

# TT20 / TT24 / P42 MDs

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3<sup>rd</sup> February 2025

# Summary

- 2024 Summary:
  - TT20 optics measurements
  - TT24 / P42 optics measurements
  - Wobbling
- 2025 Request:
  - Wobbling MD
  - Dedicated optics measurement with new transfer functions

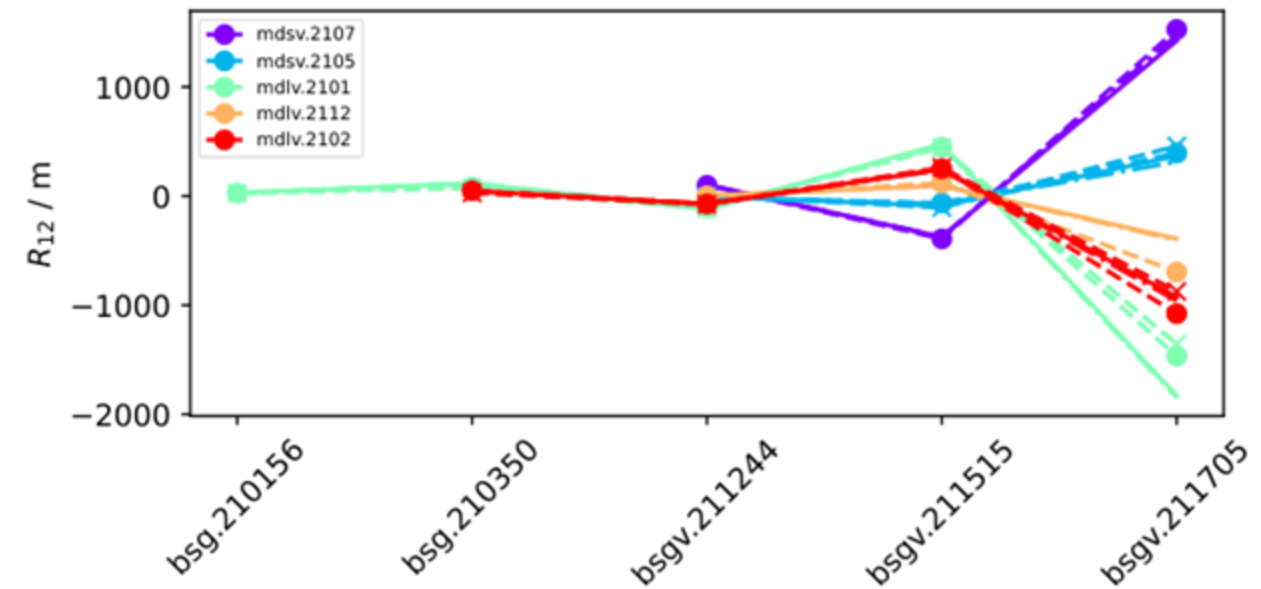
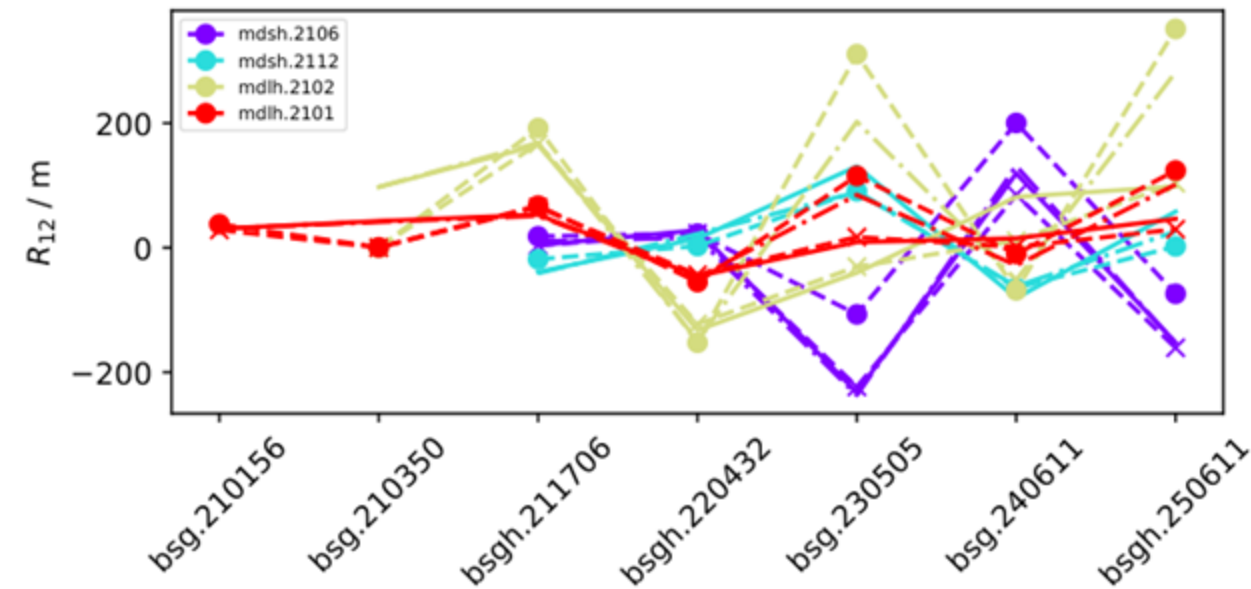
# TT20 Optics Measurements

