Fast Ion Loss on NSTX

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NSTX Results Review
September 20, 2001

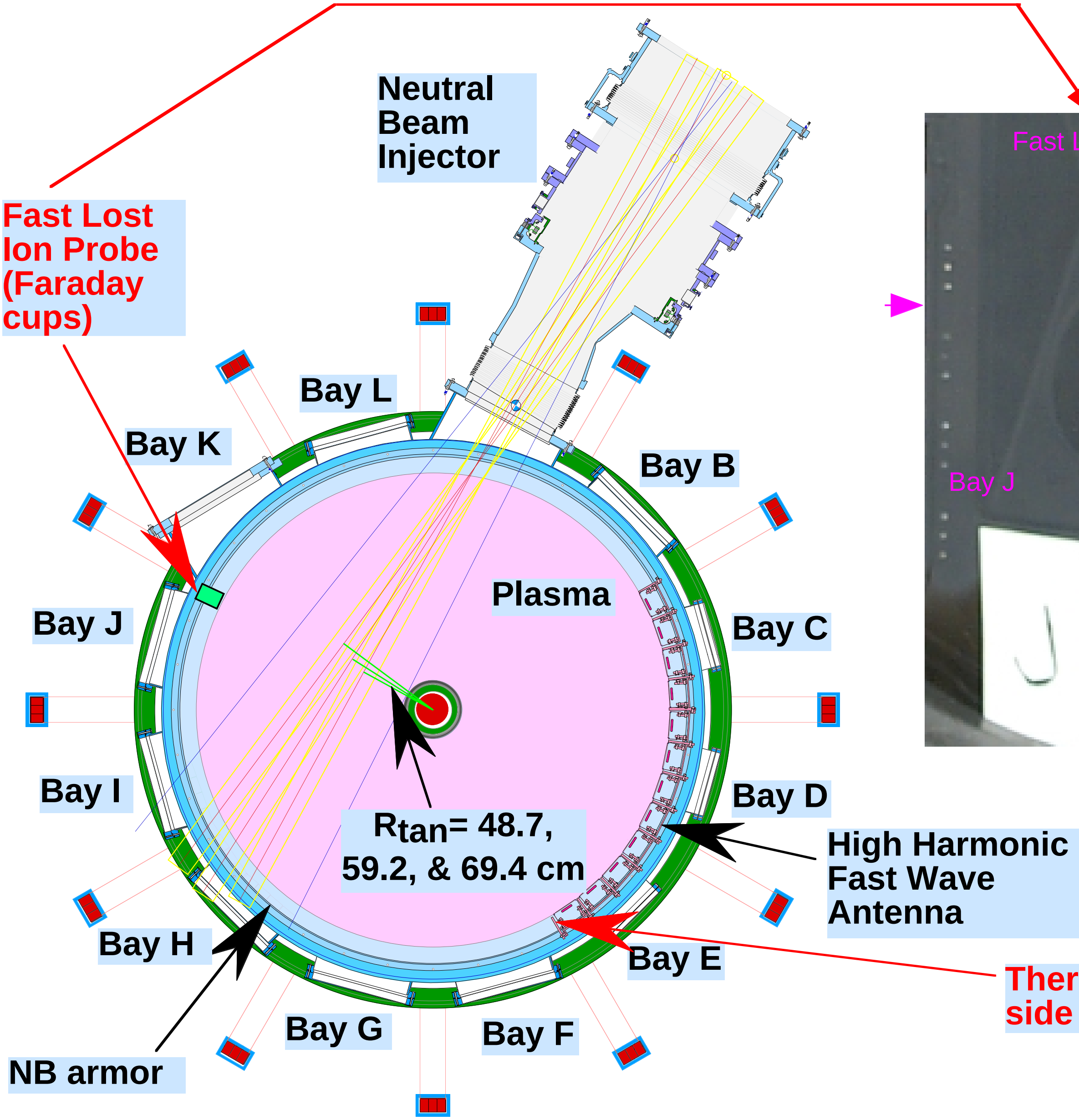
Conclusion: **Beam ion loss measurements not understood as yet; different measurements don’t agree and some don’t agree with model**

