Possible Effects of SOLC on Equilibrium, Stability, MHD Feedback Control, and Machine Operation

Did you disrupt this discharge?

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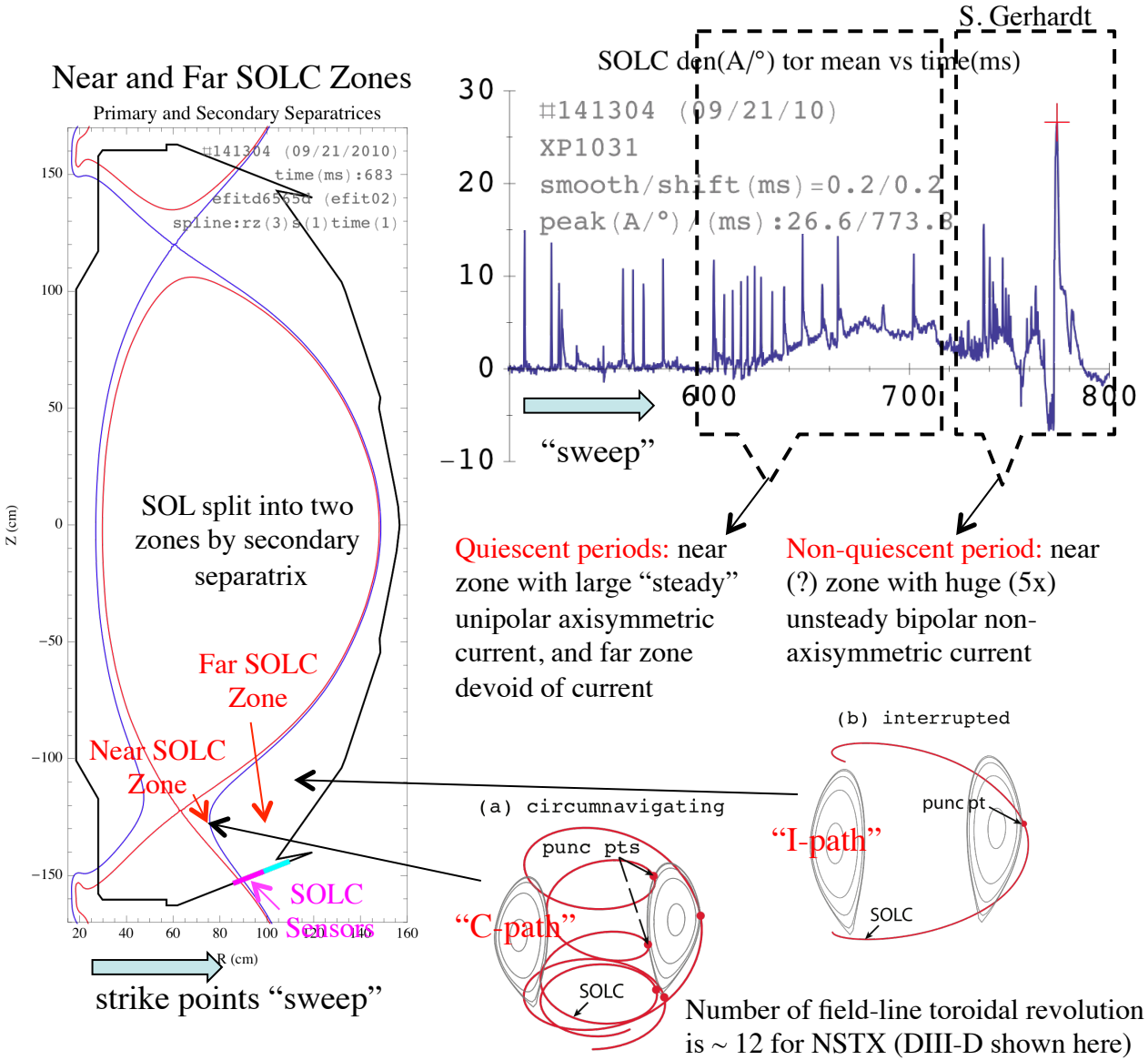
NSTX Results Review
Princeton Plasma Physics Laboratory
Nov. 30 – Dec. 1, '10

Different SOLC Paths in Near and Far Zones



In "Near and Far SOLC Zones" SOLC flows along topologically distinct "C-path and I-path" respectively, which have their end points in different pairs of divertors with different thermal environments.

Consequently, thermo-electrically driven SOLC in the two zones may exhibit distinct temporal behaviors as well as magnetic consequences.

Axi-symmetric SOLC in Near Zone, which persists over a discharge evolution time scale, may be driven by Te difference maintained by differential heat flux into in/outboard divertors.

