First Negative Ion Beam Measurement by STRIKE Diagnostic Calorimeter


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## SPIDER: Ion source and extractor prototype for ITER HNB

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>H</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beam energy</td>
<td>keV</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Maximum Beam Source pressure</td>
<td>Pa</td>
<td>&lt;0.3</td>
<td>&lt;0.3</td>
</tr>
<tr>
<td>Uniformity</td>
<td>%</td>
<td>±10</td>
<td>±10</td>
</tr>
<tr>
<td>Extracted current density (1.52x0.56 m²)</td>
<td>A/m²</td>
<td>&gt;350</td>
<td>&gt;290</td>
</tr>
<tr>
<td>Beam on time</td>
<td>s</td>
<td>3600</td>
<td>3600</td>
</tr>
<tr>
<td>Co-extracted electron fraction (e⁻/H⁺ or e⁻/D⁺)</td>
<td></td>
<td>&lt;0.5</td>
<td>&lt;1</td>
</tr>
</tbody>
</table>
# SPIDER diagnostics: integrated & complementary

<table>
<thead>
<tr>
<th>Diagnostic</th>
<th>measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caesium oven thermoc. &amp; level</td>
<td>Monitor &amp; control Cs evaporation</td>
</tr>
<tr>
<td>Spectroscopy</td>
<td>Electron temperature; density of electrons, negative ions, caesium,</td>
</tr>
<tr>
<td></td>
<td>neutral hydrogen; impurity monitor</td>
</tr>
<tr>
<td>Laser Absorption spect</td>
<td>Caesium density</td>
</tr>
<tr>
<td>Cavity Ring Down</td>
<td>H⁻ / D⁻ density</td>
</tr>
<tr>
<td>Electrostatic probes</td>
<td>Plasma uniformity, electron temperature &amp; density</td>
</tr>
<tr>
<td>Beam emission spectroscopy</td>
<td>Beam divergence and uniformity, line integrated</td>
</tr>
<tr>
<td>Beam tomography</td>
<td>Beam uniformity, resolution 1/2 -1/4 beamlet group</td>
</tr>
<tr>
<td>Neutron imaging</td>
<td>Beam uniformity, resolution 20-30 mm</td>
</tr>
<tr>
<td>Diagnostic calorimeter STRIKE</td>
<td>Beam uniformity and divergence: resolution 2 mm for 10 s pulses</td>
</tr>
</tbody>
</table>

![Diagram of diagnostic setup]

- **Source**
  - Laser
  - Fiber to detector
  - CRDS
  - LOS

- **Beam**
  - Lens
  - Fiber to detector

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Serianne - miniSTRIKE in BATMAN - 9 September 2013
Diagnostic calorimeter in SPIDER – STRIKE
(Short Time Retractable Instrumented Kalorimeter Experiment)
Requirements for STRIKE CFC target

Tests of prototypes:
- power laser (RFX-Padova)
- GLADIS facility (IPP-Garching)

M.. De Muri et al., ThuP43
Tests with mini-STRIKE in BATMAN: aims

- Assessment of diagnostic operation
- Get confidence with experimental operation
- Characterisation of BATMAN beam
- Get confidence with SPIDER spatial scale
- Get confidence with data analysis
- Validation of numerical model(s)
- Characterisation of thermal properties at low temperature in vacuum
Mini-STRIKE Design
Mini-STRIKE Design

Supporting arm

Thermal camera

Tile support and mask

1m
Mini-STRIKE Installation
mini-STRIKE in BATMAN: simulations of data
Compensation for initial temperature distribution
Compensation for initial temperature distribution
mini-STRIKE in BATMAN: data analysis
mini-STRIKE in BATMAN: $U_{\text{extr}}$ scan – hydrogen
mini-STRIKE in BATMAN: $U_{\text{extr}}$ scan – hydrogen
mini-STRIKE in BATMAN: RF scan – hydrogen
mini-STRIKE in BATMAN: pressure scan – hydrogen
mini-STRIKE in BATMAN: calorimetry – hydrogen

\[
\Delta T_1 = \frac{q_{T_1, \text{position}} t_{\text{on}}}{\rho c_s L}
\]

beam  \[
\Delta T_1 = \frac{P_{\text{beam}}}{2\pi\sigma_x\sigma_y} \frac{t_{\text{on}}}{\rho c_s L} \approx \frac{P_{\text{beam}}}{2\pi\sigma_2^2} \frac{t_{\text{on}}}{\rho c_s L}
\]

Beam Width, \( \sigma \)
mini-STRIKE in BATMAN: next campaign

- New arrangement of old mask

Ø7mm

28mm
mini-STRIKE in BATMAN: next campaign

- New mask:
  - increase of beam sampling points

Temperature Profile (Rear Side)

Temperature map on rear side of tile
NIFS NBI test stand: preparation
Summary and future work

- Design of reduced version of STRIKE
- Successful operation in BATMAN
- Development of first data analysis

- Improvement of 2D data analysis method
- Improvement of space resolution
- New measurements scheduled for beam characterisation:
  - BATMAN
  - NIFS NBI test stand