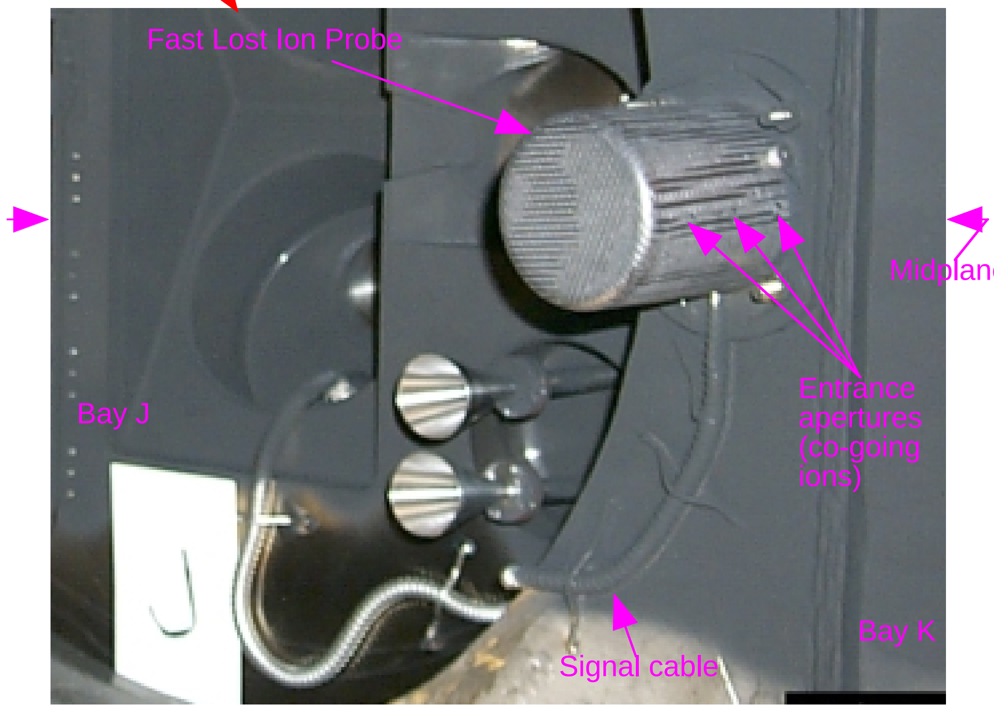
Motivations for measuring fast ion loss

- Loss rate affects plasma heating efficiency
- Wall heated by loss, could be damaged in extreme cases
- Serves as benchmark for numerical loss models
- Aids in determining mechanisms of loss
- Neutral beam (NB) ion loss serves as model system for αs in DT plasma (dimensionless parameters quite close)

NSTX beam geometry and loss diagnostics

- NSTX NBI: 3 sources, 80 keV D, 5 MW total
- Plasmas typically have 90 cm $\leq R_{axis} \leq$ 110 cm