- New TF tested both in simulations and with kick response measurements  $\Rightarrow$  can get very good agreement with data!
  - Improvement visible for all optics (still missing measurements on dedicated optics for SHiP  $\rightarrow$  only model)

## Legend:

- **Solid:** model
- **Dashed:** corrected model new TF
- **Dashed circles:** data with old TF
- **Dashed with crosses:** data with new TF

## Qsplit



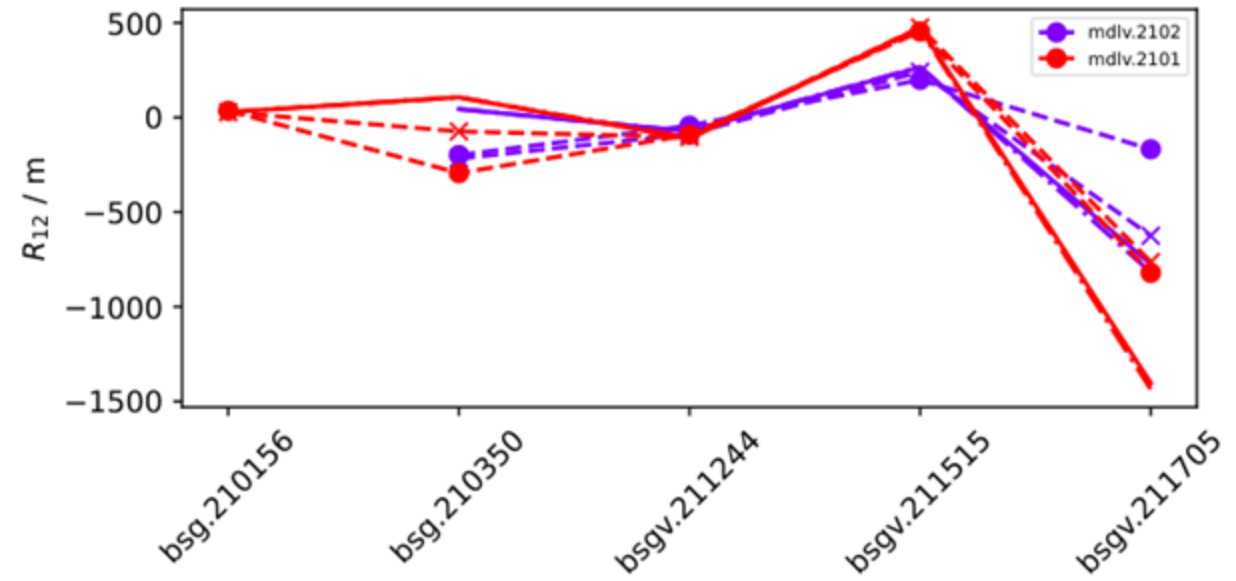
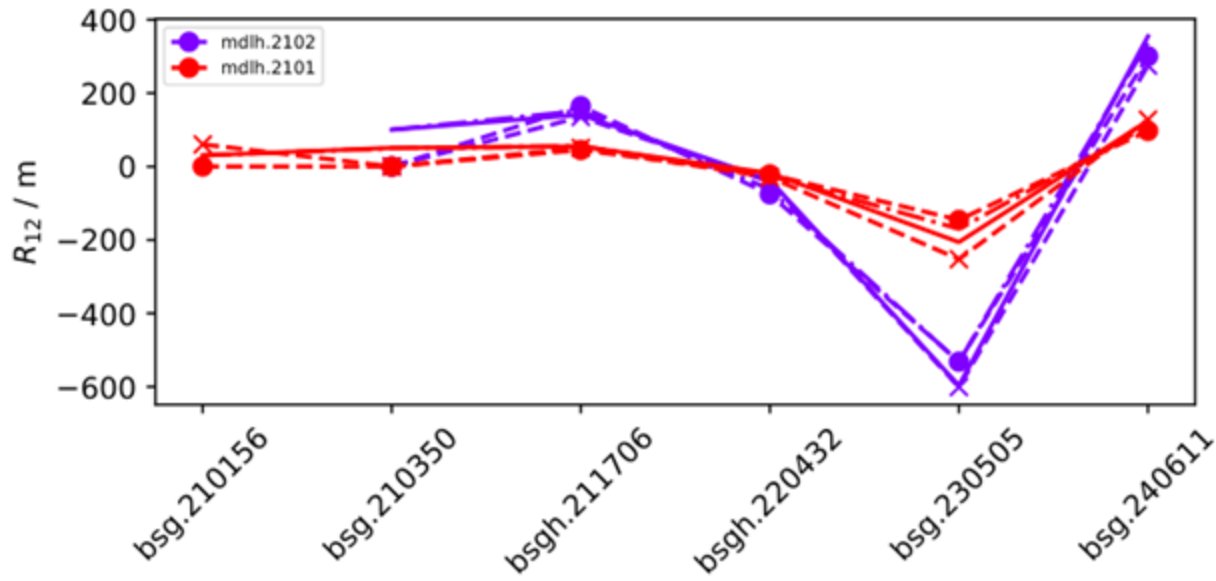
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## NoQsplit

