

# High intensity SFTPRO

T. Prebibaj and I. Mases Sole

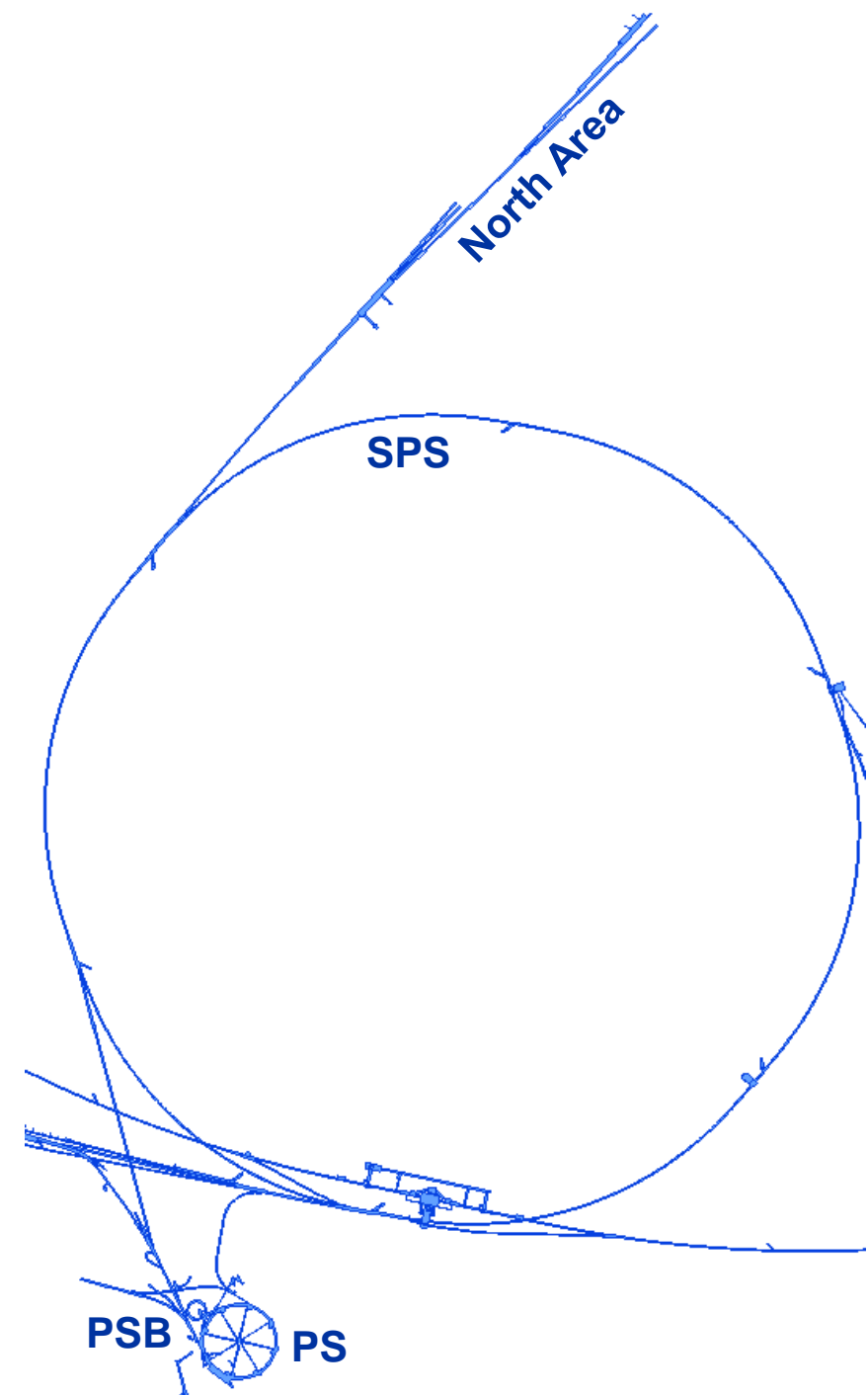
F. Asvesta, H. Bartosik, S. Cettour-Cave, H. Damerau,  
A. Huschauer, I. Karpov, A. Lasheen, T. Levens, K. Li, G. Papotti, M. Schenk,  
M. Zafeiropoulou, PSB-PS-SPS OP

And the MD support of:  
F. Asvesta & B. Salvant

See an extended version of this presentation at the [IPP meeting](#) of 22/11/2024

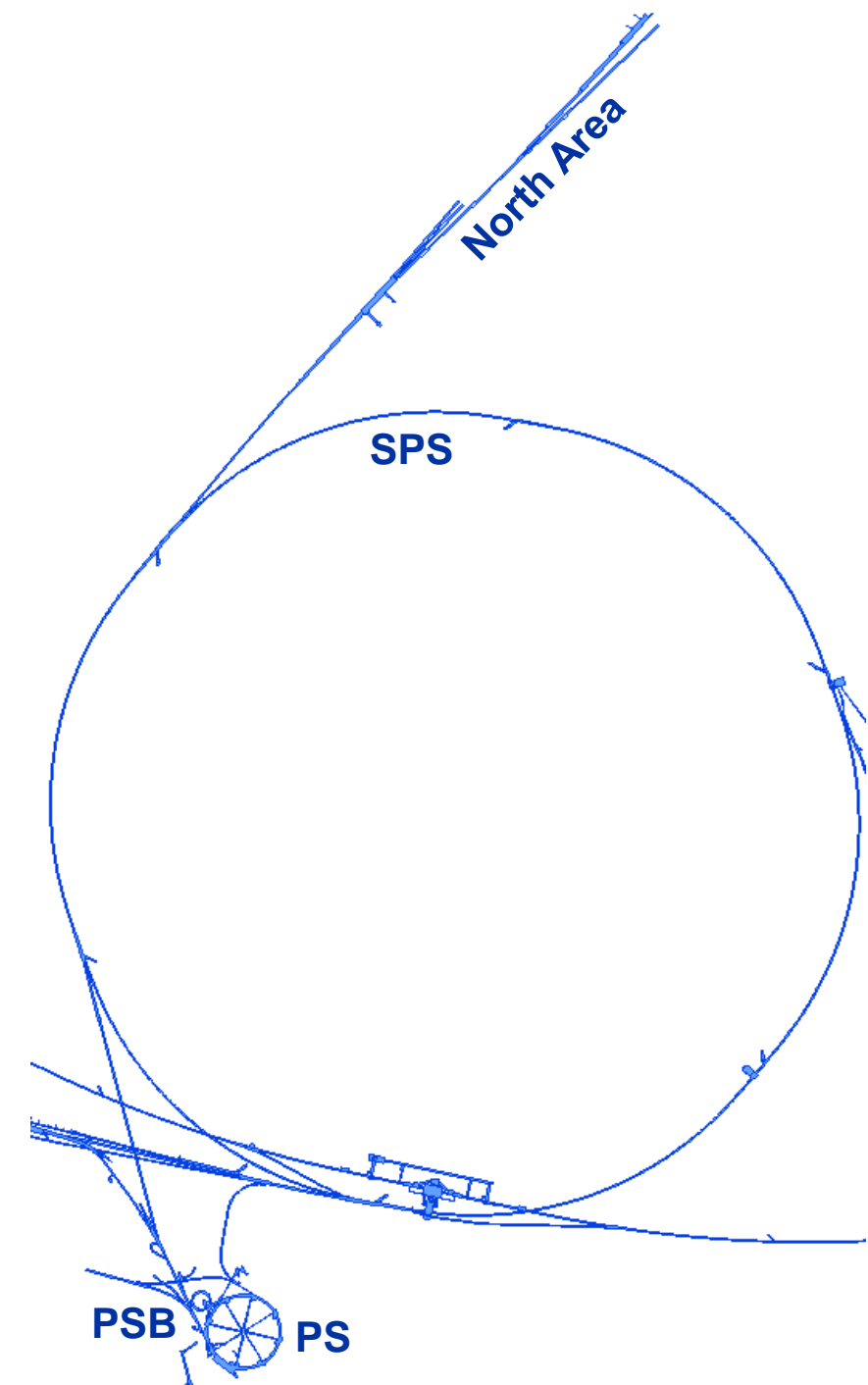
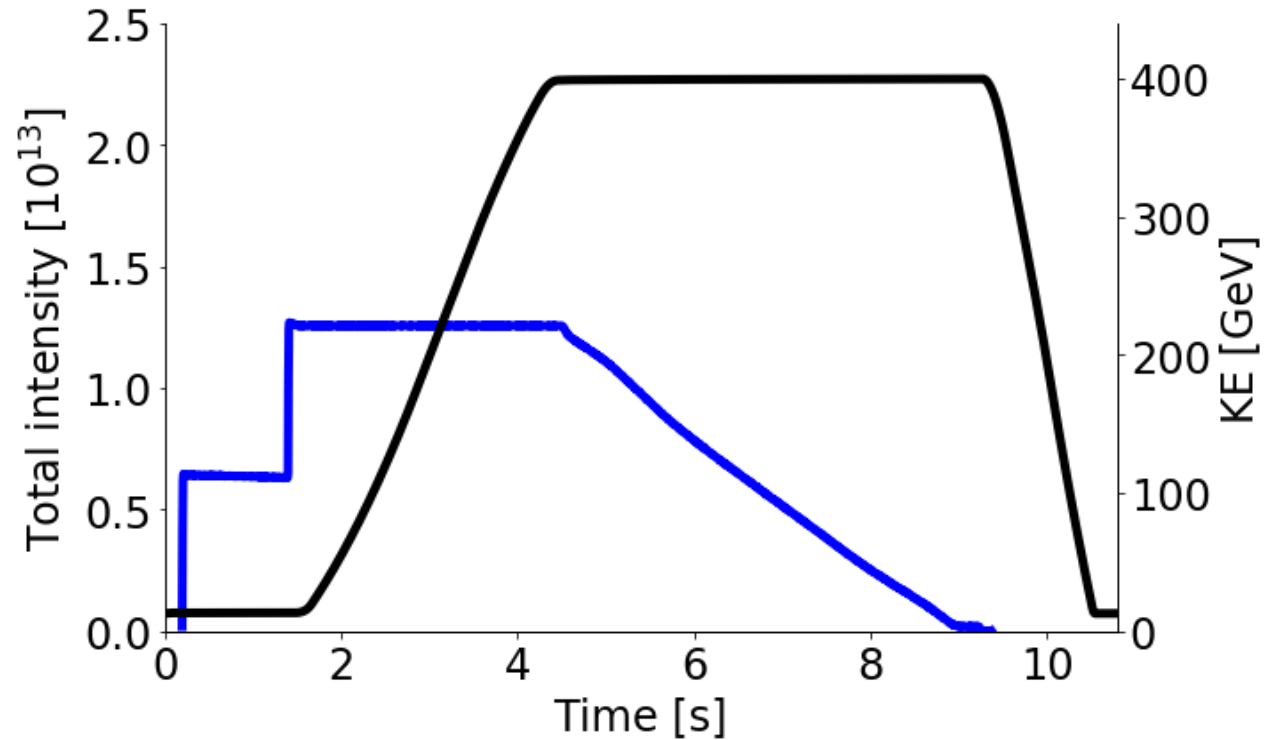
04/02/2024

