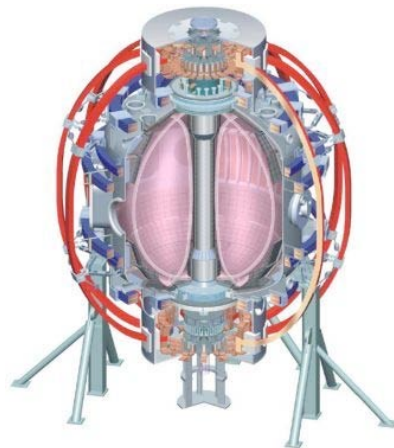


# Suggestions for KSTAR start-up, ramp-up and control experiments

College W&M  
Colorado Sch Mines  
Columbia U  
Comp-X  
General Atomics  
INEL  
Johns Hopkins U  
LANL  
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**D. Mueller - PPPL**

**US-KSTAR Workshop  
General Atomics  
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RRC Kurchatov Inst  
TRINITY  
KBSI  
KAIST  
POSTECH  
ASIPP  
ENEA, Frascati  
CEA, Cadarache  
IPP, Jülich  
IPP, Garching  
ASCR, Czech Rep  
U Quebec

# Reliable, efficient plasma start-up is essential

- High priority to maximize productivity
  - ECH relaxes constraint on field null and impurities for breakdown
- Explore range of breakdown parameters
  - Prefill pressure (from too low to too high) (E/p)
  - $V_{loop}$  (lower V means easier control, but too low can waste  $V \cdot s$ )
  - ECH power; 1st and 2nd harmonic comparison
  - Field Null/ configuration

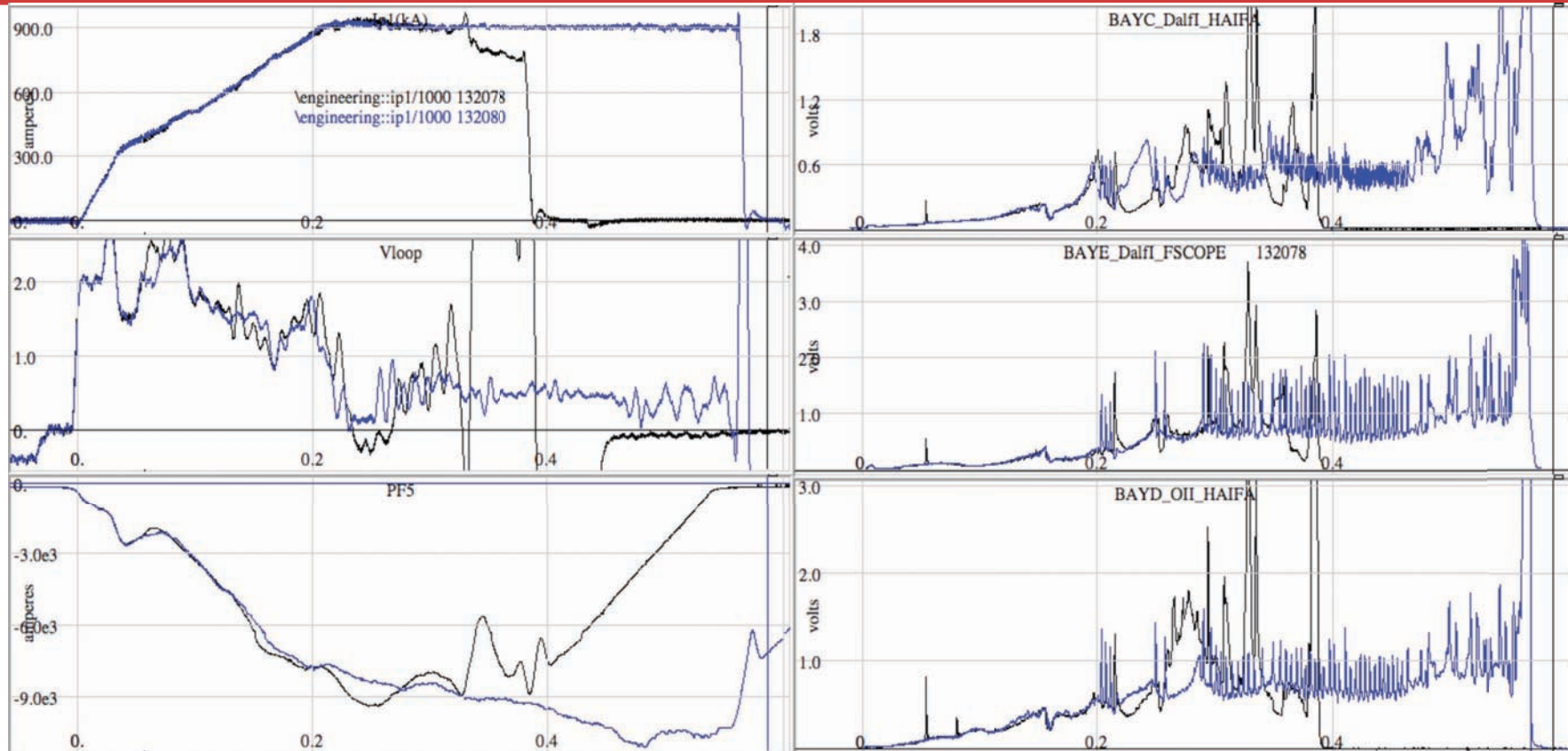
# After breakdown ramp-up scenarios are needed

- Experiments to explore the range of ramp-up parameters
  - $di_p/dt$ , high enough to not waste  $V\cdot s$ , low enough to avoid MHD
  - Gas fueling (too much  $\rightarrow$  density limit, too little  $\rightarrow$  locked modes, failure)
    - Filterscope  $H_\alpha$  spikes early often precede locked mode detection, can be “fixed” by combination of early puff and higher prefill
  - $R(I_p)$ , shape( $I_p$ ) choice:  $\sim$  constant  $q$  growth which gives high  $I_i$ ; full aperture gives lower  $I_i$  and more easily shaped plasma
  - Auxiliary heating power expected to save  $V\cdot s$
  - Non-inductive current drive

# Summary

- Design experiments to explore full range of start-up and ramp-up parameters
  - Once more interesting experiments are possible, these results will be the foundation of useful operational experience
  - It will be hard to justify run time for start-up when other exciting experiments are ready, now is the time
- Wall conditioning is important, most machines have best, most reliable operation when oxygen level is low to invisible
  - (I can't explain why, it is just an observation.)
  - Start-up experiments are not different in this regard
  - Even though ECH power will permit burn-through, better results will come when oxygen is lower
  - Start-up conditions can change when wall conditions change so be wary

# Example



- Note early Ha spikes on 132078 (black) at about 50 ms
- Such spikes are clues that the early density is low and the discharge is susceptible to a locked mode or other MHD, about 2/3 of discharges with this signature fail
- Adding an additional small amount of gas very early (10 to 50 ms) can eliminate the spikes and the success rate of the discharges improves dramatically