Simulations of EXTRAP-T2R RFP with n=12 RMP fields

V.A. Izzo[1] and L. Frassinetti[2]
[1]University of California San Diego
[2] KTH Royal Institute of Technology, Stockholm, Sweden

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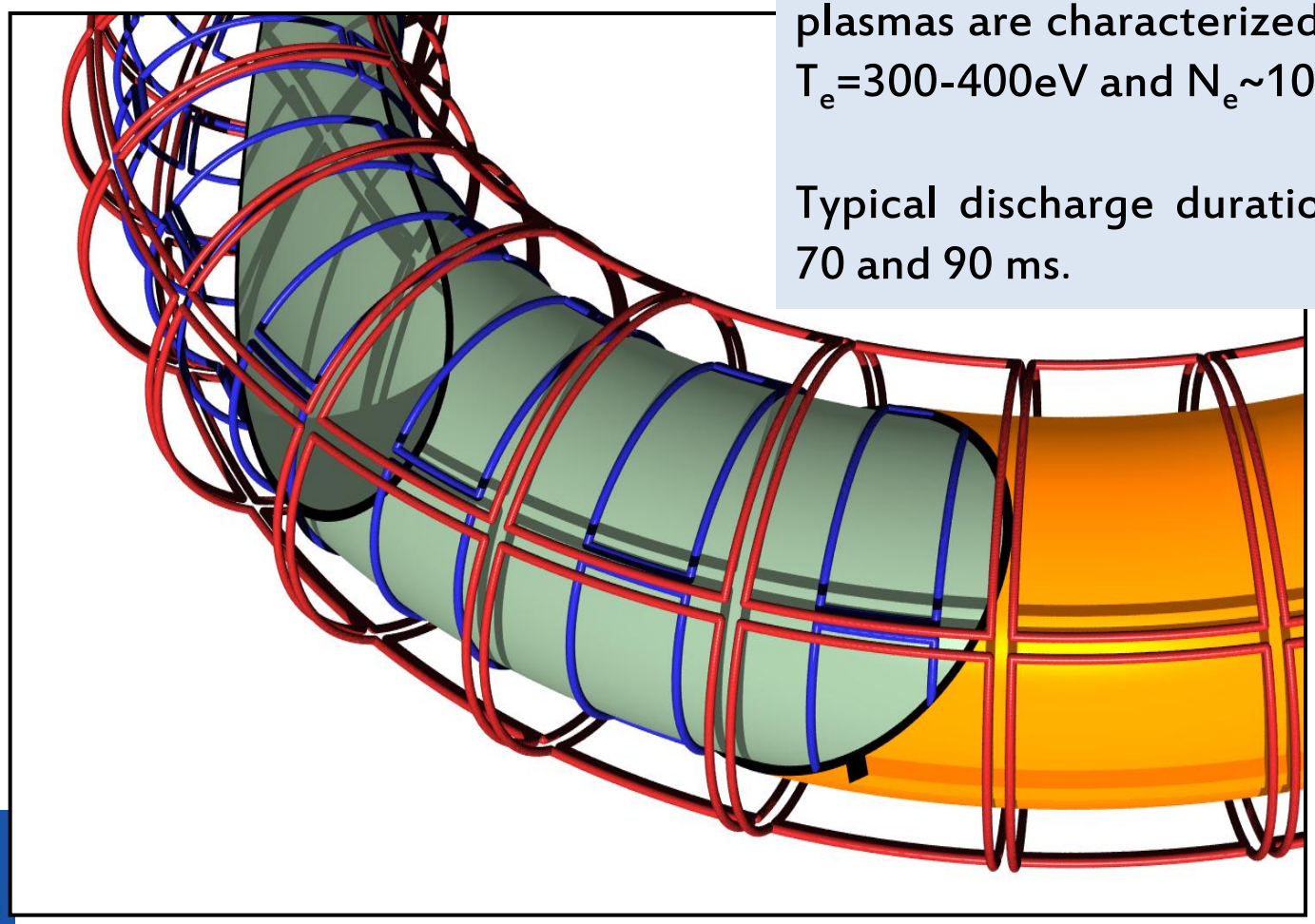
The EXTRAP T2R device

EXTRAP T2R is an RFP machine with R=1.24m and a=0.183m. Typical plasmas are characterized by I_p~100kA, T_e=300-400eV and N_e~10^{19} m^{-3}.