Injectors Performance Panel MD days 2025



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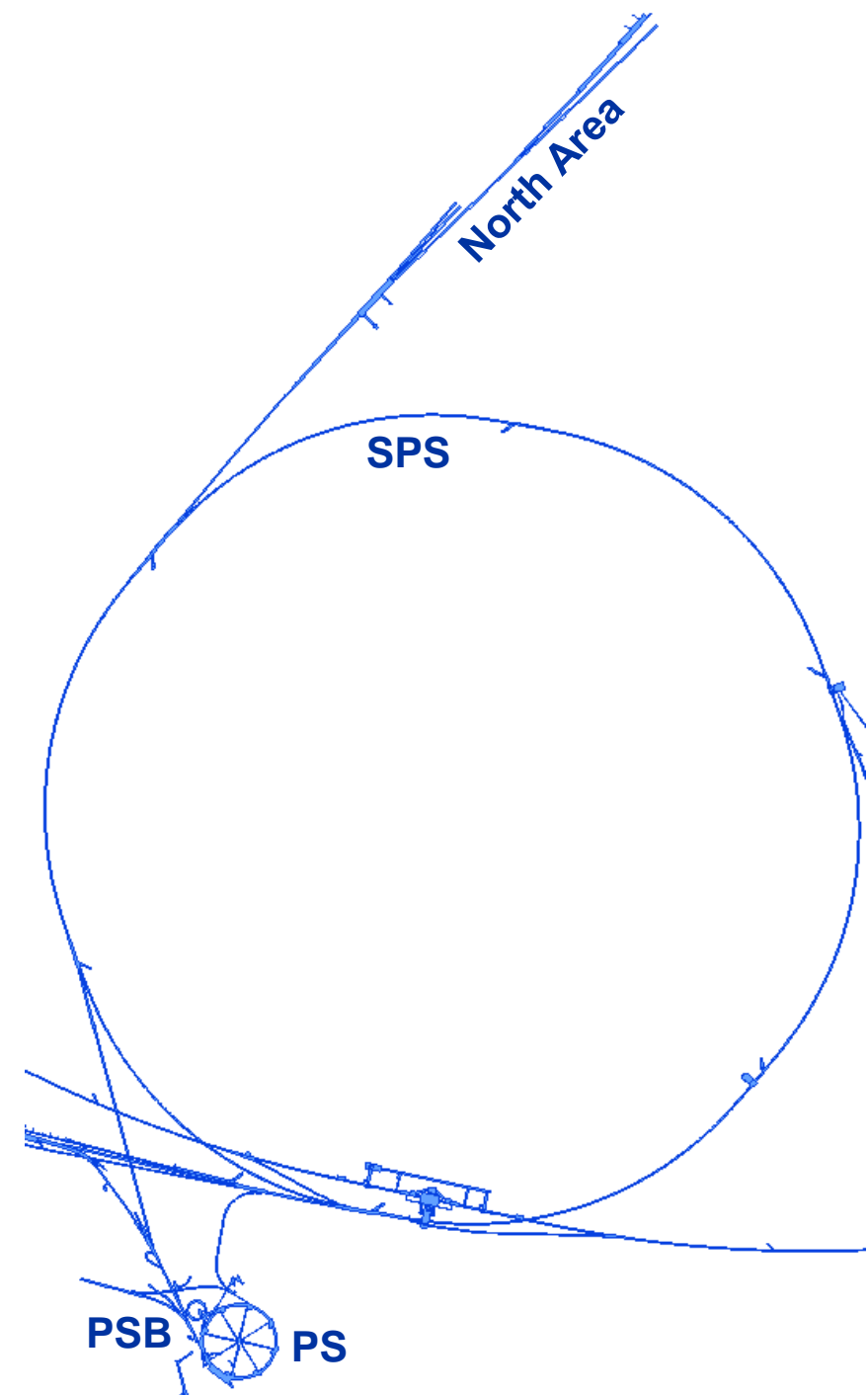
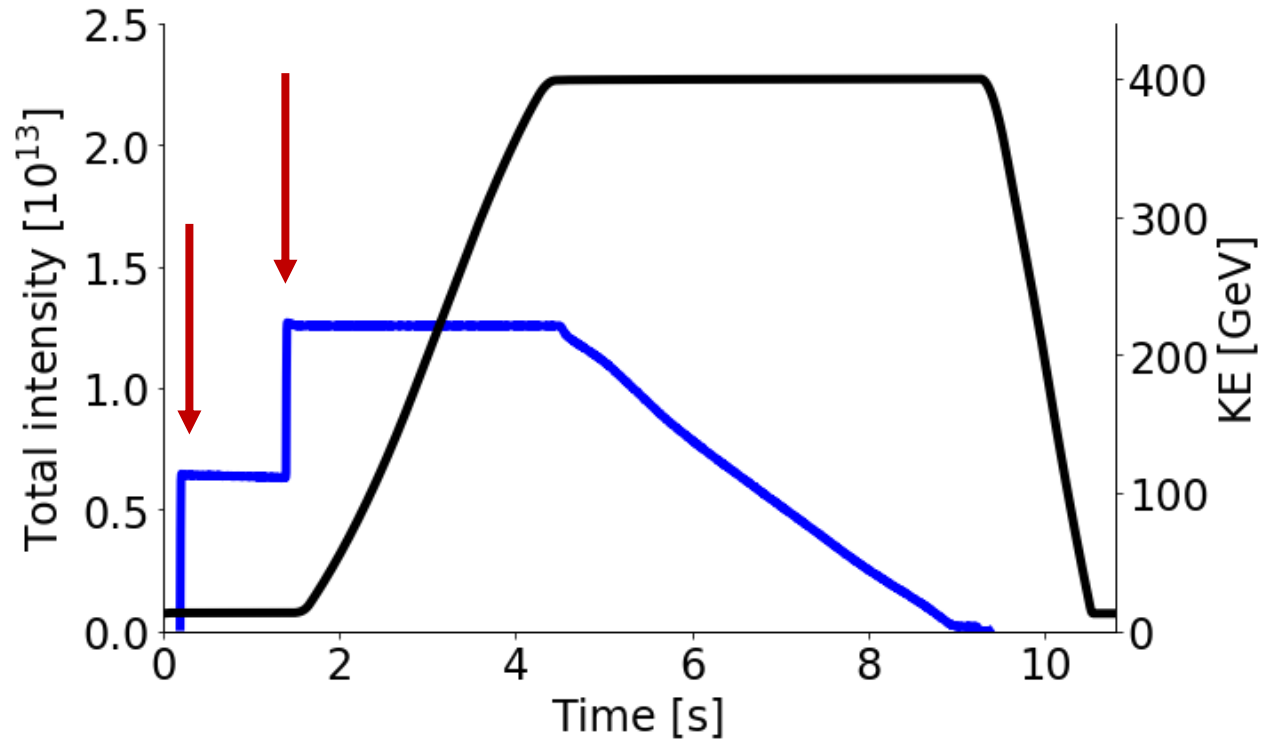
## SPS Fixed Target PROton beams