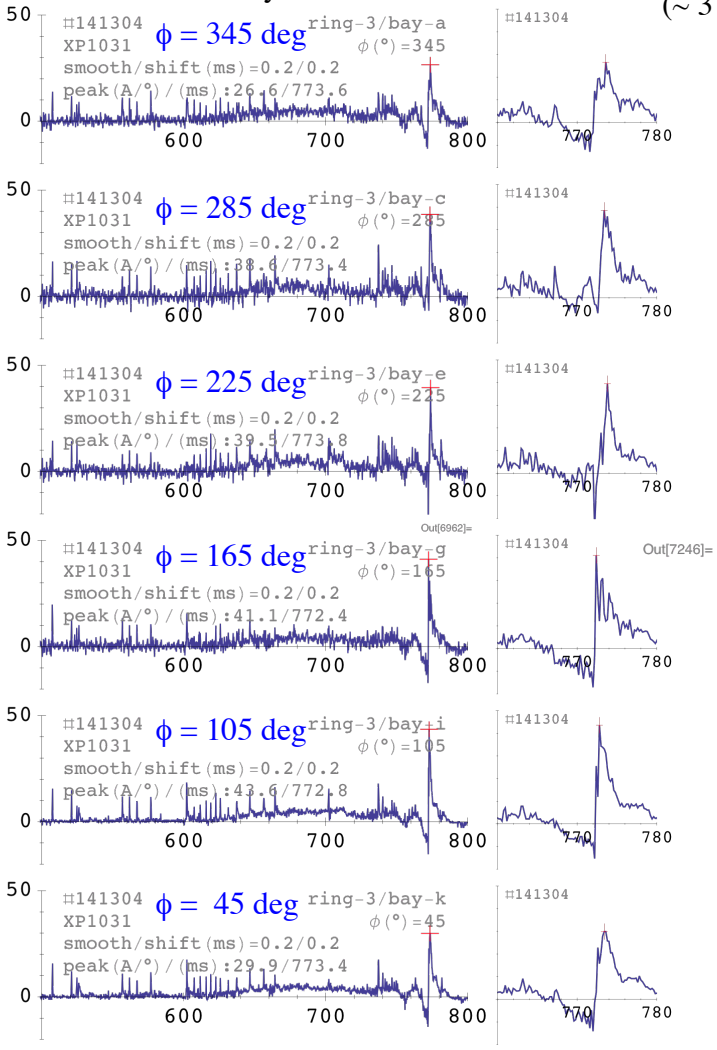
Explosively growing SOLC in Far Zone, spiky in time and non-axisymmetric, may serve as an ELM trigger.

Large Current Flows in Near SOLC Zones

Toroidal Spatial Variations

SOLC Density Vs Time

End Period

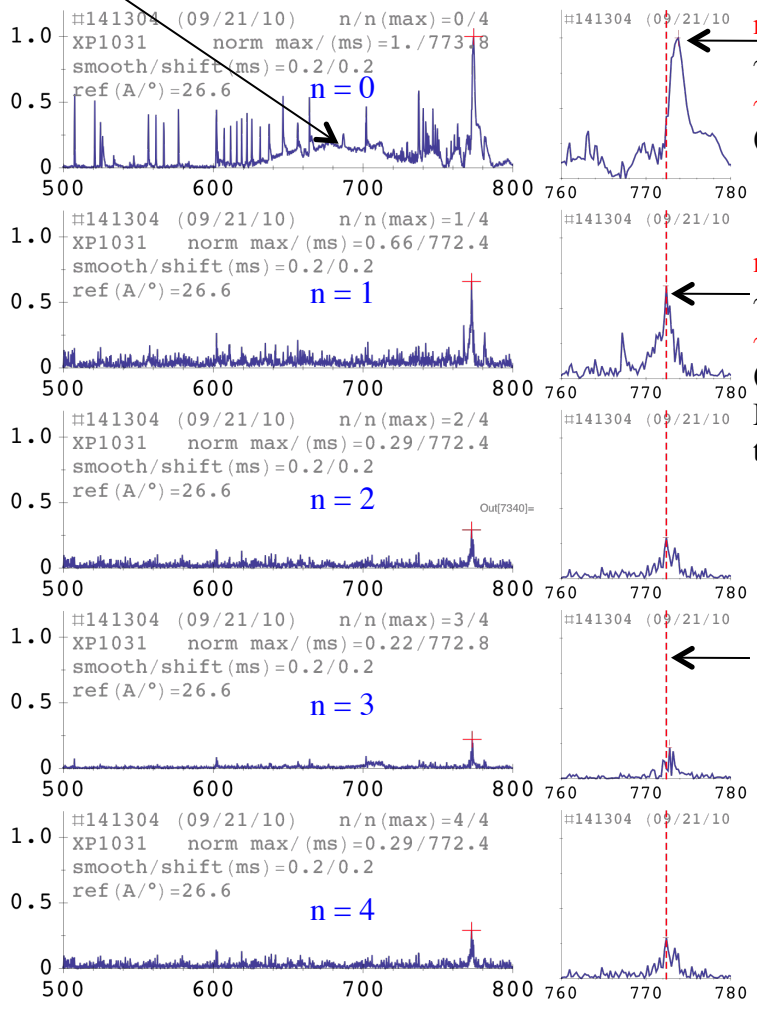


n = 0
~ 1.9 kA (pol)
~ 23 kA (tor)
(~ 3 %)