Typical discharge duration is between 70 and 90 ms.



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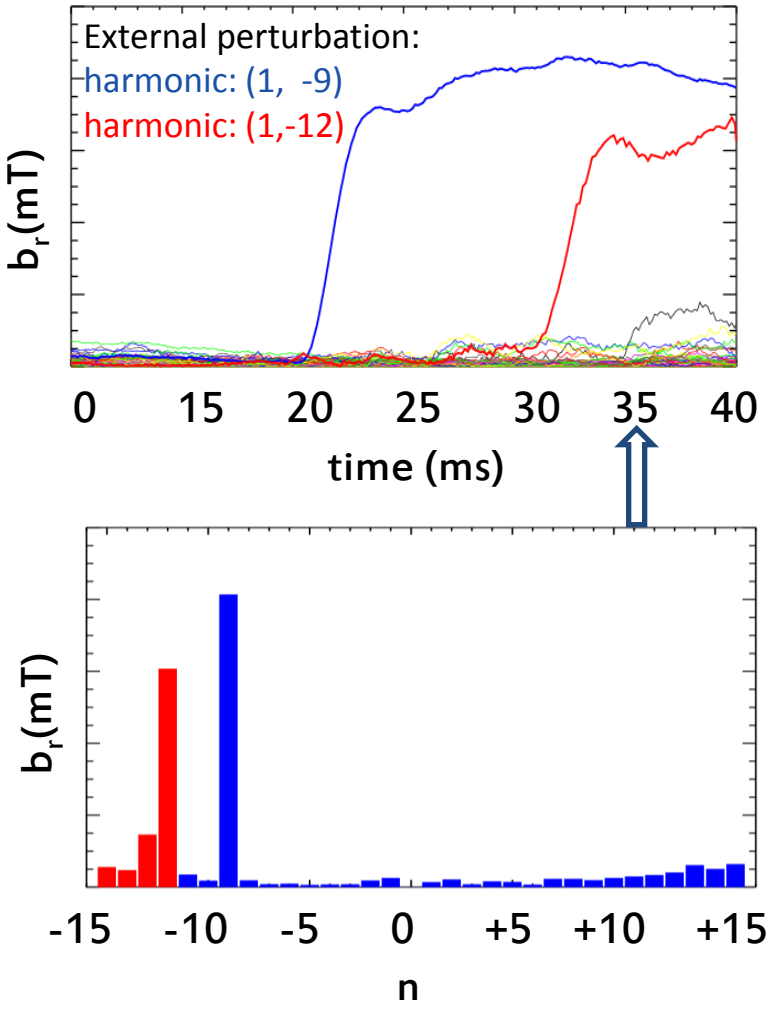
RMP screening experiments

Experiments aim to quantify RMP screening effects:

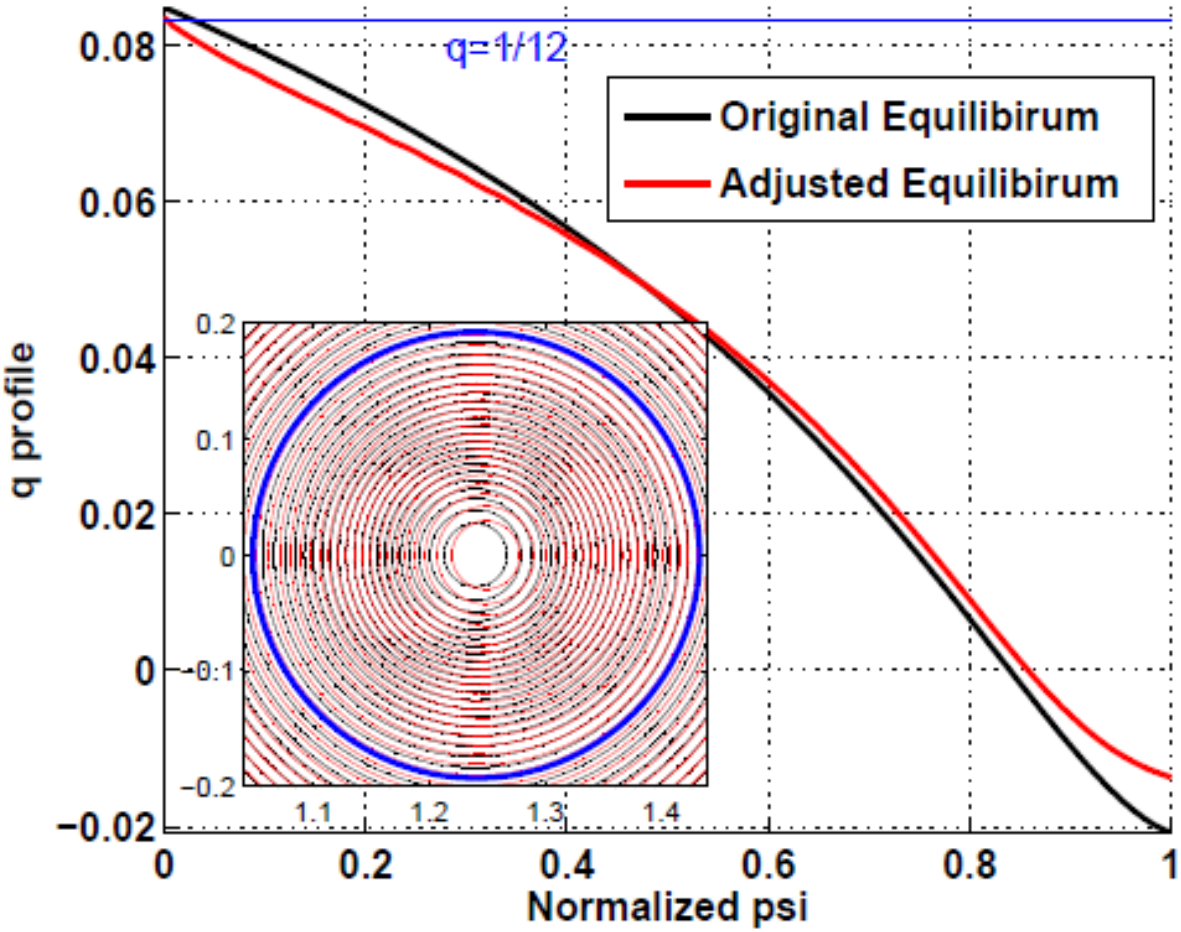
- **The effect of the RMP on the plasma is quantified by monitoring the dynamics of its corresponding TM**: it is known that a static RMP affects the corresponding TM island by amplifying and suppressing its amplitude and producing acceleration-deceleration to its velocity, depending on the relative phase between RMP and TM.
- **The plasma flow is varied by applying non-resonant perturbation** (non-RMP), that via the neo-classical viscosity (NTV) torque modifies in a relatively controlled way the plasma velocity.



Initial equilibrium was very problematic

- In initial simulation attempts, all modes grew rapidly, virtually independent of grid resolution or viscosity/resistivity

- Allowed equilibrium to adjust (transfer_eq=T, n=0 simulations, wrote new EFIT from results, reran nimset with transfer_eq=F).
  - Side note: When following this procedure B_t changes sign? Why does definition of FF' in EFIT output routine have -sign?



- New equilibrium is shifted outboard, has slightly different q-profile (n=12 still resonant in core).