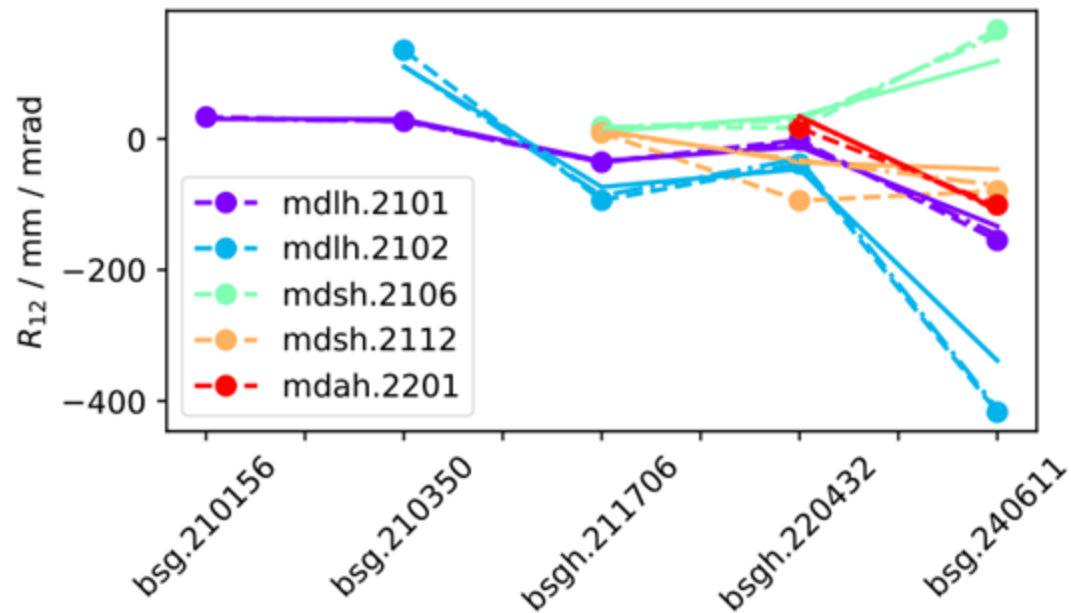


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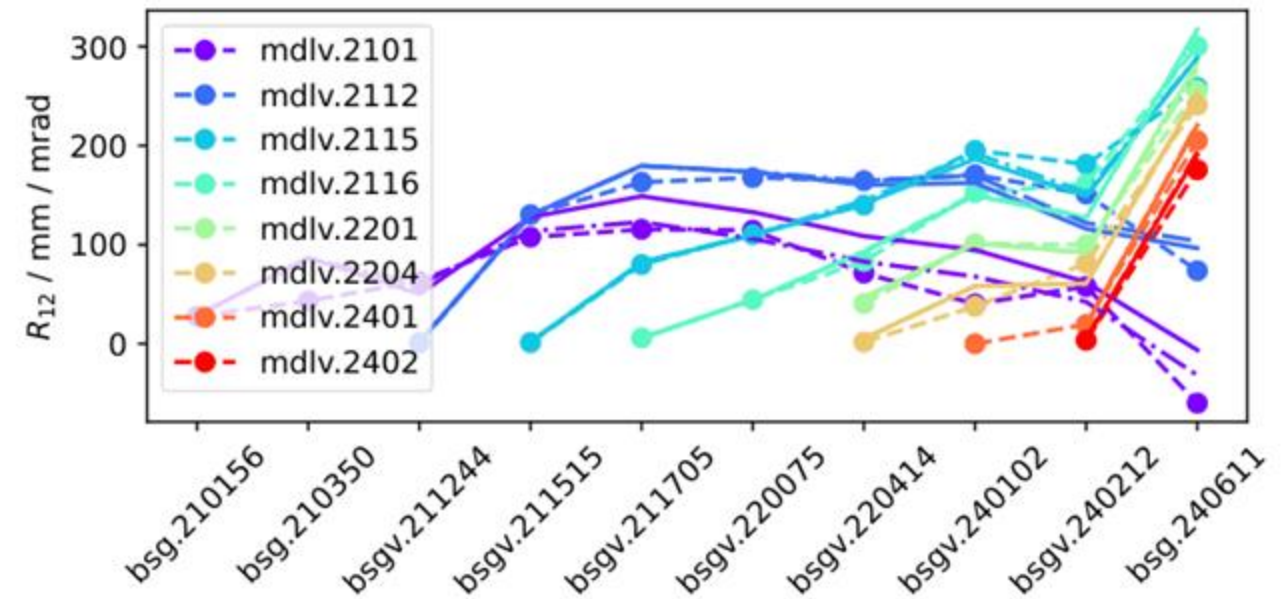
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