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Controlled Lithium Introduction

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Particle Control Task Force

NSTX-U Research Forum
MBG
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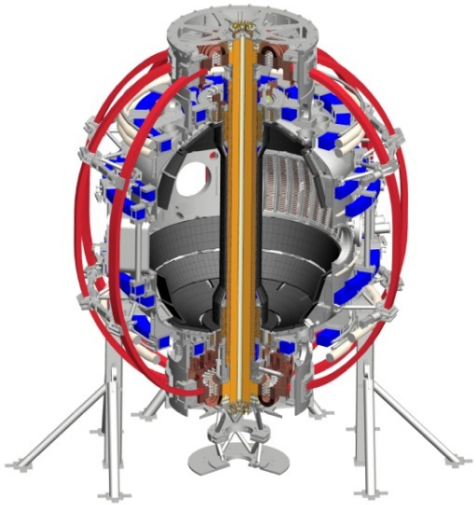

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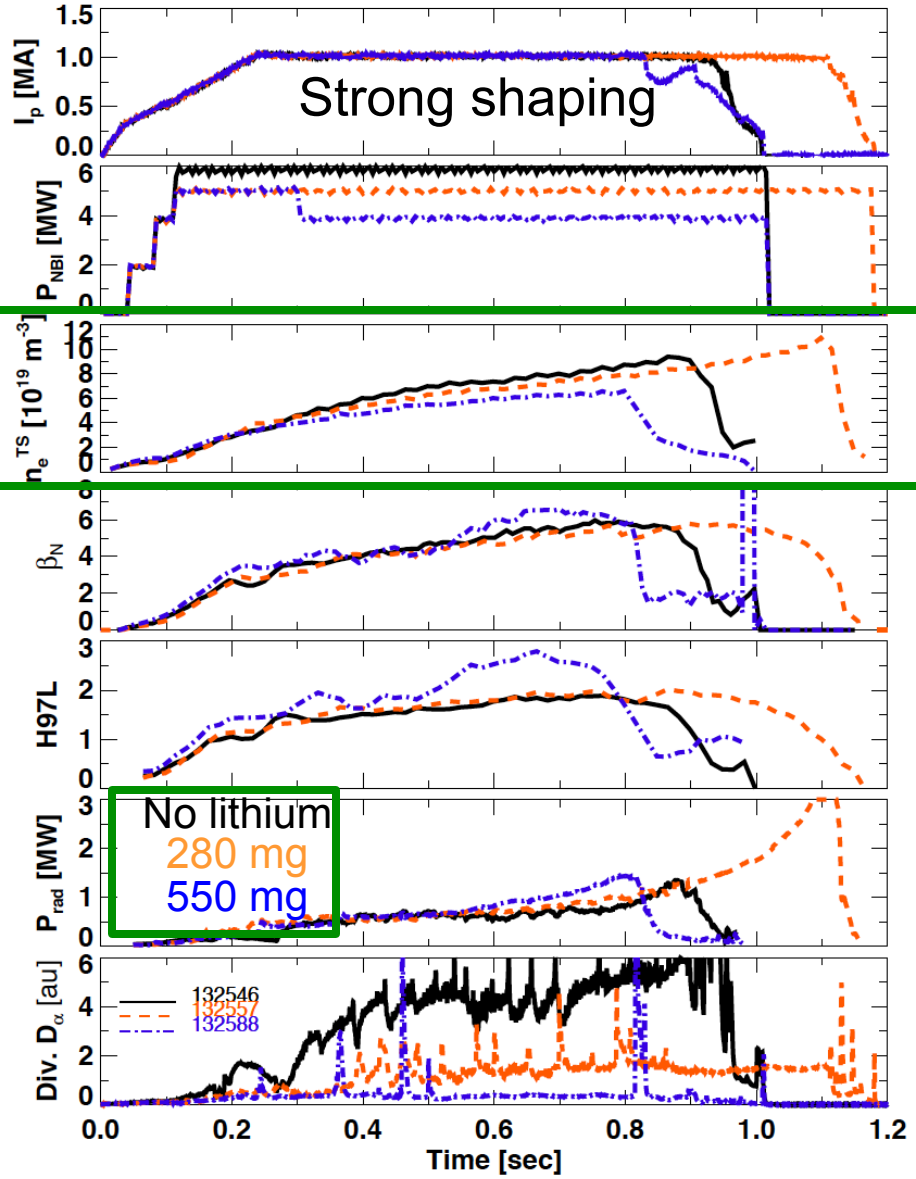
Goals and Background

- Goal: re-introduce lithium in the CY2015 run in a controlled manner. Ideally this would be at medium triangularity with OSP close to MAPP, but we may have to use high delta and document the behavior as the lithium coating is gradually increased.

