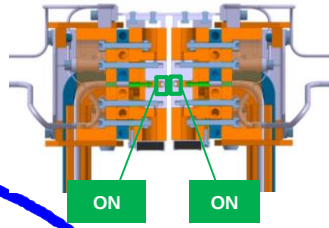
Short introduction on wire compensation in RUN3

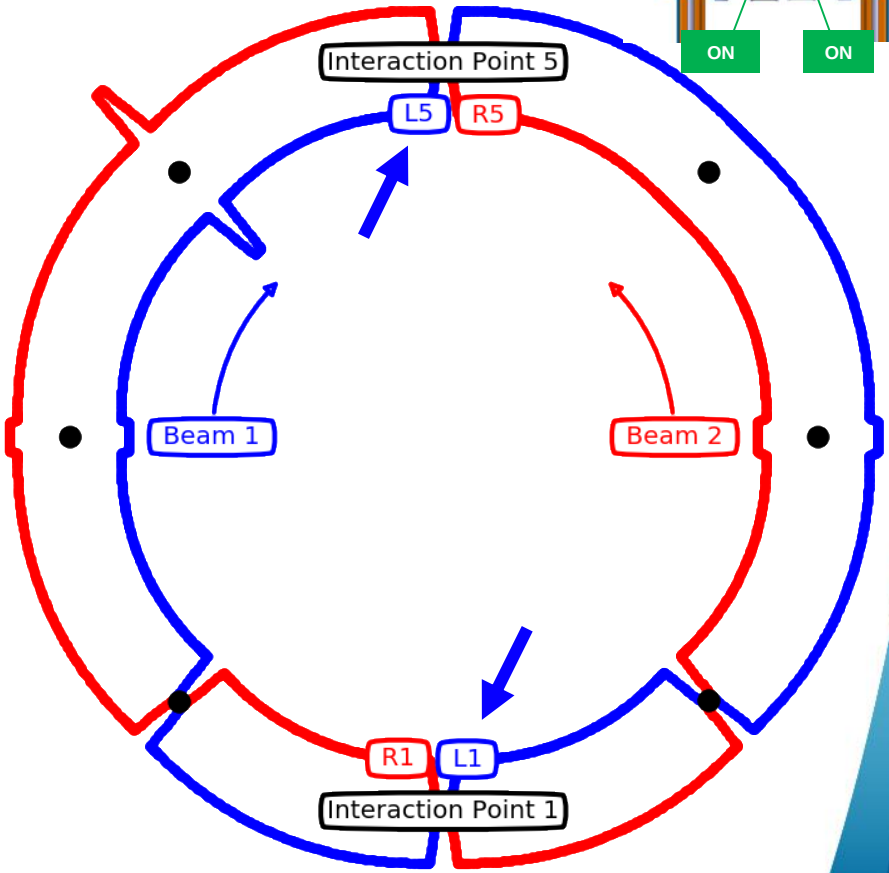
G. Sterbini, S. Fartoukh, N. Karastathis, S. Koustoglou, S. Papadopoulous, Y. Papaphilippou, A. Poyet, A. Rossi and K. Skoufaris, M. Solfaroli on behalf of the HL-LHC wire compensation team.

7th February 2020, ***https://indico.cern.ch/event/884998/***

Run3 and wires demonstrators

- Following Run2 encouraging results, it was proposed
  - **to equip also the Beam 1** with wires.
  - **to use the wires routinely** during the Run3. **Fasibility/limit still under discussion (with OP, machine protections, collimations…)**





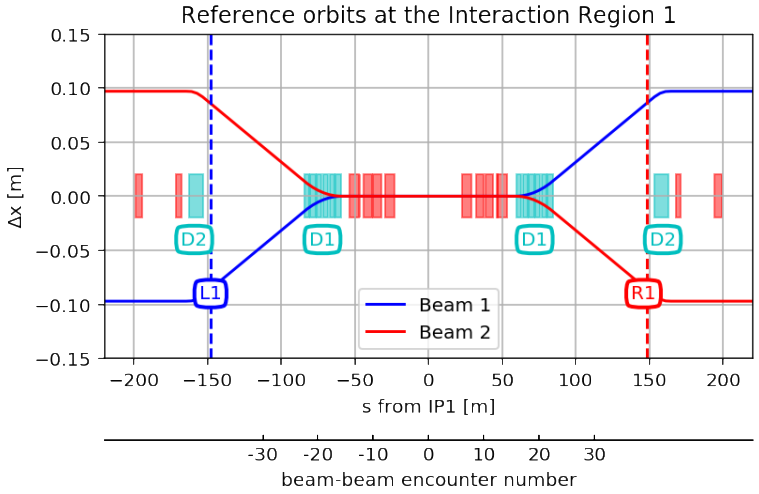
ECR https://edms.cern.ch/ui/file/2054712/1.0/LHC-TC-EC-0019-1-0.pdf

