

First studies of ITER diagnostic mirrors in a tokamak with all-metal interior: results of first mirror test in ASDEX Upgrade

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Introduction and motivation

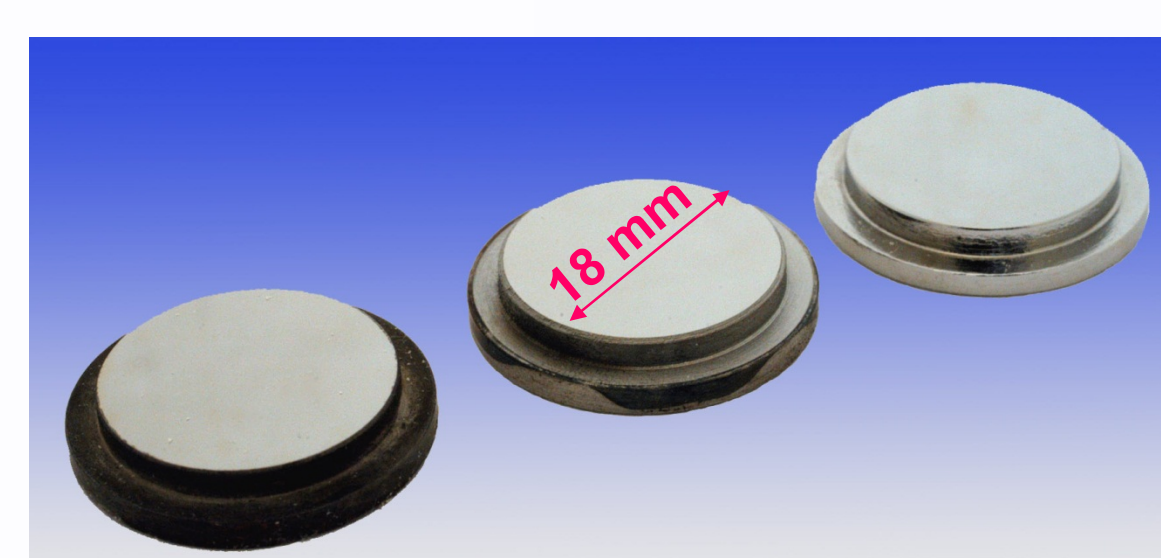
First mirror test in ASDEX Upgrade...

- First-ever test of diagnostic mirrors in a tokamak with all-metal plasma-facing components;
- Permanently heated mirrors to approach neutron and gamma heating in ITER
 - Long-term exposure
 - Detailed study of an Impact on mirror performance

...a vital knowledge for ITER first mirrors

Mirrors for exposure

Diagnostic mirrors



- Molybdenum and copper mirrors
- Characterized before and after exposure
 - Total and diffuse reflectivity
 - Elemental composition of the mirror surface

