Interaction of Sawteeth, Alfven eigenmodes and Fast Ion Transport: Progress in predictive understanding and challenges for Burning plasma Experiments.

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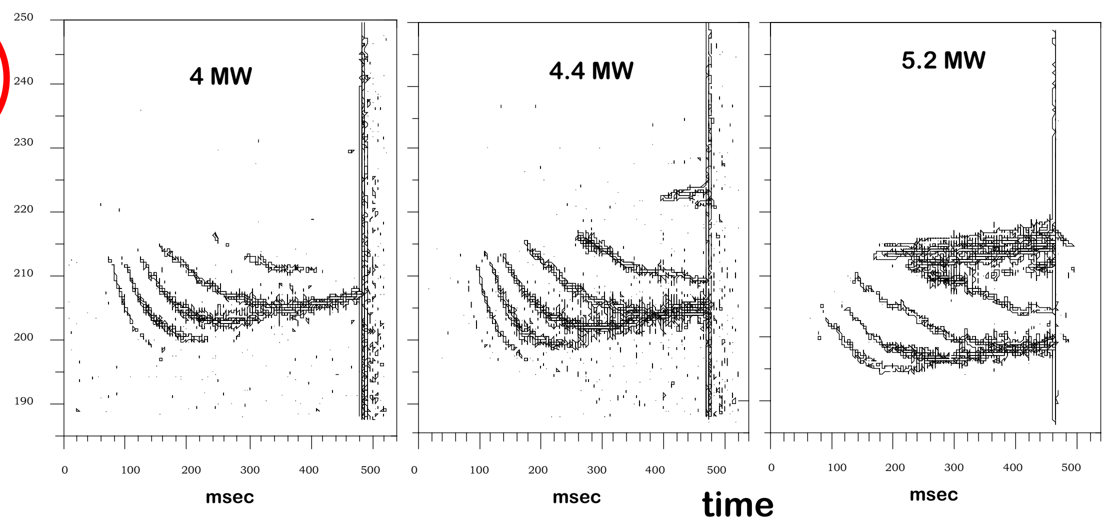
Recent experiments have shown that the stability and onset condition for the m=1 sawtooth mode is strongly tied to the stability of Alfven eigenmodes in Tokamak plasmas. Observations in TFTR show that the condition for the onset of the sawtooth is strongly determined by the existence of Toroidal Alfven eigenmodes in the core of plasmas with minority ICRF heating. We discuss the implications of these recent analysis results on predictions concerning sawtooth behavior in a tokamak burning plasma experiment and the scientific contribution of such an experiment to fast ion research. Progress in recent quantitative analysis and developments in predictive understanding will be discussed.

