Thoughts on future profile control

Presented by
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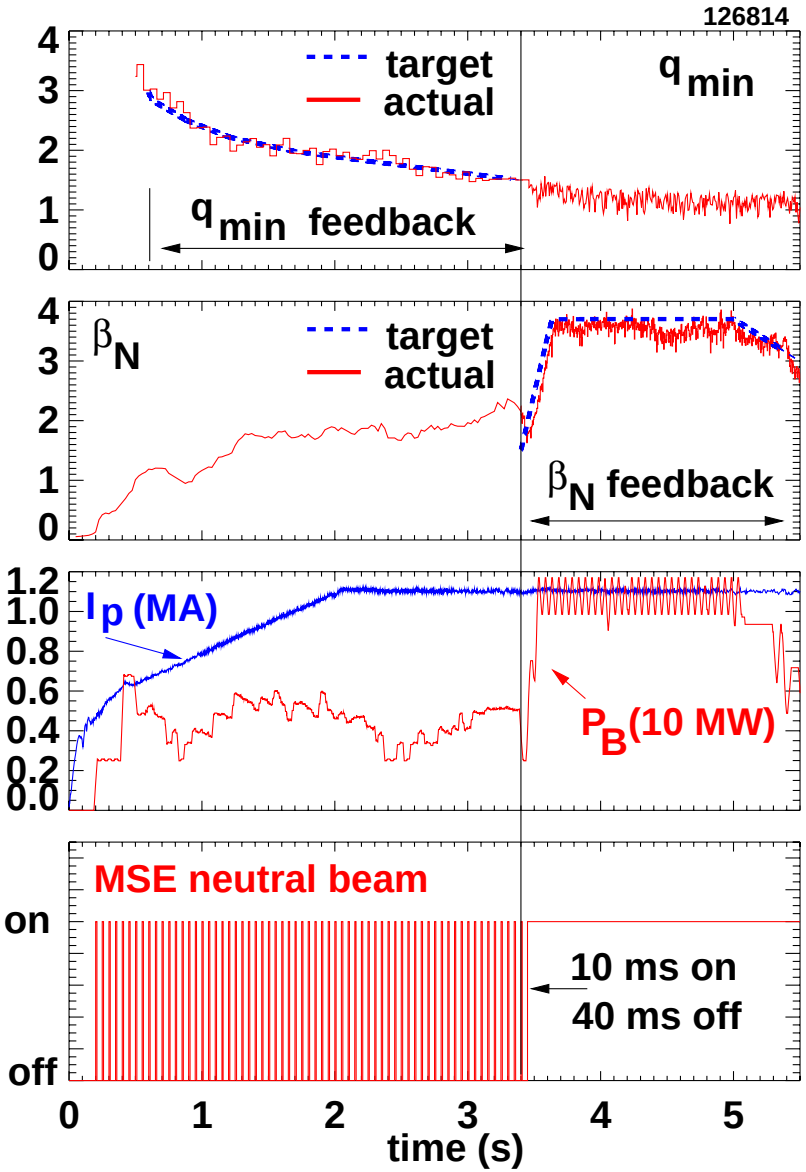
In the weak shear, steady-state scenario feedback control of the q profile is envisioned throughout the discharge



- **Concept is to produce the optimal q profile during the discharge formation and sustain it in steady-state**
- **Three phases with differing control issues**
  - Discharge formation
  - Transition to the high β_N phase
  - Steady state, high performance phase

To date, q control experiments have focused on the discharge formation phase

- **Changes in conductivity (σ, or effectively T_e) used to modify the time evolution of the inductive current profile**
- **Selection of issues:**
  - Continuous 30L for MSE data is best
  - Using all MSE channels requires 2 beams
    - Probably too much power
  - Electron heating without NBCD might be better
- **Model based controller under development**
  - Lehigh University collaboration

Specialized control algorithm probably required for the transition to the high β_N phase

- **The concept is to keep the q profile constant**
- **However, current density components will change significantly**
  - Transition from low to high bootstrap current fraction
  - Likely change in the amount of NBCD as β_N is increased
  - ECCD added
  - Unlikely that the sum of the current density components will have a constant profile
- **A plan for controller development is needed.**

High β_N phase requires excess current drive capacity in order to effectively implement q profile control

- **Present discharges barely reach 100% noninductive**
- **The external current drive, ECCD, is envisioned to provide a small fraction of the total current**
  - The maximum available ECCD should be larger than the anticipated need
  - Deposition location should be adjustable
- **Transport profile modification has been discussed as a way to control the J_{BS} profile**
- **Possible controller development in collaboration with JET group**

Possible hardware needs stemming from the control requirements of the three phases of the discharge

- Gyrotron real-time antenna steering
- Capability to turn each gyrotron on/off multiple times during a discharge
- Longer allowable on time for MSE beams
- FWCD for on axis current drive (q_0 control)
- ECCD 50% (?) larger than modeling-predicted need
- Improved MSE calibration
- Possible need for q profile diagnostic independent of beams

Modification of transport coefficient profiles is envisioned as the route to pressure profile control

- **Pressure profile affects J_{BS} and β_N limit**
  - Actuator is changes in rotation?
- **Related desired improvements:**
  - Collect more CER channels in real-time
    - data acquisition issues exist
  - Longer pulse lengths for CER beams (30, 330)
  - Better Thomson density calibration
- **Other desired improvements for control:**
  - 30R for sufficient power to obtain programmed β_N
  - Beams handle 5 ms on-time again (as in the past)