# SFTPRO

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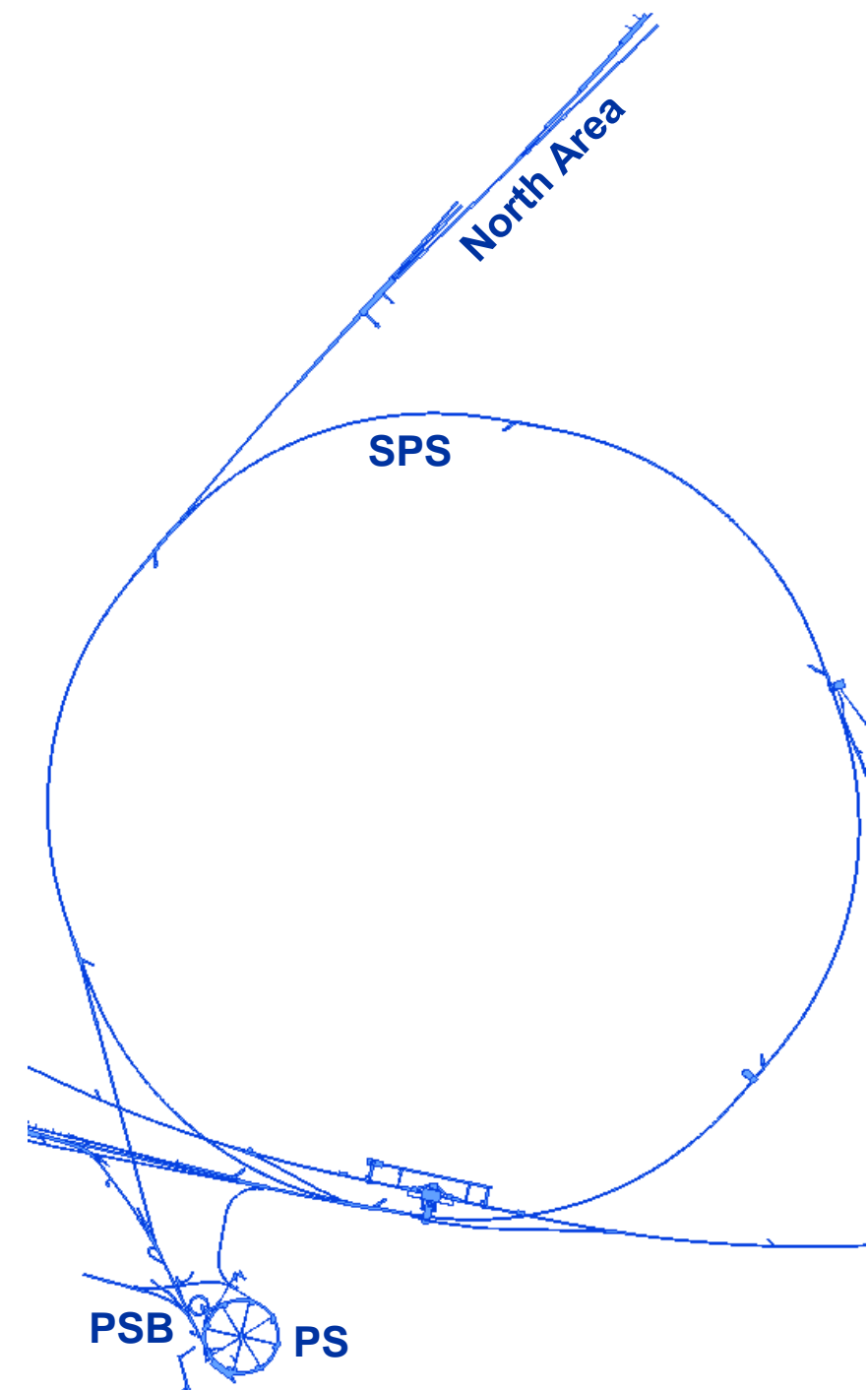
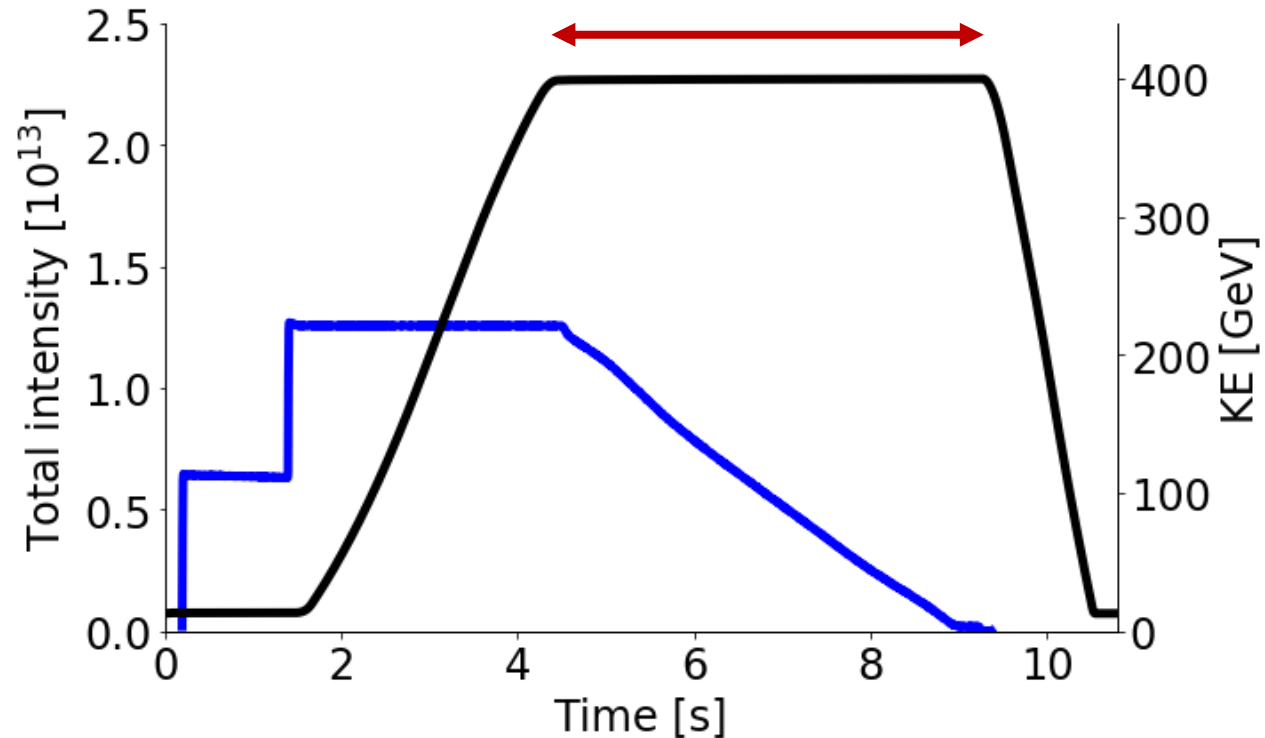
- Two injections from the PS, typically at  $1-2 \times 10^{13}$  total intensity up to  $\sim 4 \times 10^{13}$ .



# SFTPRO

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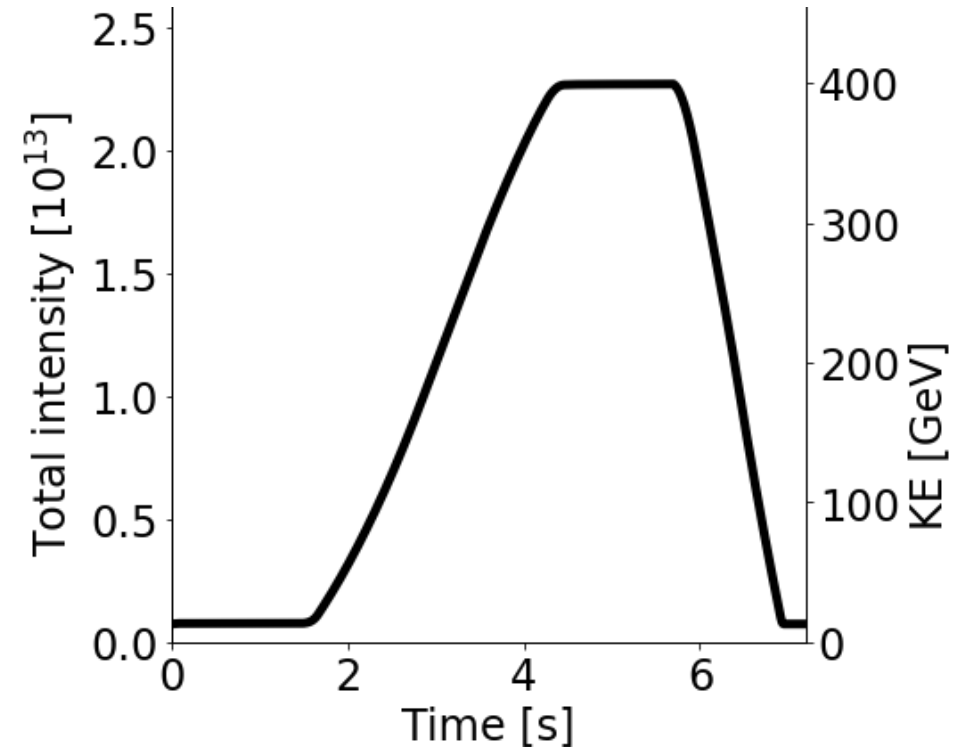
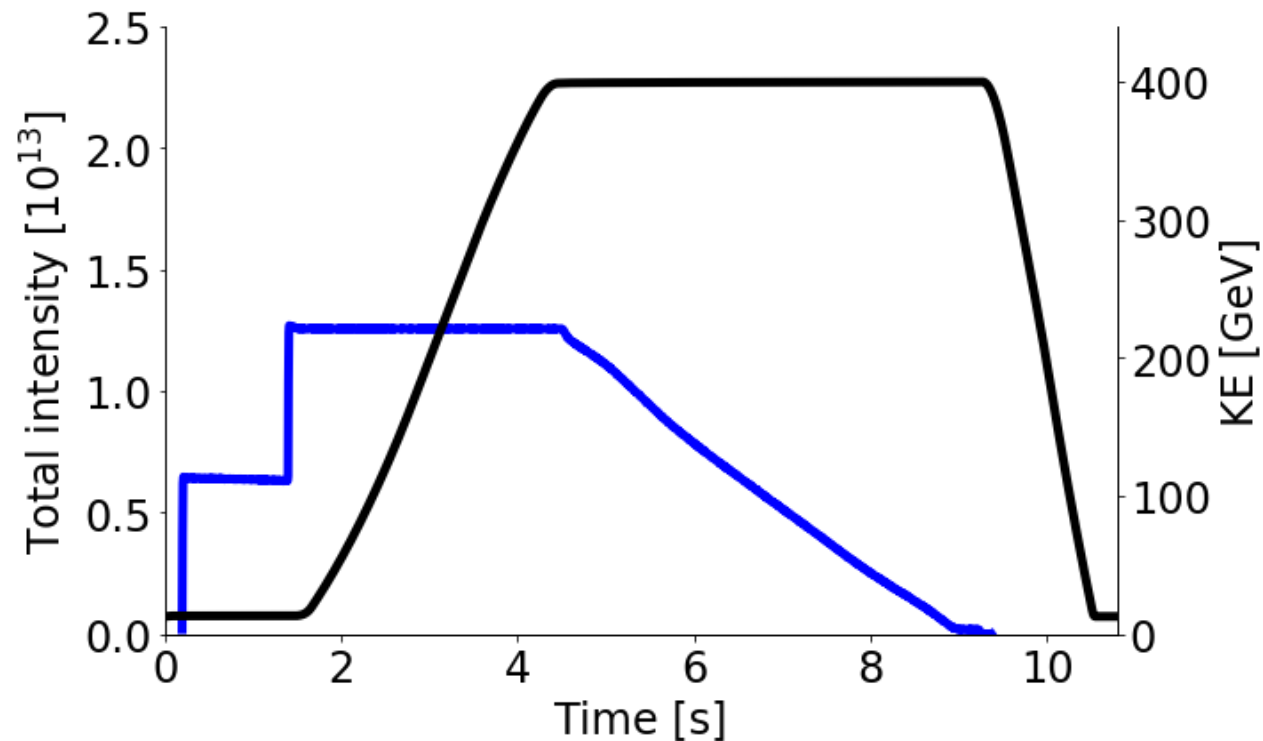
- Two injections from the PS, typically at  $1-2 \times 10^{13}$  total intensity up to  $\sim 4 \times 10^{13}$ .
- Beam is extracted towards the North Area using slow extraction (over a flat-top of 4.8s).