- A slow, controlled lithium introduction was done in the FY08 and FY09 campaigns
  - The FY08 data contributed to a large number of highly-cited papers and new insights on ELM physics
  - The FY09 data (high delta) showed nearly identical global trends to mid delta data from FY08; published in JNM 2015 (online)
  - In FY10, such a controlled/slow lithium introduction was obviated because the campaign was initiated with a large evaporation to fill the Liquid Lithium Divertor

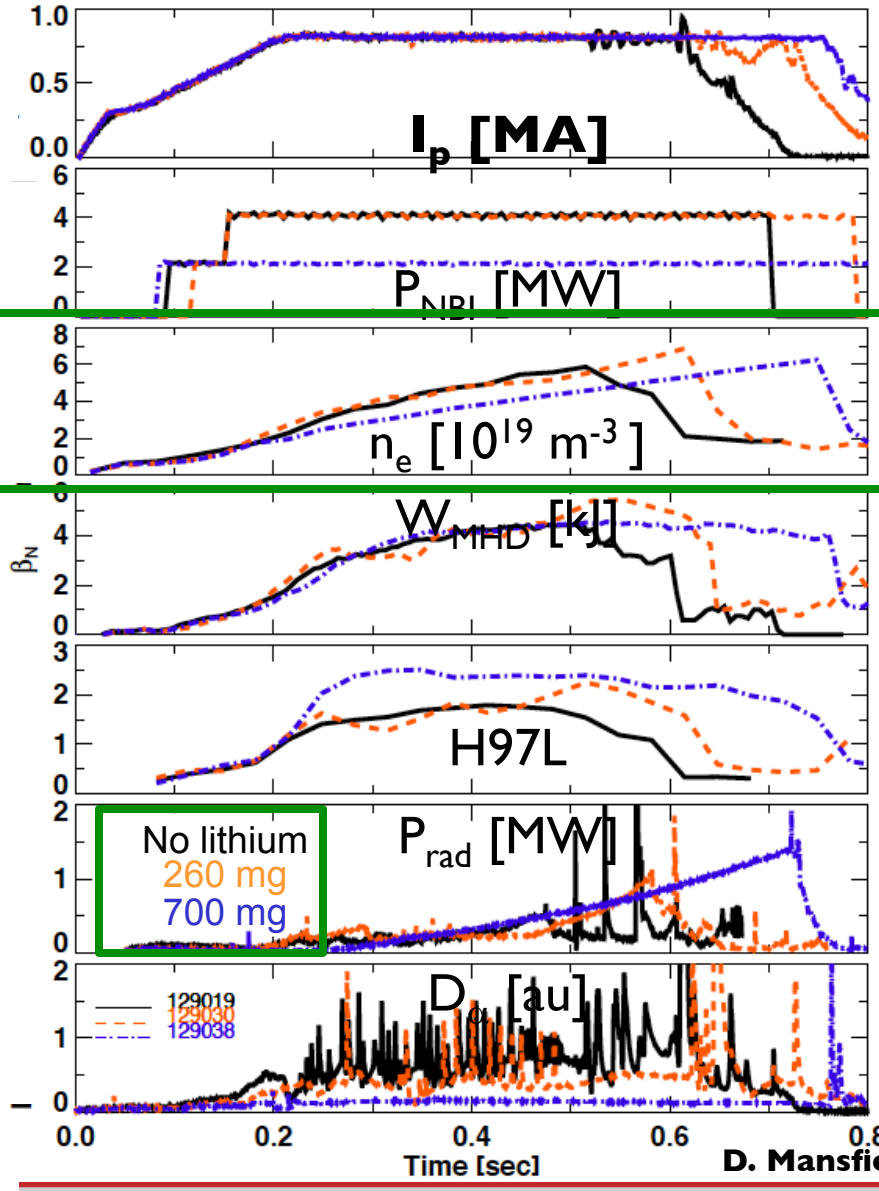
- The proposal is to revert to a controlled introduction as in FY2009 (2 days)

Performance of strongly shaped discharges improved even more with increased lithium, similar to weakly shaped ones



- I_p duration not quite optimized with higher lithium
- Reduced P_{NBI}
- Reduced dN/dt
- Comparable stored energy
- Higher confinement
- Increasing P_{rad}
- Reduced recycling, long ELM-free phases

ELM-free H-mode induced by lithium wall conditioning in weakly shaped discharges



- Pre-Li, With-Li (260 mg), with-Li (700 mg)
- Lower NBI to avoid β limit
- Lower n_e with higher gas puffing
- Similar stored energy
- H-factor 40%↑
- Higher P_{rad} /P_{heat}
- Reduced divertor recycling, ELM-free in higher dose

