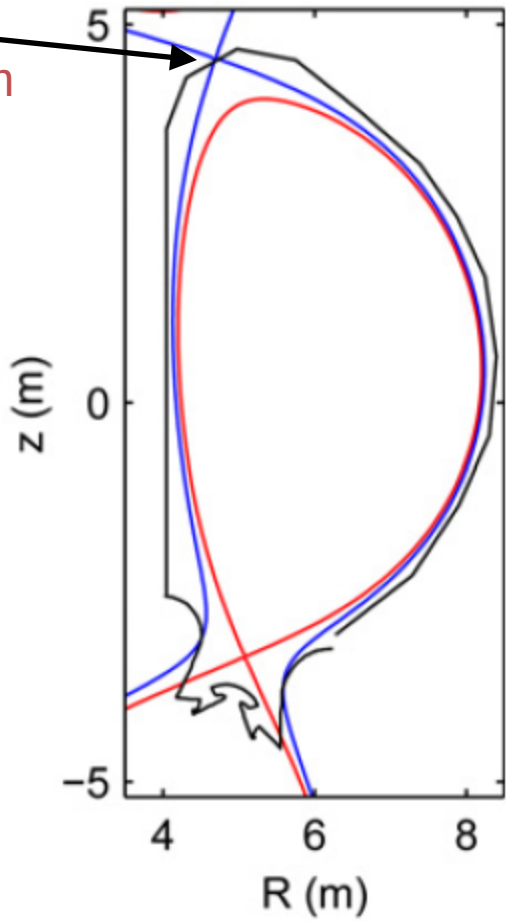
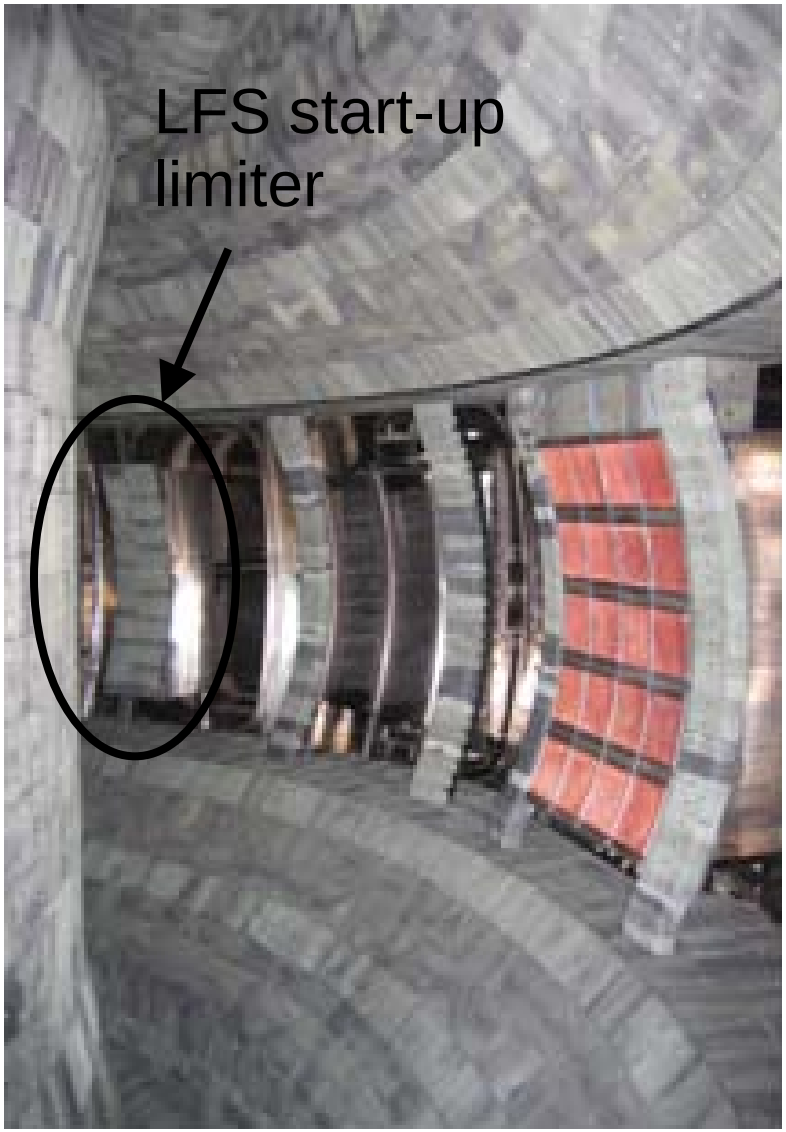
Background