Burning Plasma Workshop, Austin, 11-13 December 200

MONSTER SAWTEETH AND ALFVÉN INSTABILITIES ARE CLOSELY CORRELATED

1

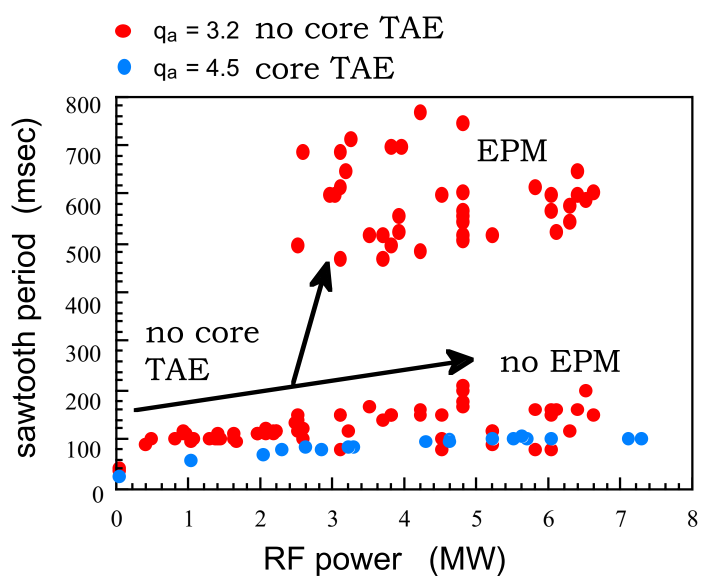


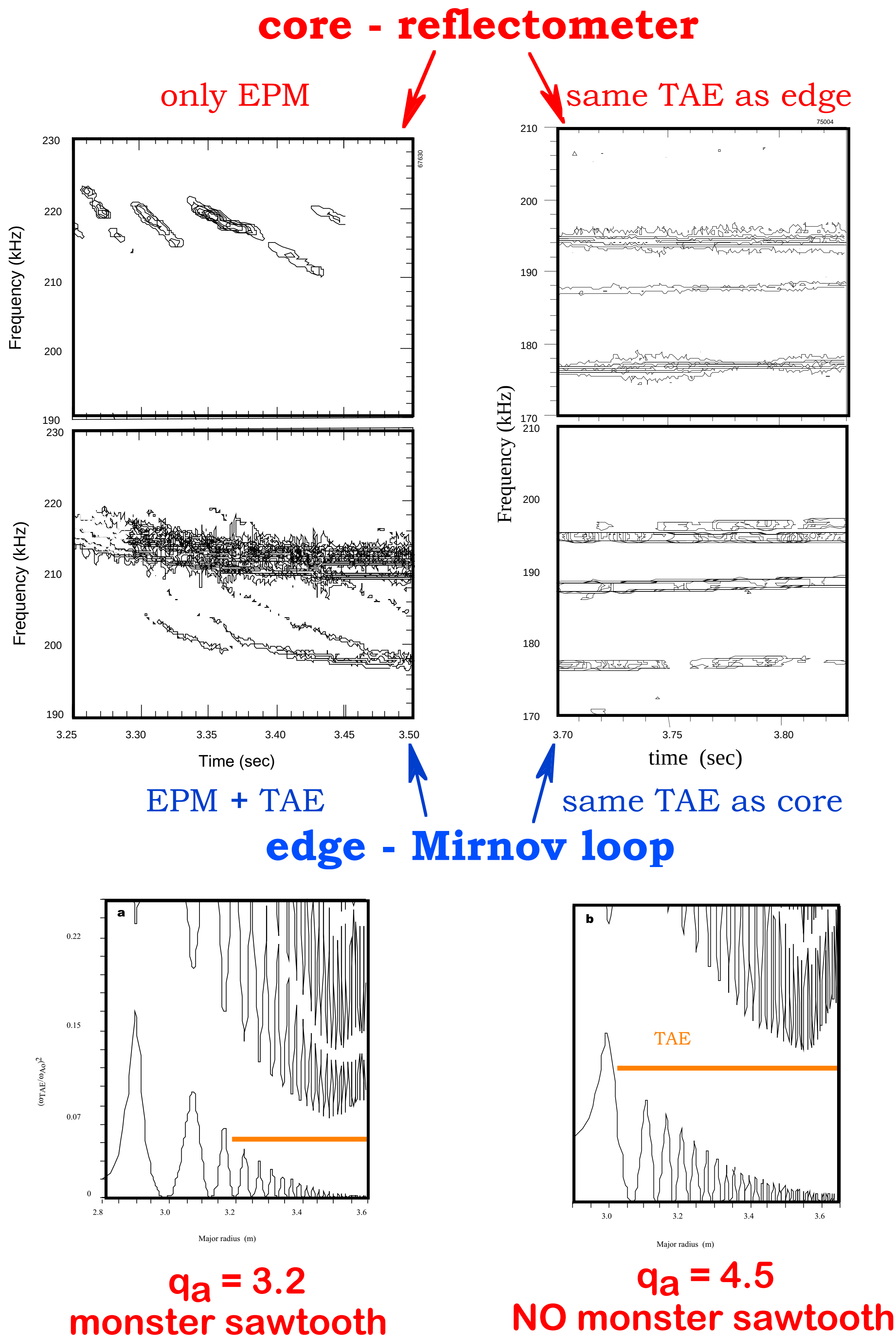
EPM <u>always</u> accompany the monster sawtooth.

EPM are excited <u>before</u> TAE.