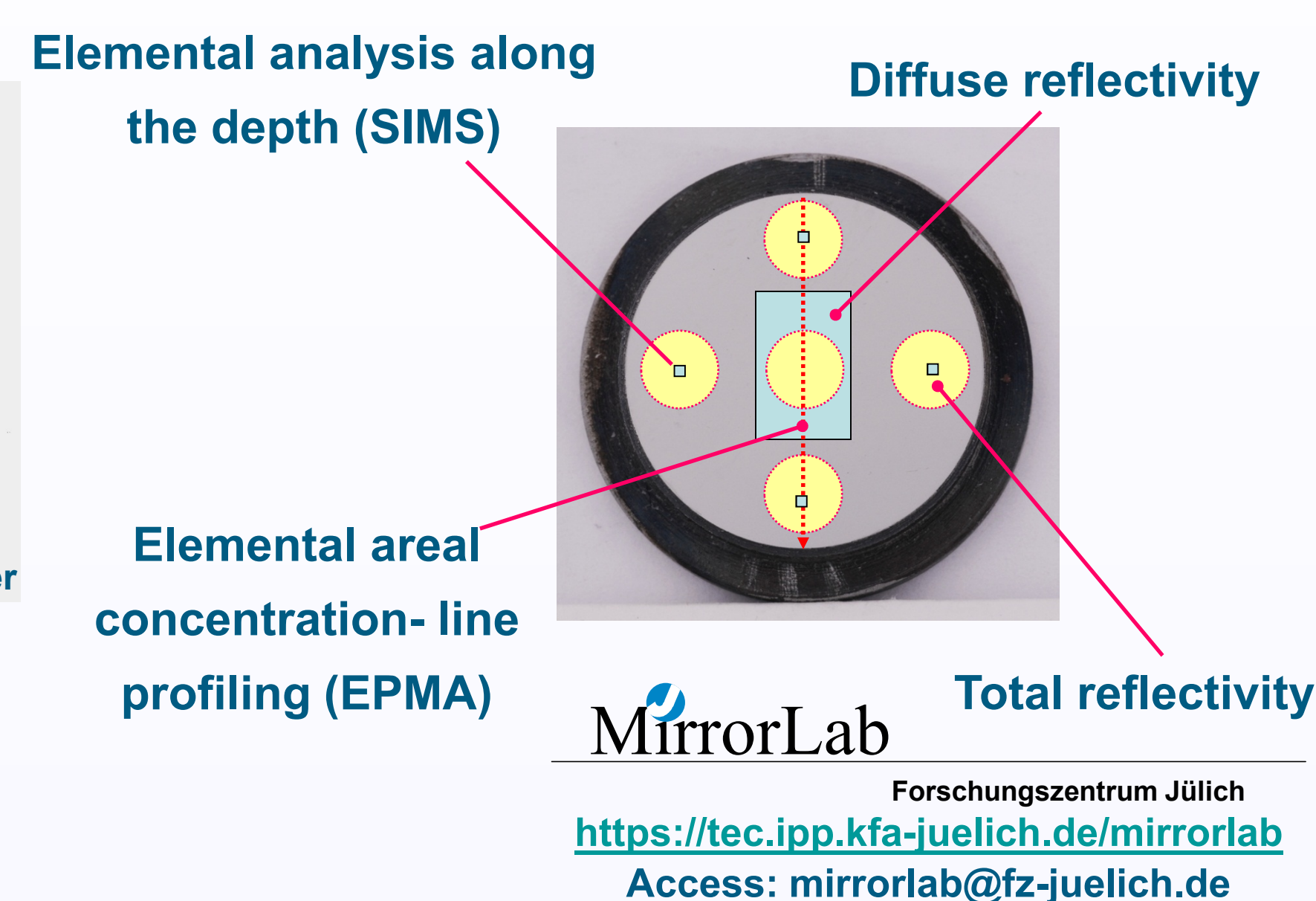
Mirror assembly

Actively heated holder with Mo and Cu mirrors



Photo: Harry Reimer

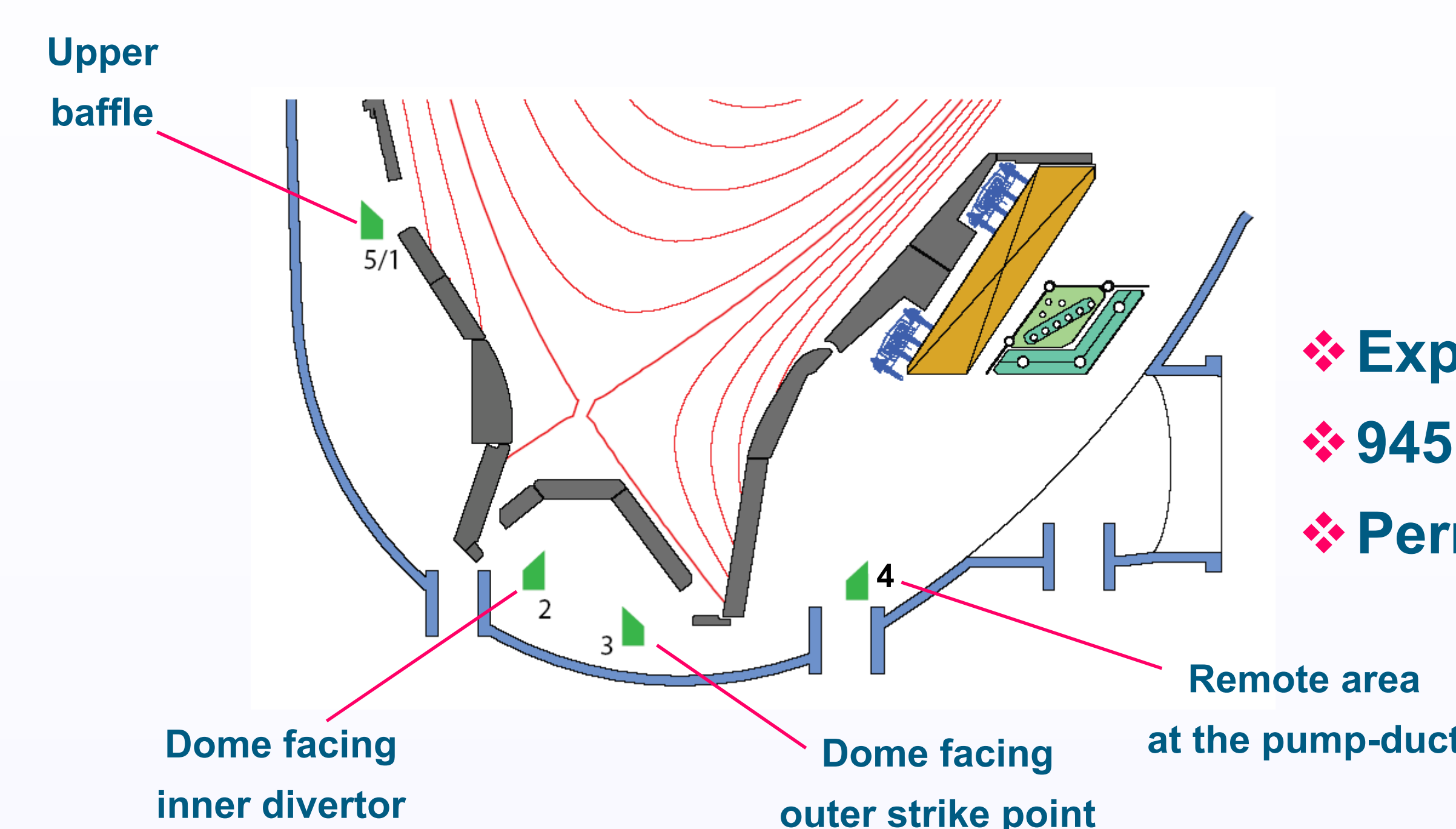
Mirror characterization: measurements locations



MirrorLab
Forschungszentrum Jülich
<https://tec.ipp.kfa-juelich.de/mirrorlab>
Access: mirrorlab@fz-juelich.de

