



Project Progress Review (PPR) 4-2026

WP- 02

Présenté par: A. Fomin

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29 Mai 2026



Outline

PERLE Lattice

- Current status + Remaining issue

Beam dynamics studies

- PERLE representation at IPAC'26
- Current status of BD studies and next steps
- Participation in cERL commissioning in 2026

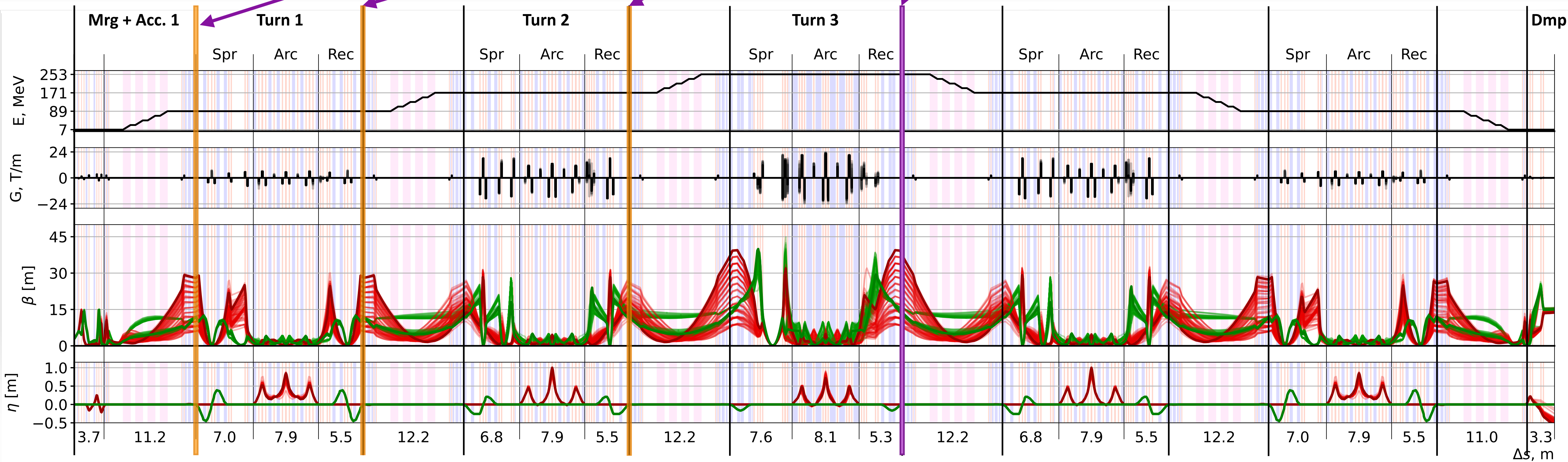
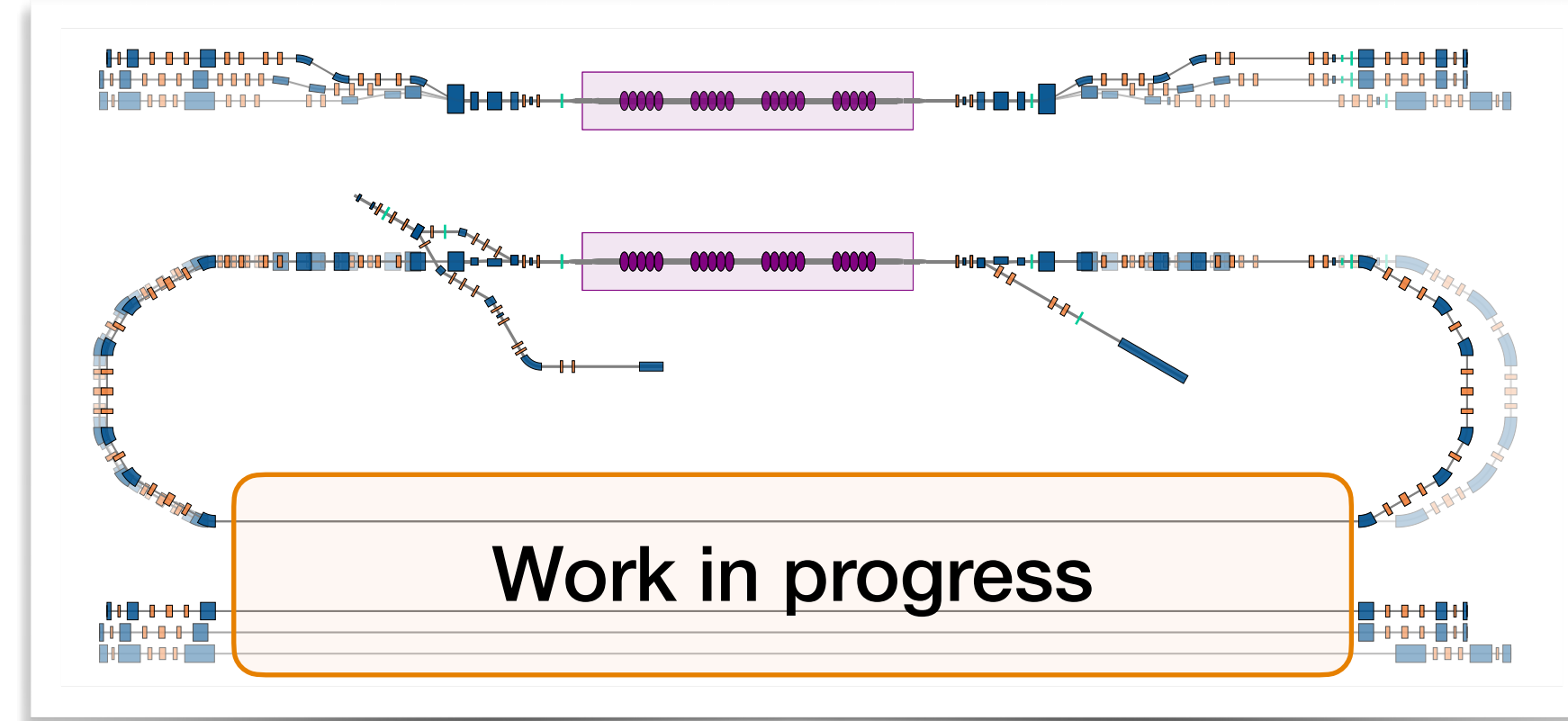
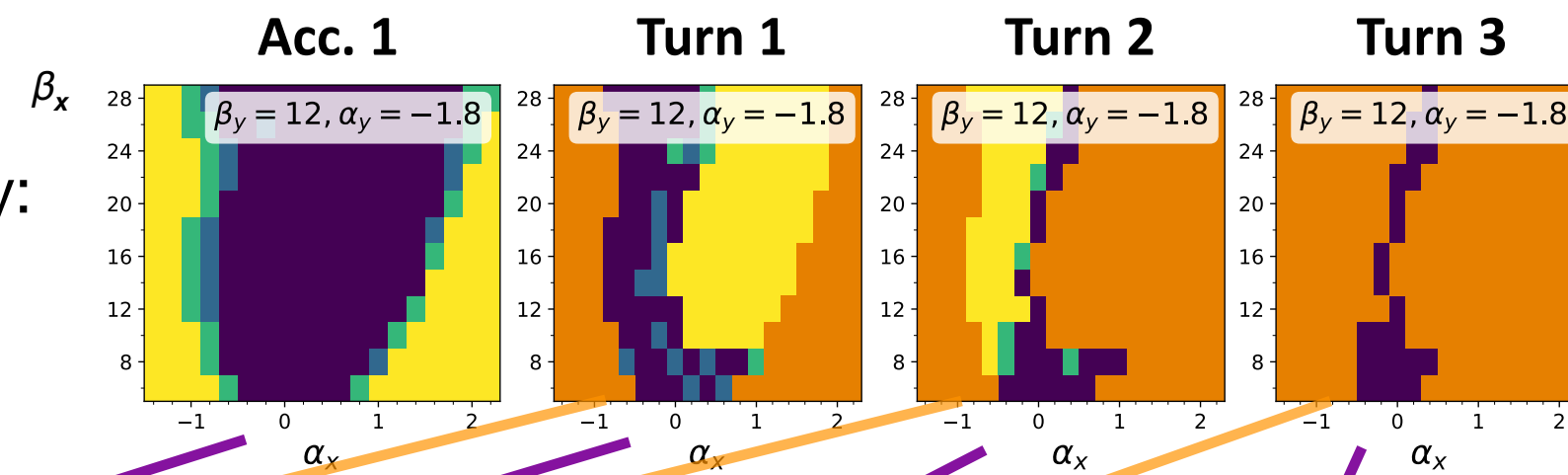
Outlook