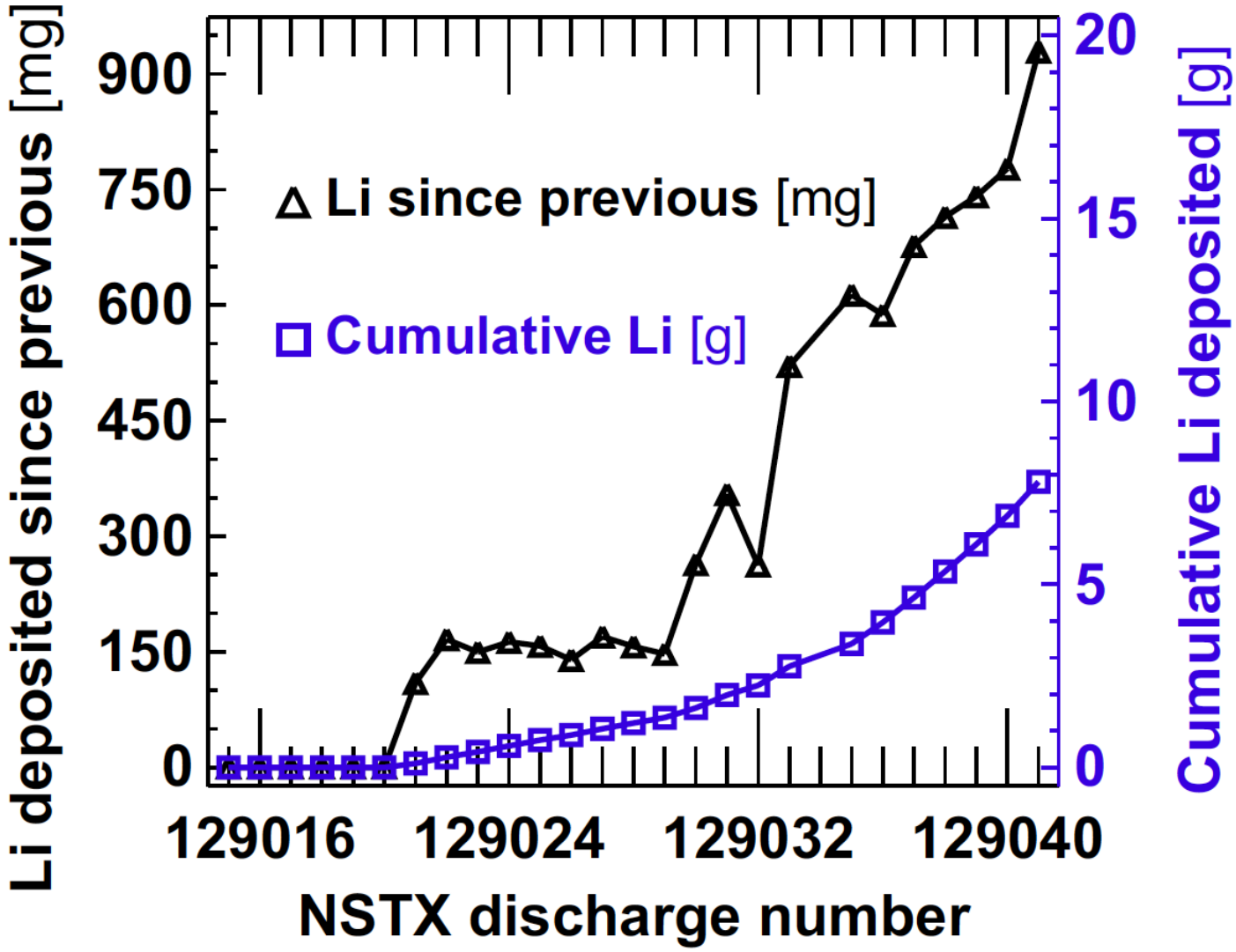
D. Mansfield, JNM 2009; R. Maingi, PRL 2009

Experimental Plan (2-3 run days; requested time from PC-TF is 0.5 run days)