Exposure in ASDEX Upgrade: details

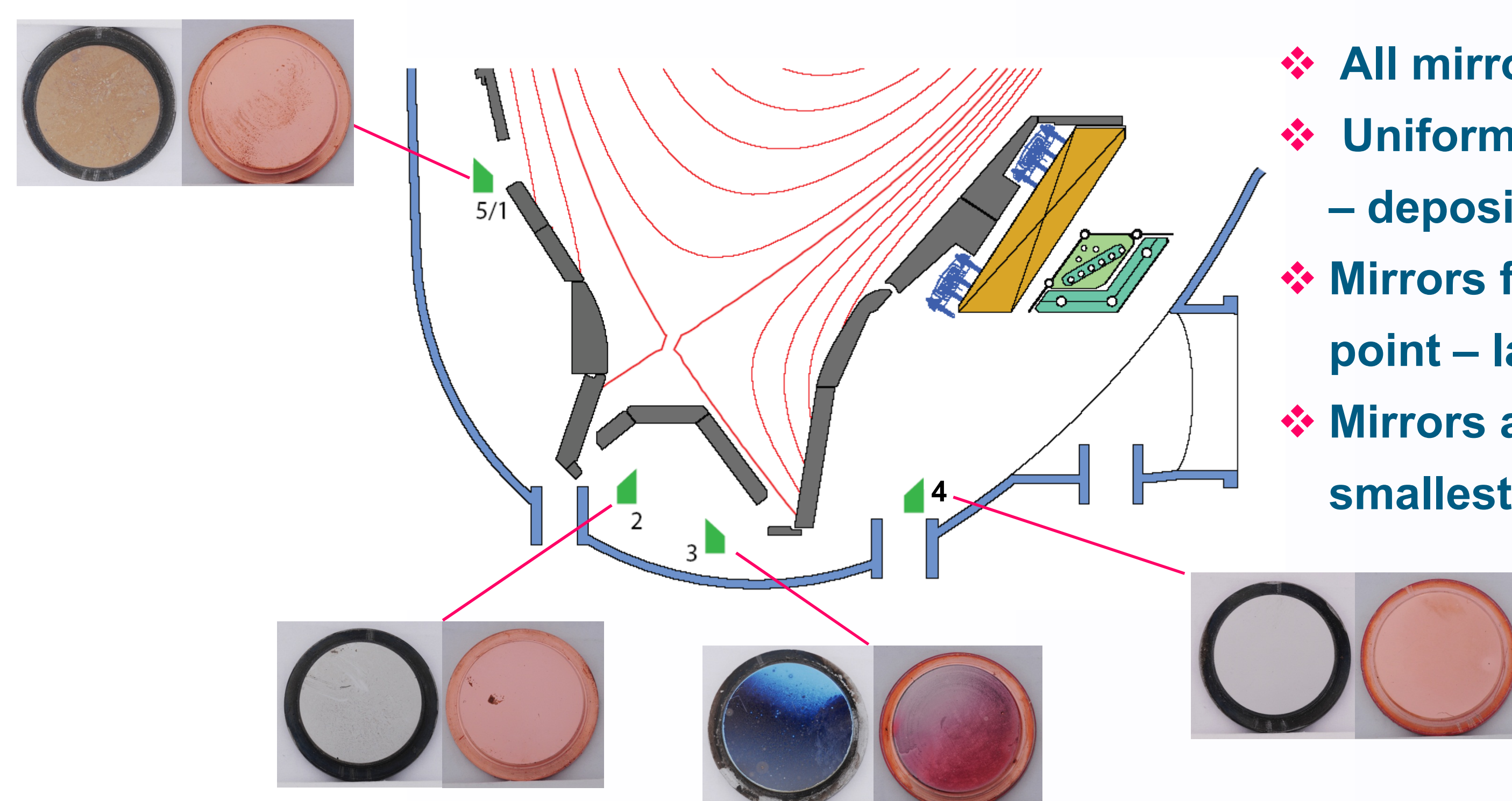
Exposure details



- Exposure from February till August 2011
- 945 discharges in divertor configuration
- Permanently heated mirrors at 145-165°C