Current status

- 3 turn optics (no Straight sec.) matched with flexibility: found all solution respecting major constraints

Ongoing:

- Design/matching of **3 straight section** with full flexibility (for all tunes)





Discussions:

Corrector-integrated quadrupoles:

- Jorg Wenninger (CERN)

Injector optimisation:

- Vitaliy Goryashko (Uppsala University)

Longitudinal matching:

- Peter Williams (STFC, Cockcroft Institute)
- Gustavo P. Segurana (MAX IV Laboratory)
- Esraa Khidr (Johannes Gutenberg University Mainz)

Halo collimation:

- Kévin André (CERN)
- Adrien Plaçais (LPSC)
- Bettina C. Kuske (BESSY)

Corrections, tracking with deceleration:

- Gustavo P. Segurana (MAX IV Laboratory)

indico.jacow.org/event/95/contributions/12396/



Conclusions



PERLE project status

04.2026 — HV conditioning up to 350 kV (ongoing) [WEP5090](#)

04.2026 — CsK₂Sb synthesized, QE=6.5% [THP2102](#)

11.05.2026 First Electrons !!! 2.5 mA (next day in the Faraday cup) [THP2104](#)

Lattice design & optics

- Single and multi turn operation
- Merger and Arcs with M56 control

Beam dynamics studies

- Longitudinal matching for Single Turn operation ← chirped distribution from the booster + M56 in Merger and Arcs [WEP5006](#)
- Static misalignments (Booster cavities + Quadrupoles in Merger and 1st turn) → correction scheme [MOP1110](#)
- Effect of non linear fields [THP2103](#)
- Halo cleaning and collimation [WEP5064](#)
- And many other

20 May 2026

Alex Fomin

PERLE Beam Dynamics and Optics

IPAC'26, Deauville, France

Sum

1 talk + 4 posters on PERLE BD + 10 posters on PERLE



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indico.jacow.org/event/95/contributions/12396/



Do NOT Miss !



PERLE Contributions:

<p><u>Beam Dynamics</u></p> <ul style="list-style-type: none"> 🔗 MOP1110 Linear imperfection and orbit correction scheme for the PERLE accelerator (R. Abukeshek) 🔗 WEP5006 Ongoing studies of longitudinal matching for the PERLE accelerator (J. Issa) 🔗 WEP5064 Halo cleaning and collimator optimization at PERLE (A. Cieplak) 🔗 THP2103 Assessing Corrector-Integrated Quadrupoles for PERLE (A. Fomin) <p><u>Injection line</u></p> <ul style="list-style-type: none"> 🔗 WEP5089 HOM study of the PERLE's booster cavity (R. Roux) 🔗 WEP5090 Status of the PERLE's injector (R. Roux) 🔗 THP2104 High current photogun for the energy recovery linac PERLE (M. Baylac) 🔗 THP2102 High quantum efficiency alkali-antimonide photocathodes for PERLE high current DC gun (M. De Vos) 	<p><u>Sustainability</u></p> <ul style="list-style-type: none"> 🔗 MOP7179 Power Balance of the PERLE Energy Recovery Linac (F. Bouly) <p><u>RF systems</u></p> <ul style="list-style-type: none"> 🔗 MOP7022 Dielectric Characterization of Beam Line Absorber Samples for Next-Generation High Intensity Electron Beam SRF Accelerators (A. P. Ruiz) 🔗 WEP6126 RF coupling choices, power requirements, and their impact on transients in the PERLE energy recovery linac (F. Bouly) 🔗 WEP6146 RF system status for PERLE (F. Bouly) <p><u>Diagnostics</u></p> <ul style="list-style-type: none"> 🔗 WEP6035 Overview of Beam diagnostics for PERLE (M. B. Abdillah) 🔗 WEP6036 Beam positions monitors for PERLE (M. B. Abdillah)
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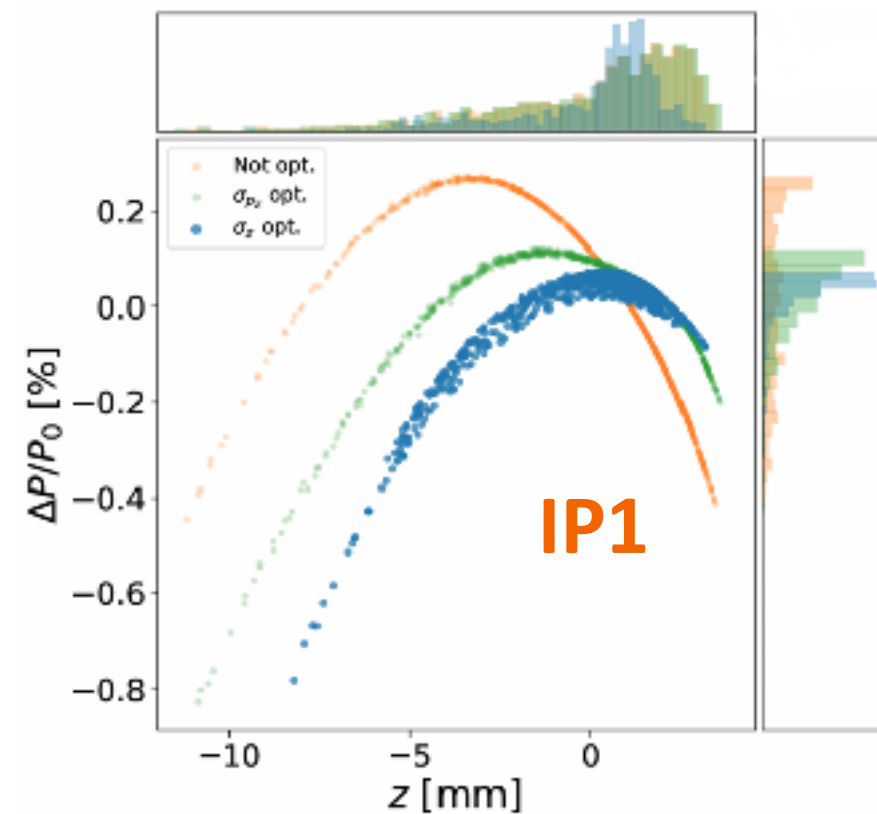
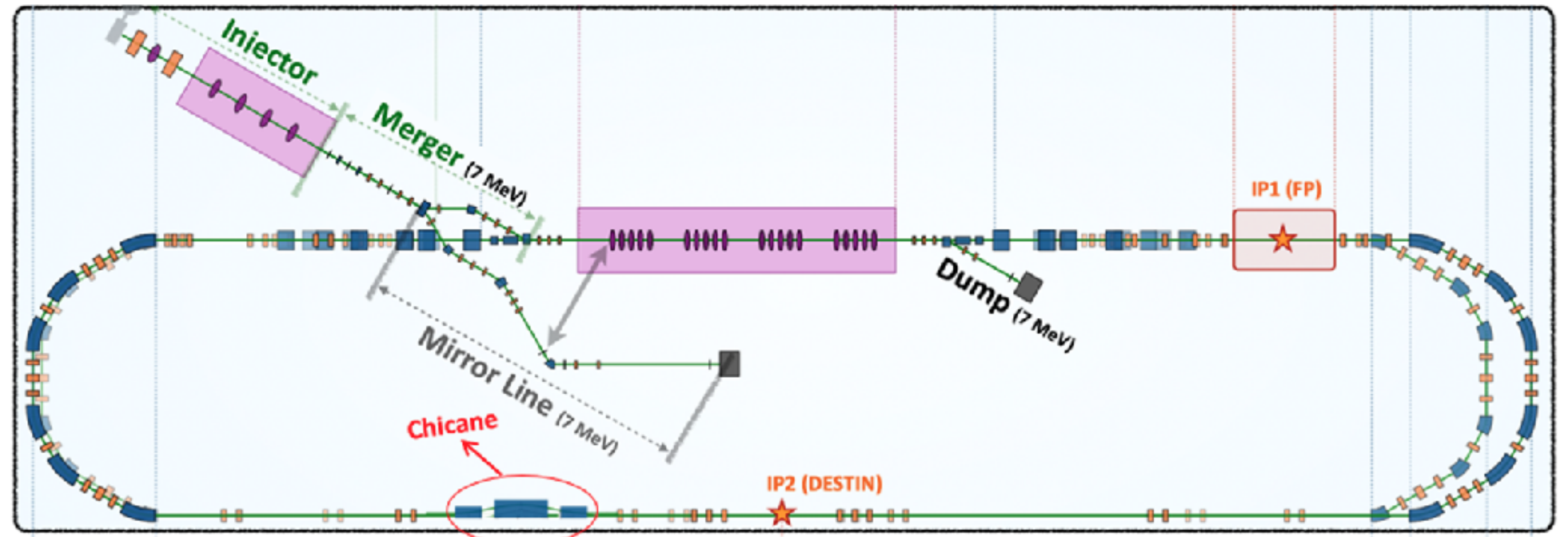
1 talk + 4 posters on PERLE BD + 10 posters on PERLE