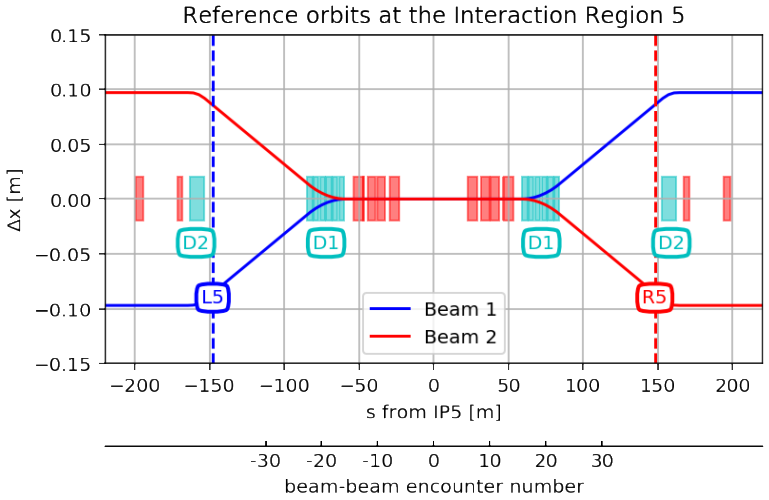
MPP https://indico.cern.ch/event/808988/

LBOC, https://indico.cern.ch/event/863458/

LHC MD DAY, https://indico.cern.ch/event/867177/

Run3 and wires demonstrators

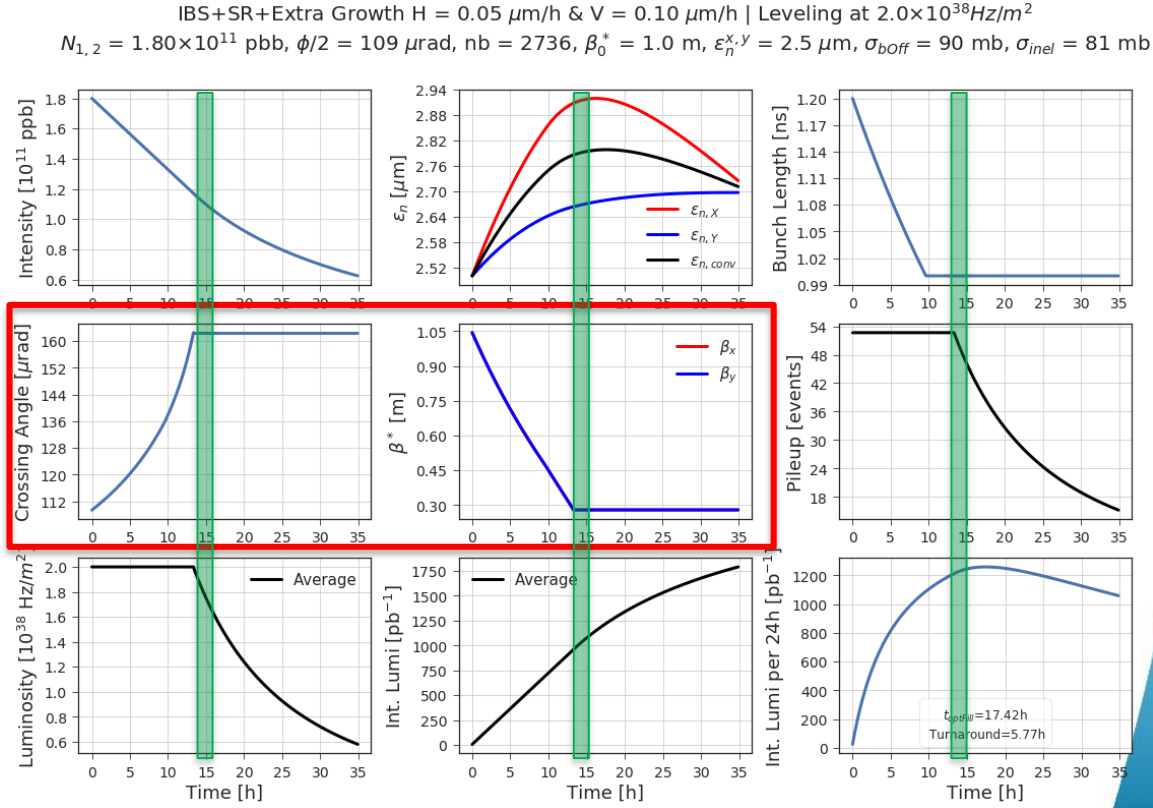




BEAM	IR	S from IP [m]	NAME	Power Converter
BEAM 1	IR1	-145.945	TCTPV.4L1.B1	RPMC.UL14.RBBCW.L1B1
BEAM 1	IR5	-147.945	TCTPH.4L5.B1	RPMC.USC55.RBBCW.L5B1
BEAM 2	IR1	145.945	TCTPV.4R1.B2	RPMC.UL16.RBBCW.R1B2
BEAM 2	IR5	147.945	TCTPH.4R5.B2	RPMC.UL557.RBBCW.R5B2

