Controlled Rampdown of High-Energy Discharges

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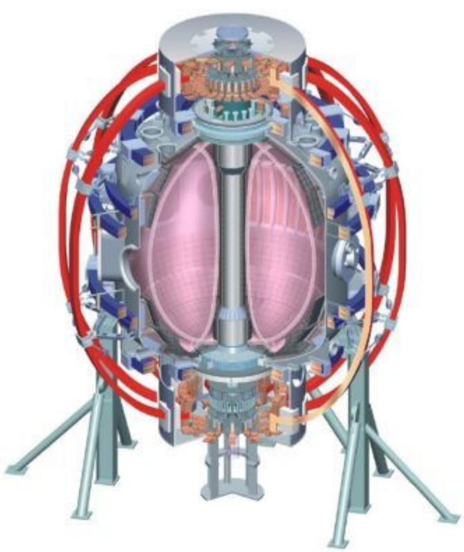

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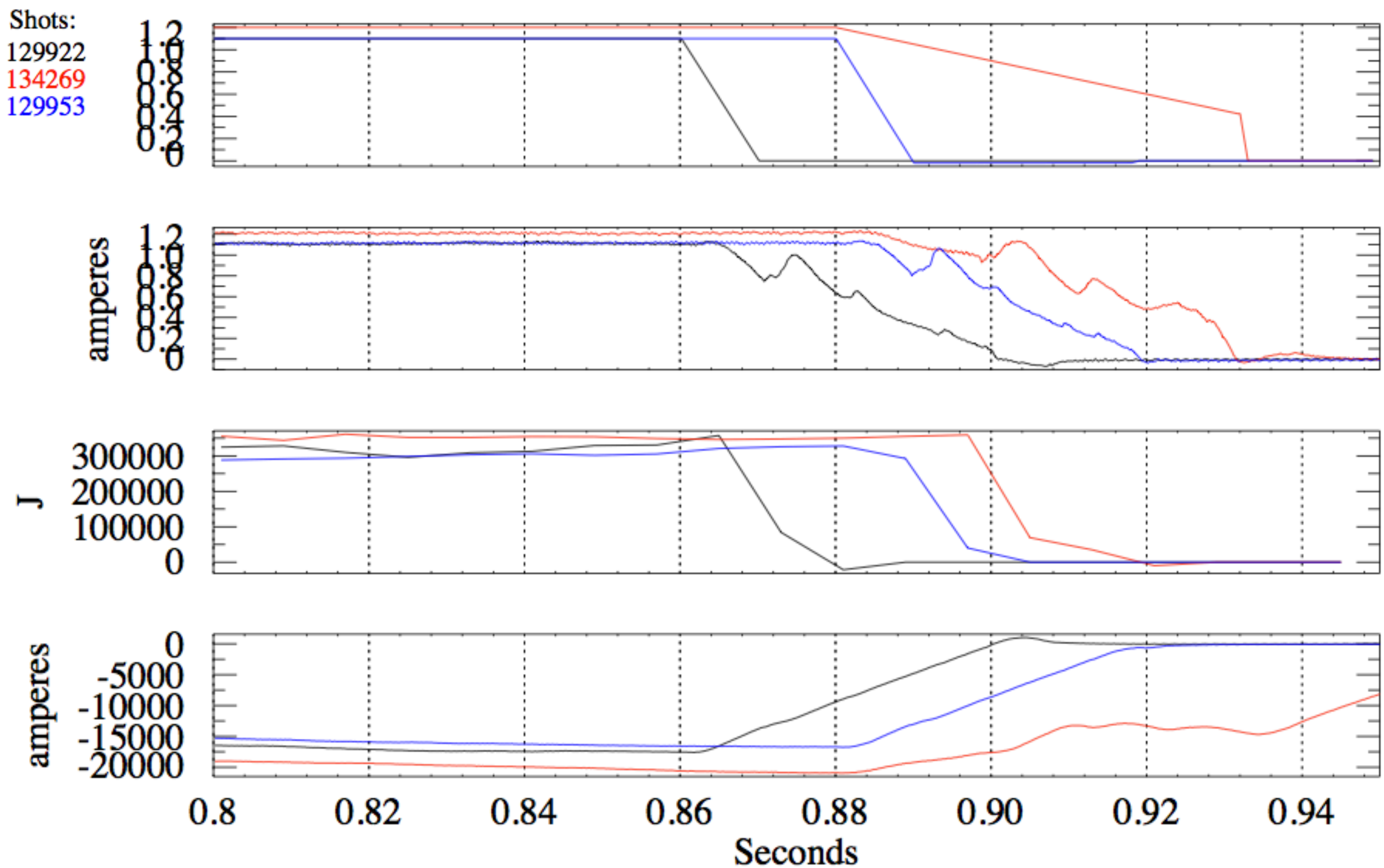
Overview of Proposed XP.