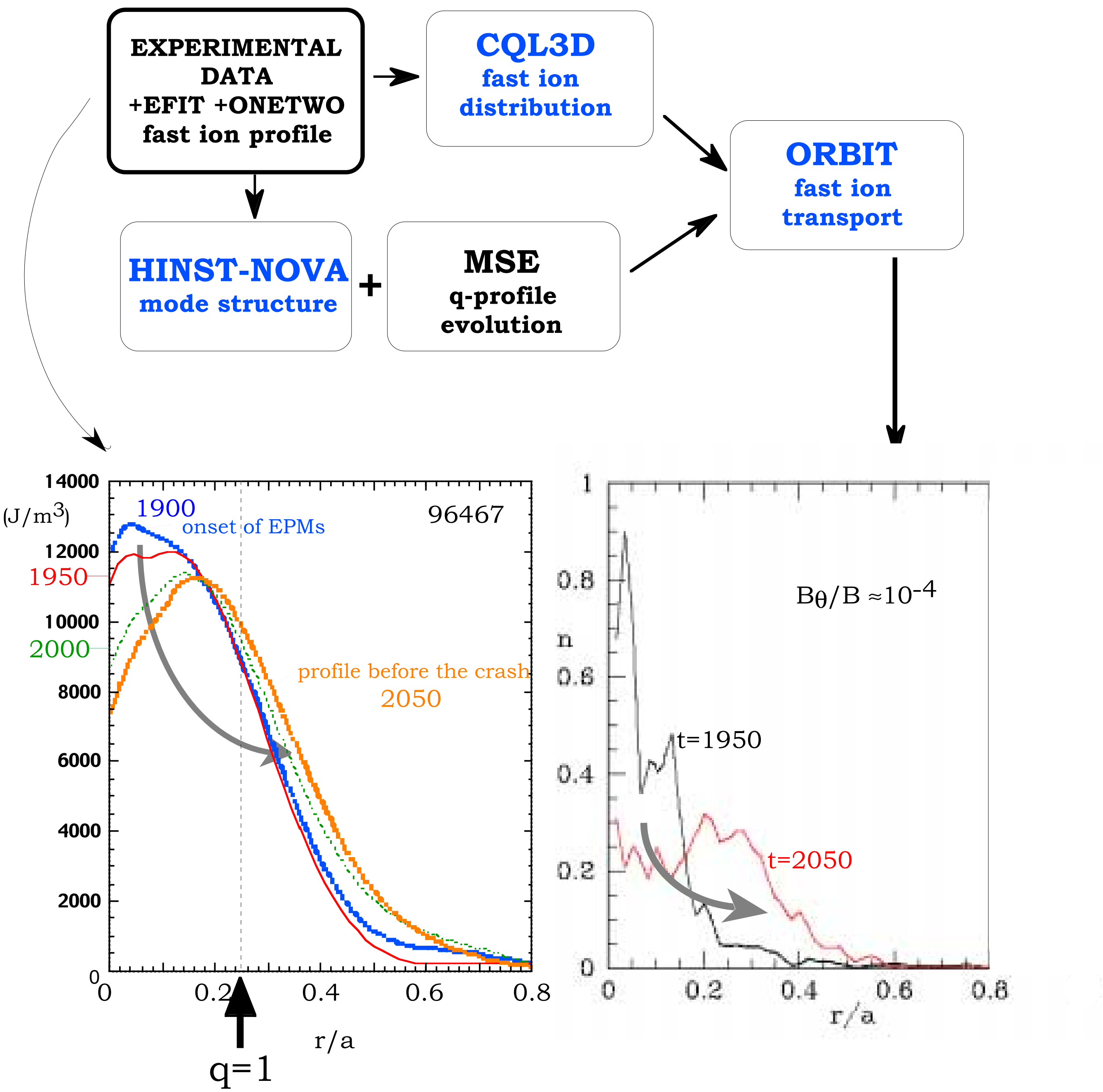
2

monster sawteeth form <u>ONLY</u> at low q_a

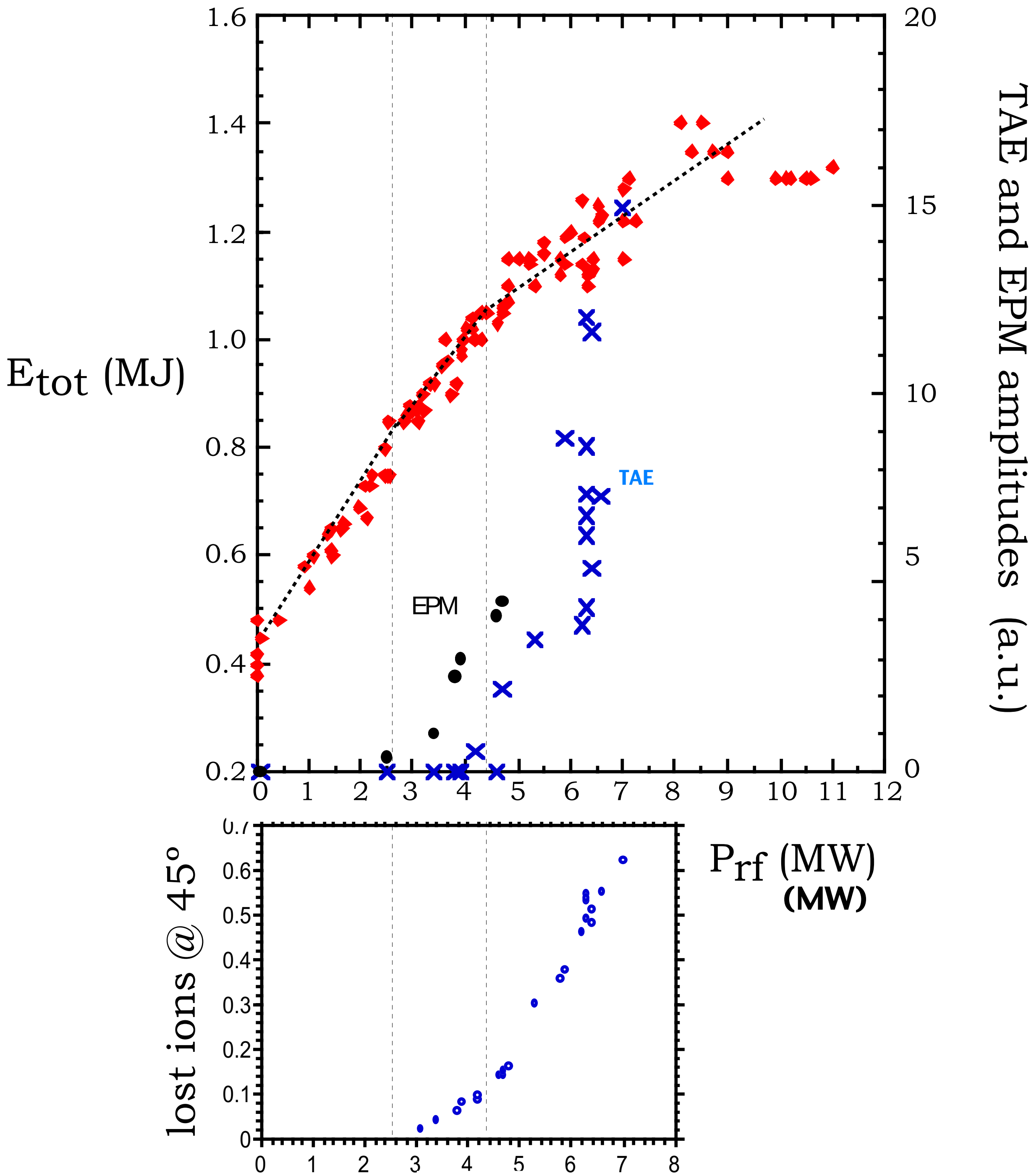



core - reflectometer
only EPM
same TAE as edge
Frequency (kHz)
Time (sec)
time (sec)
EPM + TAE
same TAE as core
edge - Mirnov loop
a
b
TAE
Major radius (m)
qa = 3.2
monster sawtooth
qa = 4.5
NO monster sawtooth