Run3 Fill Profile (2021-23)

- In 2021: **round optics** with IP1 crossing in V-plane and IP5 crossing in H-plane.
- The wires could be switched on at the end of the leveling.
- We assume Run3 collimation settings similar to Run2 ones.



Courtesy of S. Fartoukh and N. Karastathis

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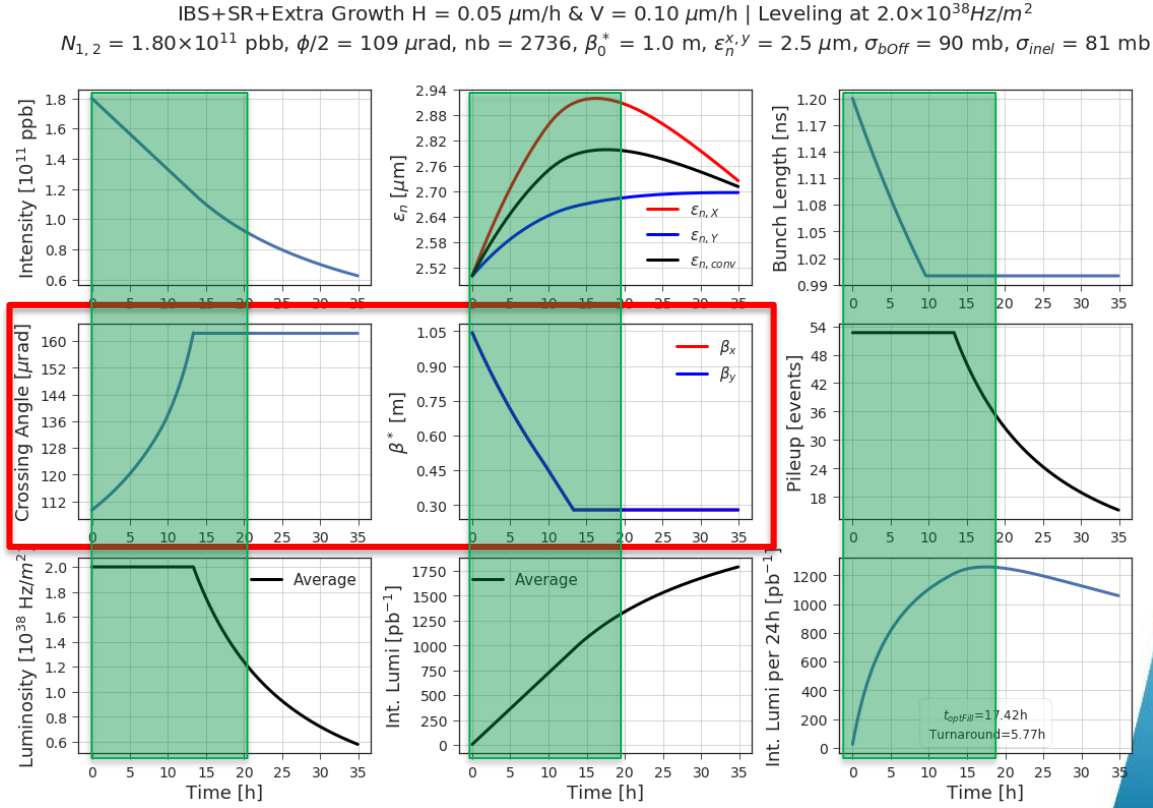
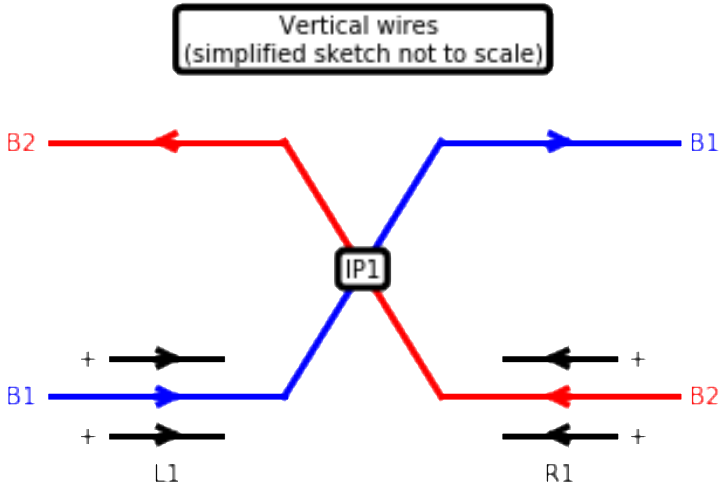
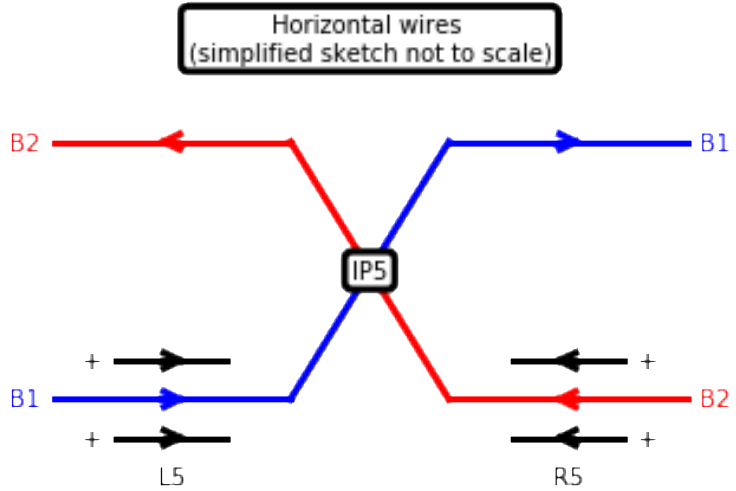