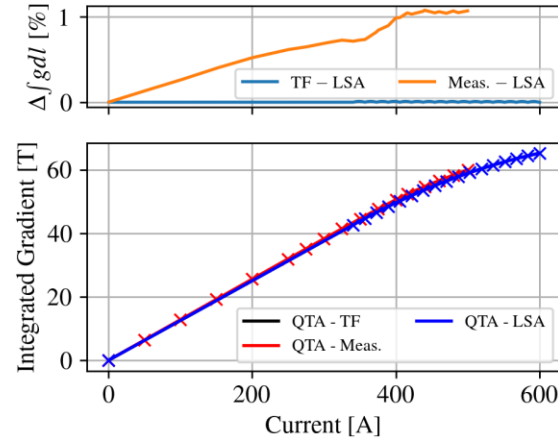
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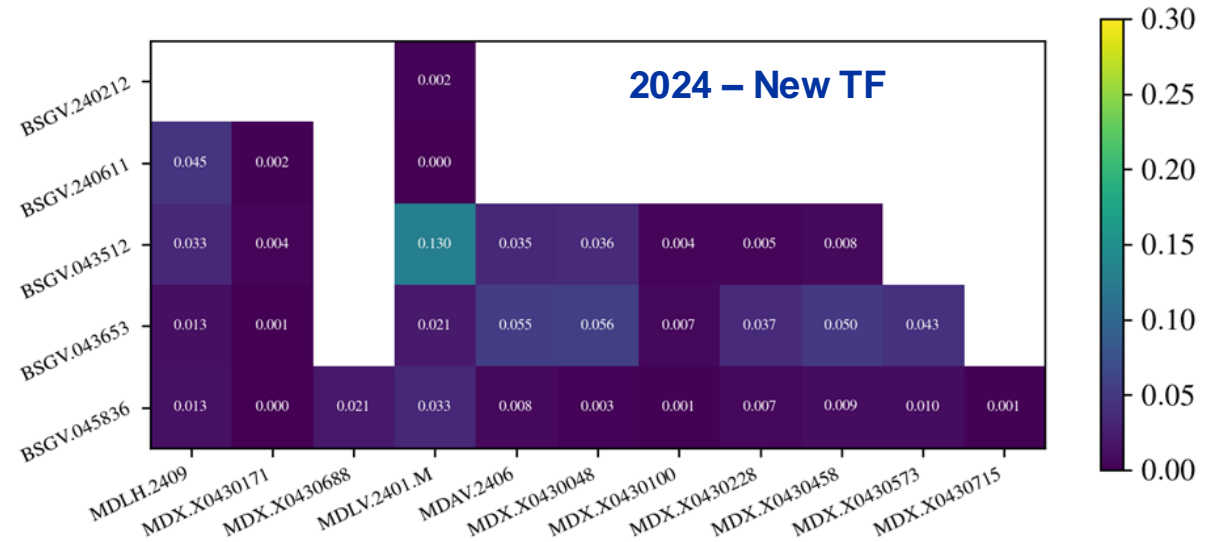
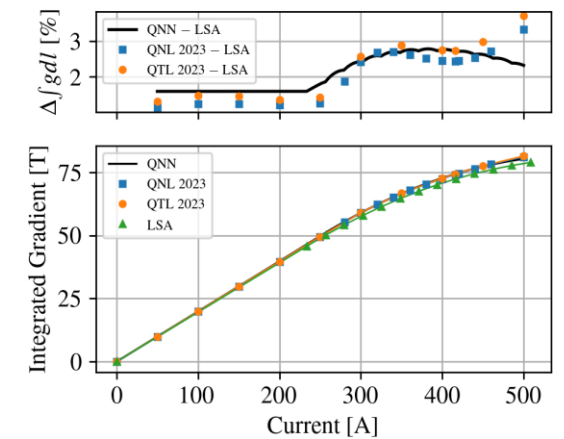
# TT24-P42 Optics – Kick Response

