Introduction

- **ITER** foresees 2 neutral beam injectors (1 MV; 40 A) at heating and current drive system. Each beam will be formed by 1280 beamlets, arranged in 16 beamlet groups (BG).
- **SPIDER** device (100 keV; 40 A) is dedicated to optimise the negative ion source performances.
- **STRIKE**, the diagnostic calorimeter of SPIDER, is requested to assess beam divergence and uniformity at the beamlet scale.

**STRIKE main features**

- **Design**: 16 CFC tiles (396 × 160 × 20 mm³) [1]
- **Heat load**: up to 5-20 MW/m² for 5-10 s
- **Diagnostic principle**: infra-red images of the tiles
- **Limit**: tiles must be observed from behind
- **Solution**: very anisotropic material → 1D CFC tiles (thermal conductivities: K_{acc}/K_{cand} = 10–20)
- **Requirement**: efficient and fast data analysis methods

Experimental data

- **Scan in different source and accelerator parameters** → Trends of fit parameters agree with beam physics expectations
  - Extraction voltage scan (V_{exc} = 40 kV; P_{av} = 50 kW)
    - Focusing/defocusing of beamlets
  - Arc power scans (V_{exc} = 3 kV; V_{acc} = 36 kV)
    - Focusing of beamlets

Heat flux reconstruction

- **Test on simulated data** (15 beamlets arranged as NIFS beamlets with reasonable widths and power)
  - Finite element simulation to obtain a test temperature map to be inverted
  - Comparison between original and reconstructed fluxes
  - First part of pulse has larger error
- **NIFS data**
  - Initial temperature of the tile is very important (non-linear thermal properties)
  - Tendency to saturation towards beam stop (t = 1 s)
  - Validation of reconstruction by a finite element simulation in COMSOL
  - Temperature values similar to reality (10-15 % range)
- **Possible improvements**
  - Inclusion of time dependence in the transfer function
  - Transfer with internal energy Δ(t)
- **Limit**
  -unlikely to be applied to STRIKE where ΔT is much larger

The transfer function method [3]

- **Tile** is considered as an operator which applies a transfer function to an input (heat flux F) providing an output (temperature T)
- **Energy flux** has to be only on the front and other heat exchange processes have to be negligible
- **Delay in heat transmission** has to be negligible (w.r.t. to camera sampling rate)
- **Anti-transfer function** given by the response to a pulsed input of known power (a laser)
- **Main issues**: Filtering and non-linearity of the material

**Conclusions**

- The diagnostic principle of STRIKE has been successfully tested by its smaller version mini-STRIKE: known trends are well reproduced with multi-peak fit analysis
- Heat fluxes reconstructed with the transfer function method are reasonable within a 10-15% range: faster and more efficient analysis are possible
- Simulations are necessary to improve the beam characterisation

References

[3] A. Antoni et al., Analysis of diagnostic calorimeter data by the transfer function technique, 9th International Conference on Ion Sources, New York, New York, USA, August (2015) to be published