Motivation and Background

(Kinetic) RT-equilibrium reconstruction is crucial because many quantities of interest are not measured directly.

Many Discharge relevant parameters can not be measured directly ... However, they can be evaluated indirectly from available diagnostic data.

Least squares solution of diagnostic data to the Grad-Shafranov model allows evaluation.

Grad-Shafranov model:
- Describes force balance of tokamak equilibrium (axisymmetric).
- Allows for distributed current source.
- Determines distribution of poloidal flux $\psi$ and toroidal current density $j_{\phi}$ in R, Z-plane.

Reconstructed pressure and current density profile for $H$-mode:
- Typical "H-mode pedestal" completely absent.
- Without kinetic data, only 3 global parameters constrained.
- Need real-time pressure profile estimation.
- Typical "H-mode bootstrap peak" completely absent.
- Need real-time current density profile constraints!

Data buffering required to robustly handle variable data availability in real-time application:
- TS outputs CORE, DIVERTOR and TANGENTIAL measurements (not in parallel), limiting data refresh rate.
- CER outputs CORE and EDGE measurements (not in parallel, no MIL).
- Need enough data points in core and pedestal for fit, using data that is not "too old".

If we assume that the data is 'correct':
- Red profile (few data points, none in pedestal region) takes form of model function but completely wrong in pedestal compared to same case but with added data from the EDGE CER, stressing importance of buffering.

Raw kinetic measurements from TS fitted to MTANH+LIN with 50 ms buffer:
- MTANH+LIN profile fit $n_{e,fit}$.
- MTANH+LIN profile fit $T_{e,fit}$.
- Compute $P_{electron}$ profile: $P_{electron} = n_{e,fit} T_{e,fit} f$.

MTANH+LIN fit generated based on CER and TS separately not robust against misaligned pedestal!

Solution inspired by CAKE:
- Fit ratio $T_i/T_e (polynomial)$.
- Anchor points with large uncertainty.
- Multiply by $T_e$ fit.
- Adjusted pedestal.
- Real-time specific:
  - Chebyshev polynomials.
  - Regularized weighted LS.

Conclusions
- Data buffering successfully implemented and tested during experiments. Enables more robust profile fitting.
- Insertion of bootstrap model improves shape of reconstructed current density.
- $T_i/T_e$ fitting in combination with RT-profile realignment is way to go forward.
- Prevent potential double pedestal when Ti is fit to MTANH+LIN.
- Correct RT-profiles from being shifted inward.