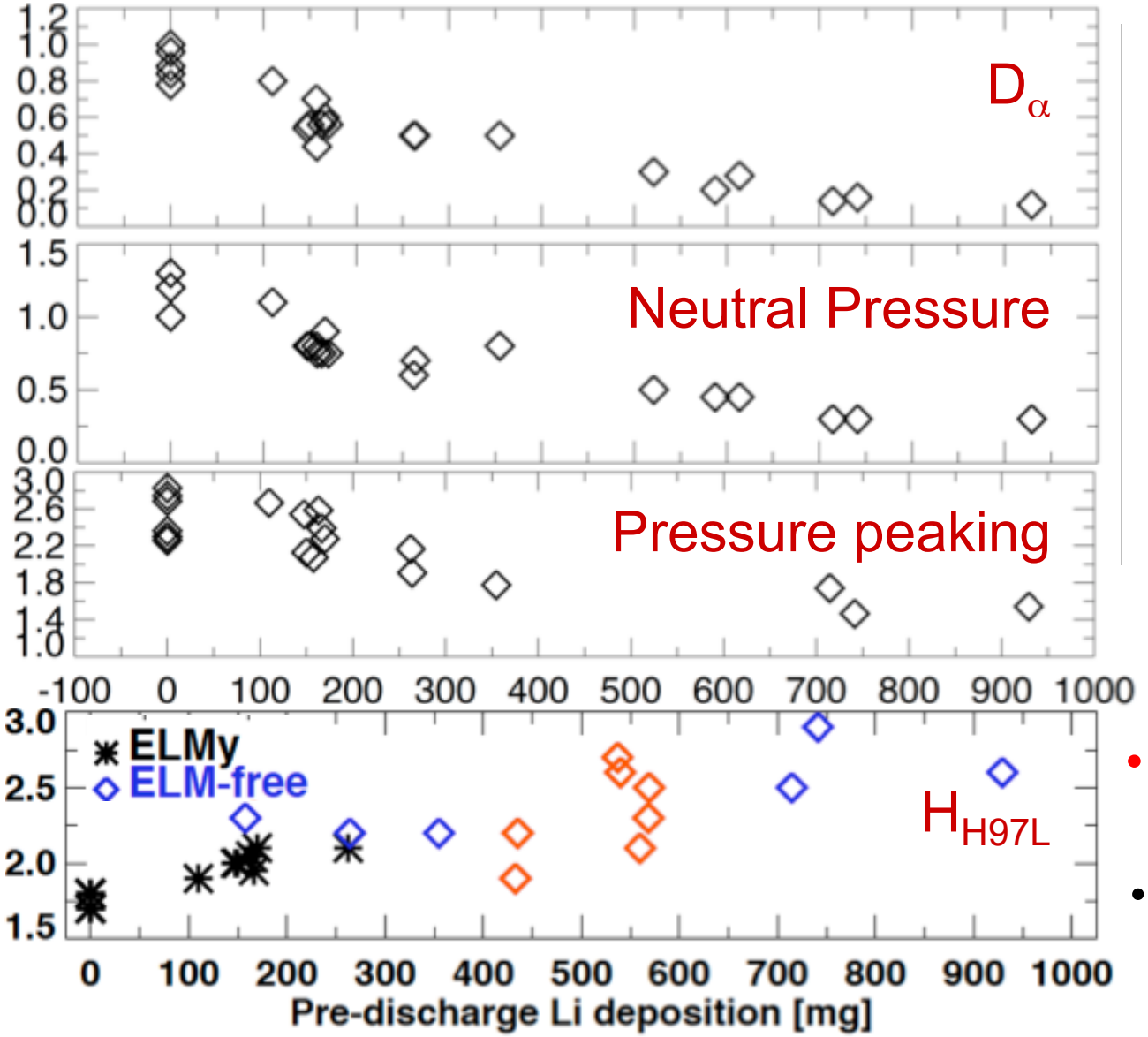
- Attempt high triangularity fiducial with no lithium
- Add in low amounts of lithium: 50 mg/discharge, and optimize the fueling and discharge timing to improve performance
- After ~ 5 discharges, increase lithium amount to 100 mg/discharge, and repeat
- After ~ 5-10 discharges, increase lithium amount to 150-200 mg/discharge
- After ~ 5-10 discharges, increase lithium to ~ 300 mg/discharge;
- Continue to higher lithium: 500 mg, 750 mg, 1g (20-30 shots)
- Document pedestal and divertor characteristics during this controlled re-introduction