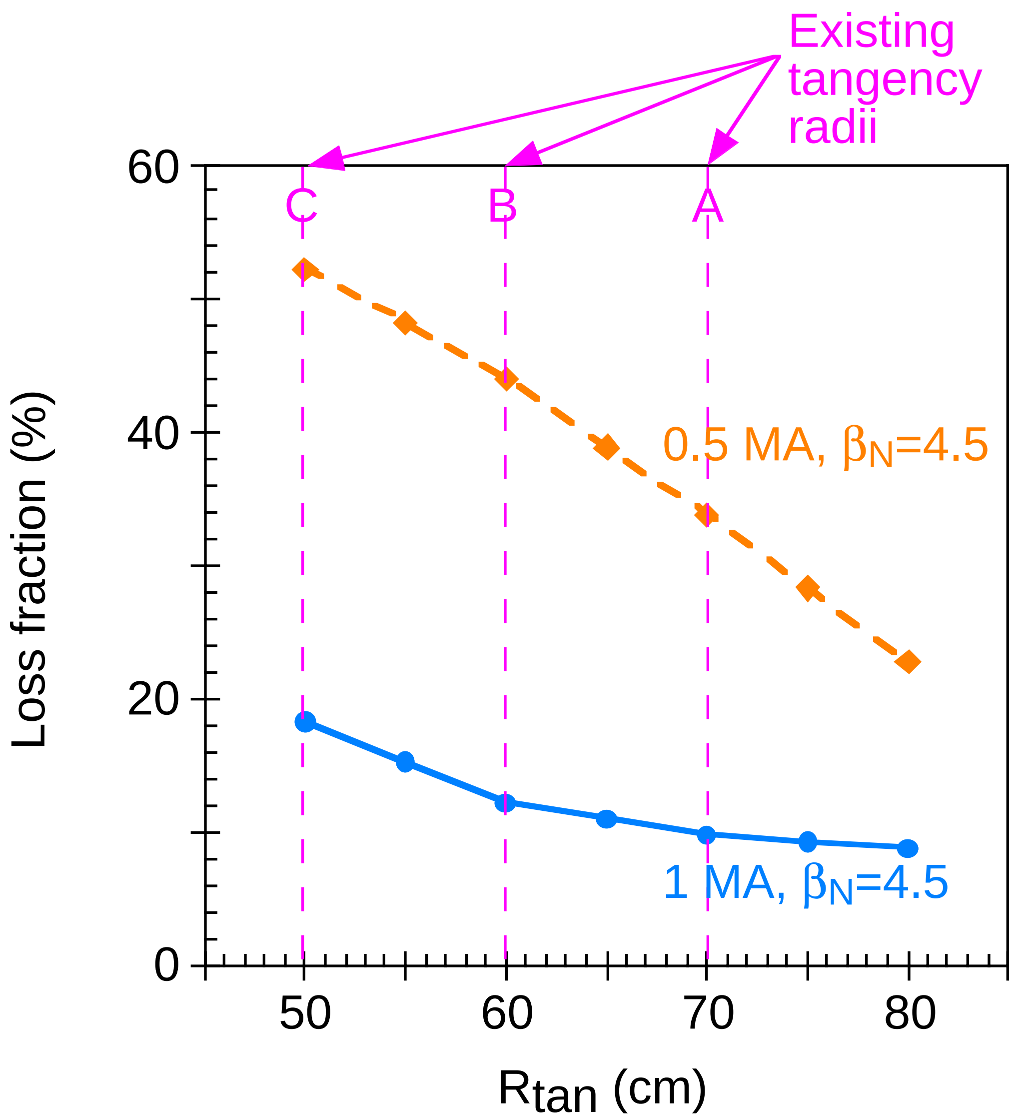




- Measure losses as current in probe or as ΔT in antenna

Beam ion loss rate model shows strong dependence on I_p and R_{tan} of beamline

NSTX



- Beamline with largest R_{tan} (A) is best confined

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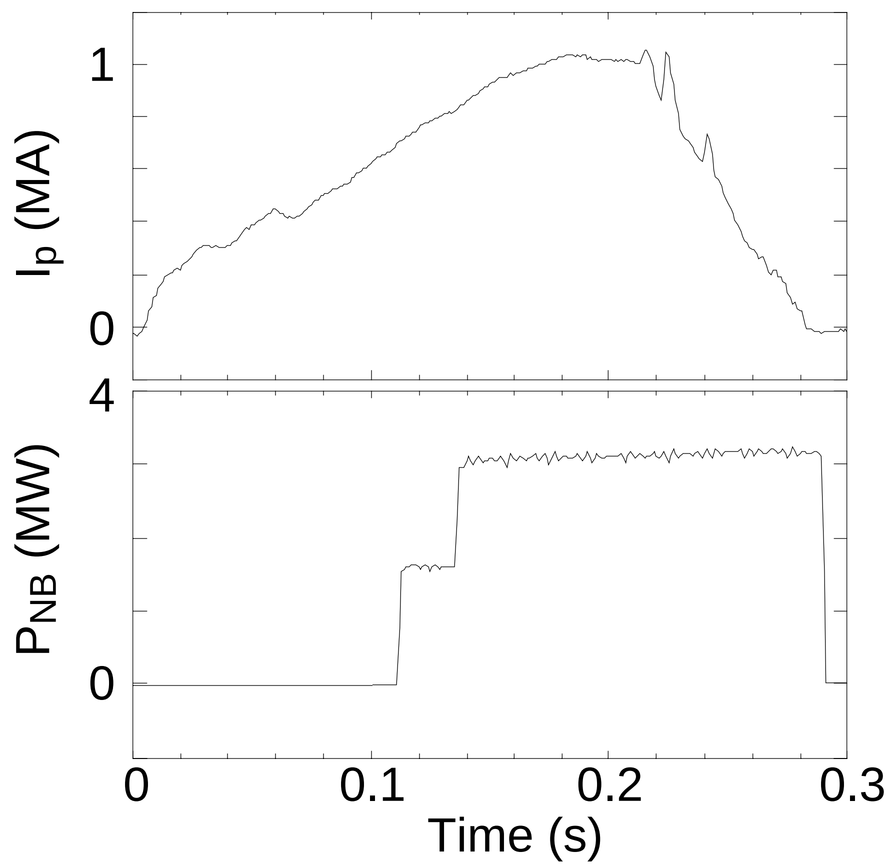
Thermocouple measurements indicate heating of side of HHFW antenna during NBI shots

NSTX

- Thermocouple measurements have been made
- Ohmic shots show no measurable ΔT
- Clear temperature rise observed for NBI shots; example: 103815



