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CHI absorber arc mitigation using large inter-shot fueling

D.J. Battaglia

Oak Ridge National Laboratory, Oak Ridge, TN

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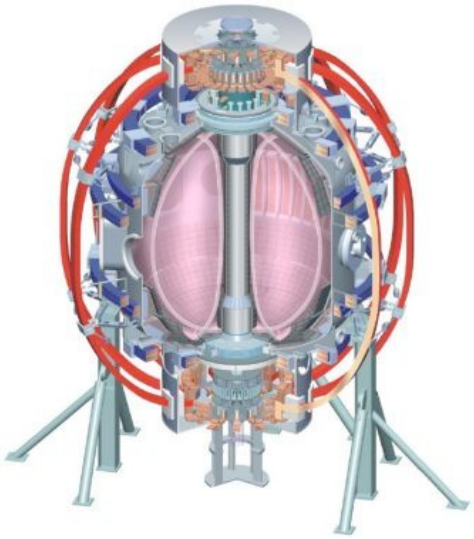

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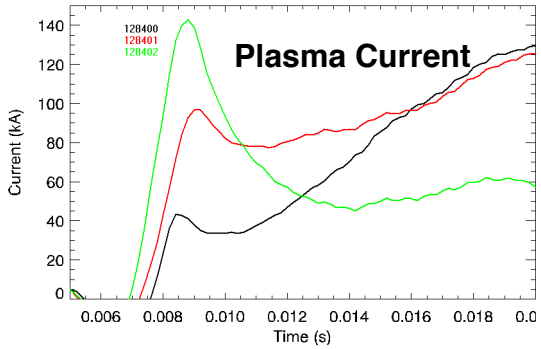
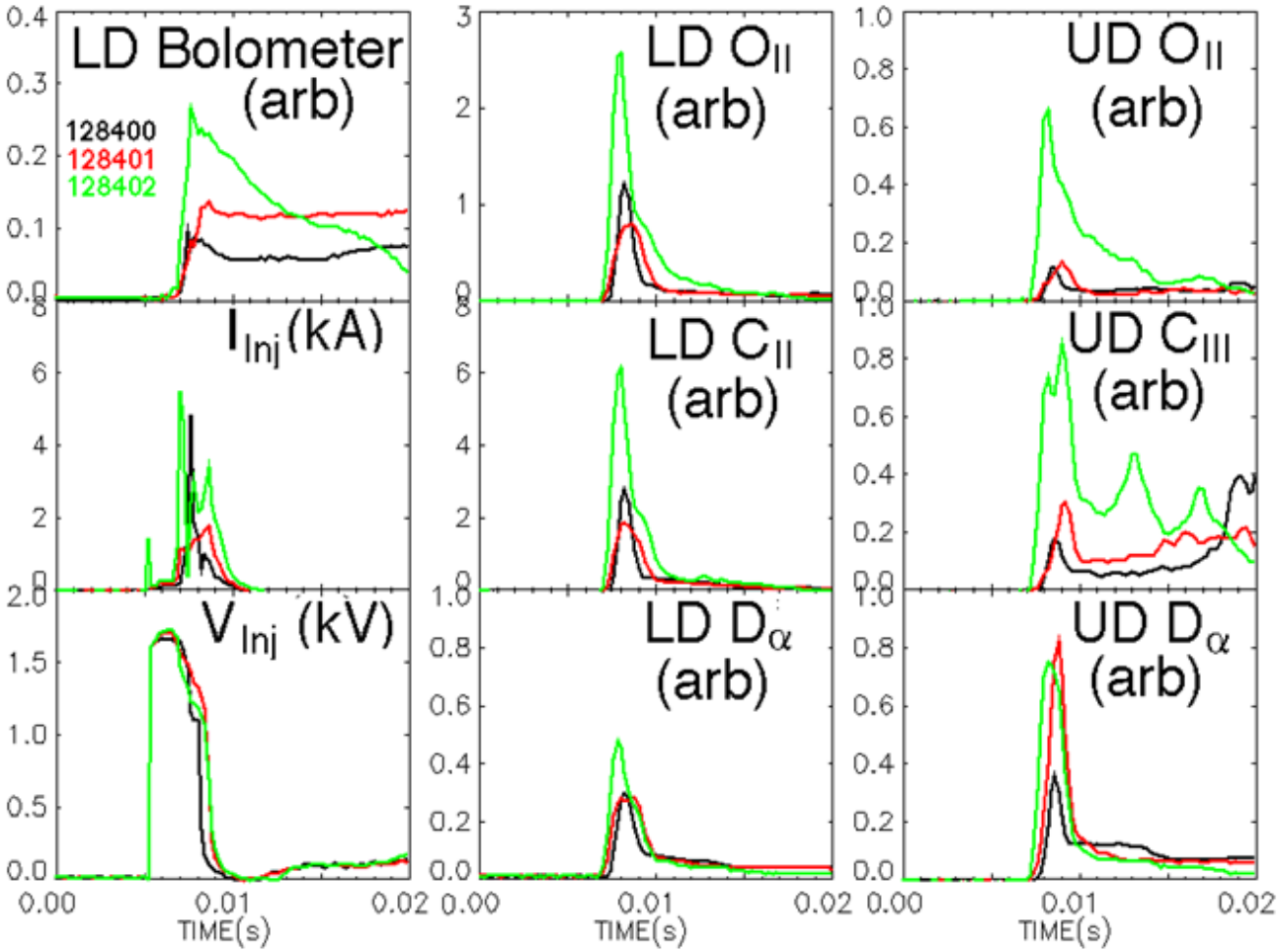
Absorber arcs lead to impurity injection and drain energy from capacitor banks