# SFTPRO

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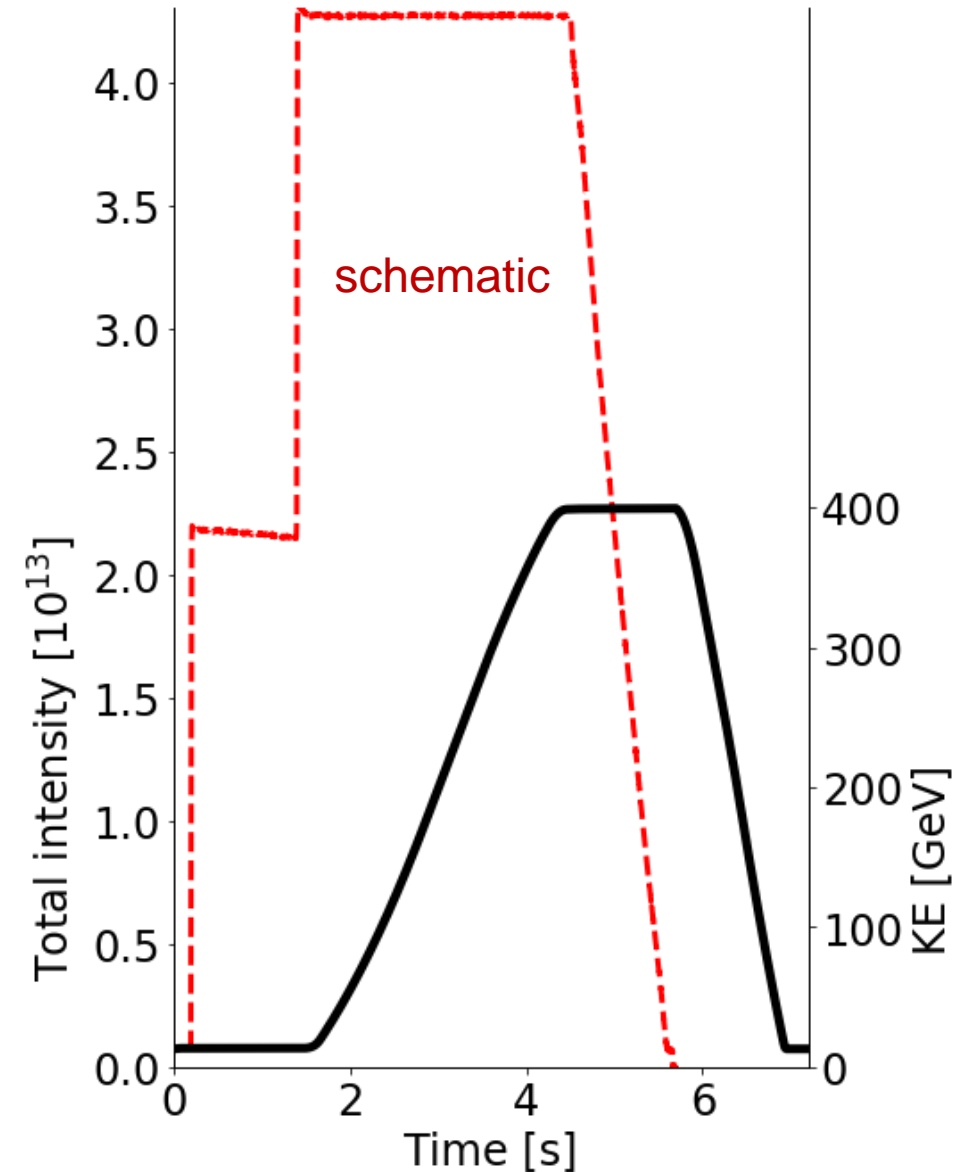
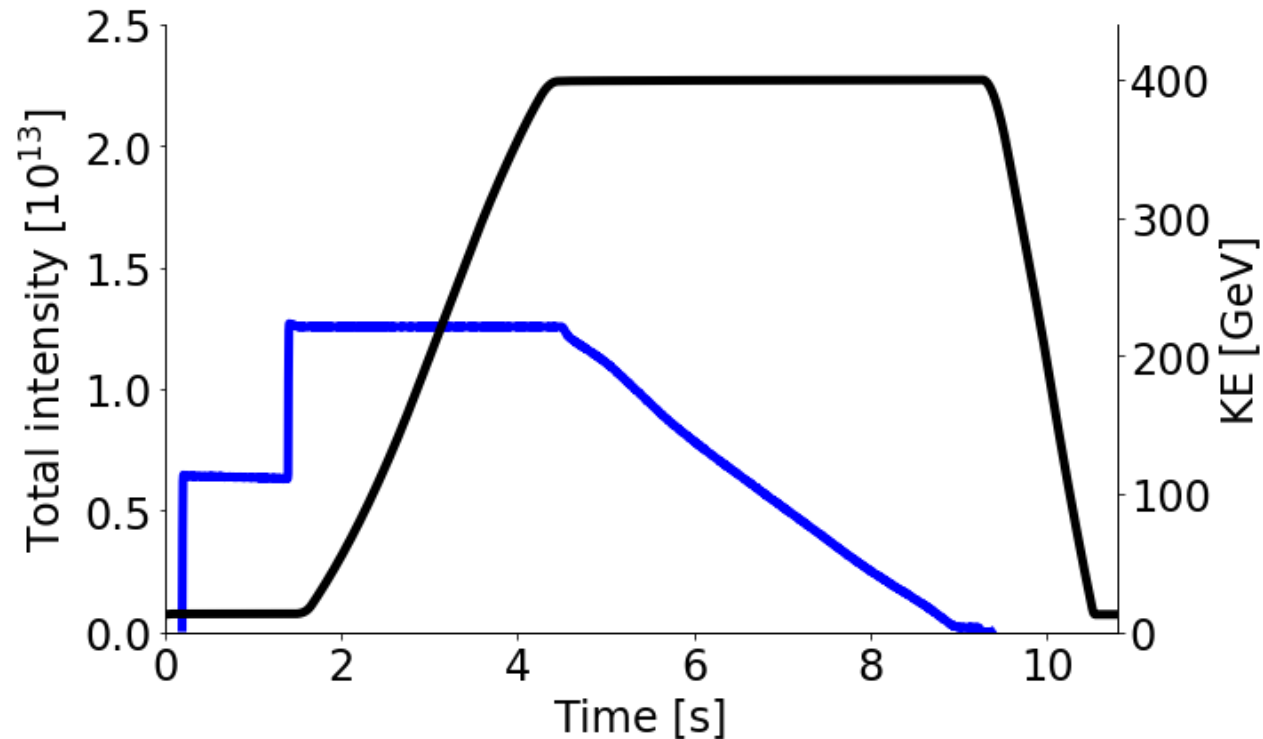
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- SFTSHiP will be similar to SFTPRO, but with shorter flat-top



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- Beam is extracted towards the North Area using slow extraction (over a flat-top of 4.8s).
- SFTSHiP will be similar to SFTPRO, but with shorter flat-top ...**and higher intensity ( $4.2 \times 10^{13}$  p/cycle)**.