Courtesy of S. Fartoukh and N. Karastathis

Rune3 and wires demonstrators

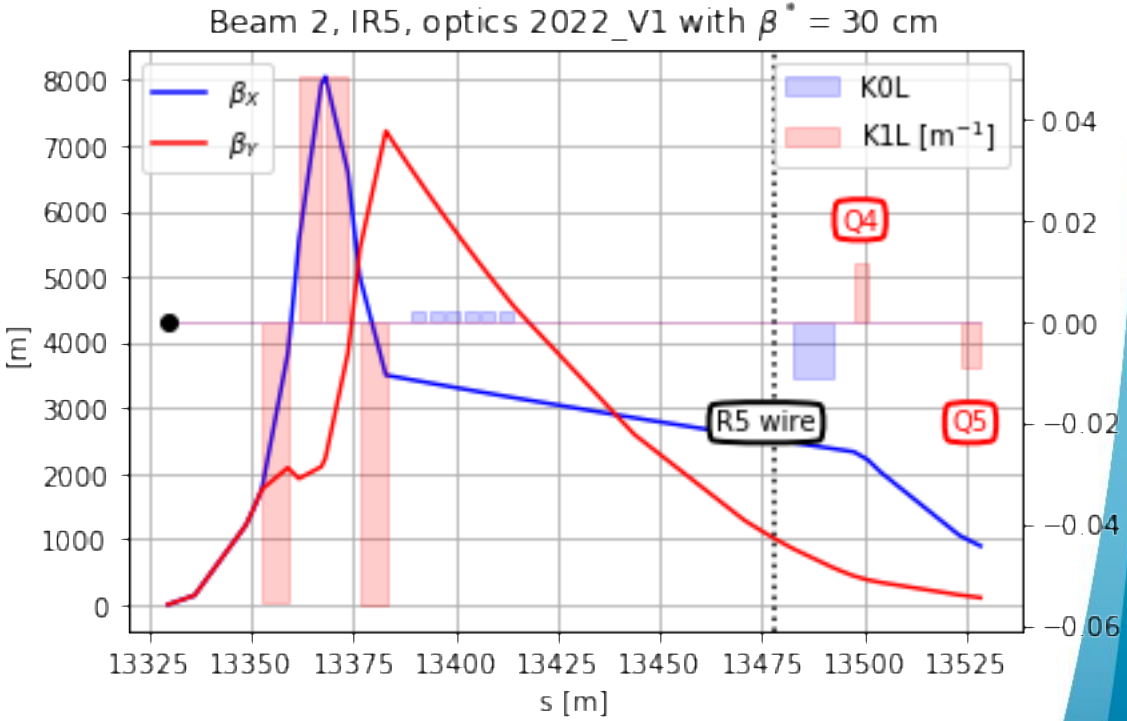




- **Left wires** on B1 and **right wires** on B2.
- Assuming tertiary at 8.5 σ (ε=3.5 μm) and 7 TeV machine (for β*=30 cm with 2022_V1 optics): wires at 9-12 mm from the beam. **Induced tune shift up to 1.4e-2!**
- **→correction is needed (Q-feedforward)**