- Many of our highest-energy disruptions occur when negative loop voltage is applied to full-energy plasmas.
  - For instance, after a level-1 fault.
  - Or when we ramp-down to fit in the TF flat-top.
- The proposed DCP for NSTX-U will also turn off the coils without warning.
  - But there is some thought of expanding to a "Machine Protection System", which will have the ability to communicate to PCS.
  - We need to understand how much warning is required.
- NSTX-U scenarios with ~ 1-1.5 MJ should be possible at 2 MA.
- Propose to manually develop rampdown scenarios for high-energy plasmas.
  - What we learn can be automated later.
    - When we near the full solenoid current limit.
    - When we get warning from MPS

EFIT Shows A Class of High Energy Disruptions With Rapid Energy Loss

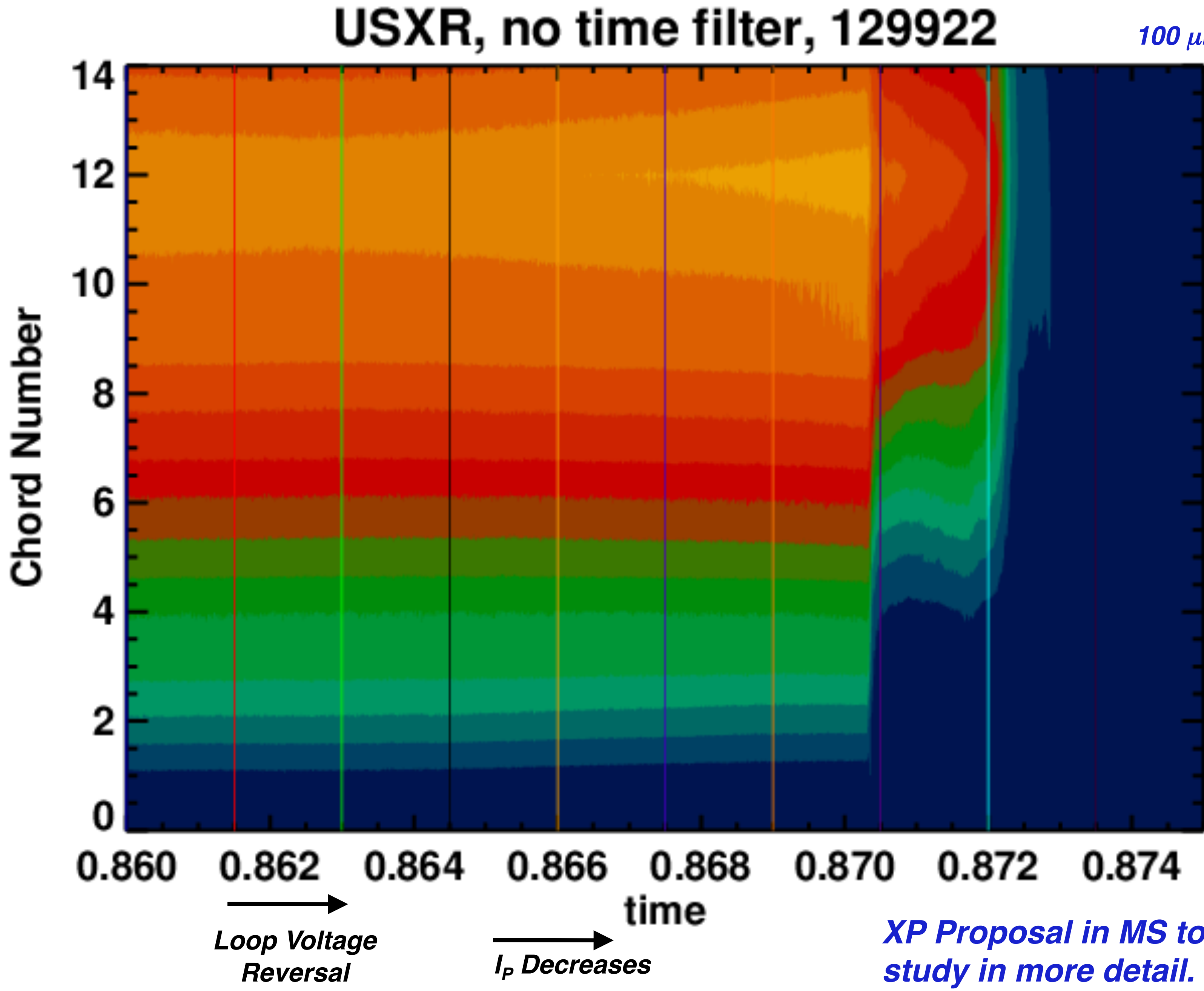
3 of the 4 largest disruptions in the last 4 years (in terms of stored energy just before disruption)