- Study in 2023 showed errors mostly in TT24
  - QTL, QNL, QTA magnet transfer function error
- New Magnet Transfer functions measured
- Further kick response studies in 2024
- With shared optics: P42 only
  - Confirming good agreement with design
- With dedicated optics: TT24 + P42
  - Optics much closer to model

QTA measurements



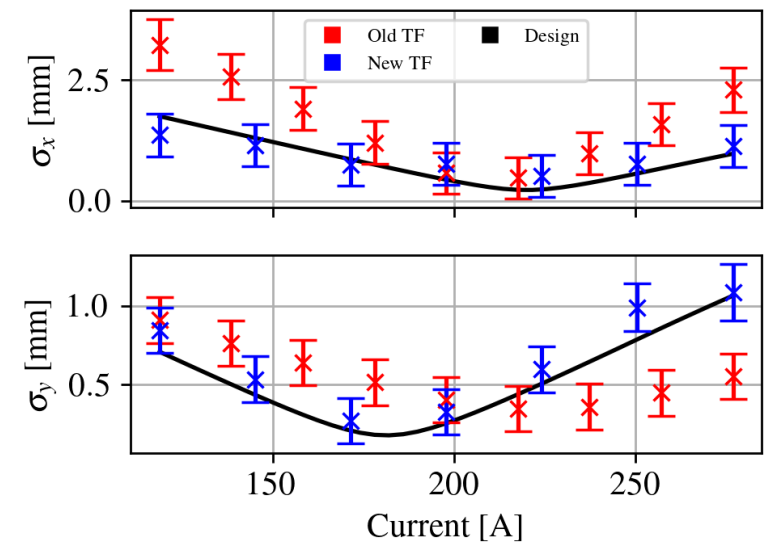
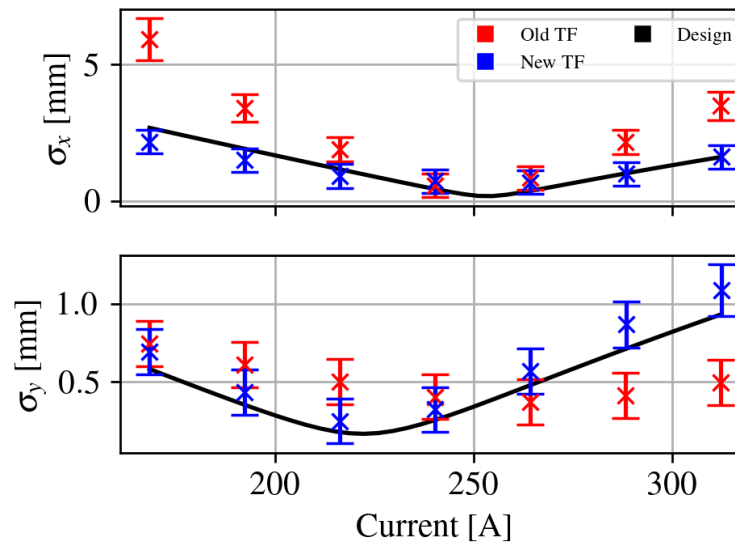
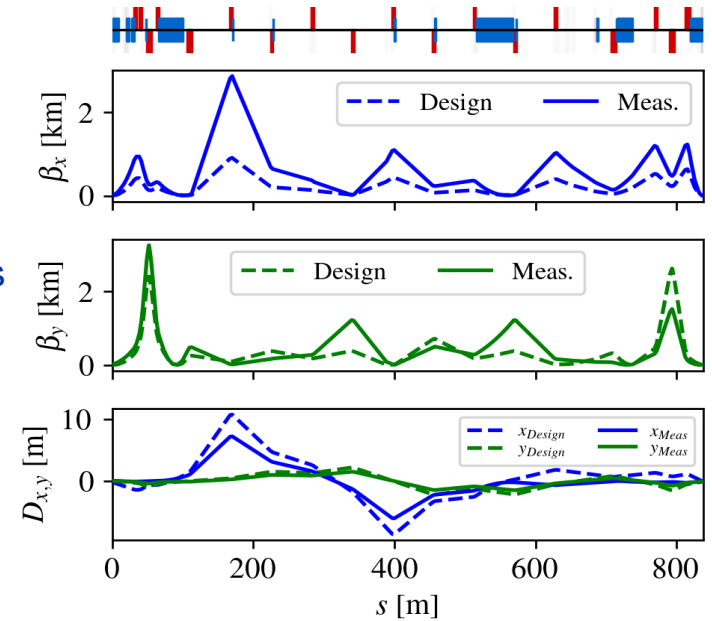
QTL-QNL measurements