- Modeling for 1 MA shot predicted ΔT=20 °C for 5 MW injection, 0.5 s pulse length
- Shot 103815 had 3 MW for 0.17 s, giving measured ΔT=3.5 °C; Scaling from modeling results predicts ΔT=4 °C—good agreement

J. R. Wilson

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Faraday cup current much smaller than model predicts; varies with I_p in direction expected

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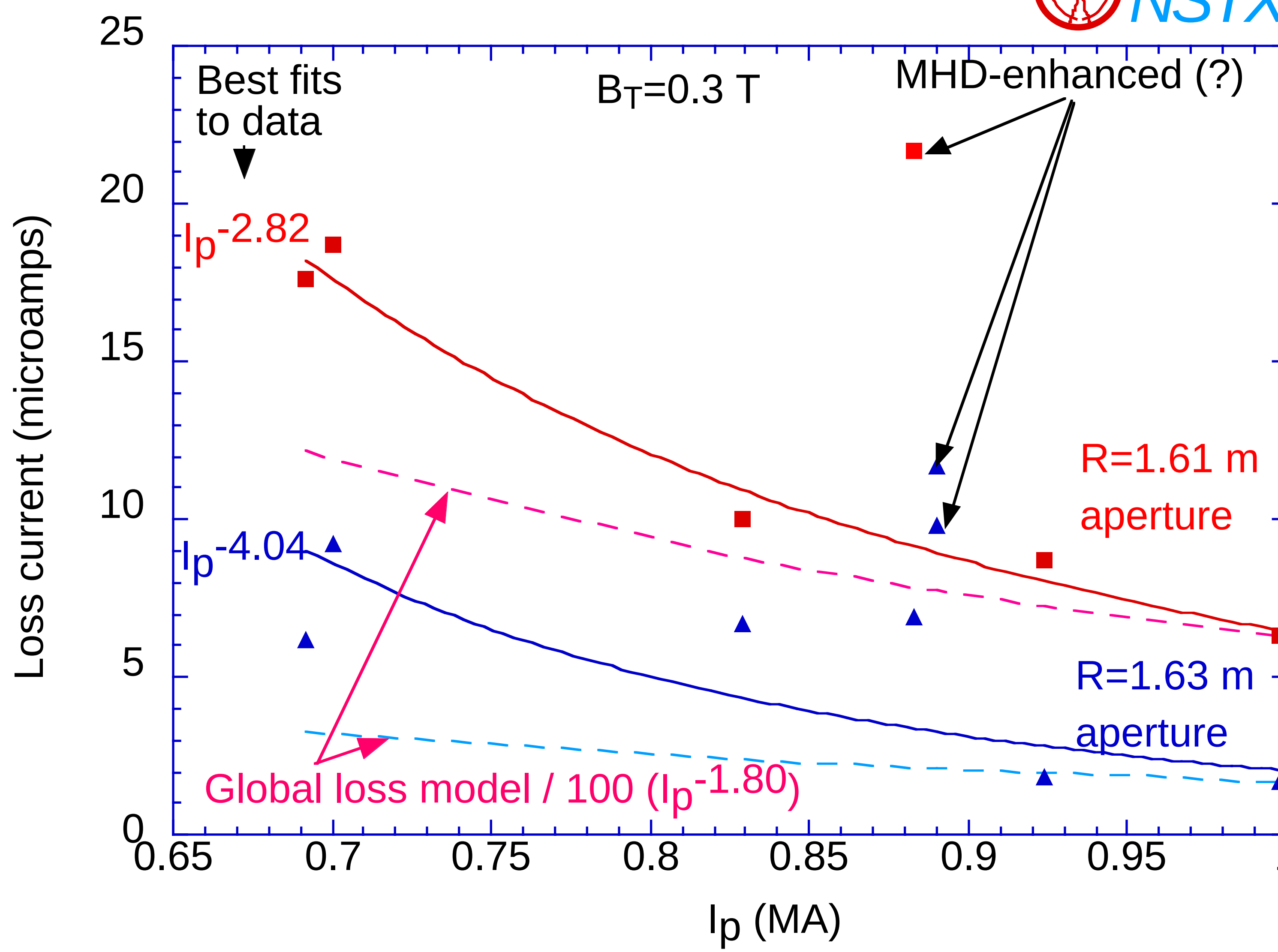

- Measured loss variously 10–100x smaller than model
- Difficult to get MHD-free signals, esp. at low I_p

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Loss varies with beam tangency radius more strongly than model predicts