Concern about steady state erosion/re-deposition in ITER

- On First Wall panels of blanket modules near top of the machine (secondary X-point region)
- Eroded material may redeposit locally along with tritium
- Codeposited tritium will be harder to remove than in the divertor (lower temperature and not designed for replacement)
- Seek a controlled benchmark for LIM-DIVIMP and ERO simulations being performed for ITER on realistic FW panel shapes.



An outboard migration experiment on EAST



Use outboard, moveable start-up limiters → proceed in two stages:

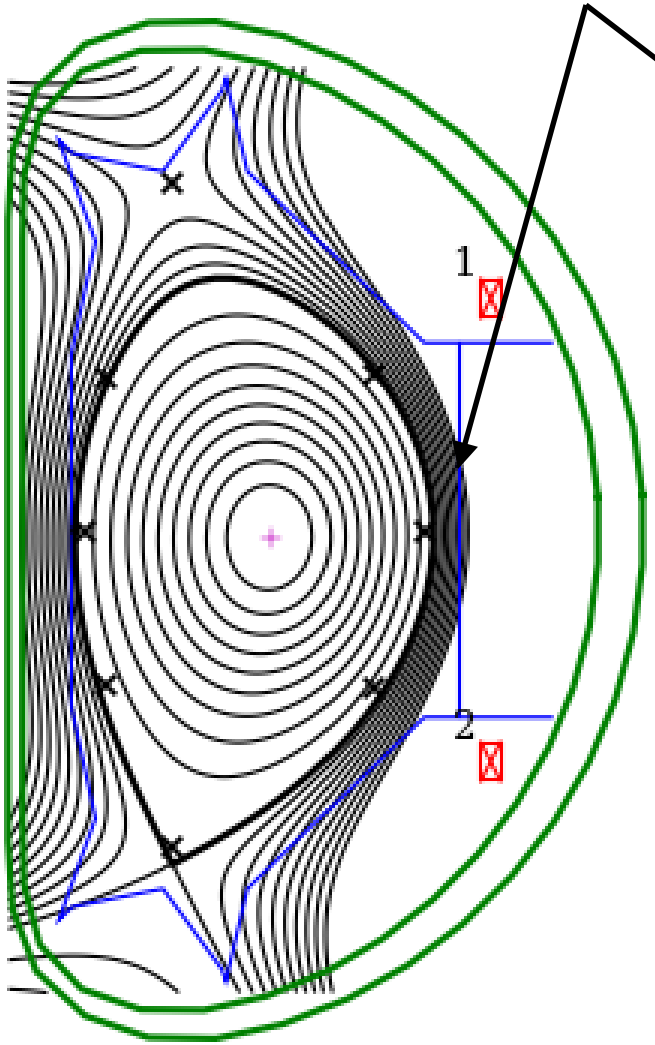
Test of concept:

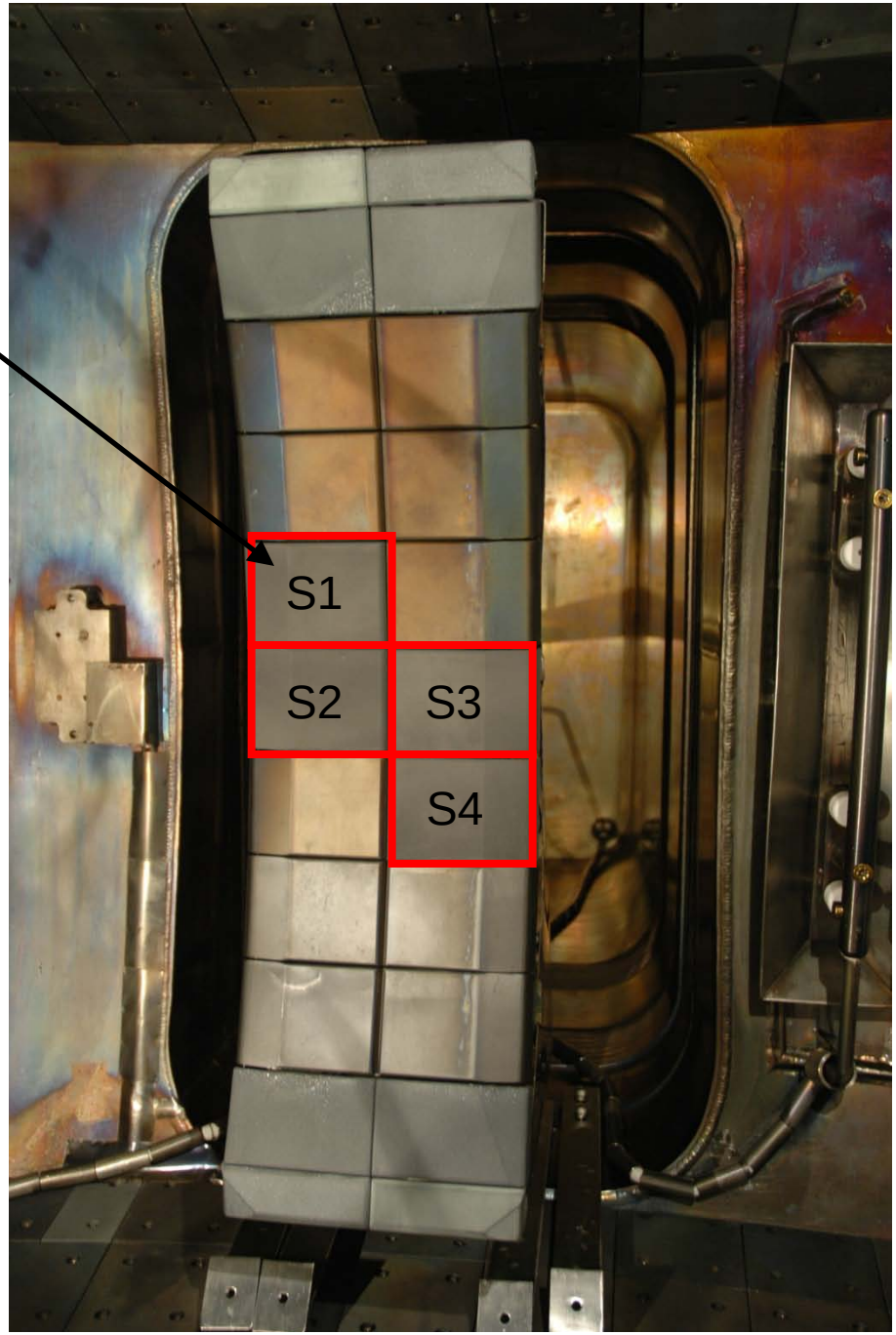
- Use current start-up limiters on LFS with existing tile geometry
- Campaign averaged
- Test depth marker technique
- Use existing diagnostics to probe edge parameters

Design new experiment:

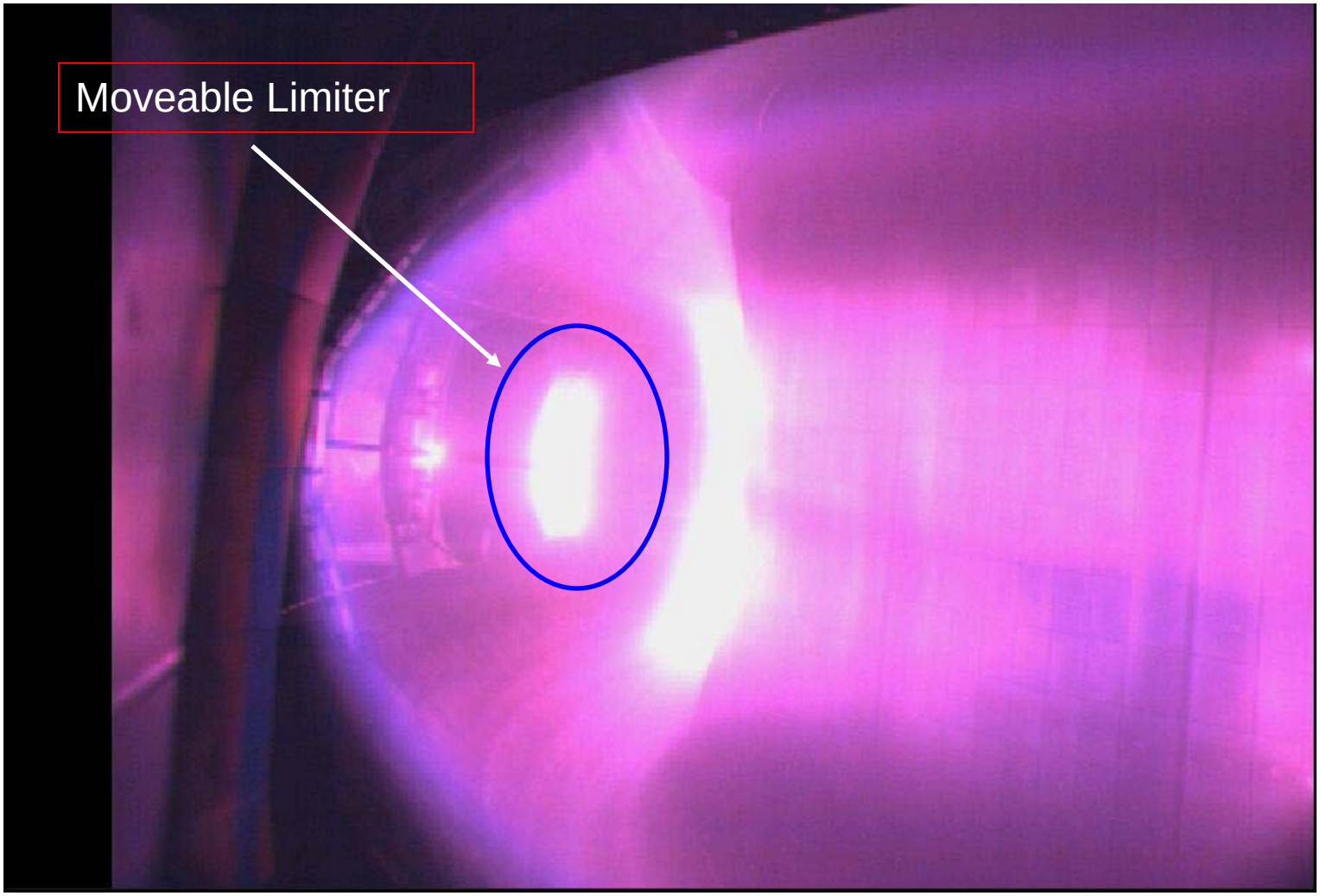
- Toroidally shaped tiles (like ITER FW)
- Instrumented for local plasma parameters
- Dedicated shot sequences with retractable limiters – avoid campaign average
- Work in He to avoid chemistry in all-C EAST