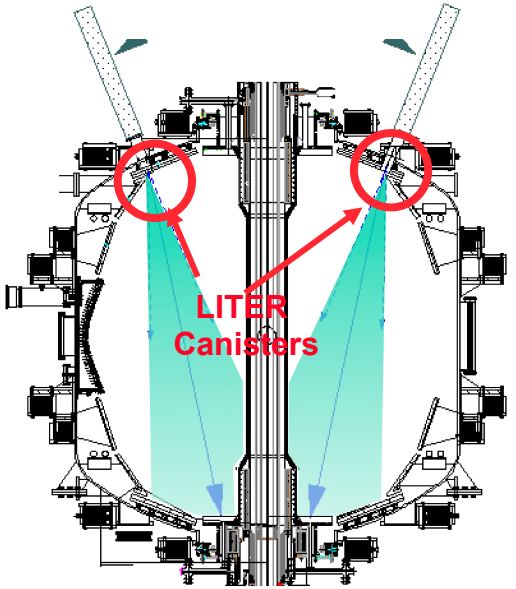
Backup

2008 run – re-introduction made in 1 (not quite optimized) run day



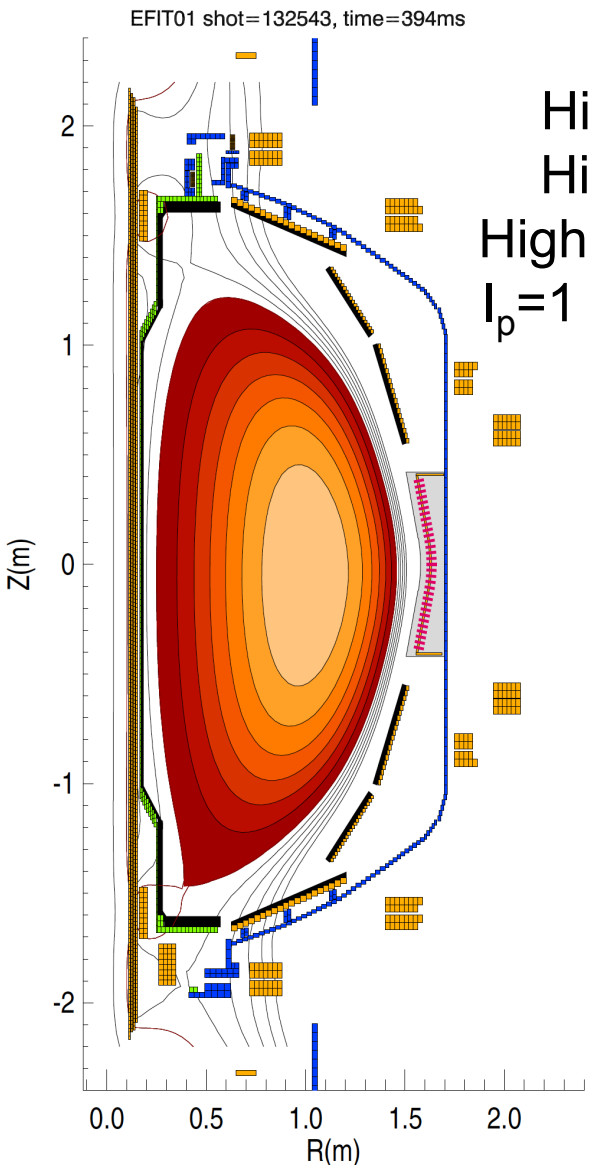
Recycling, neutral pressure, and pressure peaking decreased nearly continuously with increasing lithium; H_{H97L} increased



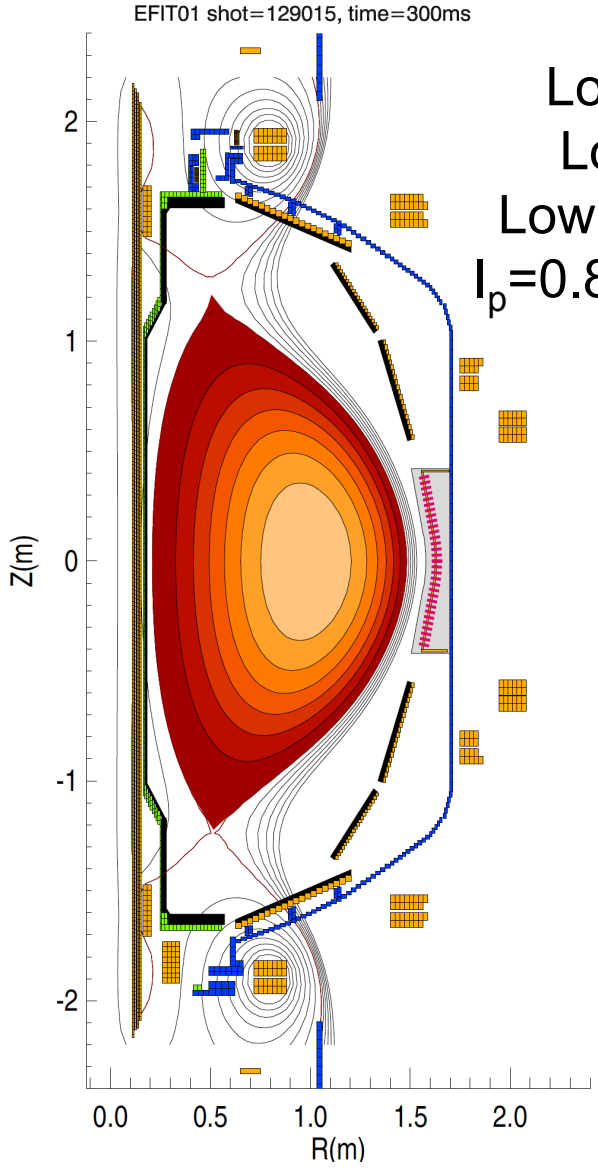


- **H_{H98y2} range from 0.8-1.4**
- Data in orange from other experiment

New dataset from highly shaped plasmas as envisioned in NSTX-U, and for future STs