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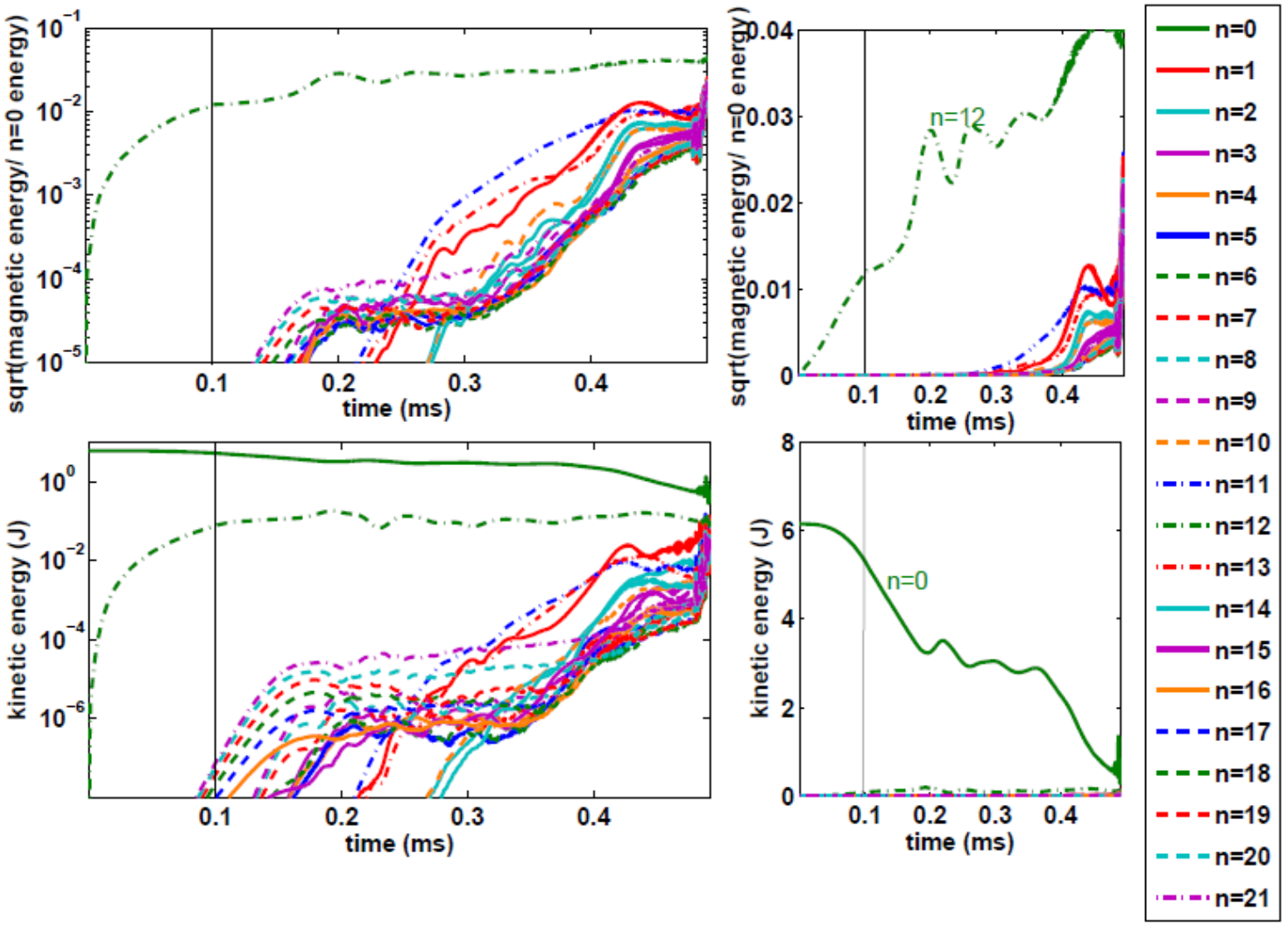
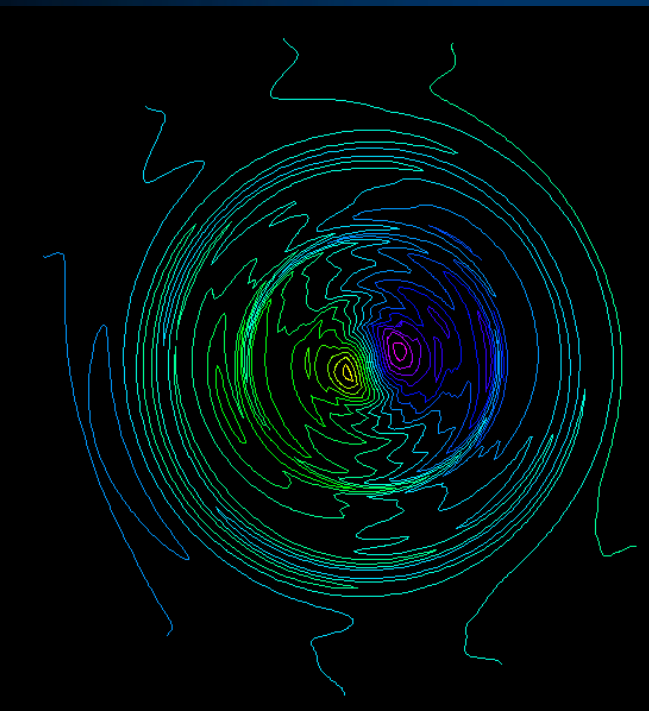
With only n=12 fields RFP (almost) reaches new saturated state