FY08: Prior to Absorber Coils



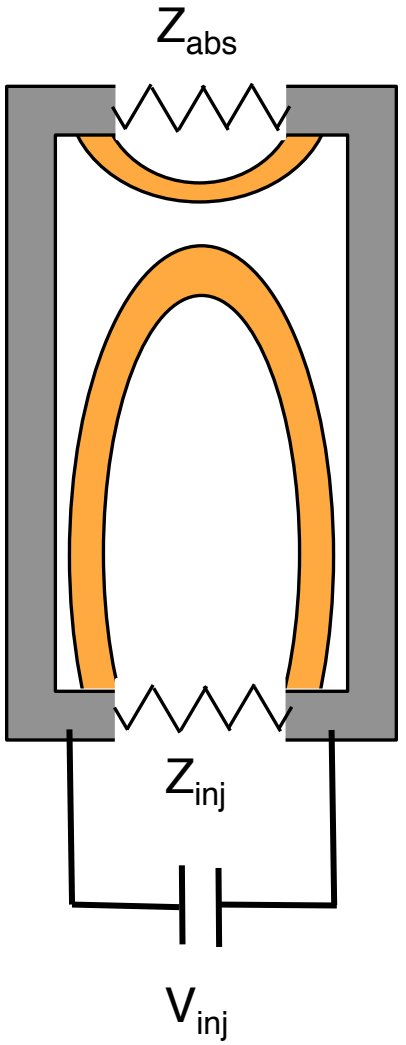
128400: 5mF (7.6kJ)
128401: 10mF (15.3kJ)
129402: 15mF (22.8kJ)



R. Raman et. al., NSTX Research Forum 2008

Discharges would benefit from mitigation of absorber arc breakdown or current

- Desire: $Z_{abs} >> Z_{inj}$
  - Enhance Z_{abs}
    - Increase magnetic shielding
    - Increase pathlength through vacuum
    - Reduce charge-carriers near absorber
  - Reduce Z_{inj}
    - Reduce pathlength through plasma (i.e. windup)
    - Increase charge-carriers in plasma edge
- Typical Z_{inj} (following breakdown)
  - NSTX: 1.5 kV / 1.5 kA ~ 1 Ω
  - Pegasus: 1.2 kV / 4 kA ~ 0.3 Ω
  - HIT-II: 2.0 kV / 20 kA ~ 0.1 Ω
  - SSPX: 0.3 kV / 200 kA ~ 2 mΩ



Operations on Pegasus used large inter-shot fueling to reduce Z_{inj} and mitigate arc-over current