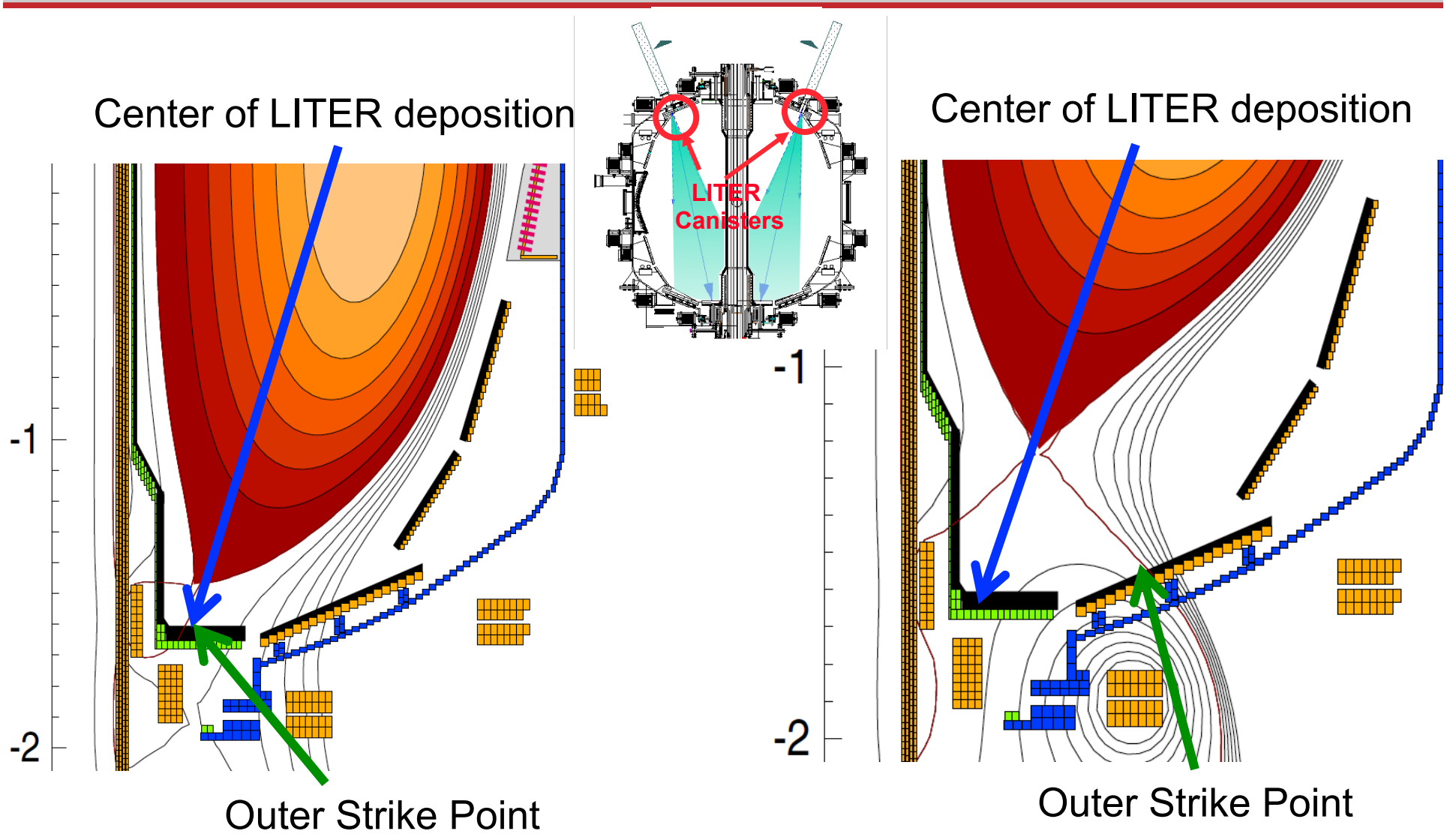


High δ (0.6)
High κ (2.2)
High squareness
I_p=1 MA, q_{95}=8.2
2009

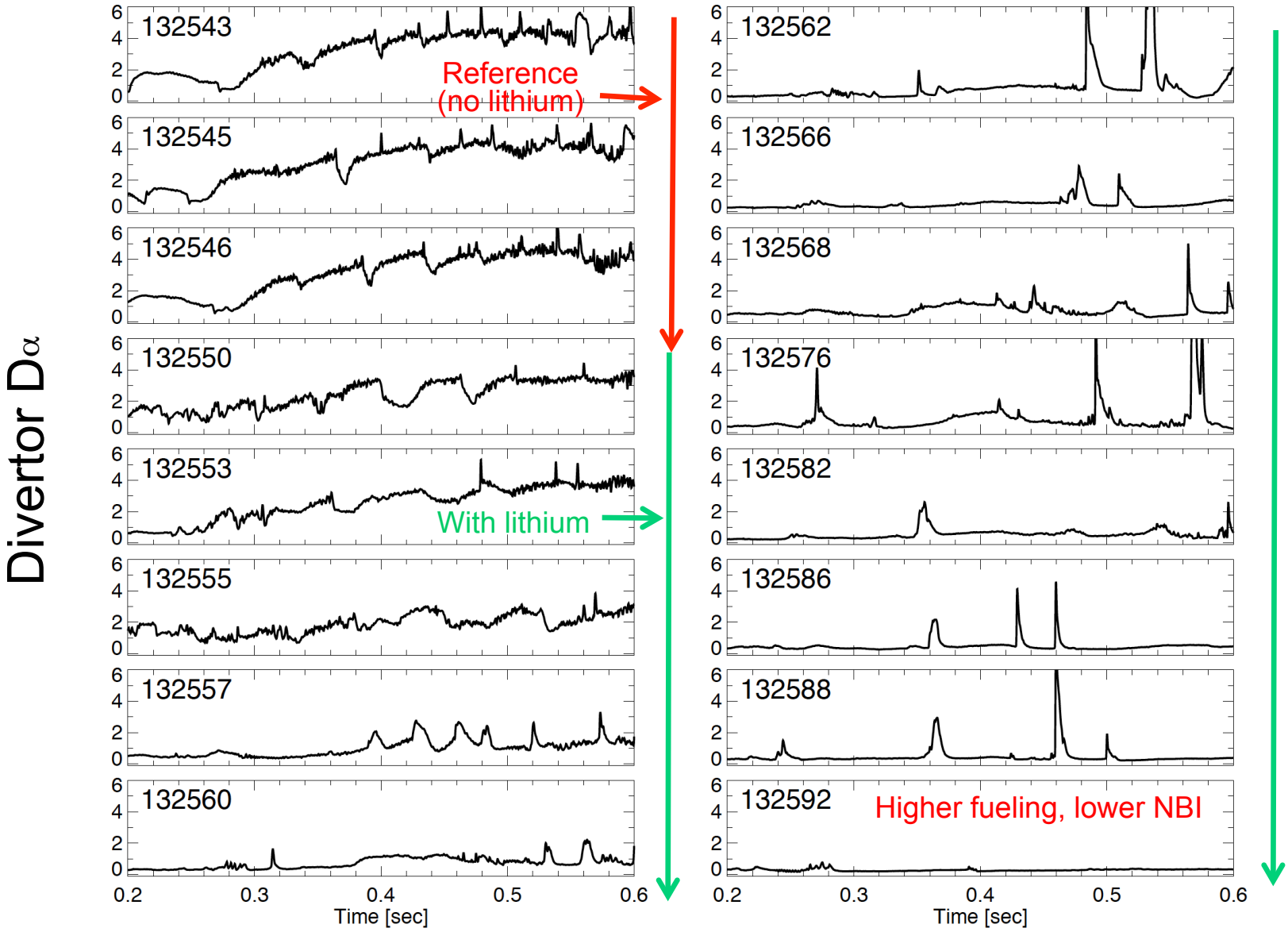


Low δ (0.46)
Low κ (1.8)