Longitudinal matching and control is important for:

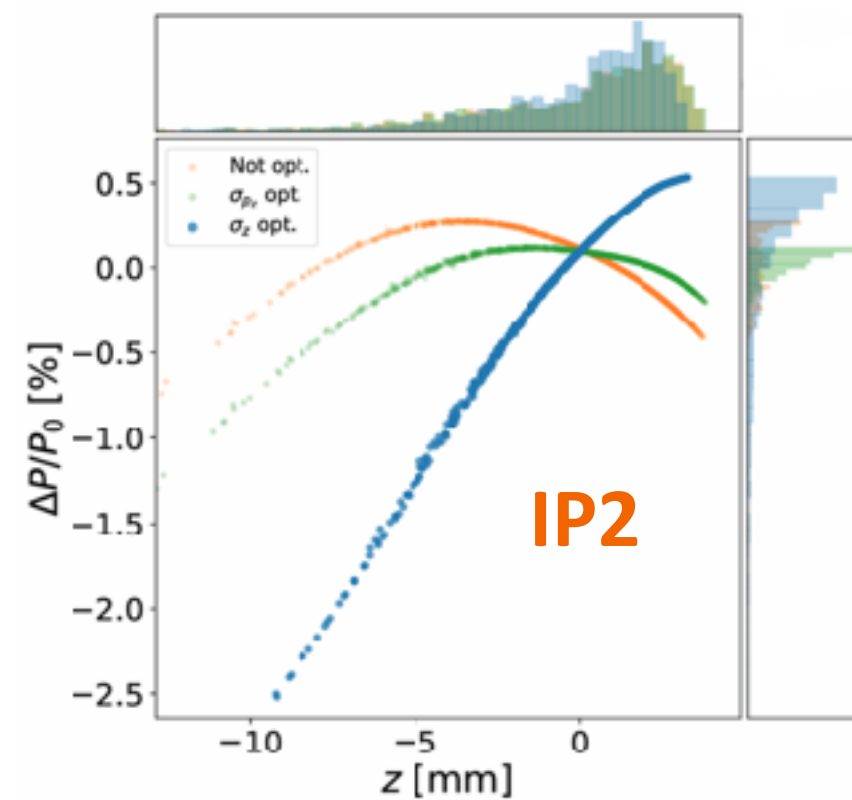
- Experiments requirements **IP1** and **IP2**
- Beam stability and losses
- Energy recovery efficiency

Tools that we can use:

- Quads for longitudinal dispersion (R56) tuning (Merger & Arcs)
- Path length chicane for phase tuning (One for each turn !)
- Sextupoles for T566, octupoles...



σ_z : 2.89mm \rightarrow 2.13mm
 σ_{pz} : 0.2% \rightarrow 0.17%



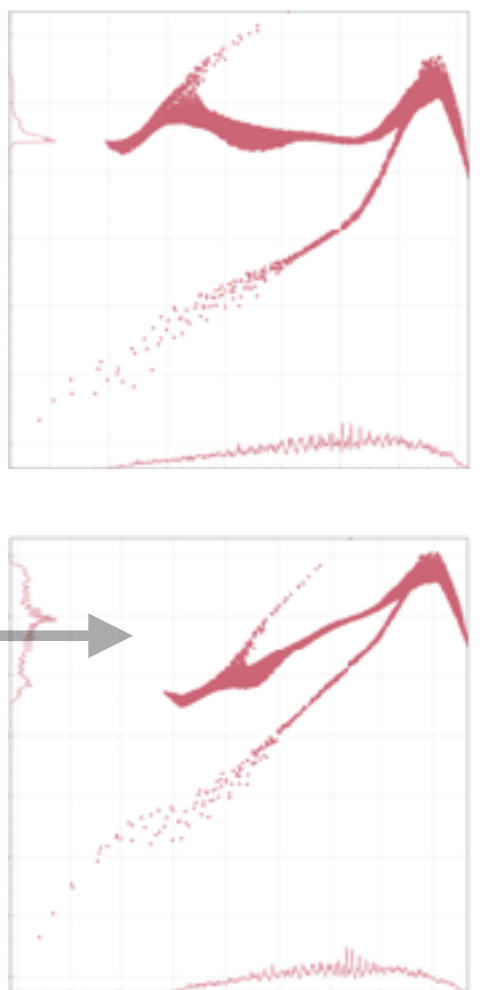
σ_z : 3mm \rightarrow 2.73mm
 σ_{pz} : 0.2% \rightarrow 0.17%

Current studies:

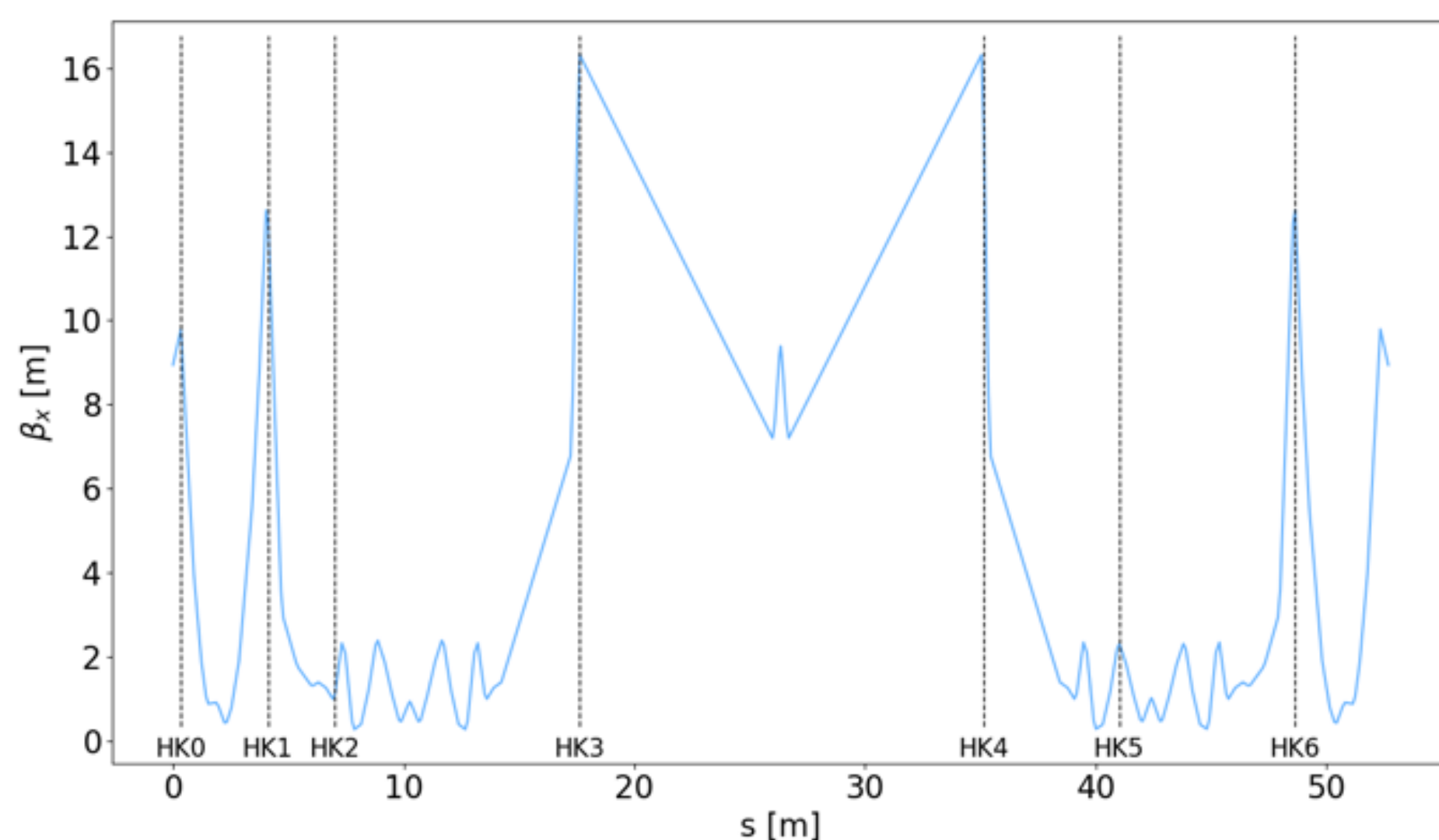
- BMAD simulation with absolute time tracking
- RF field maps (fundamental mode only)
- Path length chicane optimized