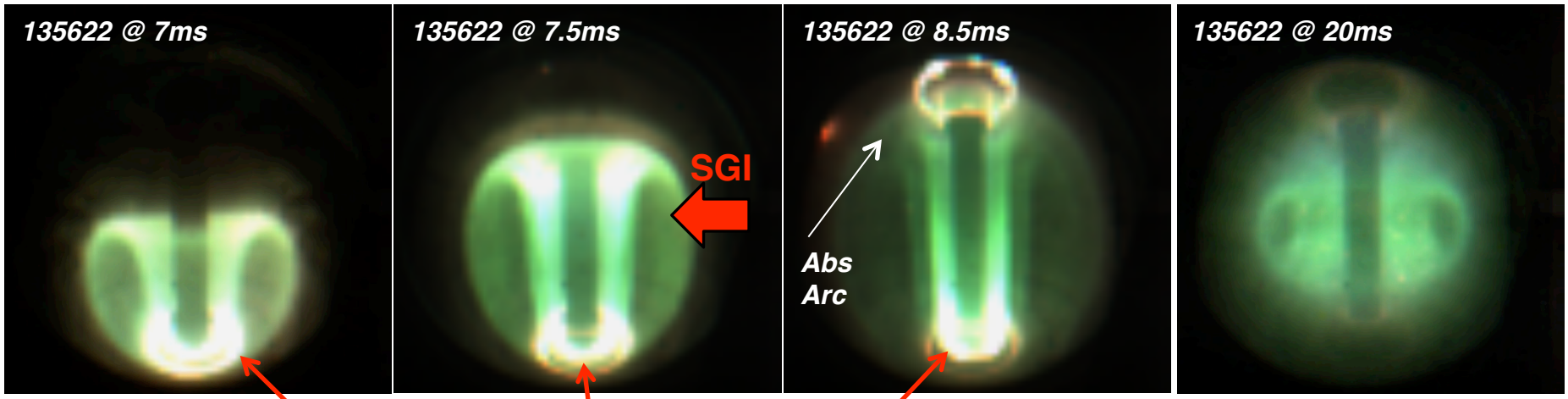
- "Arc-over" in Pegasus observed at V_{bias} > 1.2 kV for I_{inj} ~ 4 kA
  - Current shorted through conducting vacuum vessel
  - Observed concurrent increase in C, O and P_{rad}
  - Not repeatable and often killed the discharge
  - More resilient to arc-over with improved wall conditions
- Z_{inj} tailored using inter-shot fueling rate
  - Injector impedance decreases with neutral fueling
    - More charge-carriers ?
  - Larger neutral fueling rate slows down I_p ramp
    - Decreased helicity injection rate with lower V_{inj} (since I_{inj} is fixed)
    - Energy deposited into increased ionization
    - Cools plasma, increasing resistance
  - Improved "roll-over" of I_p (i.e. reduced drop in I_p at injector shutoff)
    - Longer I_p ramp leads to increased L_i ?

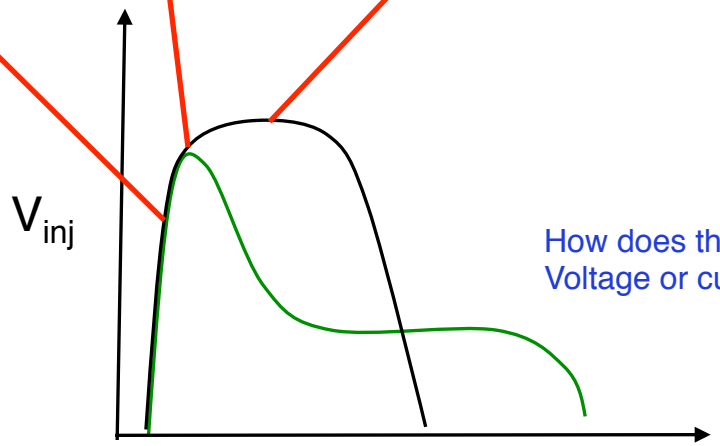
Propose experiment to lower Z_{inj} for CHI in NSTX using a large inter-shot gas puff

- Propose 1 day experiment: Use SGI following CHI breakdown to reduce V_{inj} and slow down I_p ramp
  - Start with discharge just below threshold for absorber arc
    - Ex: 135614 (15 mF) with I_p ~ 250 kA
  - Increase SGI pressure until discharge is over gassed
  - Increase CHI bank stored energy … repeat
- Positives:
  - Could extend length of CHI pulse if stored energy is increased
  - SGI fueling may increase ionized fraction, reducing the edge neutral pressure near the absorber
  - Slower I_p ramp may allow upper PF coil ramp to add additional PF field near absorber (i.e., shape control)
  - Denser SOL may reduce transport of sputtered impurities

Backup

SGI puff ~ 0.5 ms after breakdown





How does the power supply work?
Voltage or current regulated?