Visual observations

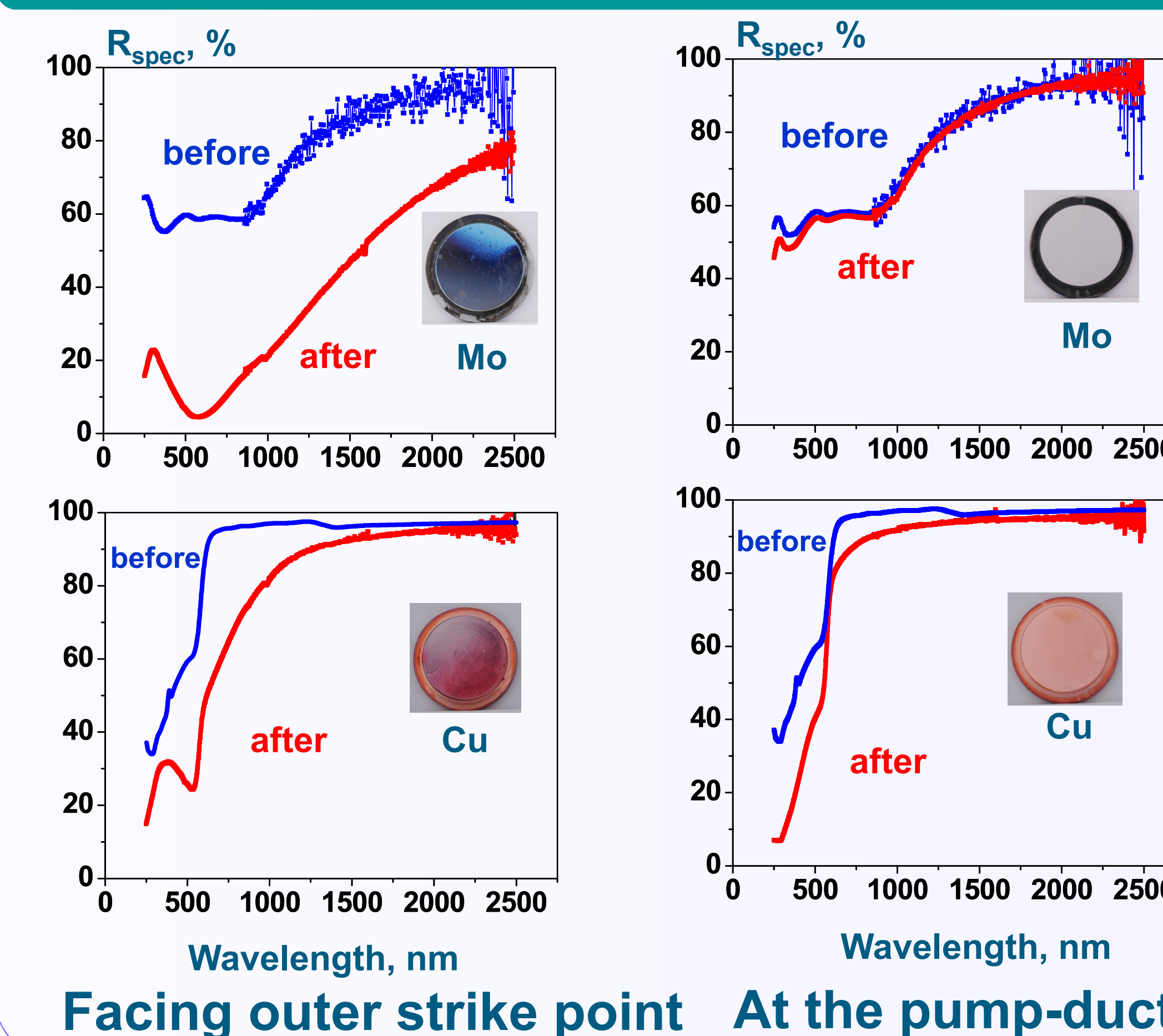
Molybdenum and copper mirrors after exposure



- All mirrors had deposition
- Uniform deposition pattern – deposition by neutrals
- Mirrors facing outer strike point – largest deposits
- Mirrors at the pump-duct – smallest ones