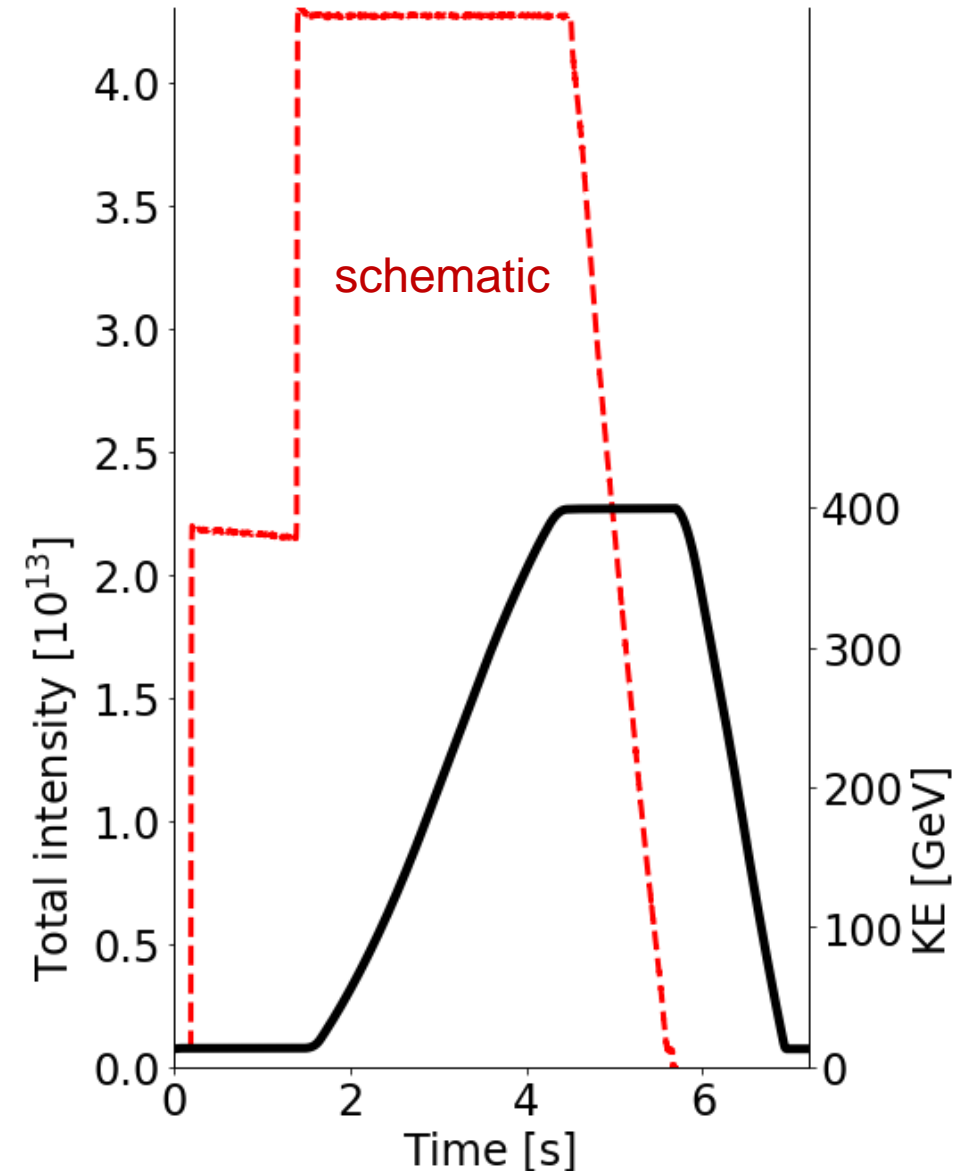
# SFTPRO

## SPS Fixed Target PROton beams

- Two injections from the PS, typically at  $1-2 \times 10^{13}$  total intensity up to  $\sim 4 \times 10^{13}$ .
- Beam is extracted towards the North Area using slow extraction (over a flat-top of 4.6s).
- SFTSHiP will be similar to SFTPRO, but with shorter flat-top ... **and higher intensity ( $4.2 \times 10^{13}$  p/cycle)**.

## MD goals

- Optimize transmission & working point for different intensities.
- Study beam at SHiP intensities ( $\sim 4.2 \times 10^{13}$ ).
- (Ultimately) systematically study intensity reach of the SPS beyond SHiP intensities (?)



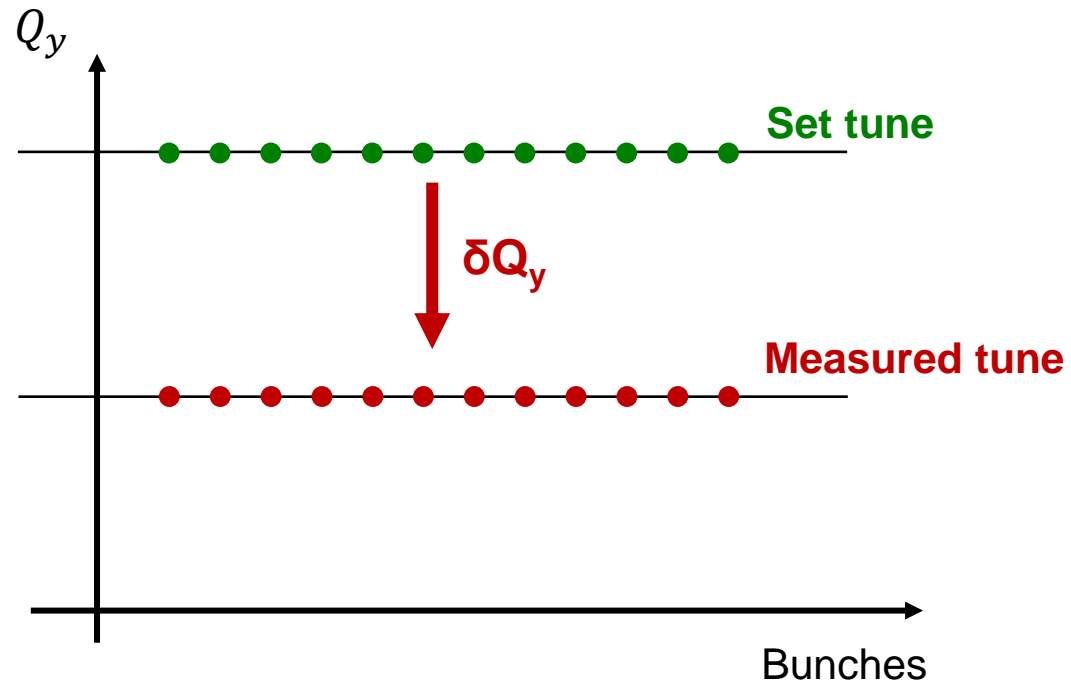
# Challenges of SFTPRO/SFTSHIP

**Any intensity increase of the SFTPRO in the SPS is tedious.**

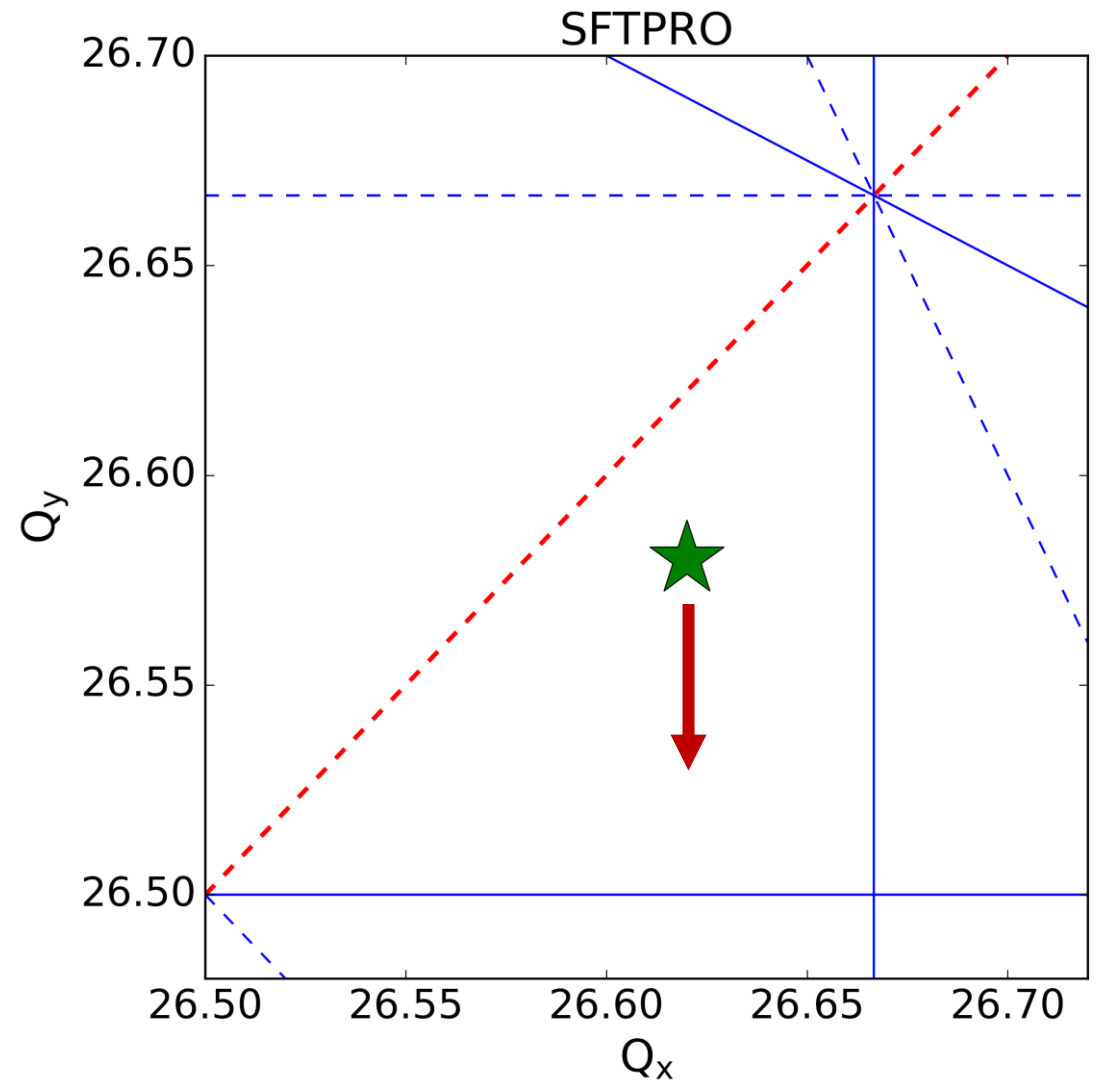
- The SPS is almost full of bunches (2x2100) which makes it prone to **coupled bunch instabilities**.
- Chromaticity, octupoles and transverse feedback are used to control beam stability at increasing intensities.
- **Tune control is crucial for beam stability!**