Four prepared tiles were exposed on the EAST moveable Limiter

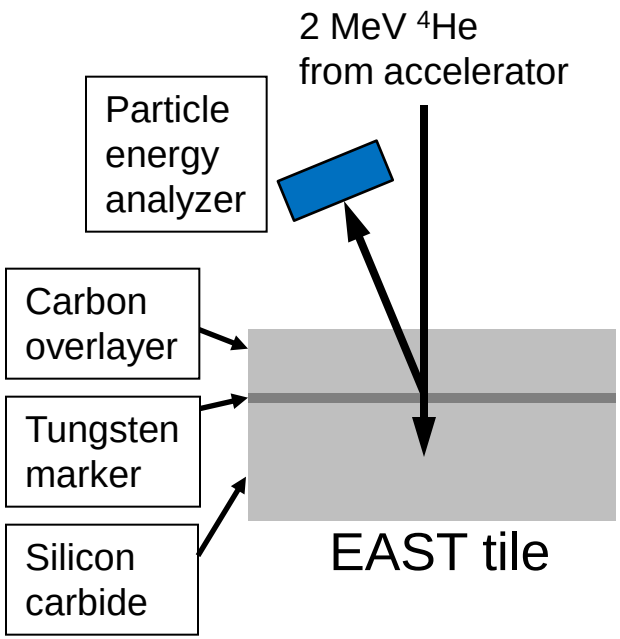


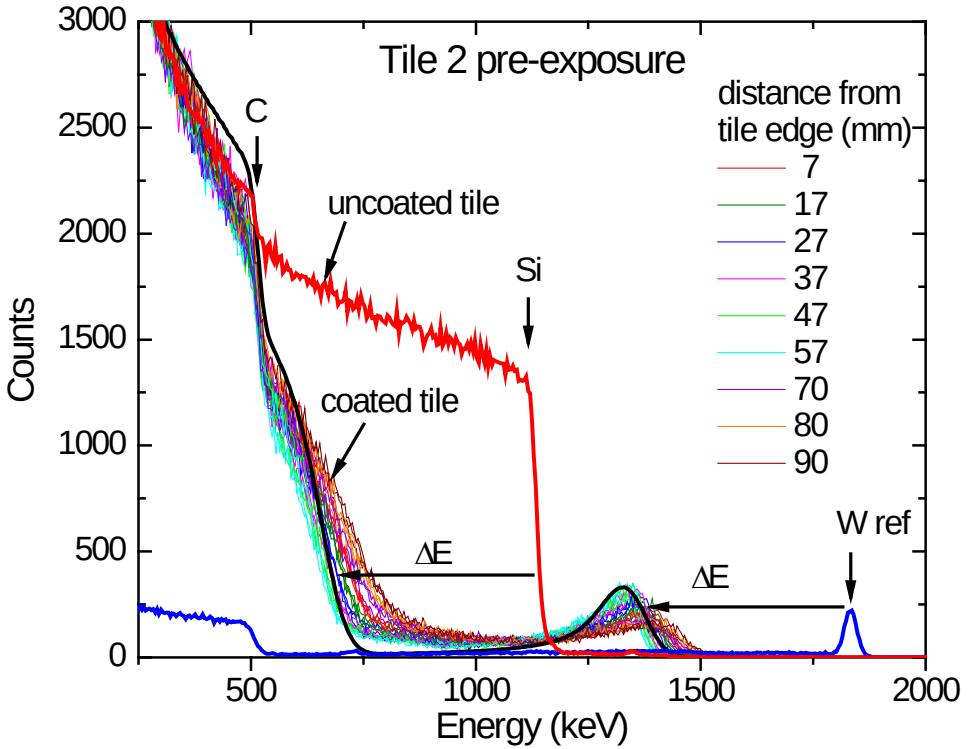


Light emission shows strong plasma interaction with the moveable limiter

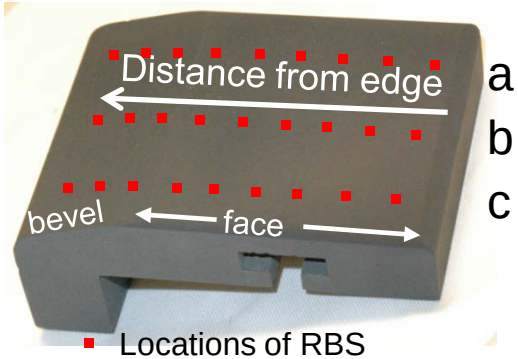


Erosion was determined from the change in thickness of a thin carbon film measured by RBS





3 scans (abc) along center
and ± 2.3 cm offset from center



- Locations of RBS
  Analysis beam spot 1x1mm
  Tile size 7x10 cm

- A tungsten depth marker was prepared on four tiles by vapor deposition of W (~1nm) followed by C (~1μm).
- Exposed to plasma for 37100 seconds during 2010 run campaign .
- RBS spectra were measured at 27 points on each tile before & after exposure in EAST.
- Thickness of carbon film is determined from energy loss ΔE of particles scattered from W and Si.
- Erosion/deposition is determined from change in depth of W and Si.