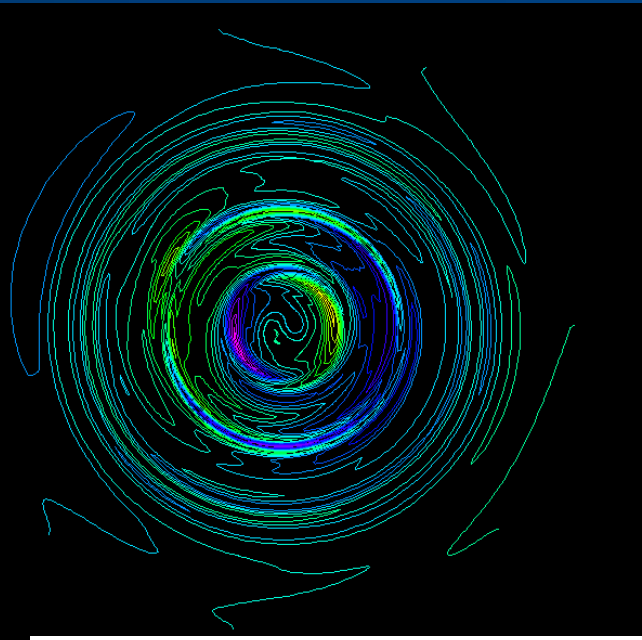
- Ramp until 0.1 ms, n=12 mode continues to grow, then oscillates
- New (almost) steady conditions between 0.2 and 0.4 ms. Lower velocity, oscillations similar to experiment.



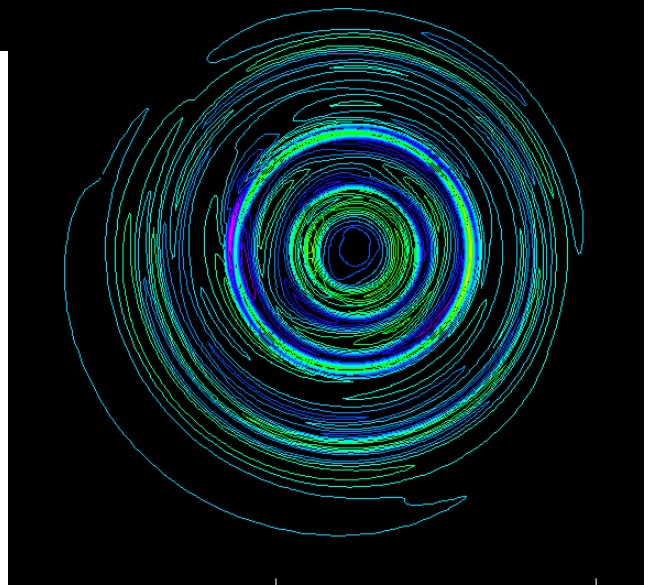
Structure of the three continuously growing modes at 0.35 ms



n=1 B_{tor}
(m=0)



n=11 B_{tor}
(m=1)



n=13 B_{tor}
(m=1)