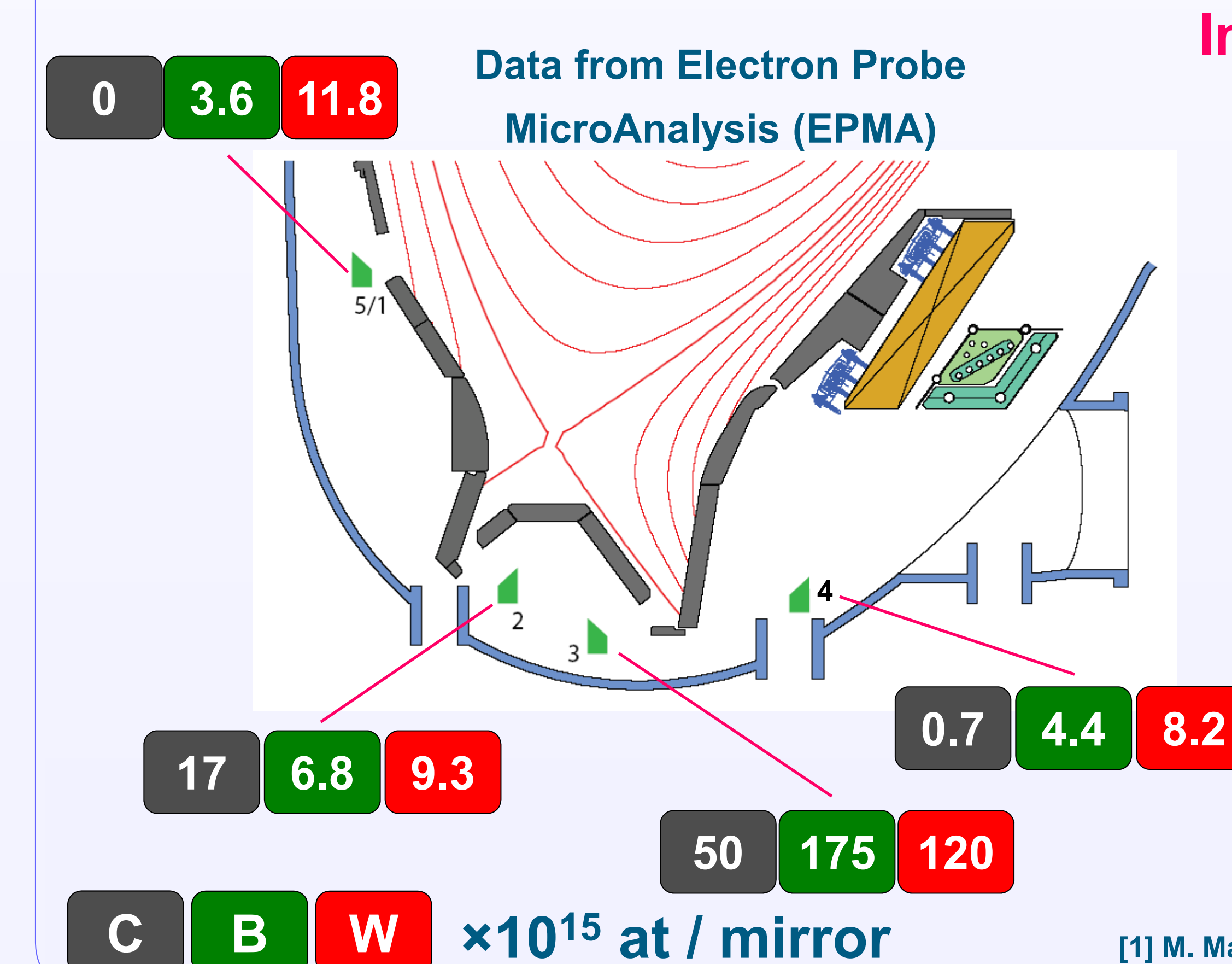
Significant progress achieved

Results: evolution of reflectivity



- Reflectivity of all mirrors degraded
- Strongest decrease on the mirrors facing the outer strike point
- Least decrease for mirrors in remote areas
- The most affected wavelength range: 250-1250 nm