Preliminary results:

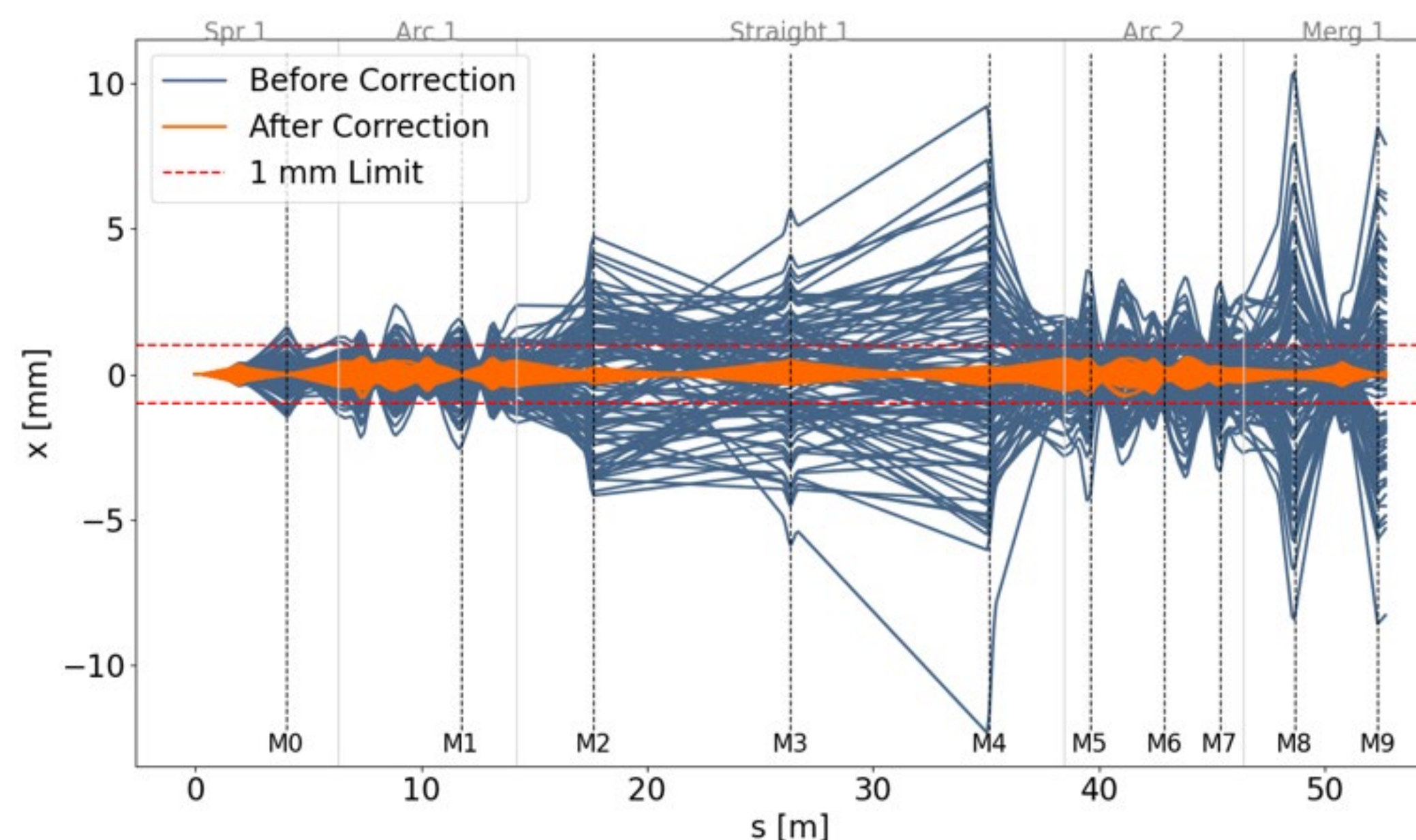
- Chirped distribution from booster is helpful
- Single Turn configuration not optimal for energy spread
- Multi-pass configuration is ideal for longitudinal matching



- Recalculating the optics of Turn 1 with all (45) quadrupoles misaligned: Misalignment affects the dispersion in both planes. No effect on Beta function.
- Gradually adding kicker-Monitor pair and observe the next places to mount the BPMs. In each step, the value of the previous HK_n are fixed from the previous optimization and introduced directly to the lattice



- positions of all kickers & monitors for the 1st turn are found: 7 kickers and 10 BPMs are needed.



Simulation of 100 beam orbits along the 1st pass of PERLE (**blue**) and corrections (**orange**)