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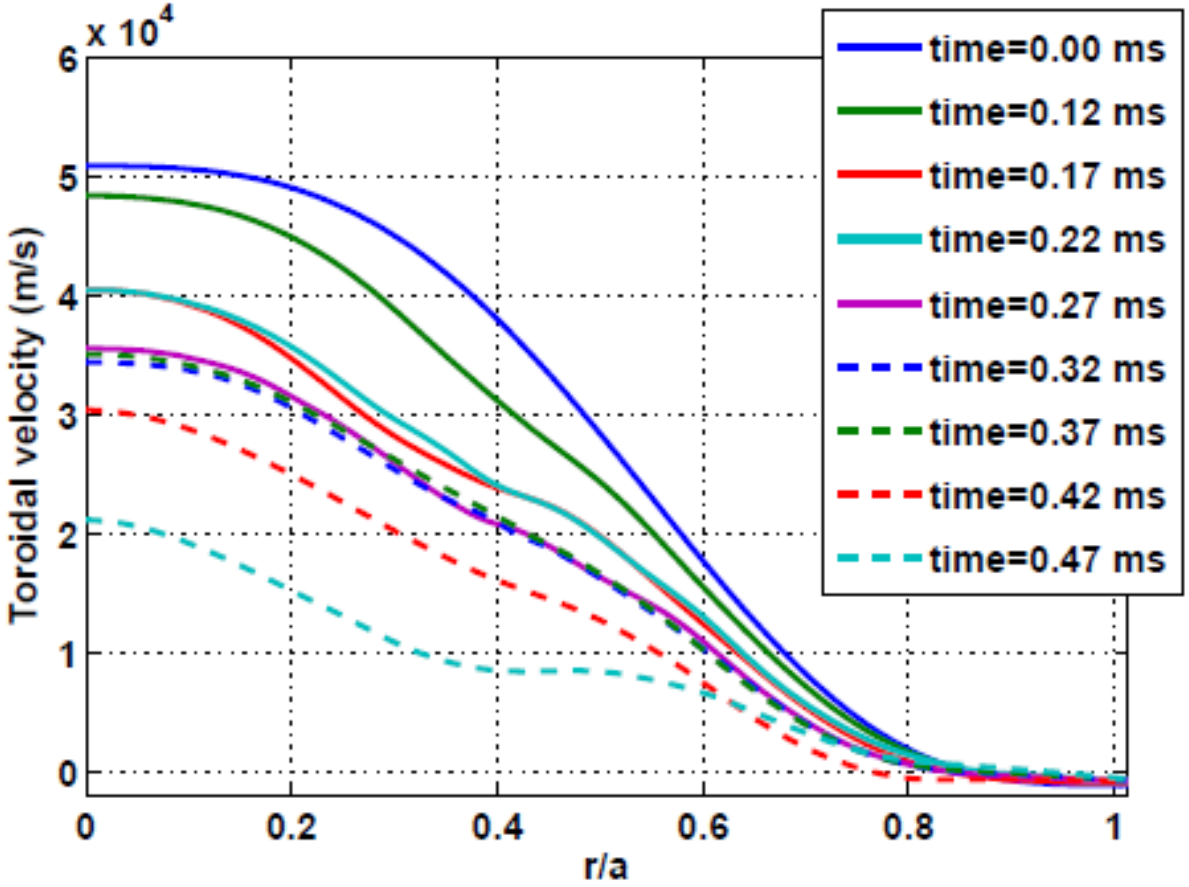
Toroidal rotation hovers at reduced values, briefly (kin_visc=10)

Toroidal rotation profile: Initially slows, then hovers at 40km/s , then 35 km/s, before finally dropping rapidly toward zero.