Toroidal Harmonic (SVD) Analysis

SOLC *Normalized* Harm Amp

End Period



n = 0
~ 10 kA (pol)
~ 120 kA (tor)
(~ 17 %)

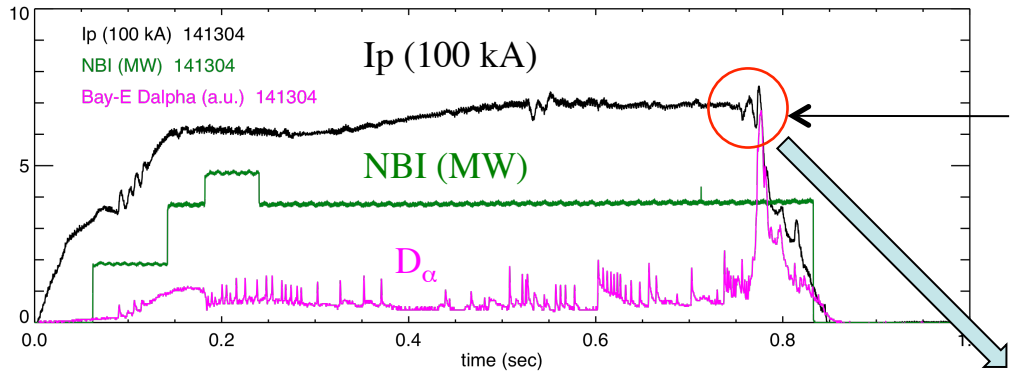
n = 1 (RMS)
~ 4.5 kA (pol)
~ 54 kA (tor)
(~ 8 %)
MHD?
thermal instability?

n > 0 leads n = 0
causality?

NSTX

SOLC May Affect Machine Performance

Discharge Overview



A commonly observed I_p *signal* behavior just before disruption may be traced to SOLC, not to *true* plasma current.

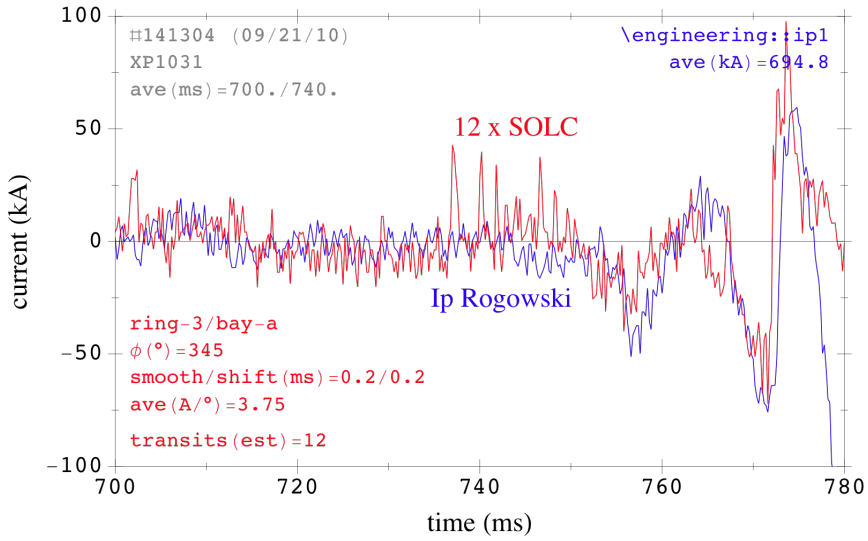
SOLC may account for up to ~ 10 % of I_p *signal* in this discharge.

Axisymmetric and/or non-axisymmetric parts of SOLC may affect machine performance:

- Report false plasma current and position
- Sound false alarm for growing MHD modes
- Report false MHD mode phase (*positive* f.b.)
- Change vertical stability (n-index)
- Destabilize MHD modes

Did this discharge die an unnecessary death because feedback control tried to save the discharge when it did not need to be saved?

Toroidal Current (Deviation from Mean) vs Time



Out[6157]=

Do high-performance (parameter-pushing) discharges suffer similar problems?

Summary

•Two SOL regions, "Near SOLC Zone" and "Far SOLC Zone," demarcated by a secondary separatrix and having current paths (field lines) of significantly different geometries, circumnavigating path ("C-path") and interrupted path ("I-path"), have been identified,

•During quiescent periods, the near zone has (i) "steady," (ii) axisymmetric, (iii) (co-I_p) unipolar current, and the far zone is substantially devoid of current.

•During non-quiescent periods (excepting ELMs), (i) large, (ii) unsteady, (iii) both axisymmetric and non-axisymmetric, (iv) bipolar current flows, *possibly* only in the near zone (yet to be confirmed – data might exist).

•SOLC, in both axisymmetric and non-axisymmetric forms, may affect equilibrium reconstruction (off-line and real-time), MHD stability (e.g., min shear point in peeling-ballooning analysis, kink-stability), and feedback operation (e.g., false reporting of plasma current and location, and MHD existence and phase).

•SOLC in the near zone can be fairly well characterized; it may be worthwhile to attempt to correct for its influence in equilibrium reconstruction, MHD feedback control, and machine operation.