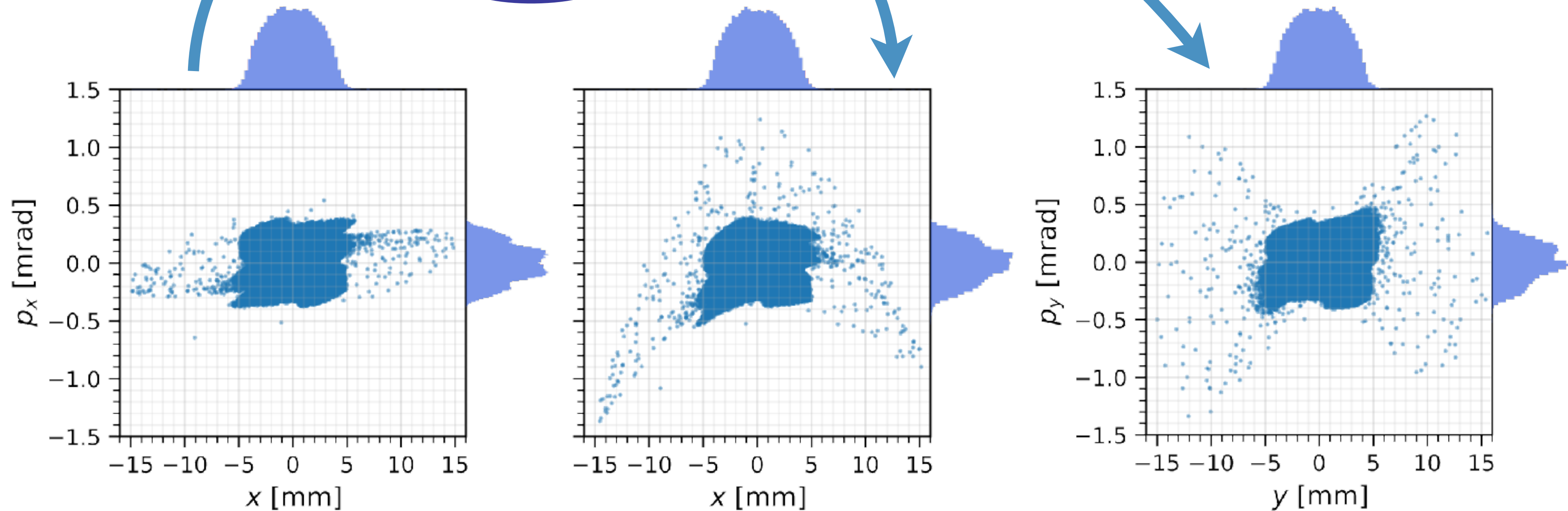
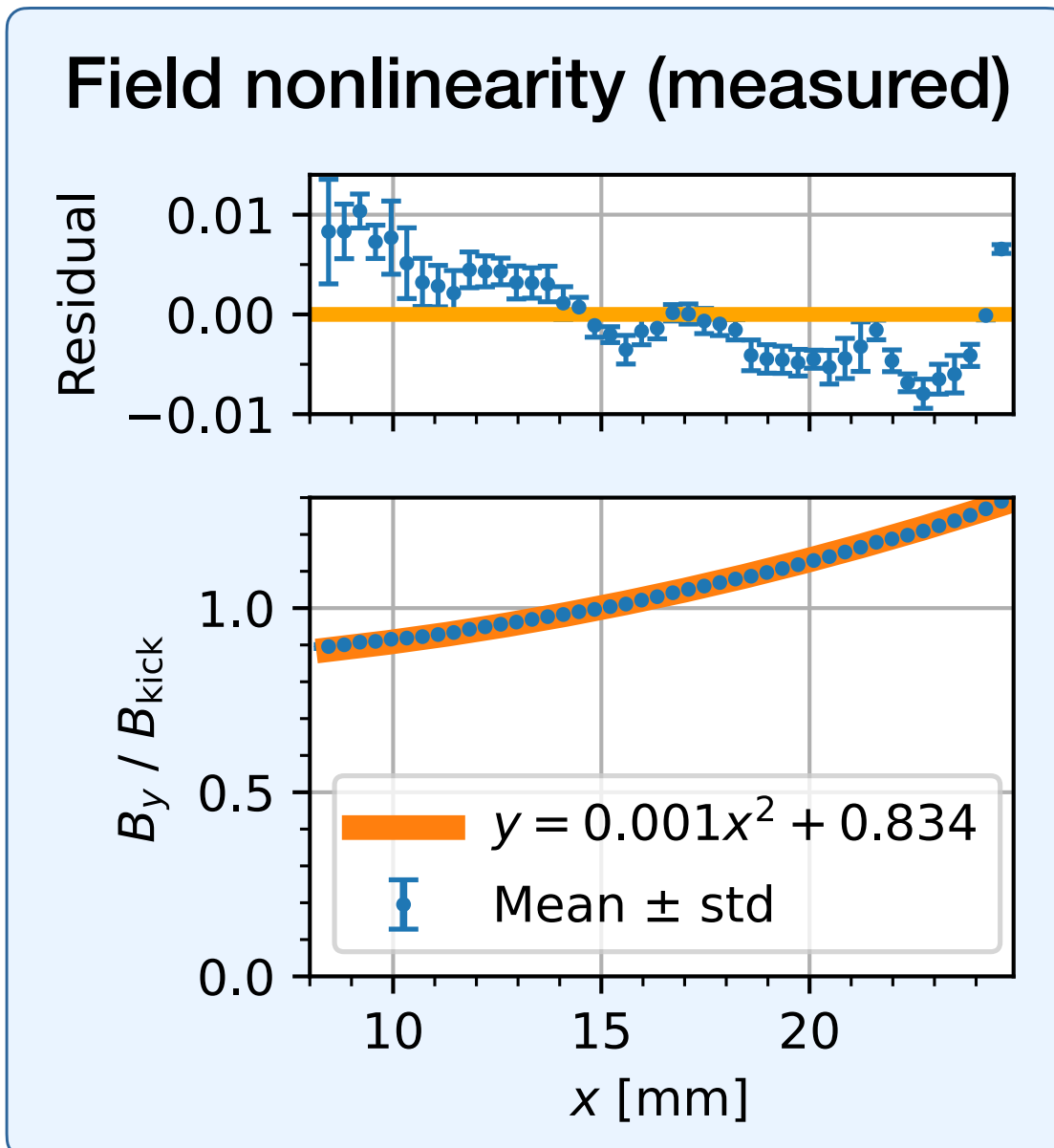
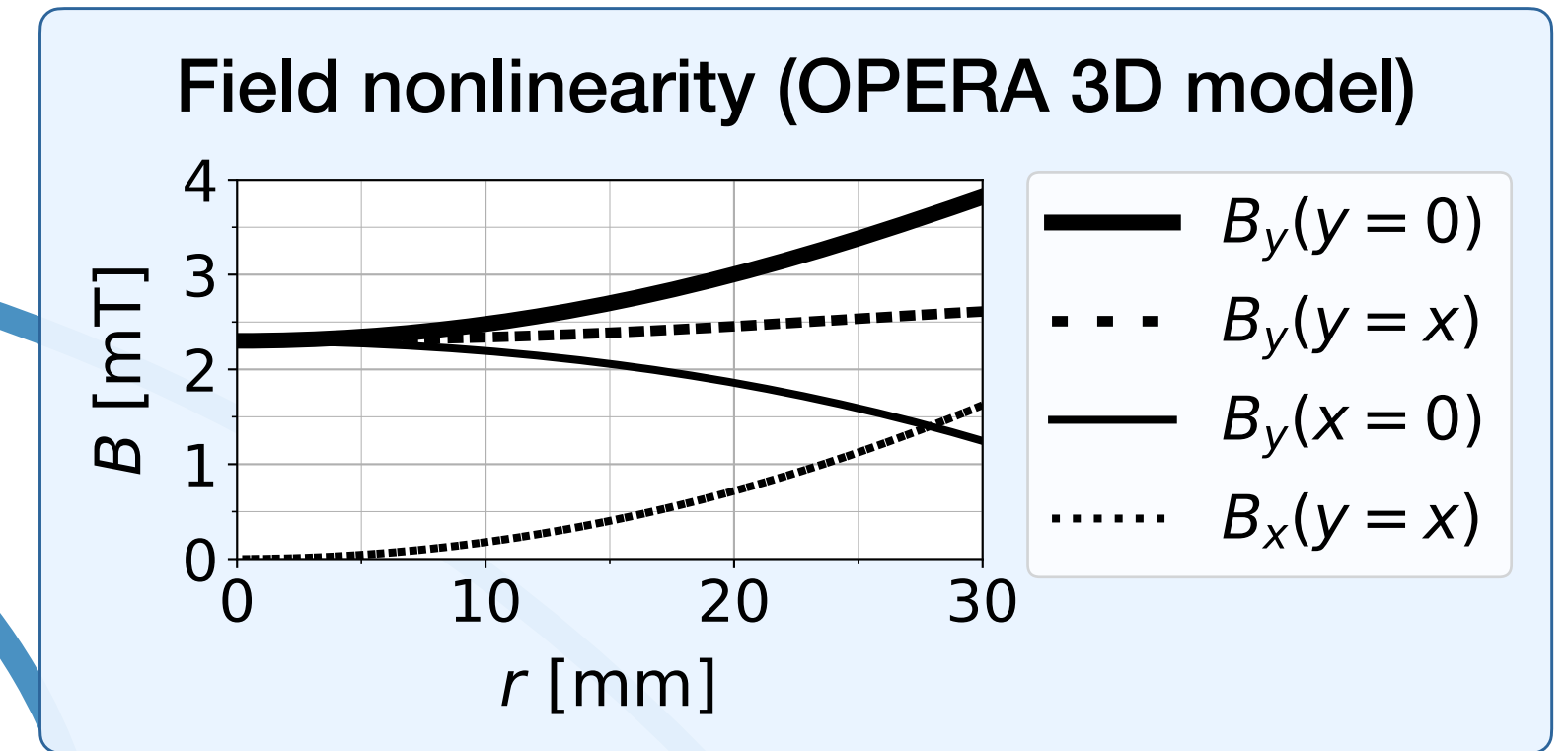
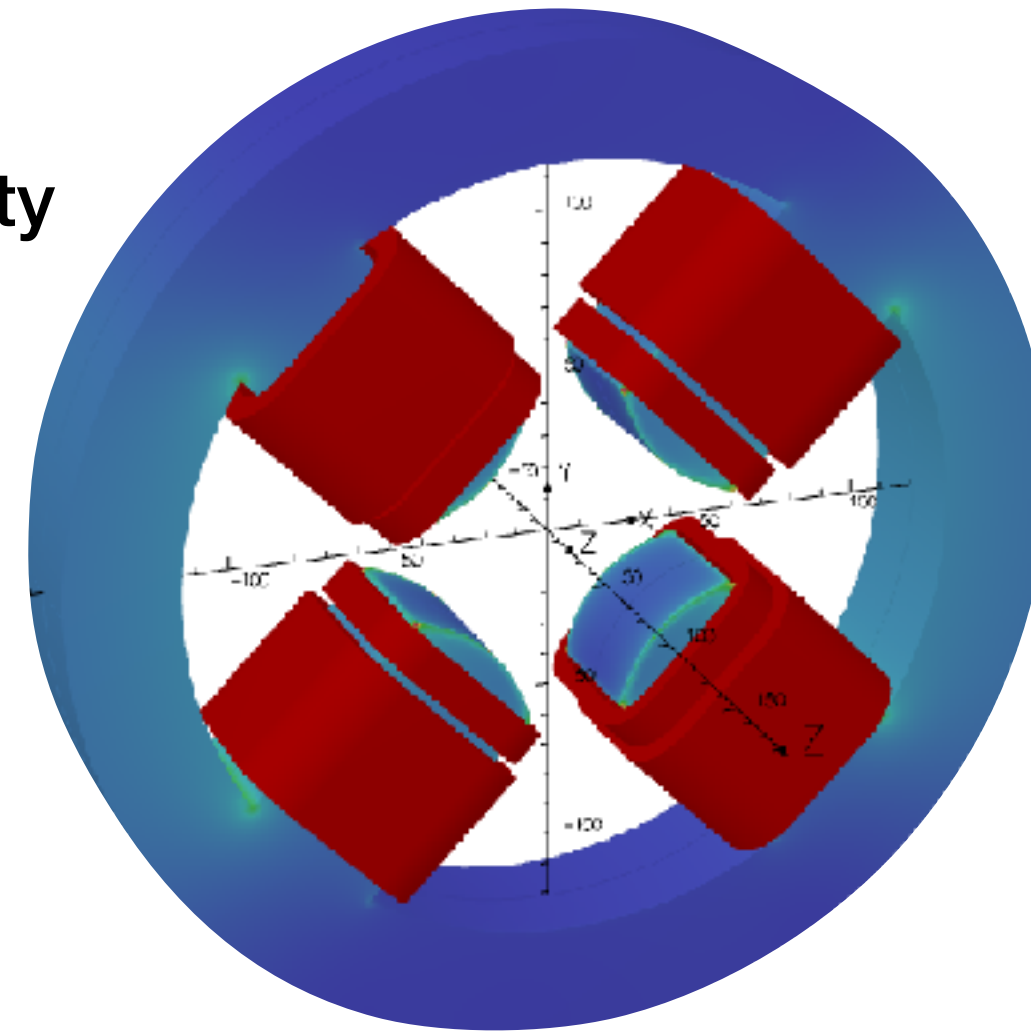
Compact correctors → nonlinear off-axis fields