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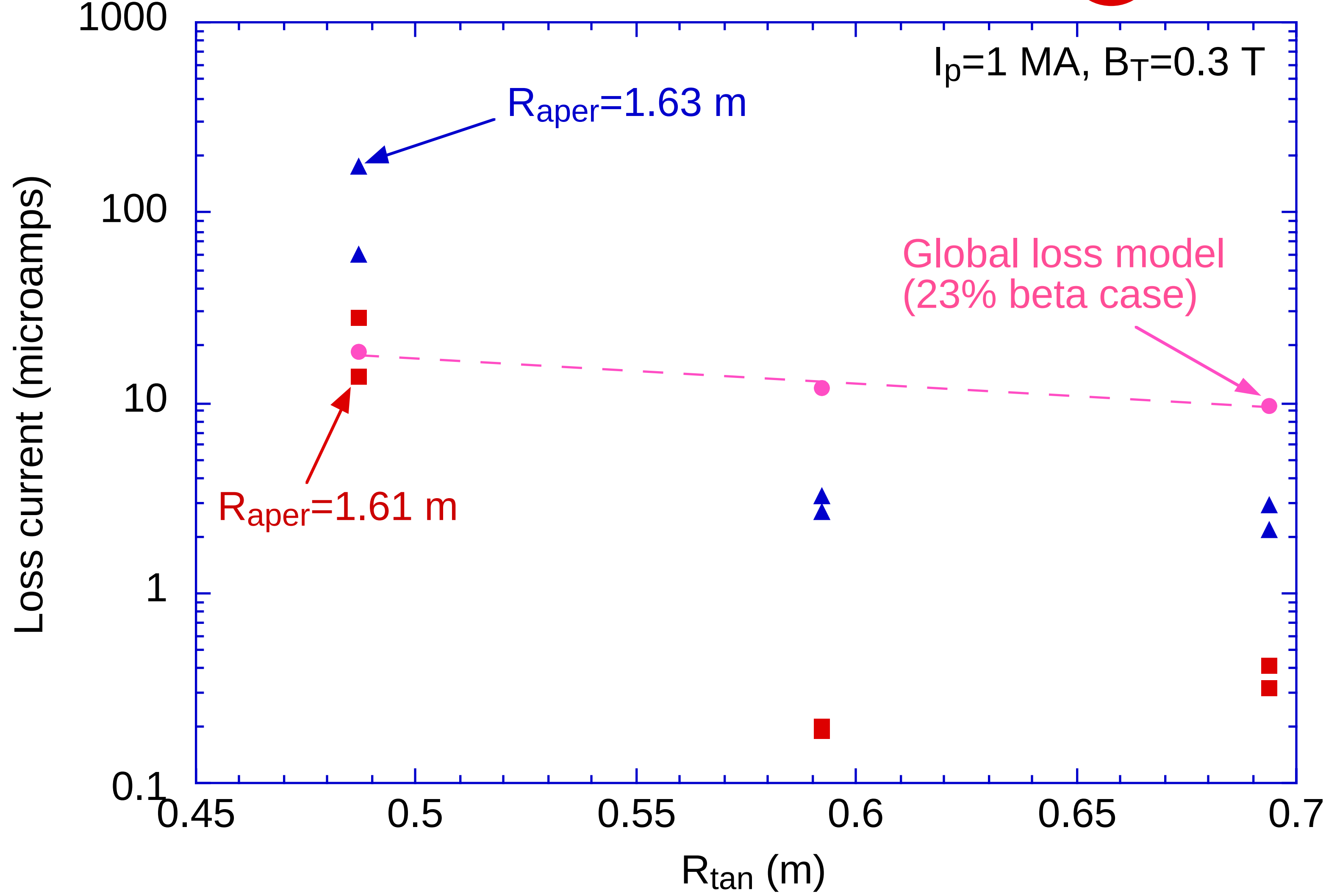

- Variation of local loss could differ from global prediction
- Global prediction not for same equilibrium & $n_e(\psi)$

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Conclusions

NSTX

- Thermocouple data indicates loss to side of HHFW antenna that is around level predicted by model.
- Faraday cups measures loss rate ~10–100x smaller than modeled rate; origin of discrepancy unclear.
- Loss rate varies with Ip more strongly than predicted by model.
- Expected R_{tan} dependence of loss seen in FLIP data: loss from source C > that from source B, but ratios not in agreement with model

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Future work

- Probe to measure energy & pitch angle of lost ions is being built
- Modeling needs to be upgraded to focus on orbits accepted by probe & made parallel to permit analysis of numerous experimental cases within a reasonable amount of time (now: 20 hours per condition)