Disruption Occurs Immediately After Loop Voltage is Reversed

USXR Analysis Shows that the Heat is Lost in Two Steps, Very Rapidly

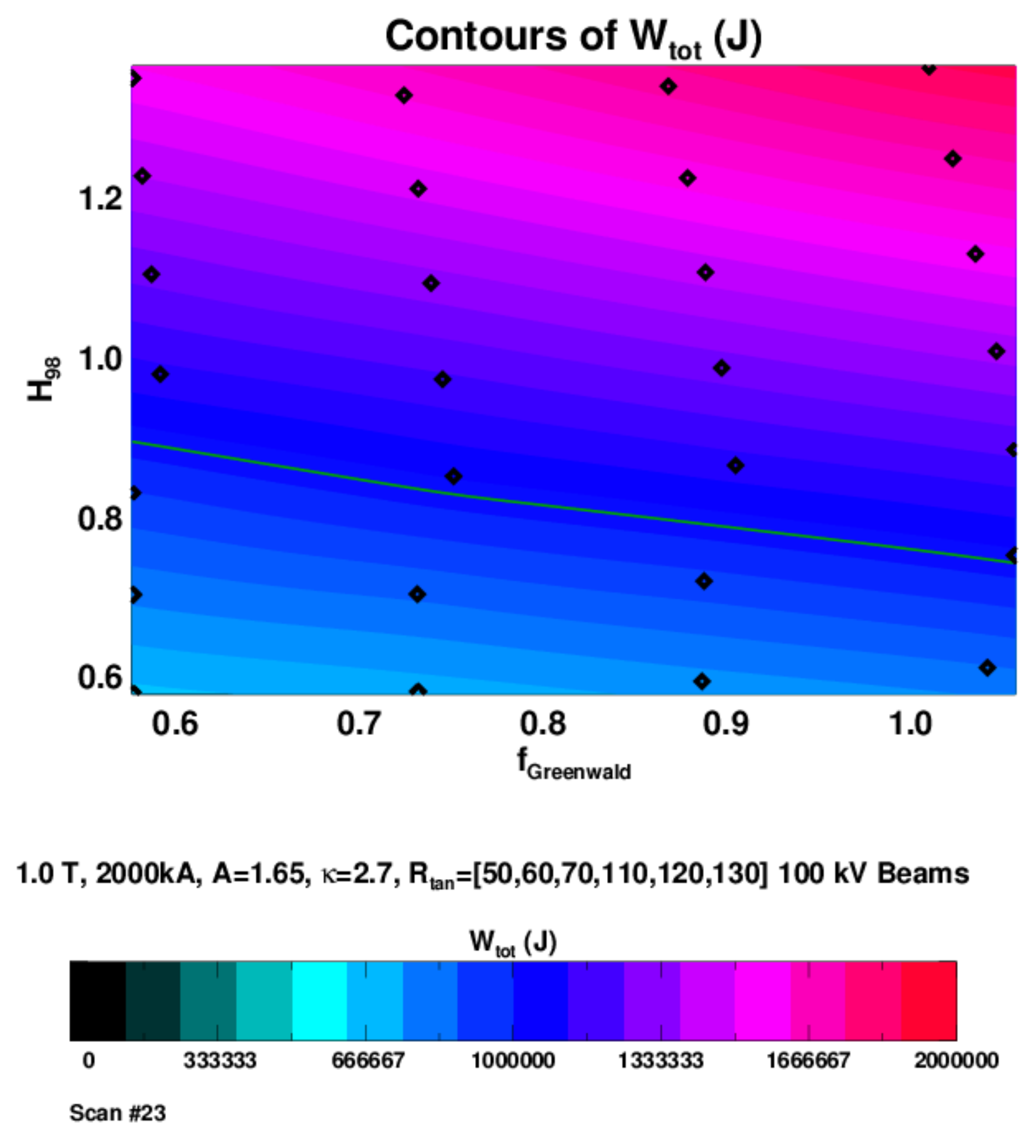
100 μm Filter, HUP



XP Proposal in MS to study in more detail.

NSTX-Upgrade Plasmas Will Have a Lot of Stored Energy

- Free-boundary TRANSP.
- 15 MW input power.
  - Can do this for 1.3 seconds.
- 2 MA, 1 T
- A=1.65, κ=2.7, 10 cm outer gap.
- Zeff=2, D_{FI}=0
- “1 stick of dynamite” = 2000 BTU = 2 MJ



Do we need to be more careful about soft-landing these plasmas?

Experiment Proposes to Develop Rampdown Scenarios for I_P>1 MA, W_{MHD}~300 kJ Discharges.

- Target is I_P>1MA fiducial like plasma with 6 MW.
- Begin with a β_N rampdown (using controller?).
  - What power do we H->L at, and is it disruptive (F_P too high)?
  - How much is the flux consumption increased?
- Add I_P rampdown.
  - Try to avoid f_{GW} becoming too high (H->L timing critical).
  - What is the fastest rate?
- Negative loop voltage and lower β_N drives up l_i?
  - Do we need to limit on CS, reduce elongation?
- Goal: Get smoothly to ~200-300 kA, ~10 kJ, without transients or loss of vertical control.
  - and as quickly as possible.
- Request: 1 run day, could make good start in ½ day.