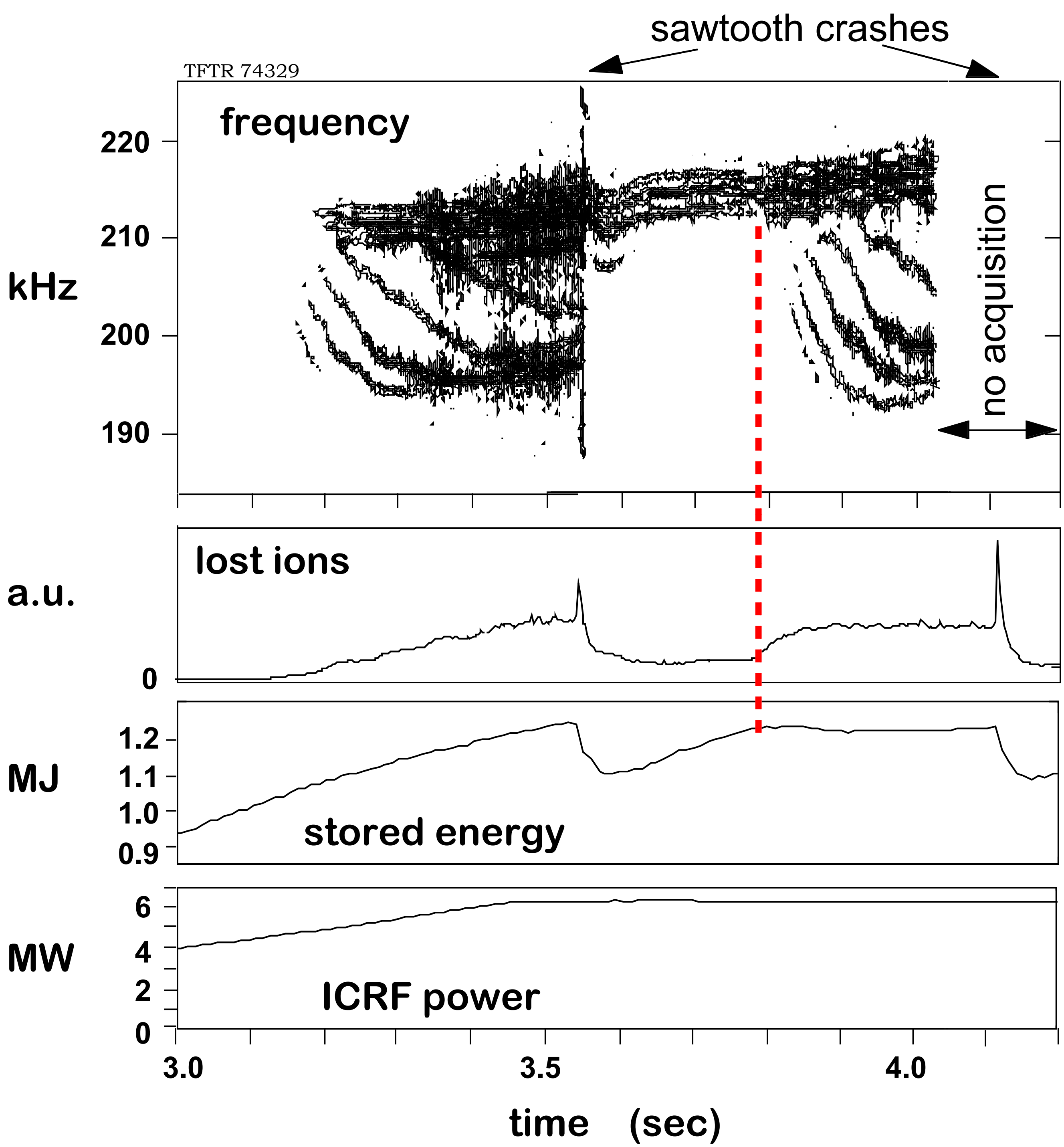
THE EPM TRANSPORT FAST IONS RADIALLY



MAXIMUM ION LOSSES AND HEATING DEGRADATION WHEN BOTH EPM AND TAE ARE PRESENT



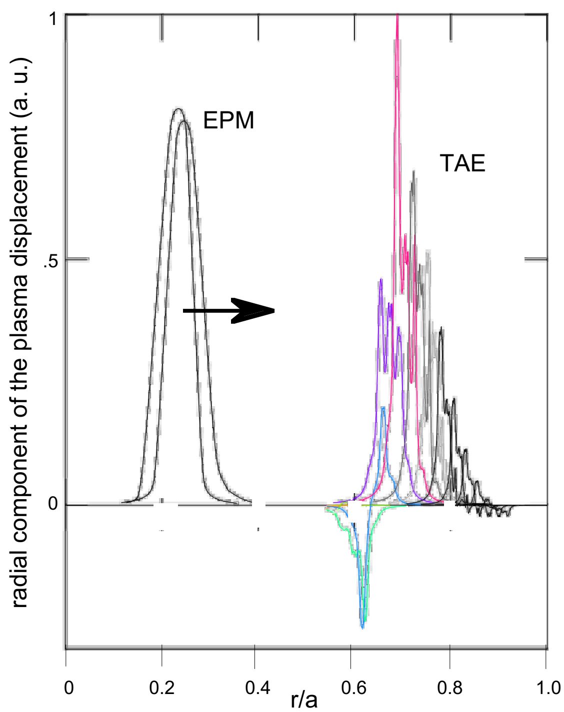
The fast ion losses, triggered by the EPM, are due to the combination EPM+TAE



SUMMARY

1 EPM transport the fast ions across r(q=1)
⇨ sawtooth crash

2 TAE transport the fast ions to the plasma edge
⇨ ion losses / degradation of heating efficienc



1 KEEP EPM AND TAE SEPARATE

low magnetic shear "closes" the Alfvén gap

2 PREVENT THE RADIAL SHIFT OF THE EPM

stop the q-profile broadening

The monster sawtooth are stabilized by deeply trapped ions.

The EPMs are destabilized through the transit or bounce time of the ion orbits.

What's happening when the fast ions (alphas) are isotropic?

How much of our understanding can be extrapolated to alphas?