Results: deposit characterization

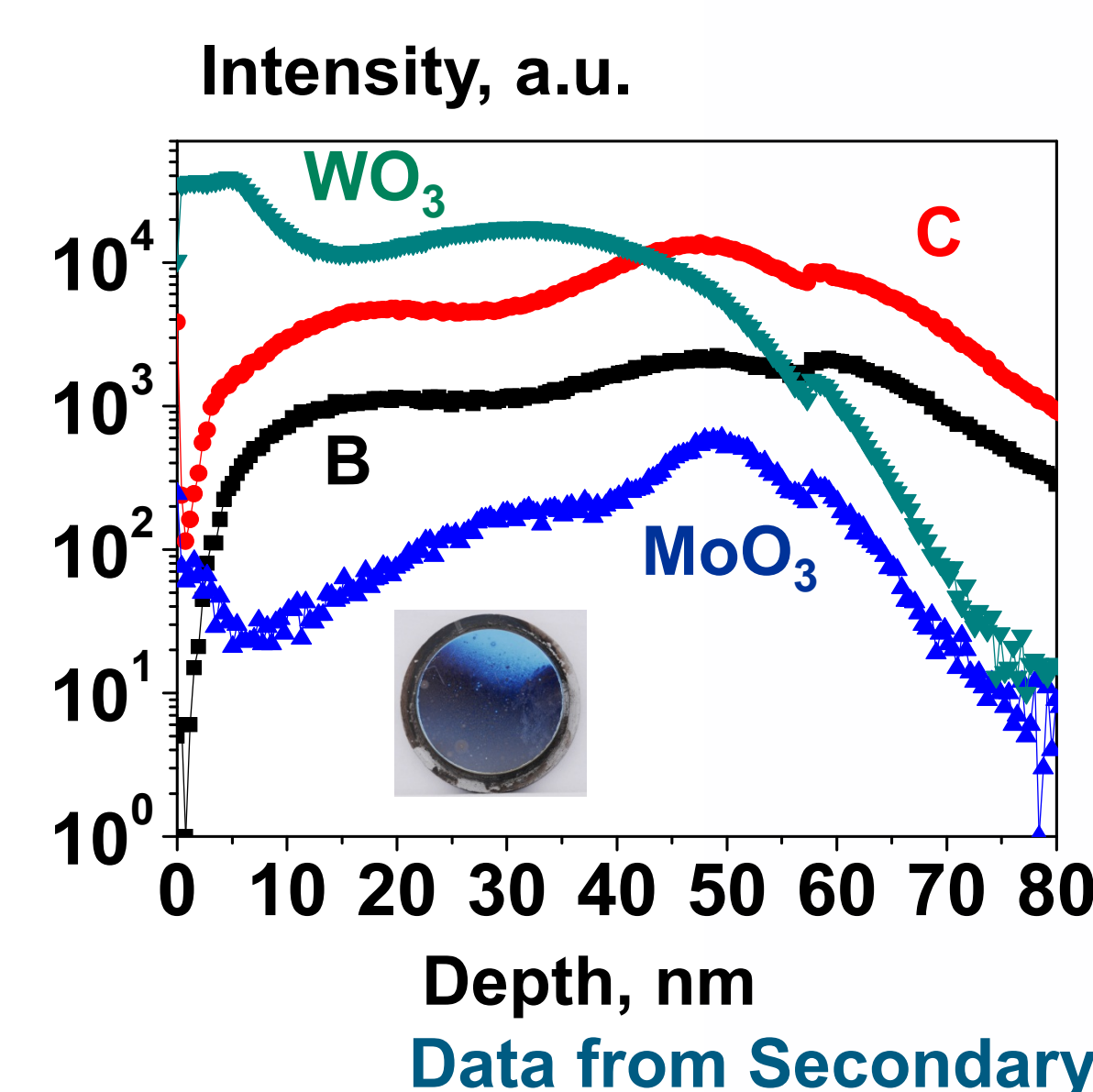


Impurity distribution

- Carbon found only on mirrors exposed under the dome
- 80% of entire deposition on the mirror facing outer strike point – local source [1]
- Overall deposition ~ 10 lower than with carbon PFCs [1]

[1] M. Mayer et al. Nuclear Fusion, 46 (2006) 914

Elemental composition of deposits



- Deposits contain W oxides, B and oxygen;
- Minor fraction of carbon
- Molybdenum oxidation due to air storage prior to exposure

Summary

- Reflectivity of all exposed mirrors degraded
- Mirrors far away from plasma experienced least decrease of reflectivity
- 10-times lower overall deposition with W PFCs as compared with earlier studies
- Carbon is not the main contributor in deposits anymore
- Deposition mitigation and mirror recovery measures are required and R&D in progress for ITER diagnostics

Disclaimer: Views and opinions expressed herein do not necessarily reflect those of the ITER Organization

Outlook

- Further investigations of tungsten and boron migration in the dome and remote areas of ASDEX Upgrade
- Cleaning of exposed mirrors using plasma sputtering to attempt the mirror recovery
- Studies of deposition mitigation on the mirrors using the shaped diagnostic ducts and shutters

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