Q- feedforward

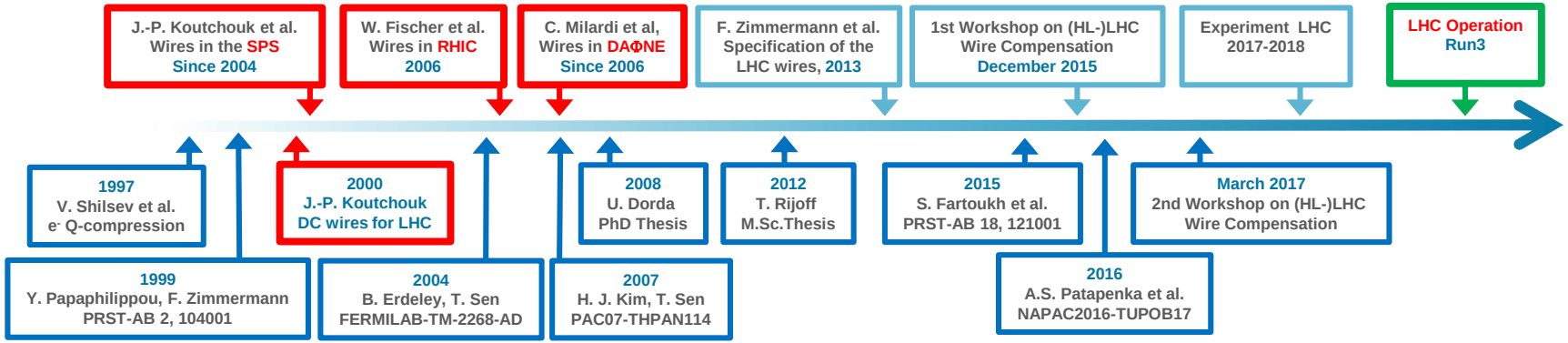
- IF the beam/wire are aligned, no effect of the Closed Orbit → no CO-feedforward (there is always a CO-feedback).
- In Run2 we used the Q4 and Q5 for the Q-feedforward.
- Axel is looking for the best Q-feedforward strategy in Run3.
- The Q4/Q5 are not supposed to be “trimmed” on-line during operation (like the arc trim quads): this will have implication on the use of the wire.



Failure scenarios under studies

- Overheating of the wires
  - → interlocks (see Adriana's presentation)
- Failure of the wires converters
  - → interlocks (see Adriana's presentation)
- Drift of the converters
  - → phase interlock (to be discussed with OP and MPP)

Thank you for the attention.



On behalf of the HL-LHC wire compensation team

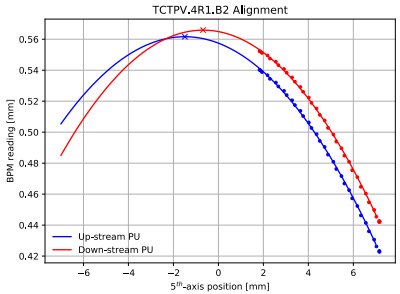
D. Amorim, G. Arduini, H. Bartosik, A. Bertarelli, R. Bruce, X. Buffat, L. Carver, C. Castro, G. Cattenoz, E. Effinger, S. Fartoukh, M. Fitterer, N. Fuster, M. Gasior, M. Gonzales, A. Gorzawski, G.-H. Hemelsoet, M. Hostettler, G. Iadarola, R. Jones, D. Kaltchev, K. Karastatis, S. Kostoglou, I. Lamas Garcia, T. Levens, A. Levichev, L. E. Medina, D. Mirarchi, J. Olexa, S. Papadopoulou, Y. Papaphilippou, D. Pellegrini, M. Pojer, L. Poncet, A. Poyet, S. Redaelli, A. Rossi, B. Salvachua, H. Schmickler, F. Schmidt, K. Skoufaris, M. Solfaroli, G. Sterbini, R. Tomas, G. Trad, A. Valishev, D. Valuch, J. Wenninger, C. Xu, C. Zamantzas, P. Zisopoulos and all participants to the design, production and commissioning of the wire compensator demonstrators.