Experiment finds steady state value at ~25 km/s

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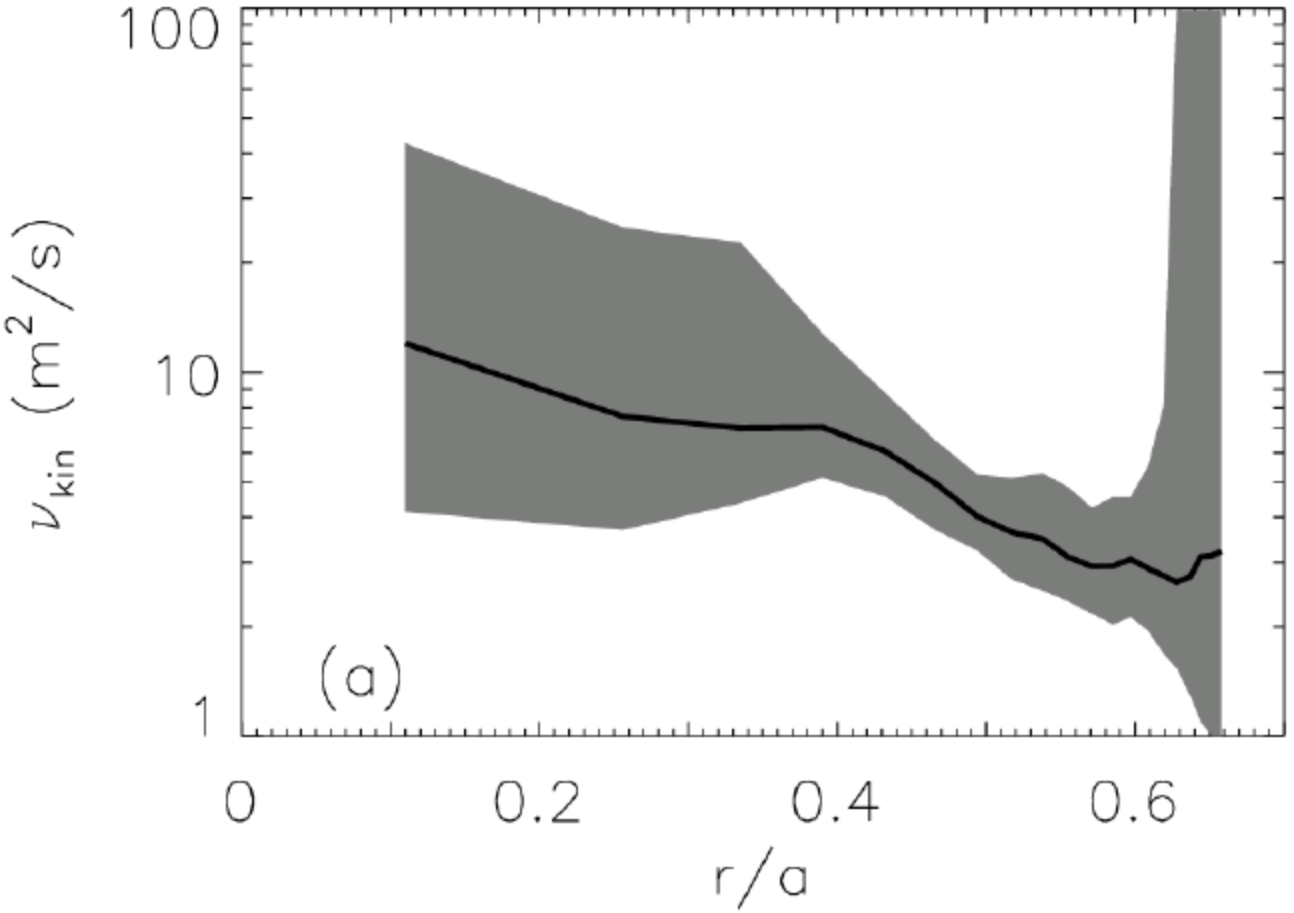
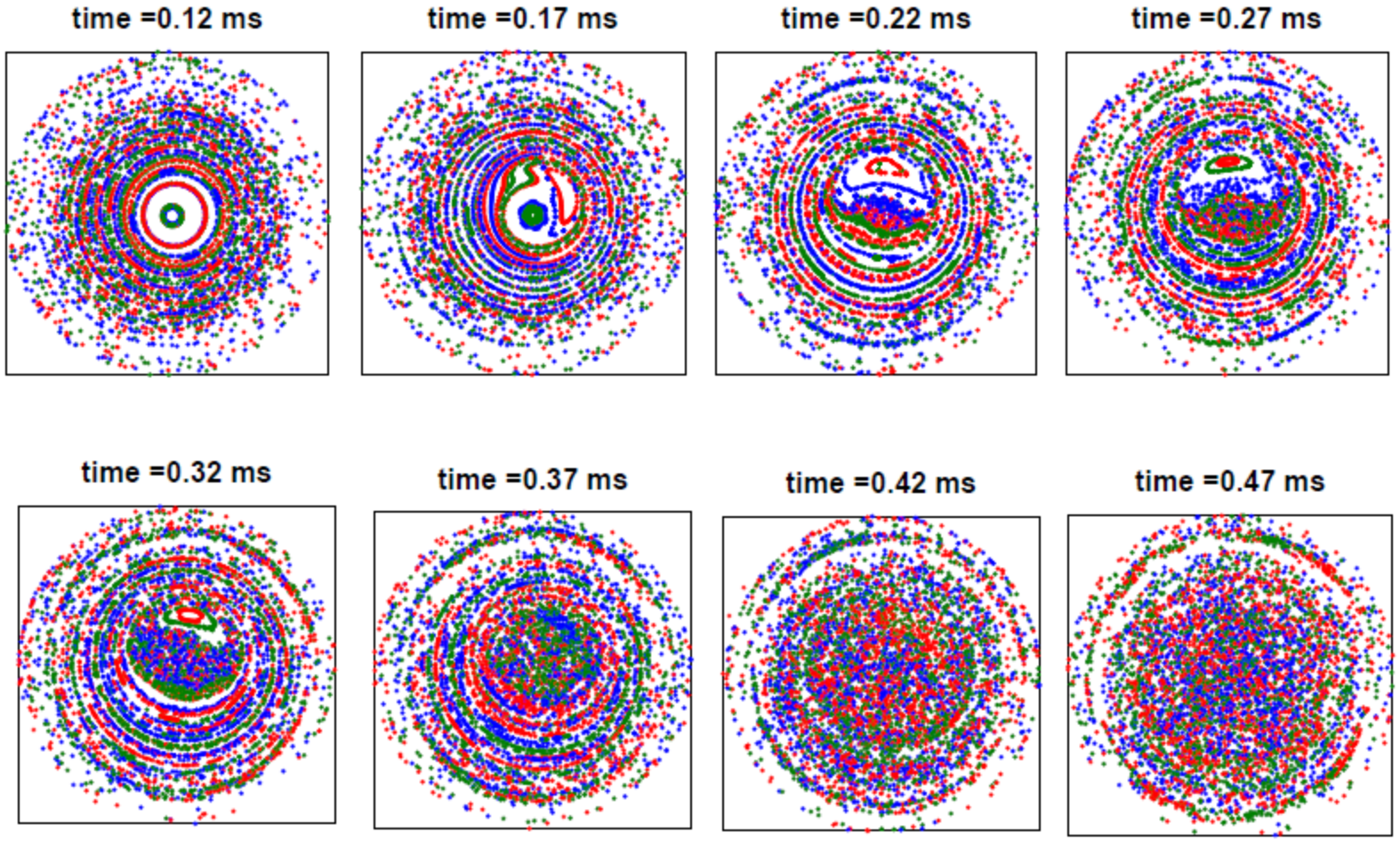
A lot of margin for error in the experimental viscosity (esp. near edge)



In simulation with kin_visc=1000 nothing happens
(very small 1/12 island, no profile changes)

Island forms, rotates briefly, finally plasma becomes fully stochastic



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Ongoing work

- Question: Why does rotation eventually crash, rather than maintaining a new steady state? (May try cylindrical geometry)

- Viscosity scan to cover range of experimental uncertainty

- Case beginning with applied n=9 initial velocity profiles

- More careful comparisons with experiment as well as mode screening theory

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