Low squareness
I_p=0.8 MA, q_{95}=7.6
2008

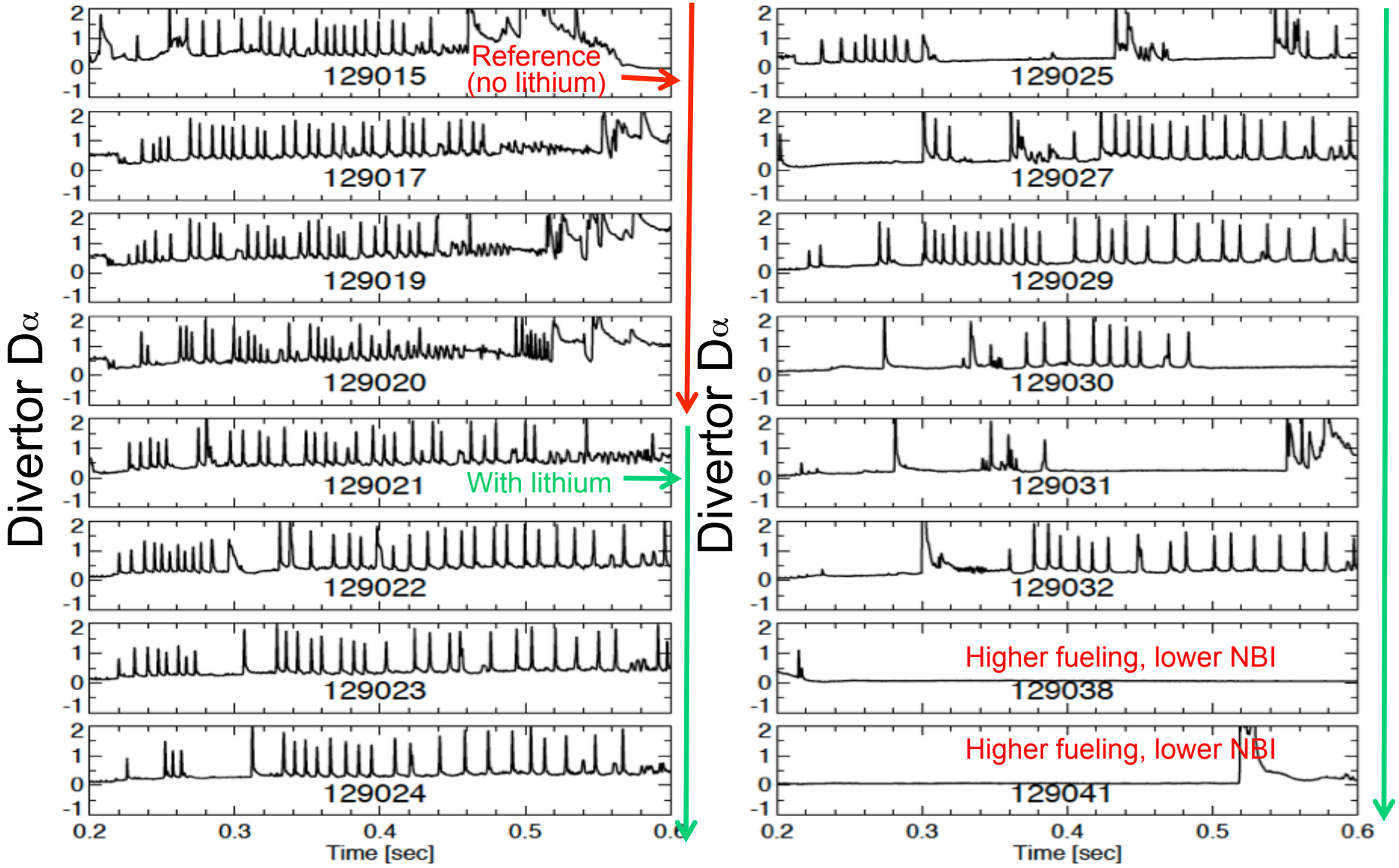
LITER deposition centroid relatively far from outer strike point in lower triangularity discharge