# TT24-P42 Optics – Quad Scan

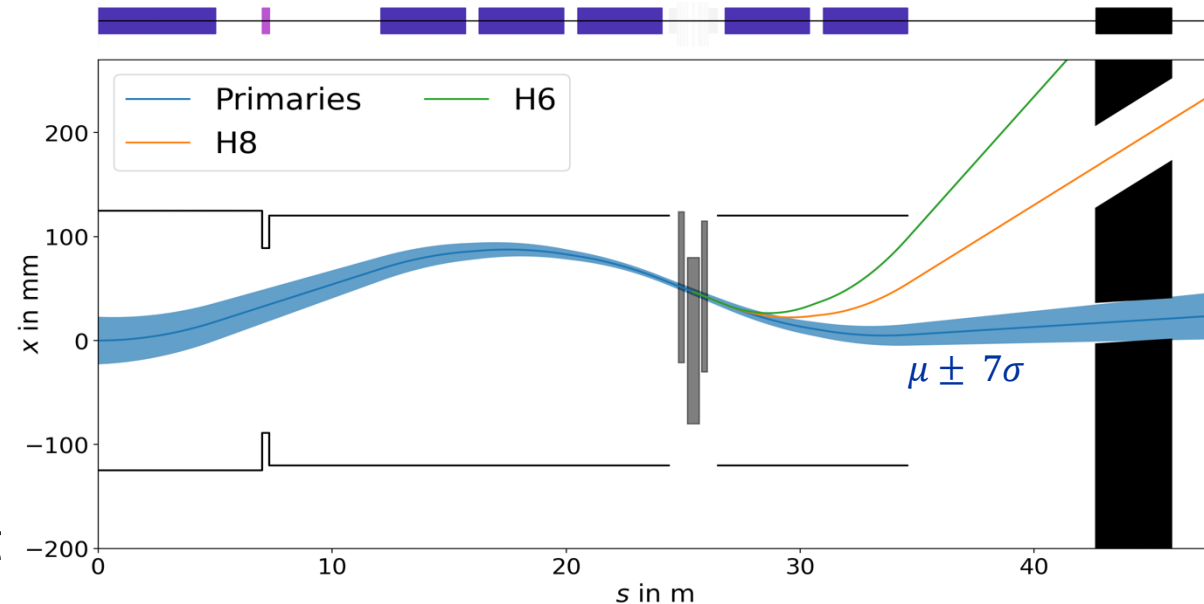
- Quad scan performed fitting initial conditions at T4 with dedicated optics
  - 2023 showed big discrepancy to model
  - Caused by TF issue across TT20
  - Profiles on some grids too large to measure size
- New TF tested in 2024
- Quad scan shows much better agreement with model
- Beam profile can be measured with all monitors

Actual optics vs design 2023



# T4 Wobbling MD 17.07.2024

- With the wobbling, we bend the beam significantly to generate offsets at T4 of the order of 3 cm for generating secondary beams
  - we typically change from one side to another  $\sim 15x$  / year
- Each change requires re-steering in P42
- Goal for HI-ECN3 is to make these transparent
- During the MD, we tested different wobbling settings based on different calculations to find the source of the changes in P42
  - Difficult to disentangle the effect of the wobbling and the auto-steering in T4 (wobbling change requires movement of TBIU and TBID)  $\rightarrow$  We took measurements for fixed wobbling with and without auto-pilot
- Simultaneously, measured sources of muons to EHN1 vs. target length. Found muons are well-correlated with targets - but disagrees with operational difficulties earlier in year.





# T4 Wobbling MD Request for 2025

- Goal is to ensure T4 wobbling is passive to P42 as practice for BDF/SHiP operation
- Look for small changes in orbit but will frequently inhibit extraction → request **dedicated MD**
- Repeat of last year's measurement with new transfer functions, hysteresis compensation, better control over auto-steering
  - Auto-steering reacts on measurement of the split foils → TBIU and TBID need to be moved to the horizontal position corresponding to the horizontal beam position of the split foils
  - Hysteresis isn't accounted for, but we need to switch polarities of the wobbling magnets to achieve positive or negative secondary beams in H6 and H8
  - Recent measurements of the hysteresis of the MTNs imply percent-level differences to a degaussed magnet (up to  $70\mu\text{rad}$  for  $400\text{GeV}/c$ )
  - Transfer function for MTNs has been measured, too - up to  $50\mu\text{rad}$  for  $400\text{GeV}/c$
- Different wobbling also imply different dispersion at T4 → simultaneous measurement of dispersion in T4 / P42 (for input to dispersion-dominated losses downstream)

# HI-ECN3 Dedicated Optics Request

- Request 1x day MD to complete dedicated optics measurements throughout TT20 → P42
  - kick responses and quad scans
- Will repeat some measurements with new TFs and validate



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