BACKUP SLIDES

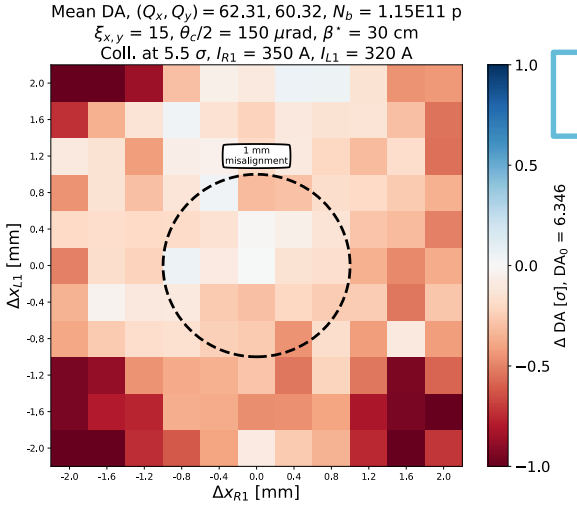
Effect of a 5th-axis misalignment

- After installing the wire prototypes in IR1, **a misalignment of the 5th-axis was observed (~2mm)** [4]
- The first MD was an opportunity to **measure** this misalignment and to **partially realign** the collimator during the following technical stop
- DA study was done to understand **the sensitivity** on this alignment
- **Below ~1mm** misalignment, the effect on DA is negligible
- Results obtained after the re-alignment showed that it had a beneficial effect (misalignment < 1mm)

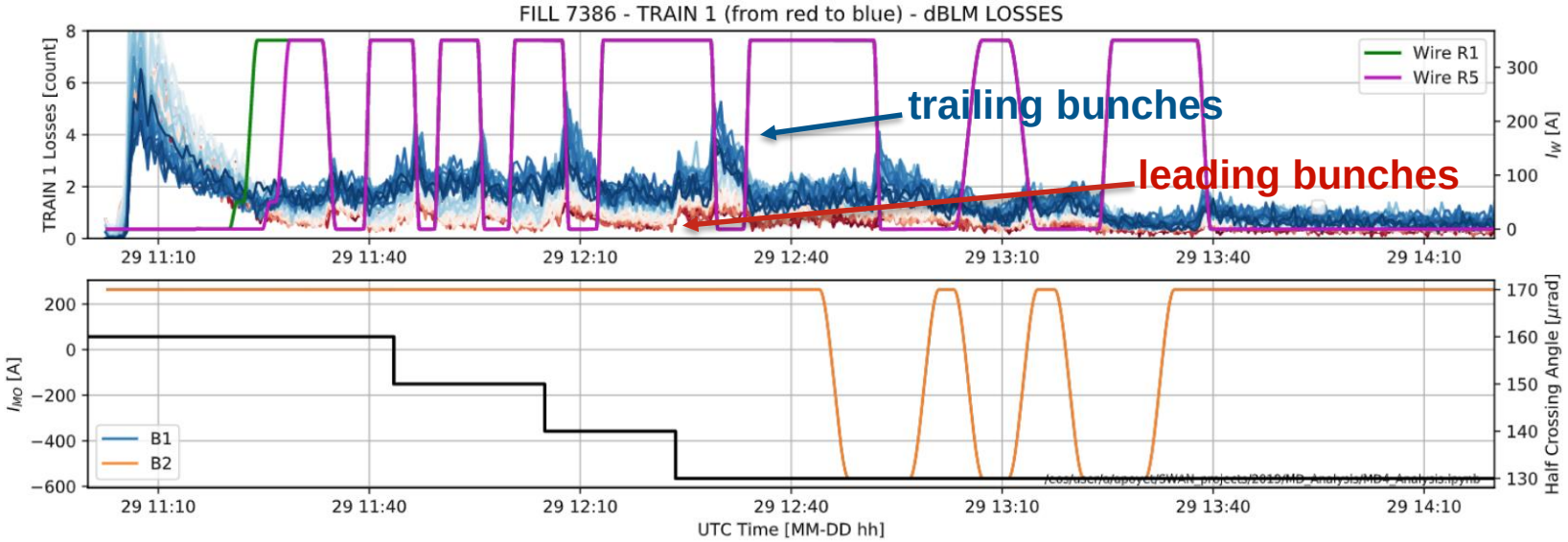
Alignment procedure during the MD



DA dependency on the misalignment



Bunch-by-bunch analysis (I)



- In the HI experiment the wire is more effective for the trailing bunches.

Bunch-by-bunch analysis (II)

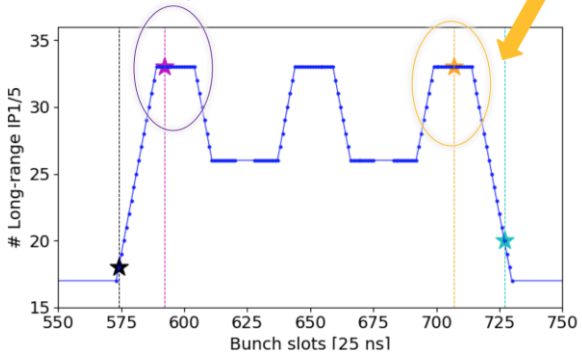
- Several observation during 2018 run showed indeed that the trailing bunches are the most critical in terms of losses.