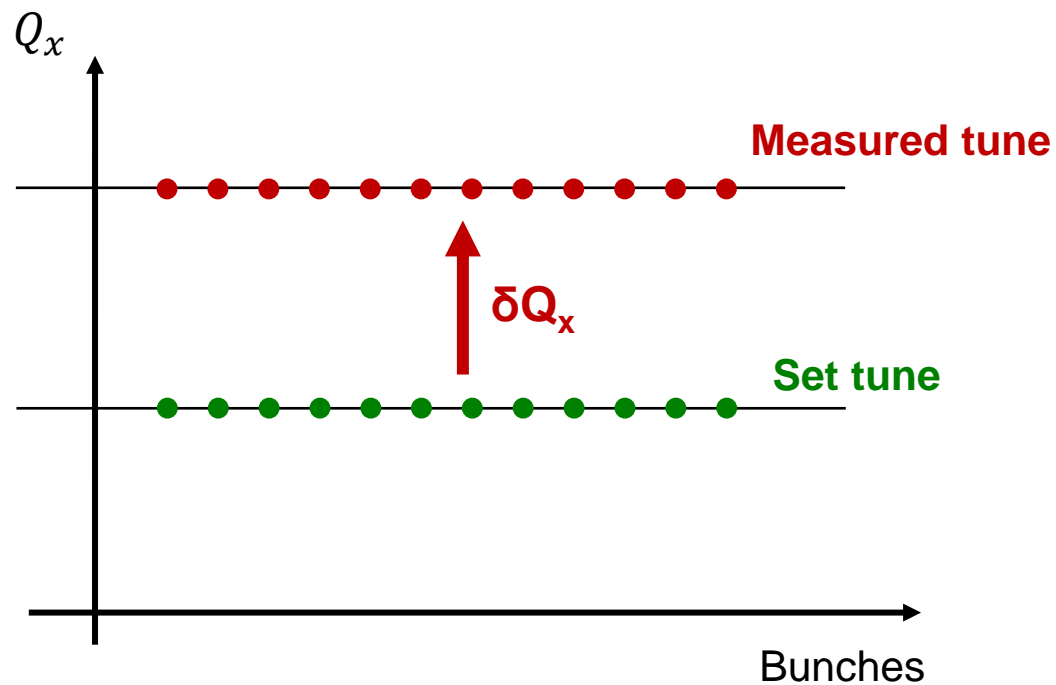
# Coherent tune-shift with intensity



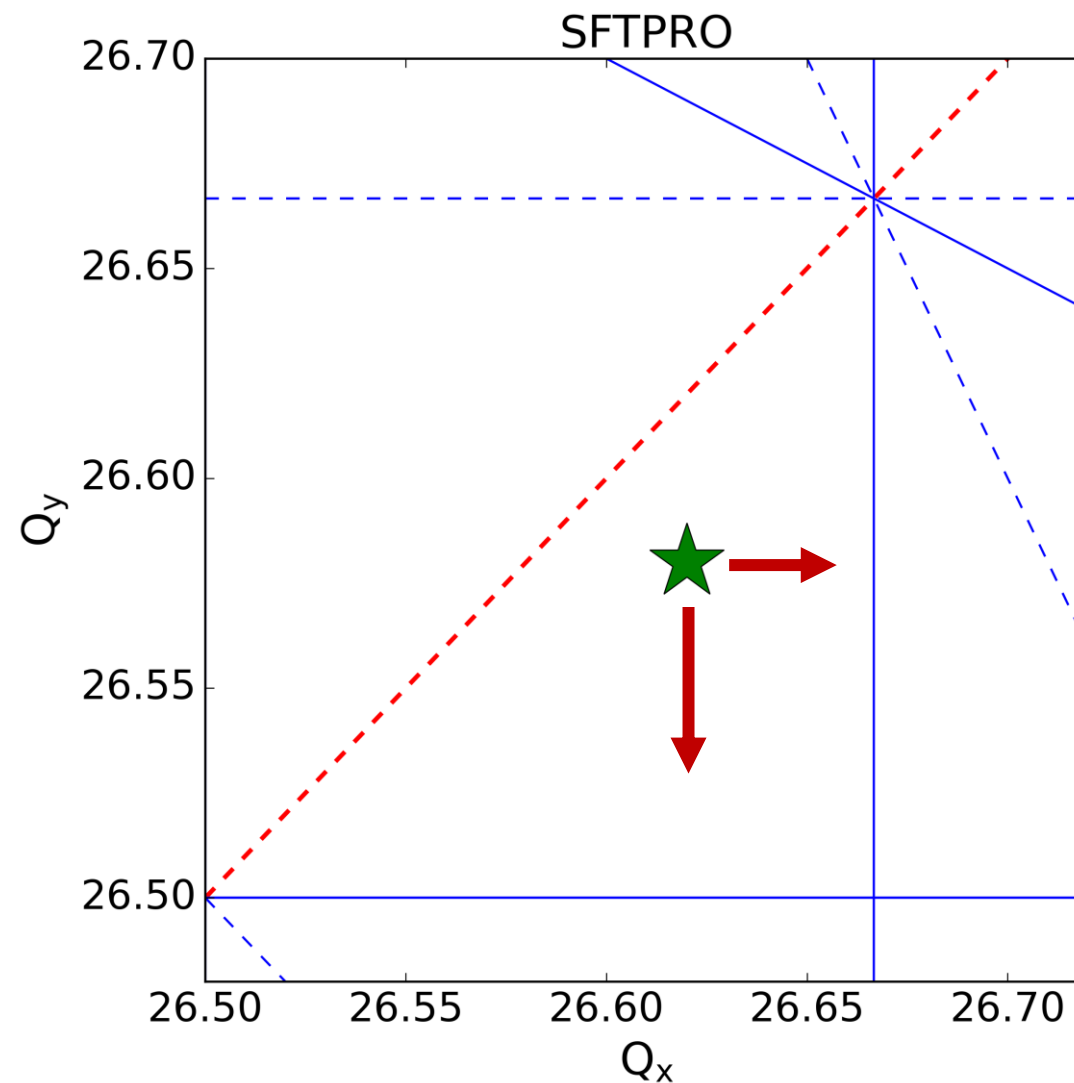
Total tune shift = single-bunch tune shift  
+ multi-bunch multi-turn tune shift