Beam size trade-off: space charge ↔ halo from nonlinearity

cERL kick maps (measured) → real-field validation

OPERA + BMAD → emittance, steering, halo impact

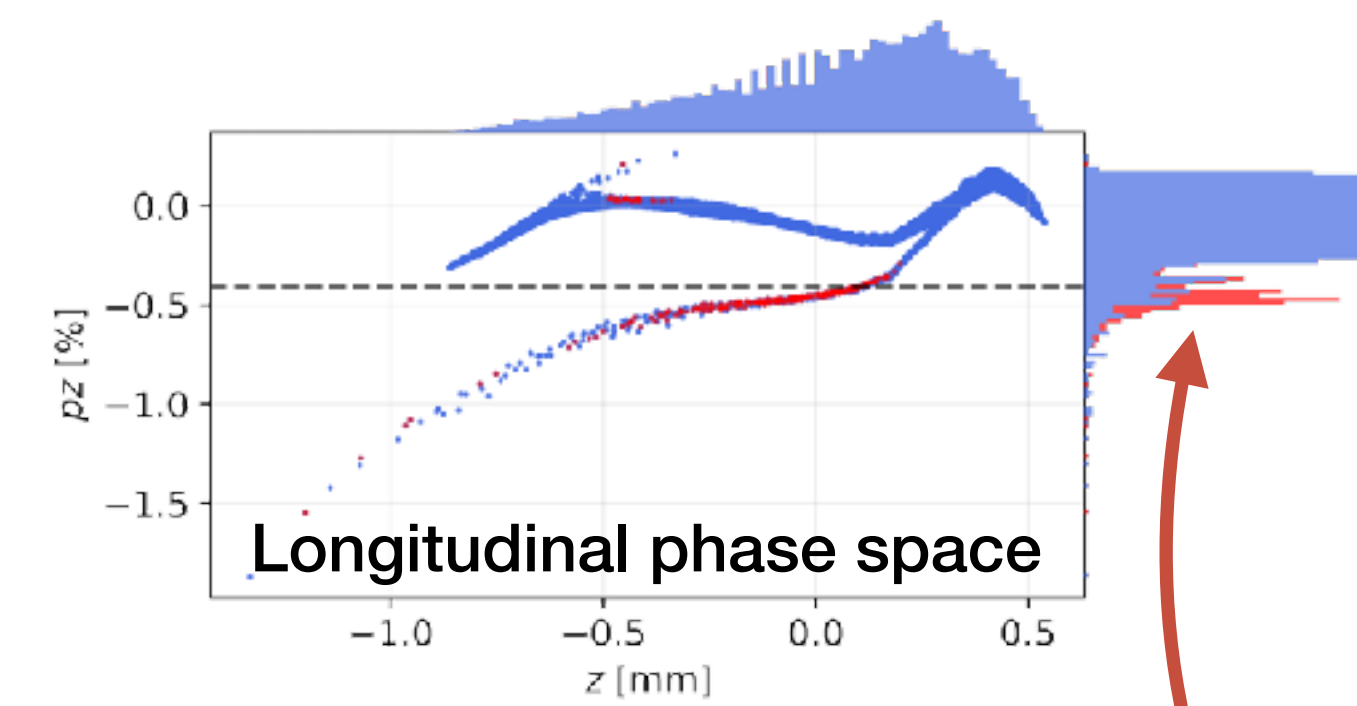
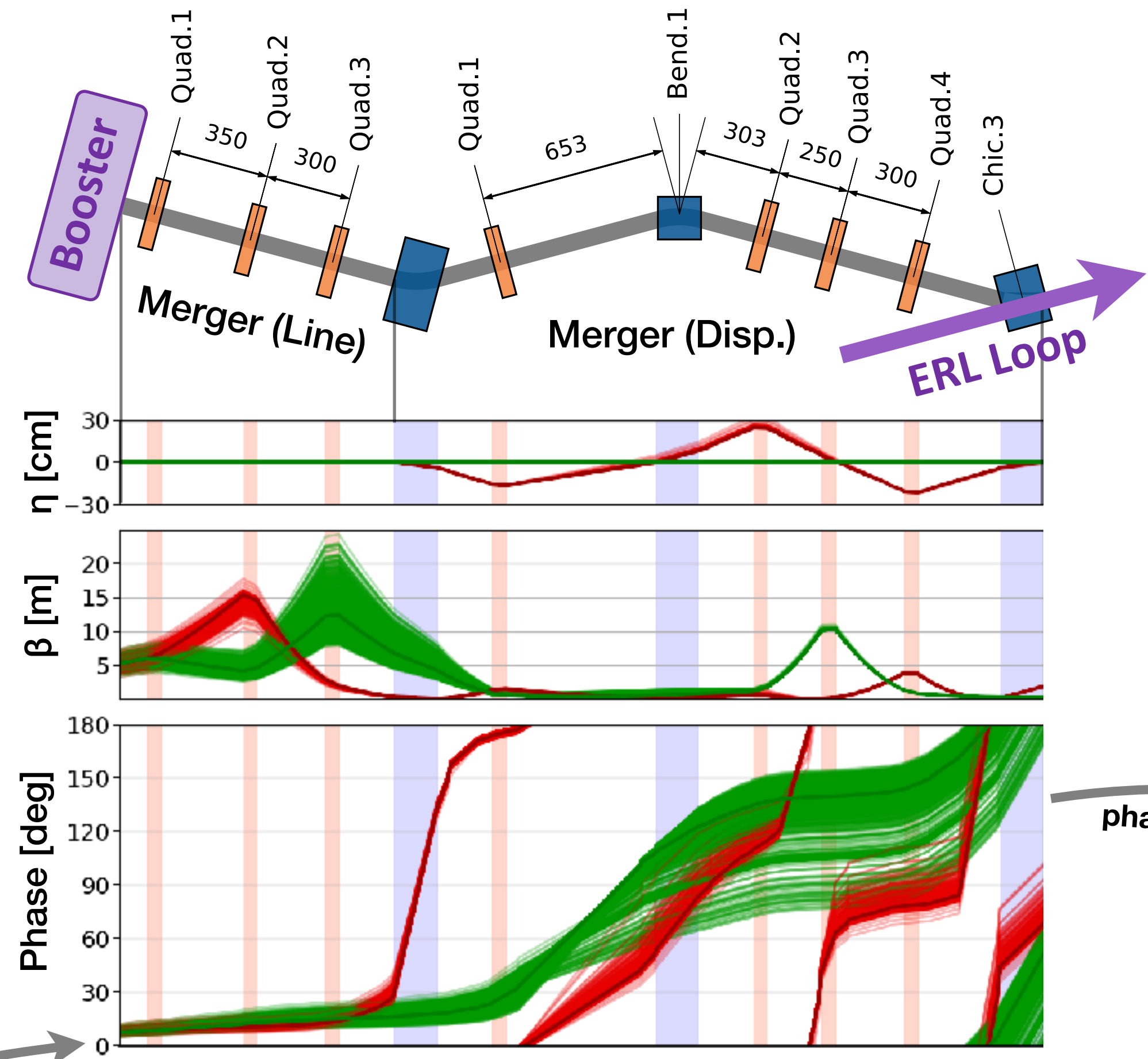
→ Design limits & lattice placement for PERLE