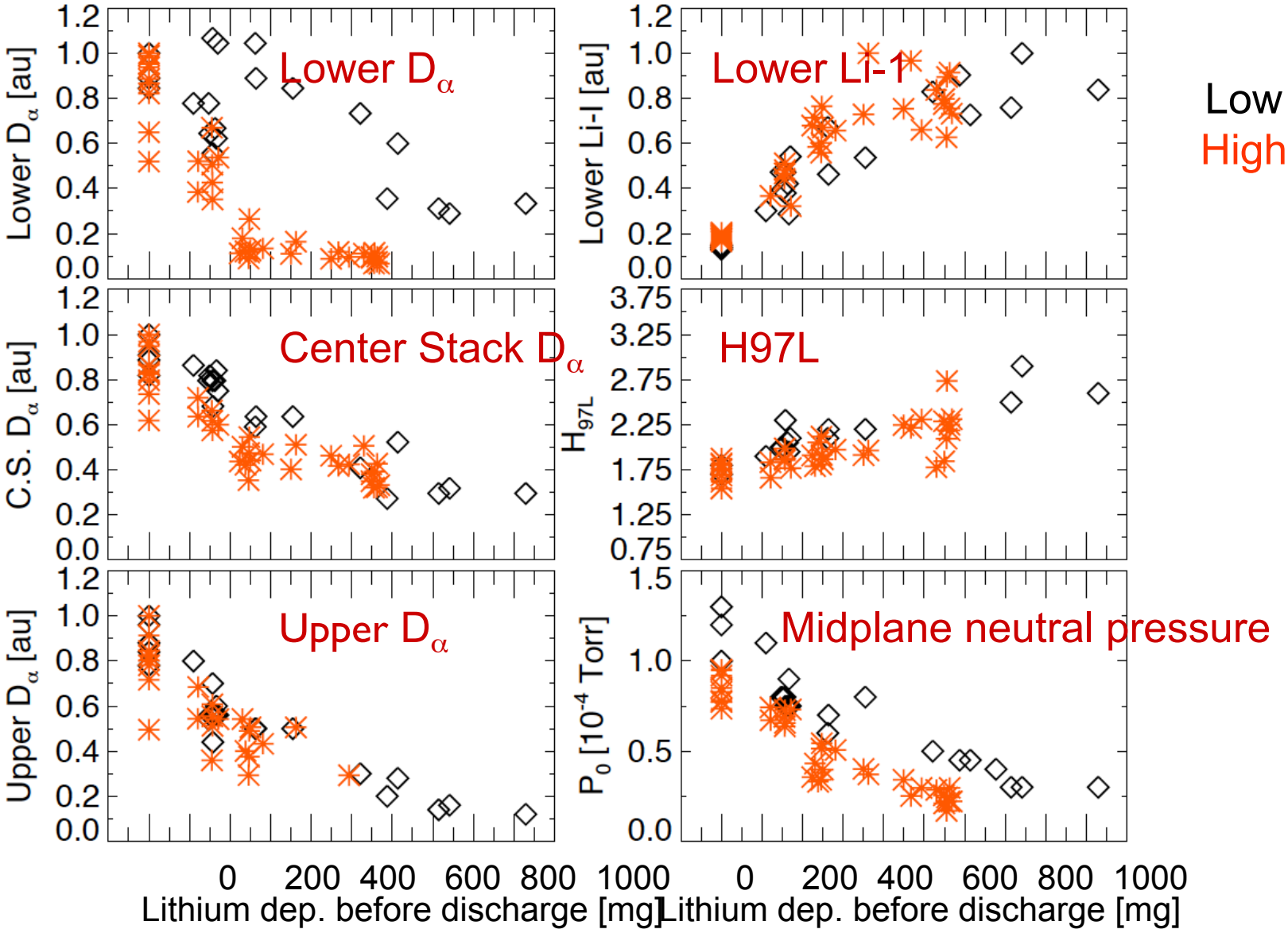
ELM evolution similar at high δ but ELMs never quite completely eliminated during this new experiment



ELMs eliminated gradually during original low δ experiment



D_α and neutral pressure decreased, and H97L increased with increasing pre-discharge lithium evaporation in all data



Low shaping

High shaping