Disruption indicators for JT-60SA:
Slowing down of macroscopic MHD modes
MARFE detection by VIS camera

M. Gelfusa[1], E. Peluso[1], R. Rossi[1], T. Craciunescu[2] and A. Murari[3]

[1] University of Roma Tor Vergata, Italy
[2] INFLPR, Romania
[3] Consorzio RFX, Italy

Slowing down and locking detection of maroscopic MHD modes

Mode locking precedes most of disruptions in tokamaks and mode lock amplitude-based predictors demonstrated to have very high prediction performances, with warning times acceptable for mitigation [1,2,3].

Classical Mode Locking Amplitude based indicators:

1. Needs calibrated signals (offsets and drifts must be corrected or taken into accout)

2. Needs a threshold calculation and/or a supervised approach

⇩

Hard to apply from the day 1.

New Mode Locking Frequency based indicator :

1. Signals do not need calibration (anomaly detection)
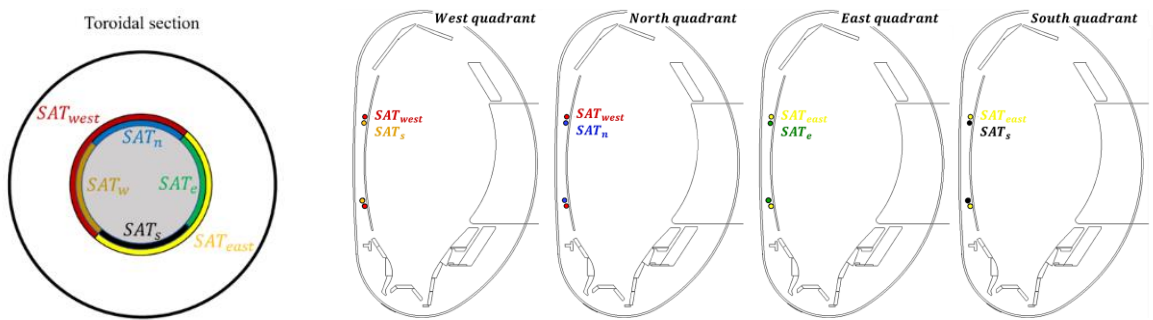
2. It does not need the determination of a threshold

⇩

Day 1 applicability is possible

ASDEX-Upgrade 4-saddle coils system (used to measure radial perturbation B_r)

$$\widehat{B_r} = \sqrt{\underbrace{\left(\int \left(\dot{B}_n - \dot{B}_s\right) dt\right)^2}_{B_r^{ns}} + \underbrace{\left(\int \left(\dot{B}_e - \dot{B}_w\right) dt\right)^2}_{B_r^{ew}}}$$
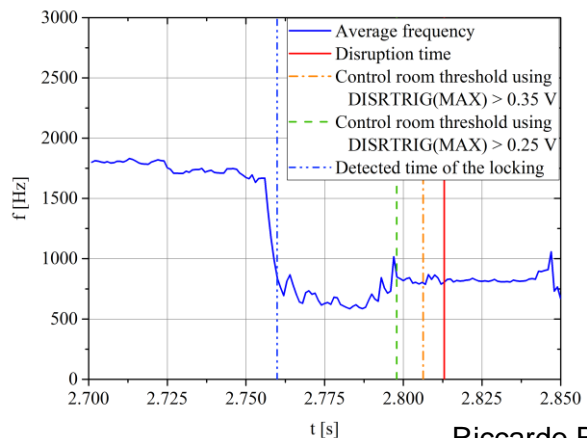
Methodology

Local FFT (small time window)

⬇

Average frequency of the signals

$$f_{ew}(t) = \frac{\sum f_i I_{ew}(t, f_i)}{\sum I_{ew}(t, f_i)}$$

Results

| Disruptions (177)	DISRTRIG25 DISRTRIG35		F-based
	0.25 V	0.35 V	
Detected [%]	86.44%	72.88%	93.79%
Missed [%]	13.56%	27.12%	2.82%
Early (<1s) [%]	3.95%	1.13%	3.39%

Slowing down indicator: Next steps

- Test the indicator on JET to validate the degree of transferability between machines.

- Evaluate what diagnostics can be used at JT-60SA.

MARFE detection, tracking and characterisation

High visible radiation on the high field side of the poloidal plane is often observed by the visible cameras (and it precedes the mode locking and electron temperature anomalies) [5]
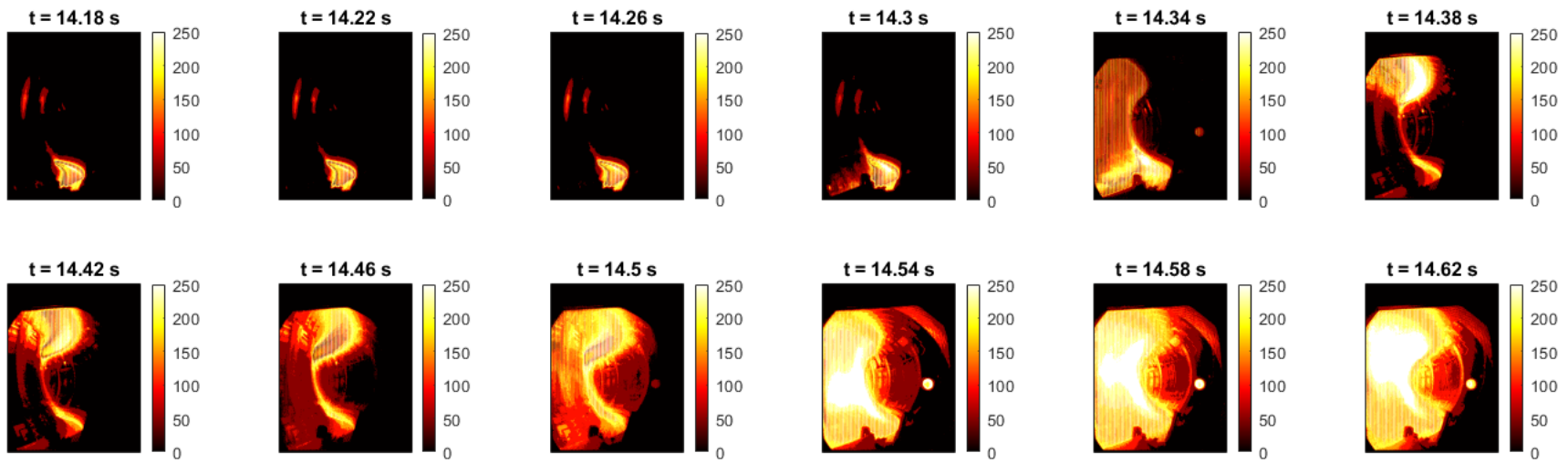
We are developing a simple and fast algorithm to detect anomalous VIS radiation, track and characterise it.

Tests will be done with JET VIS cameras.

References

1. S.N. Gerasimov et al 2020 *Nucl. Fusion* **60** 066028
2. A. Murari *et al* 2018 *Nucl. Fusion* **58** 056002
3. A. Murari *et al* 2019 *Nucl. Fusion* **59** 086037
4. E. Peluso et al 2020 *Appl. Sci.* **10** (21), 7891
5. T. Craciunescu et al. *IEEE Transactions on Plasma Science* 2014 **42** (8)