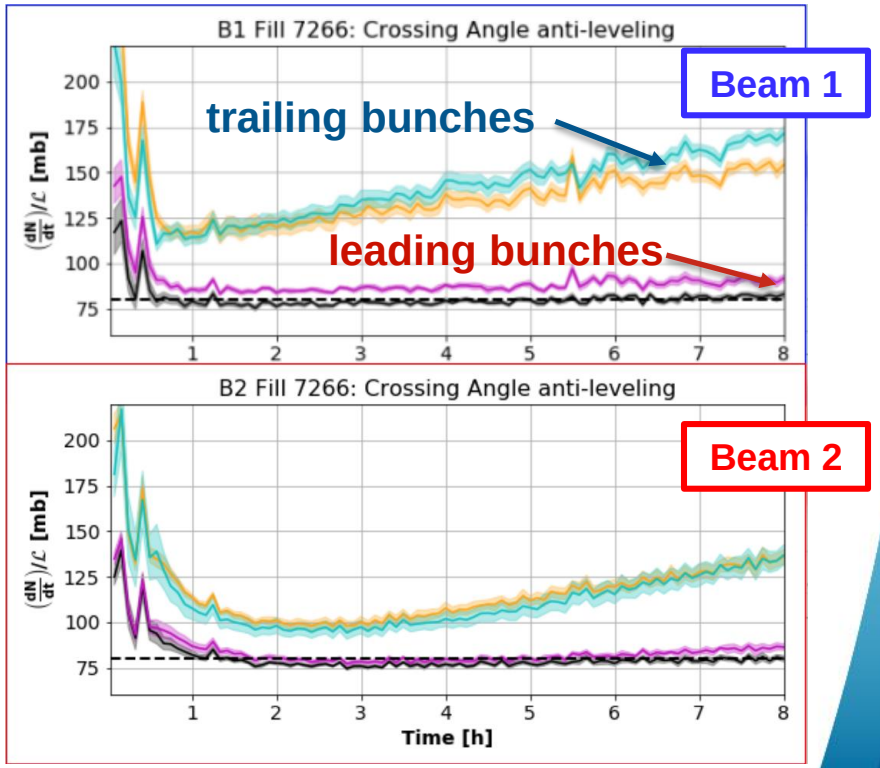
Classes:

I. NoBB
II. BB
III. BB-ecloud
IV. NoBB-ecloud

DA optimizations are based on **BB Class**

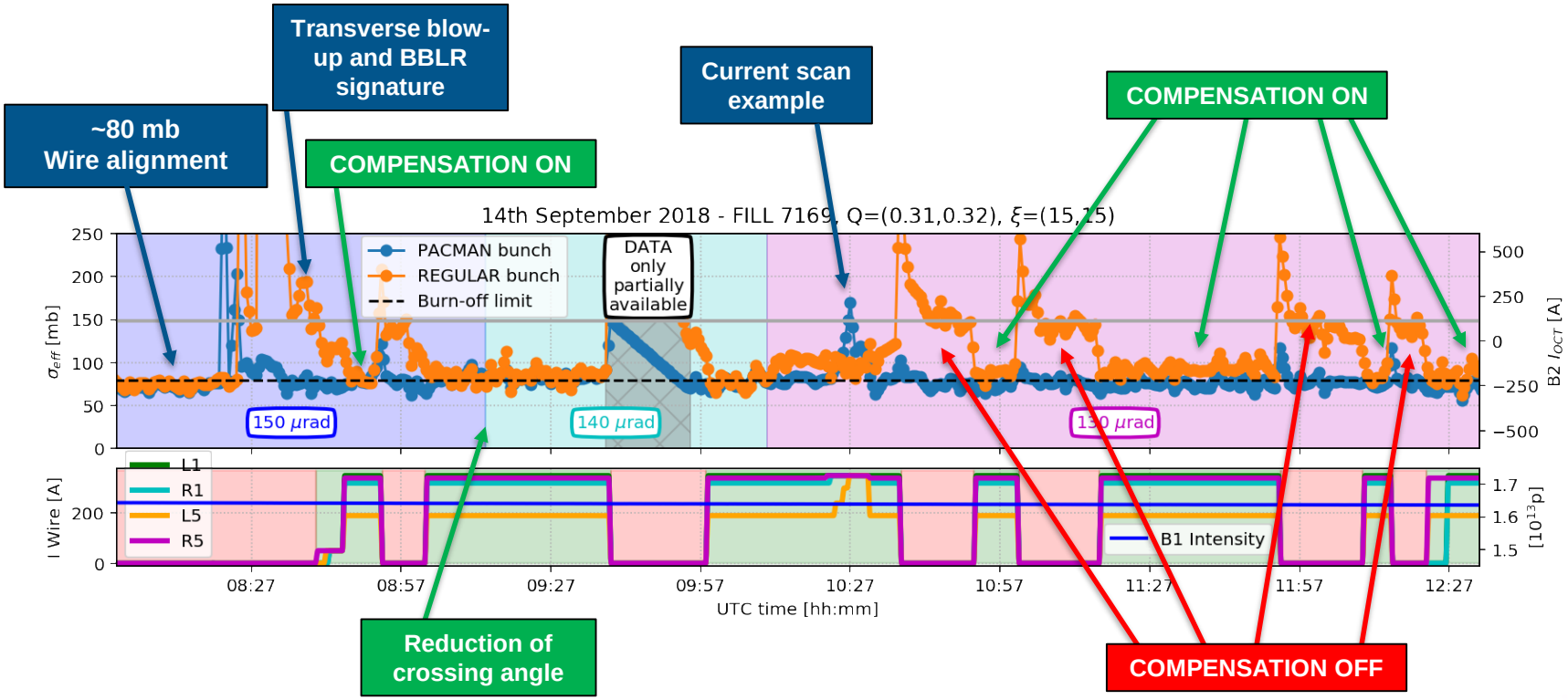
Applied on Class **BB-ecloud**





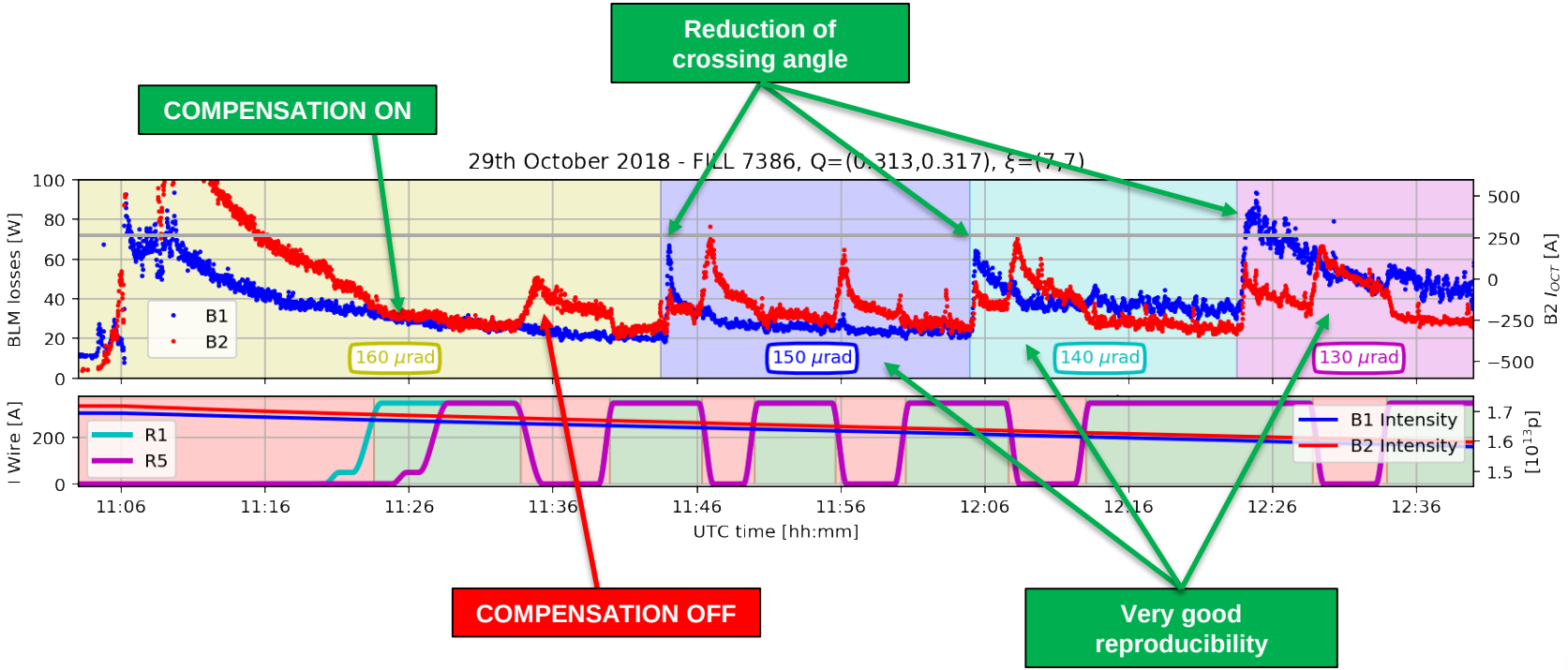
Courtesy of S. Kostoglou and S. Papadopoulous

Low-Intensity experiment



- **Almost full compensation, even at reduced crossing angle, for regular bunch whereas head-on bunch not degraded.**

HI experiment (operational conditions)



- **Compensation provides a reduction of B2 losses of ~20%.**