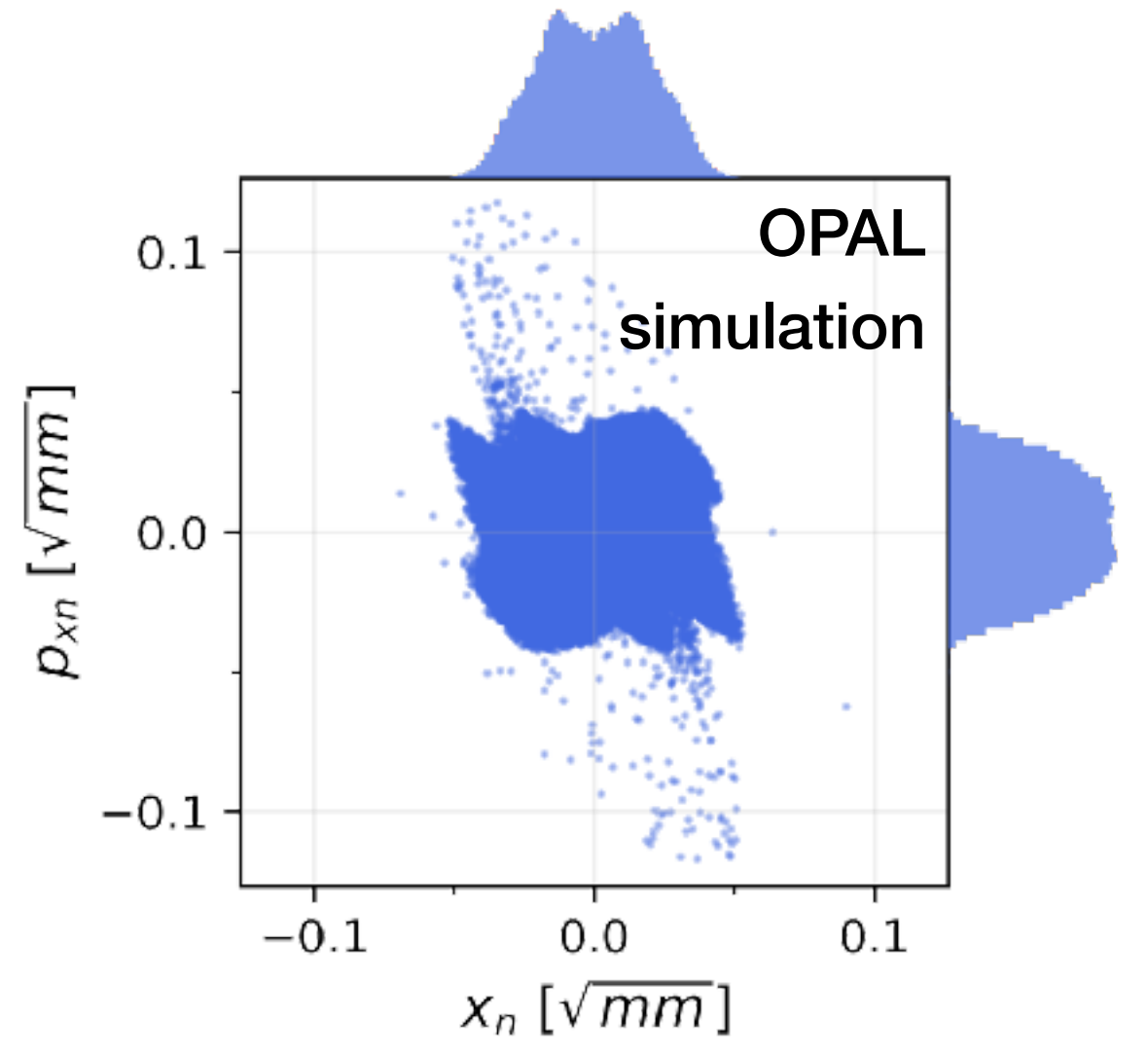
Halo cleaning and collimation at PERLE

- Limited dispersion for effective off-momentum collimation
- Dedicated collimation locations identified
- Result: reduced transverse halo factor
- Partial cleaning of the longitudinal halo population

WEP5064 (A. Cieplak)



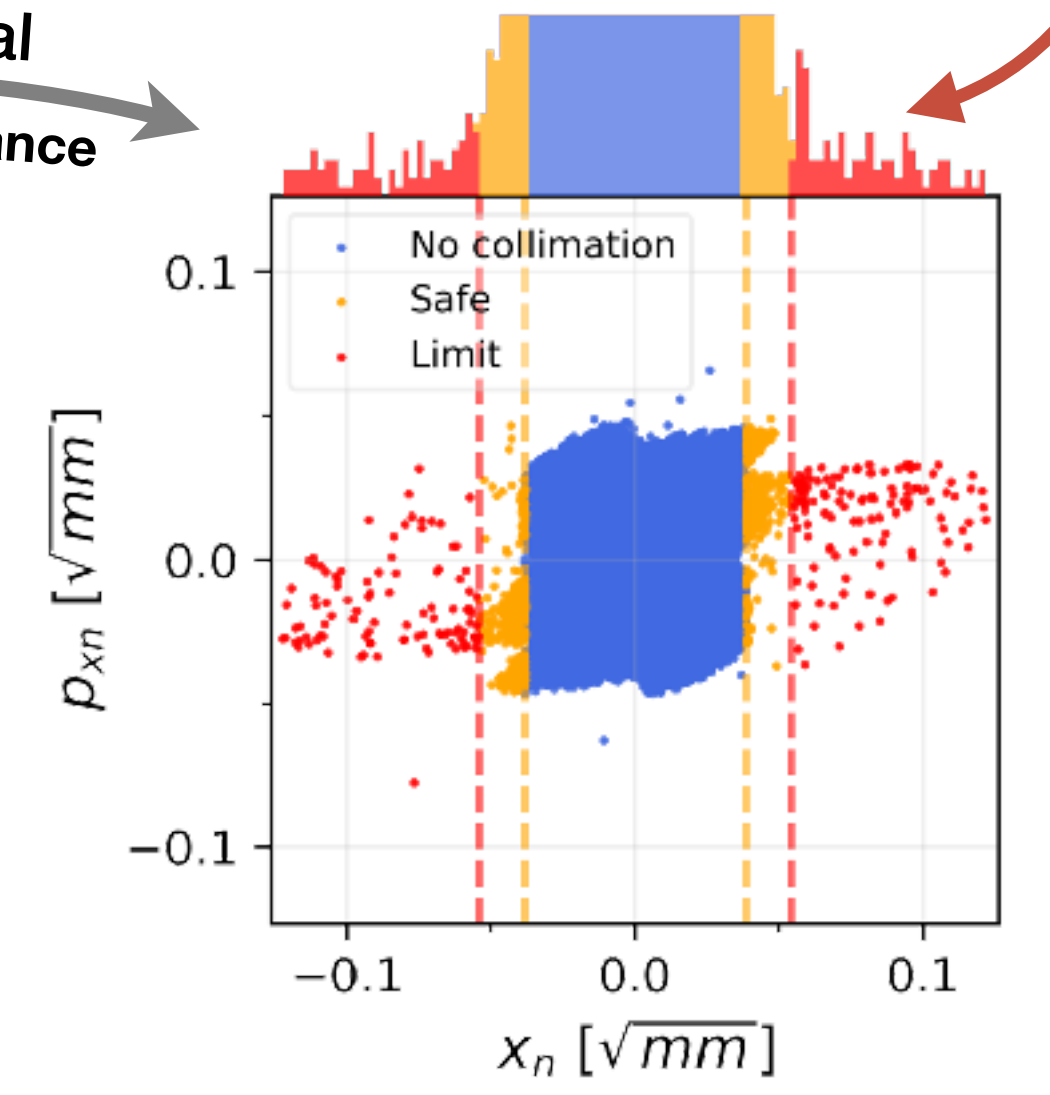
Initial distribution (x,px)
courtesy of C. K. Monaghan