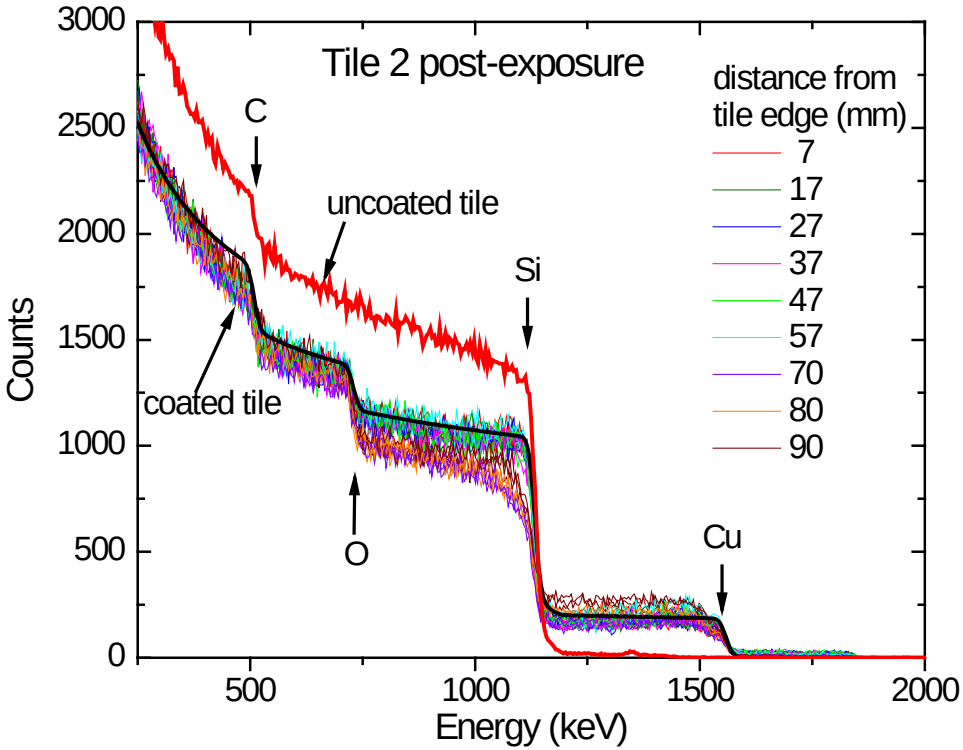
Post-exposure RBS shows erosion & deposition

Heavy red curve is spectrum for EAST tile before deposition of W, C coating

Heavy black curve is simulation using SIMNRA.

Height of Si edge gives fraction of area which is bare SiC (~ 50%).

Remaining fraction of area is covered by deposit of C, O, and transition metals (Cr - Cu) (plus HD not measured by RBS)