# Coherent tune-shift with intensity

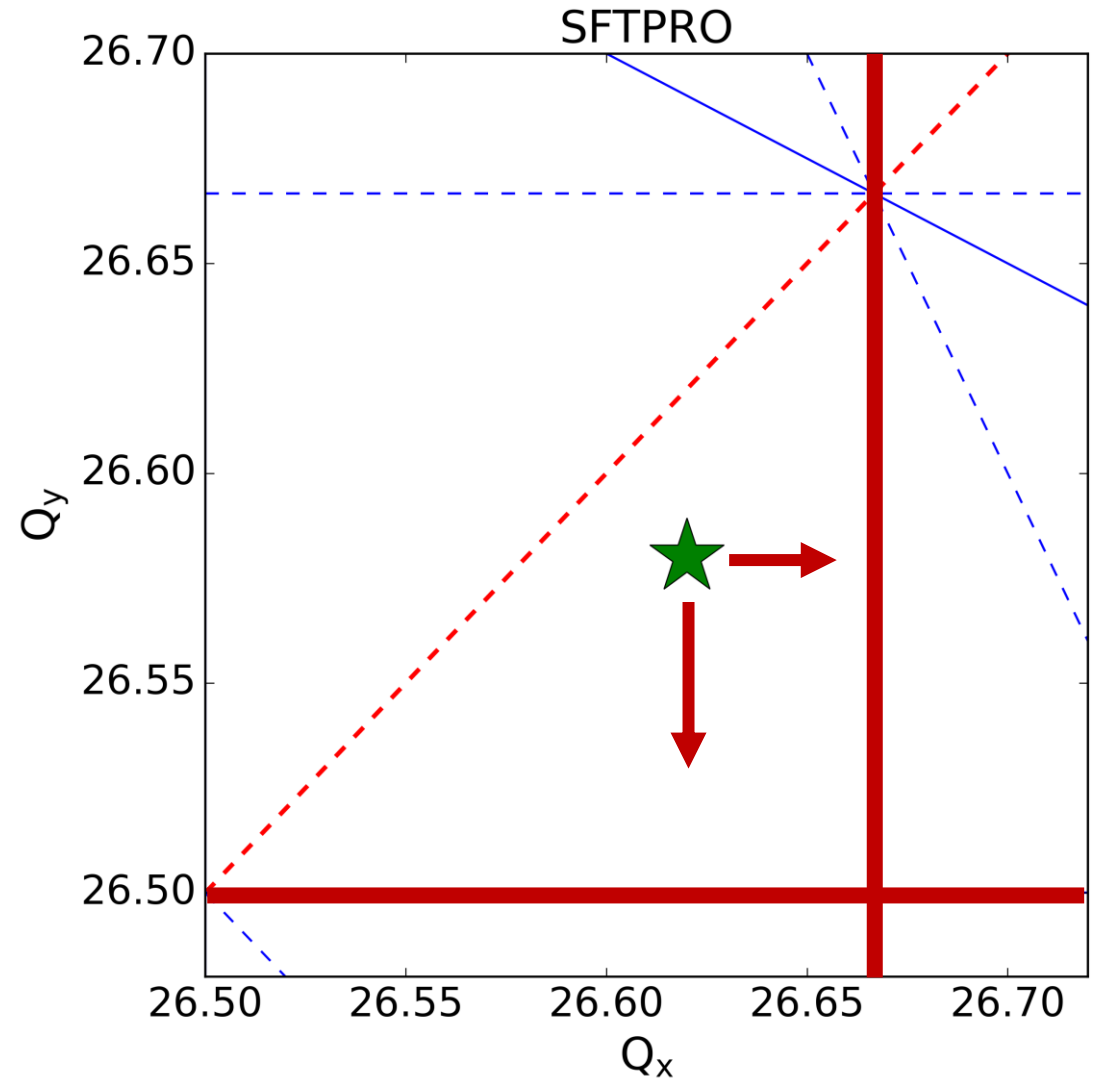


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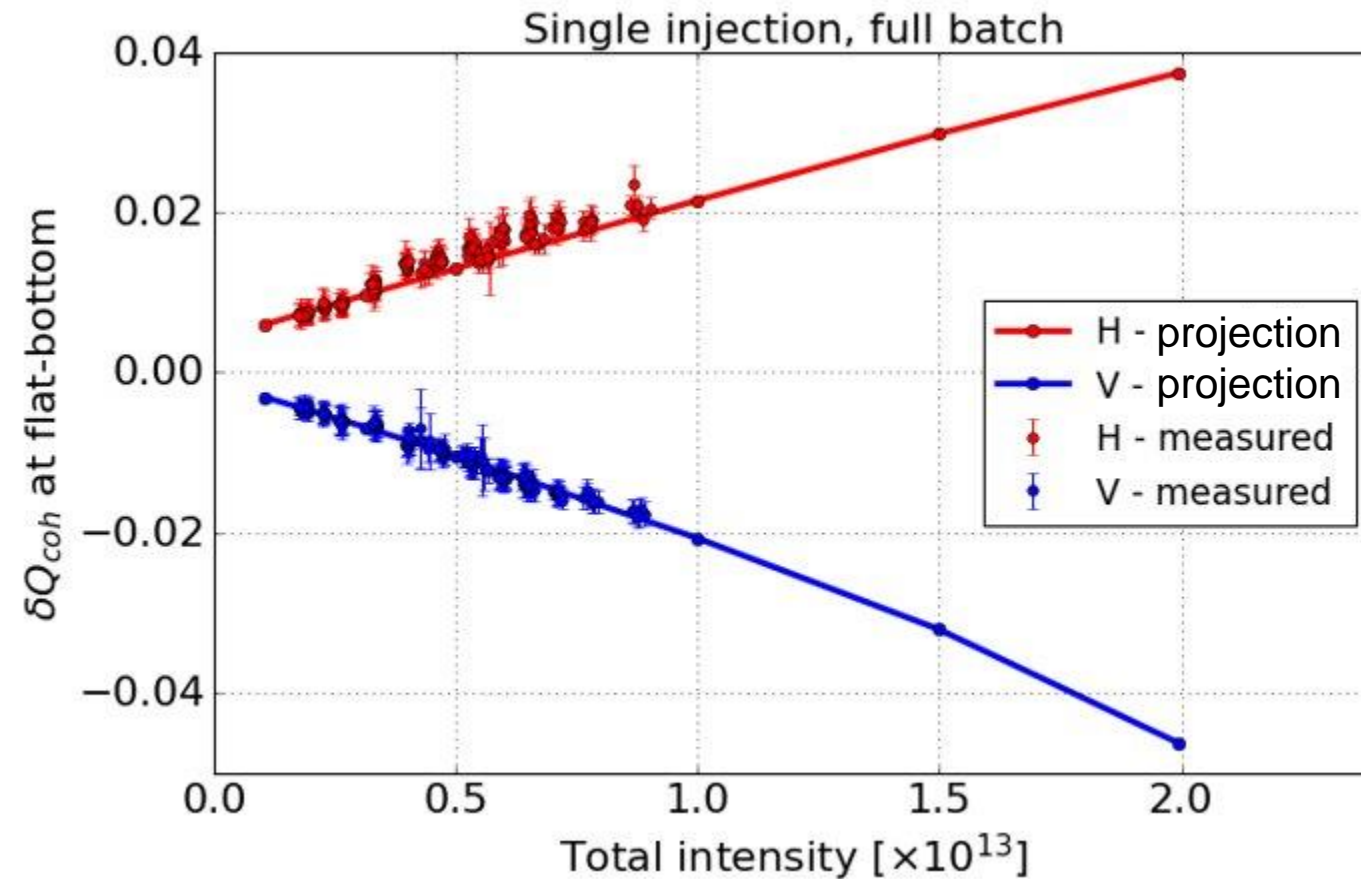
# Coherent tune-shift with intensity

- Coherent tune-shift can **drive the beam to resonances** – half-integer in the vertical plane and 3<sup>rd</sup> order resonance in the horizontal plane.
- Tune-shift depends on:
  - Intensity per bunch (i.e. total intensity – very important at SHiP regimes).
  - Number of bunches (i.e. number of injections).
  - Energy (i.e. dynamically changes during ramp).



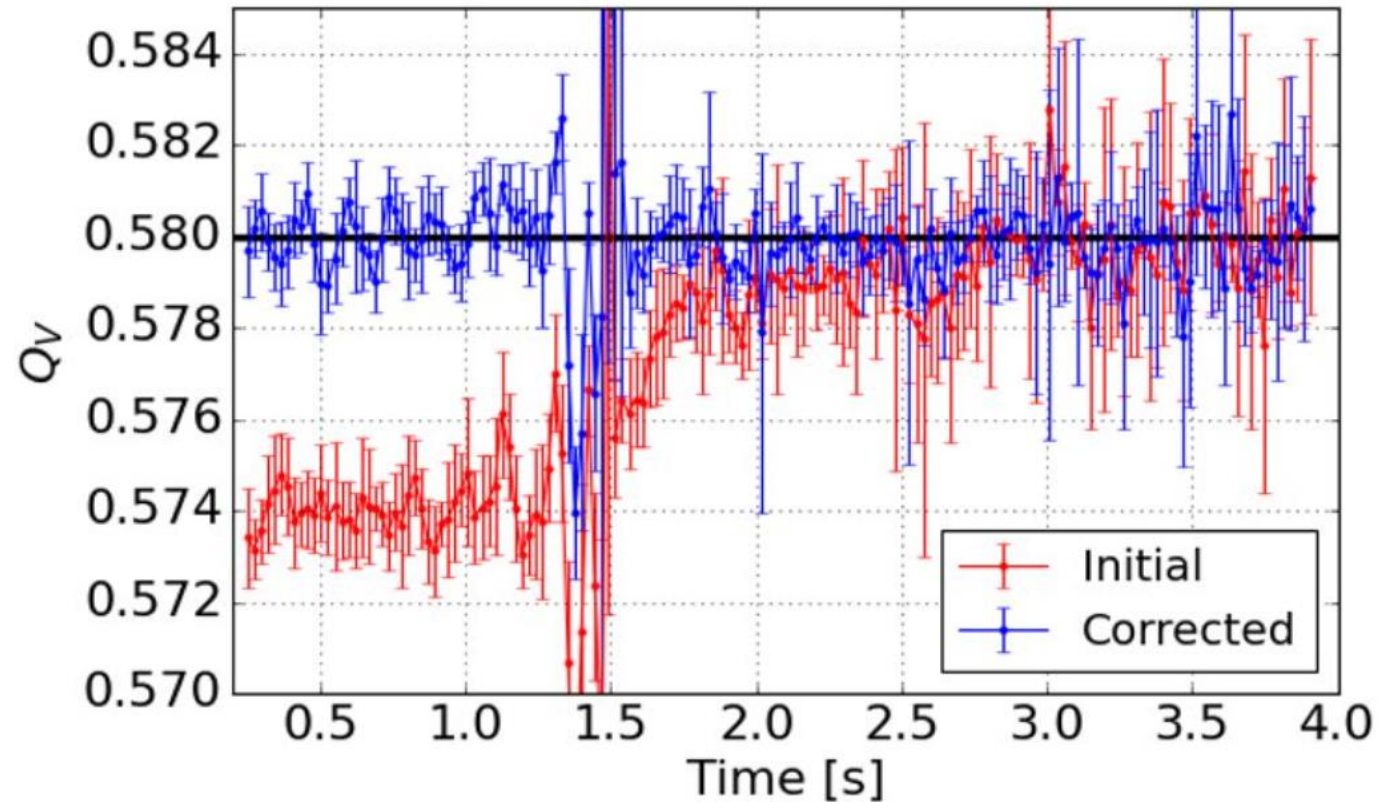
# (Some) MD results from 2024

Measured coherent tune-shift with intensity and energy at SPS cycle for single injection.