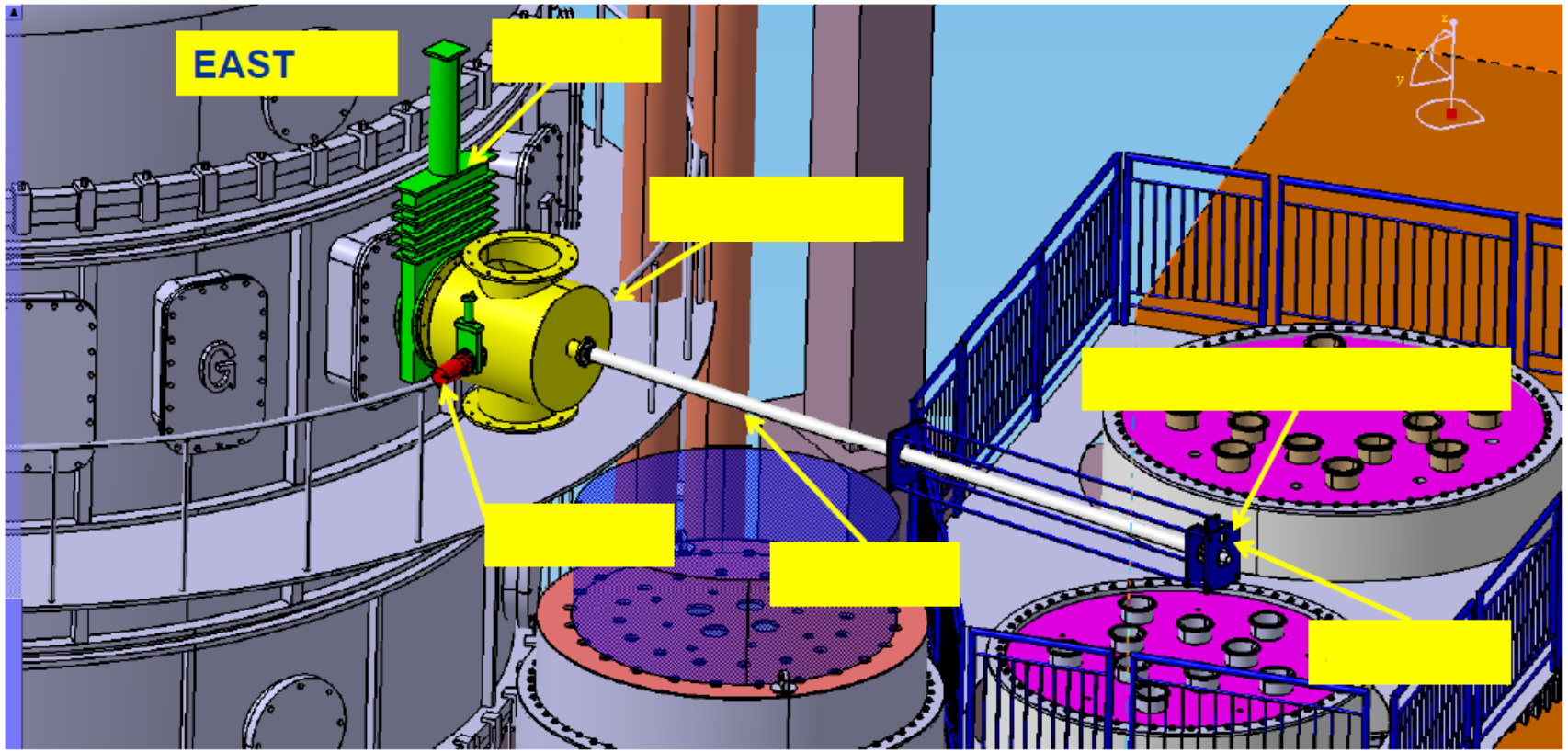
Main features of post-exposure RBS spectra:

1. Edge due to scattering from silicon has moved back up to energy of uncoated SiC.
   This shows that the carbon film was completely removed over ~ 40% to 60% of the beam spot area.
2. New edges due to scattering from oxygen and transition metals are present.
   This shows a fraction of the surface is covered by deposited material.
   Average metal concentration = 0.006 to 0.03 atom fraction.
3. Simultaneous erosion & deposition is due to surface roughness. Erosion from peaks, deposition in valleys gives erosion/deposition non-uniform on a scale much smaller than the beam spot size.

Summary of results

1. The carbon film was completely removed over ~ 40% to 60% of the area. Not surprising considering the long exposure time.
2. Some deposition was also observed.
   A fraction of the surface is covered by deposited material containing carbon, oxygen and transition metals, with average metal concentration = 0.006 to 0.03 atom fraction.
3. Erosion & deposition both occur due to surface roughness, localized erosion from peaks, deposition in valleys.
4. Erosion/deposition is fairly uniform over the four tiles.

Next step: Dedicated shot sequences with retractable probe.



A new materials evaluation system will be installed at H-Port at the mid-plane on EAST, and is expected to be operational during the next run campaign. This will be very helpful for the EAST Erosion/deposition experiment. The large size (300x200mm) enables exposures of large components for short durations instead of the full campaign, for better defined exposure conditions.