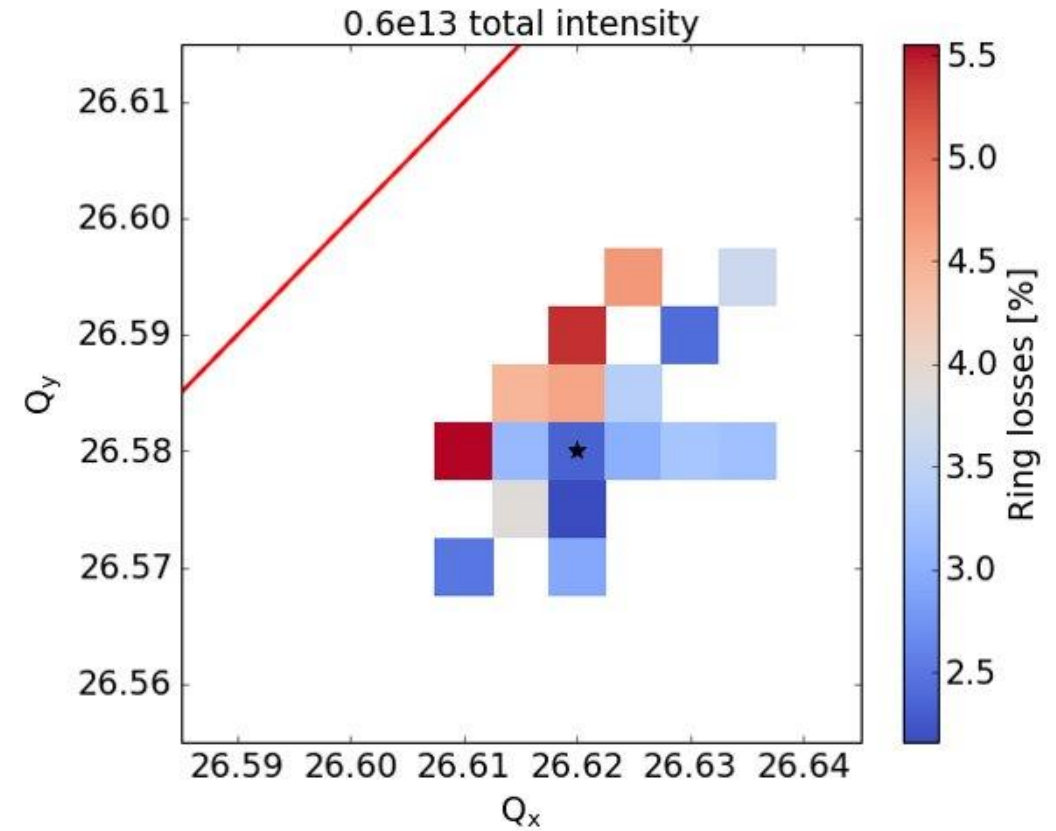
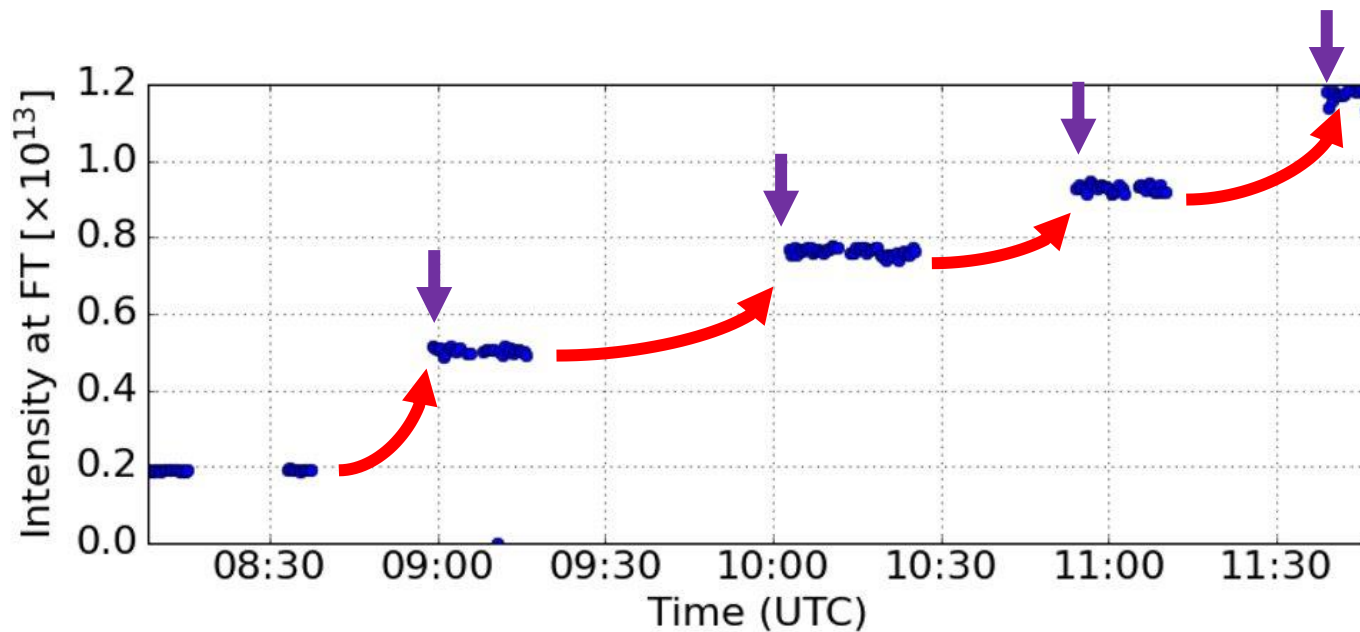
# (Some) MD results from 2024

Prepared energy and intensity dependent **tune correction functions**  
(like Laslett corrections in LHC beams).



# (Some) MD results from 2024

Started working on beam **intensity ramp** (using the **tune correction**)  
& **identifying optimal working points**.



# MD goals and wishes for 2025

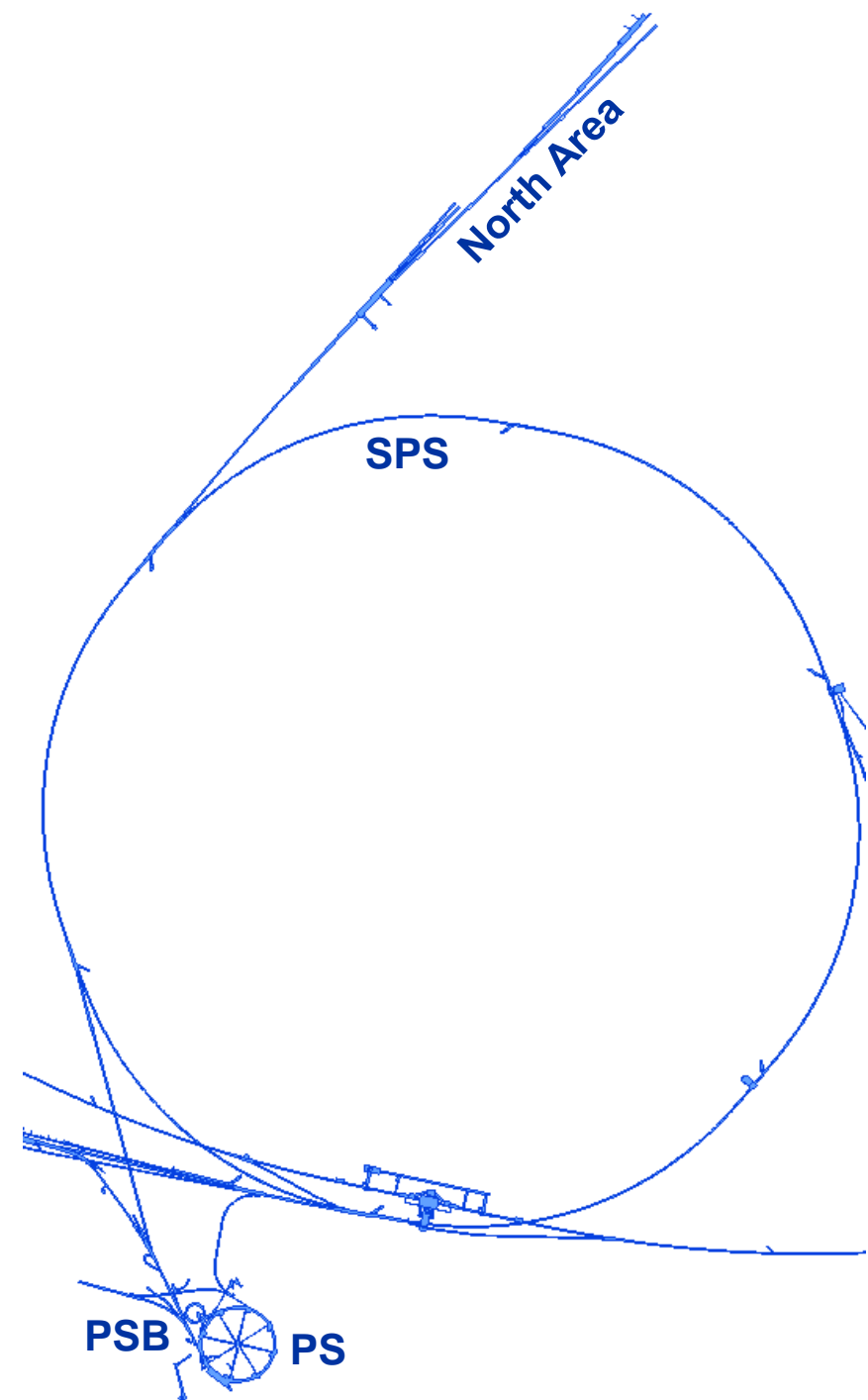
## Goals for 2025

- Prepare Laslett-correction functions for the SHiP cycle.
- Finalize the working point optimization for all intensities.
- Continue intensity ramp-up to  $4.2 \times 10^{13}$  p/cycle and beyond.
- Test supercycle configurations with multiple, consecutive SHiP cycles.

## Wishes for 2025

- Maintain a sufficient number of short parallel MDs for the **intensity reach of SHiP** cycle and the **transmission studies** during PS-to-SPS transfer.
- A dedicated MD to test **future super-cycle configurations (in combination to hysteresis effects studies)**.

# Thank you!



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