Initial after the Booster

Initial:	$H_x = 0.77$	Collimated:	$H_x = 0.49$
	$H_y = 0.74$		$H_y = 0.47$
	$\eta_{ } = 0$		$\eta_{ } = 77\%$

Optimal phase advance

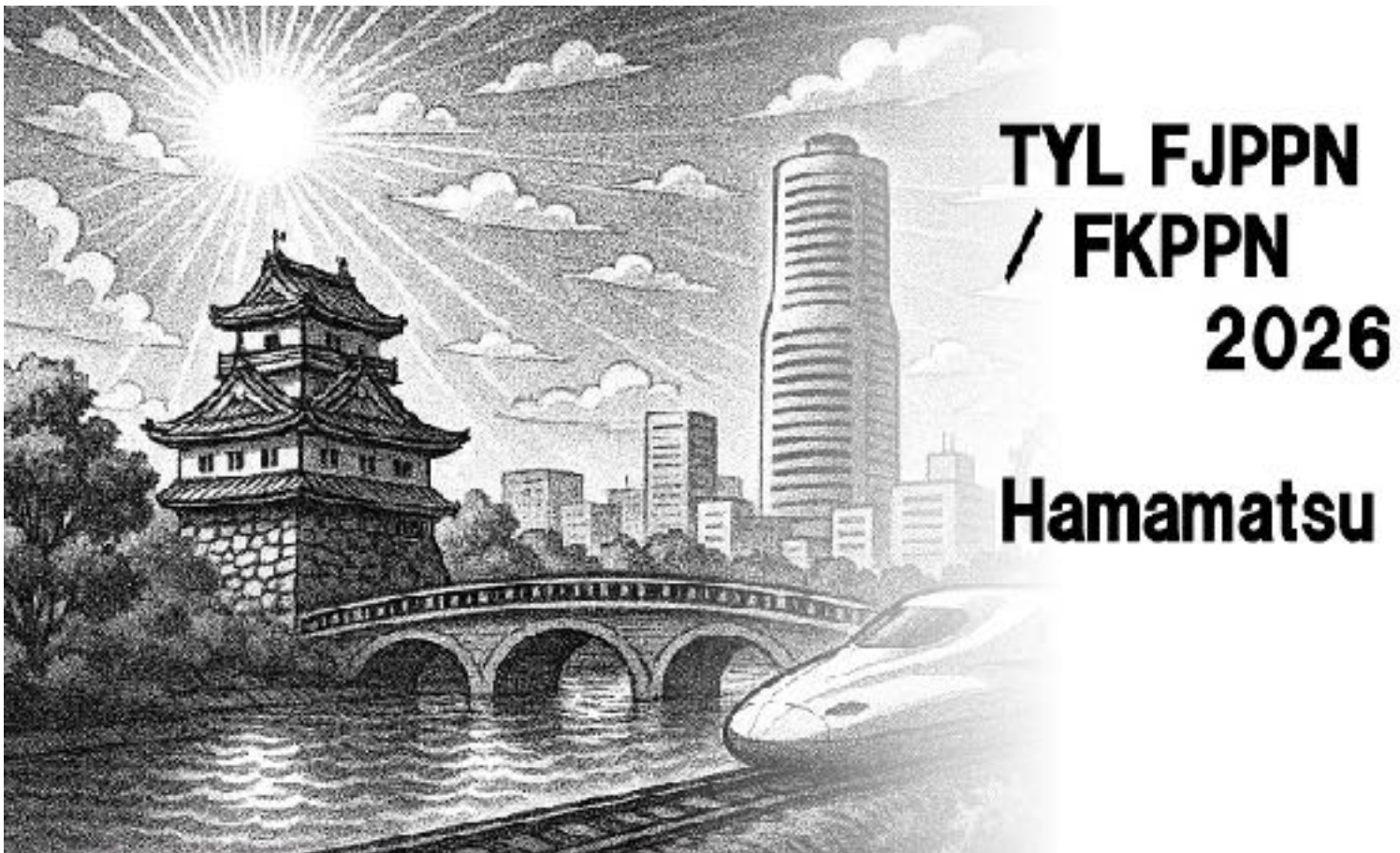


Correlation between transverse and longitudinal halo

Joint Workshop of TYL/FJPPN and FKPPN

May 18-21, 2026 (Hamamatsu, Japan)

<https://conference-indico.kek.jp/event/364/contributions/7888/>



R&D toward next generation Energy Recovery Linacs

CNRS/IN2P3/IJCLab (Orsay, France)

Alex Fomin*, Rasha Abukeshek, Walid Kaabi, Julien Michaud, Akira Miyazaki, Raphaël Roux

CNRS/IN2P3/LPSC (Grenoble, France)

Maud Baylac

KEK/iCASA (Tsukuba, Japan)

Hiroshi Sakai, Miho Shimada, Kensei Umemori, Masahiro Yamamoto

Hiroshima University (Hiroshima, Japan)

Lei Guo

**On behalf of the PERLE Collaboration*

FR → JP:

- Participation in **cERL commissioning**

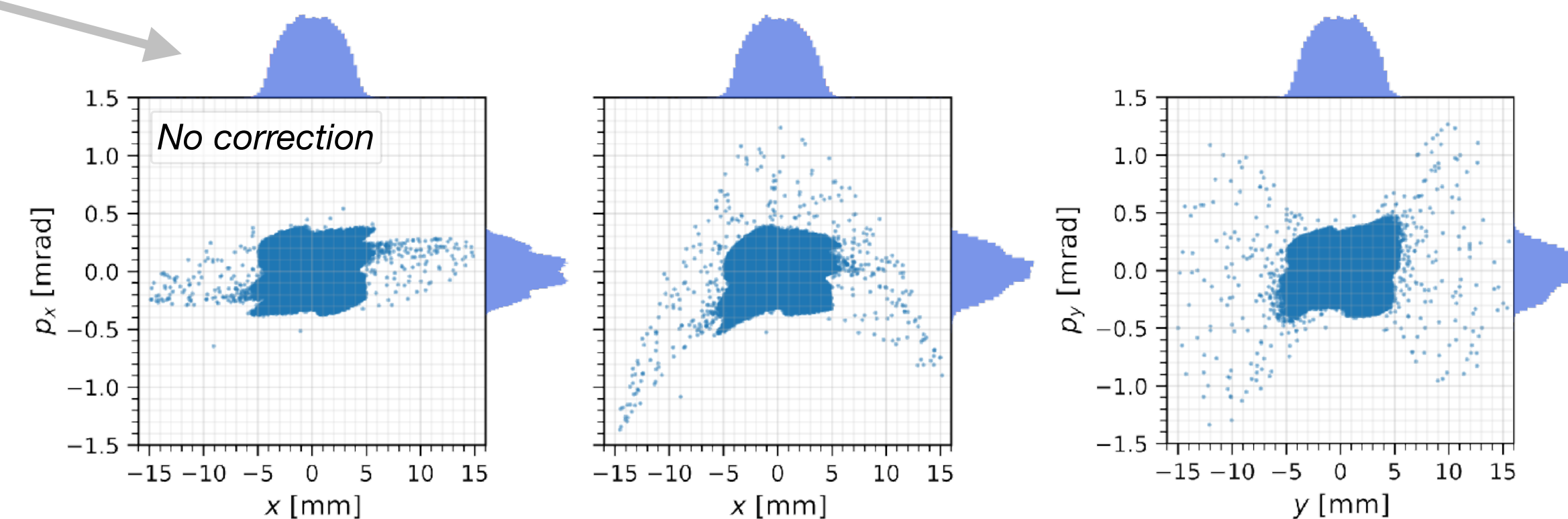
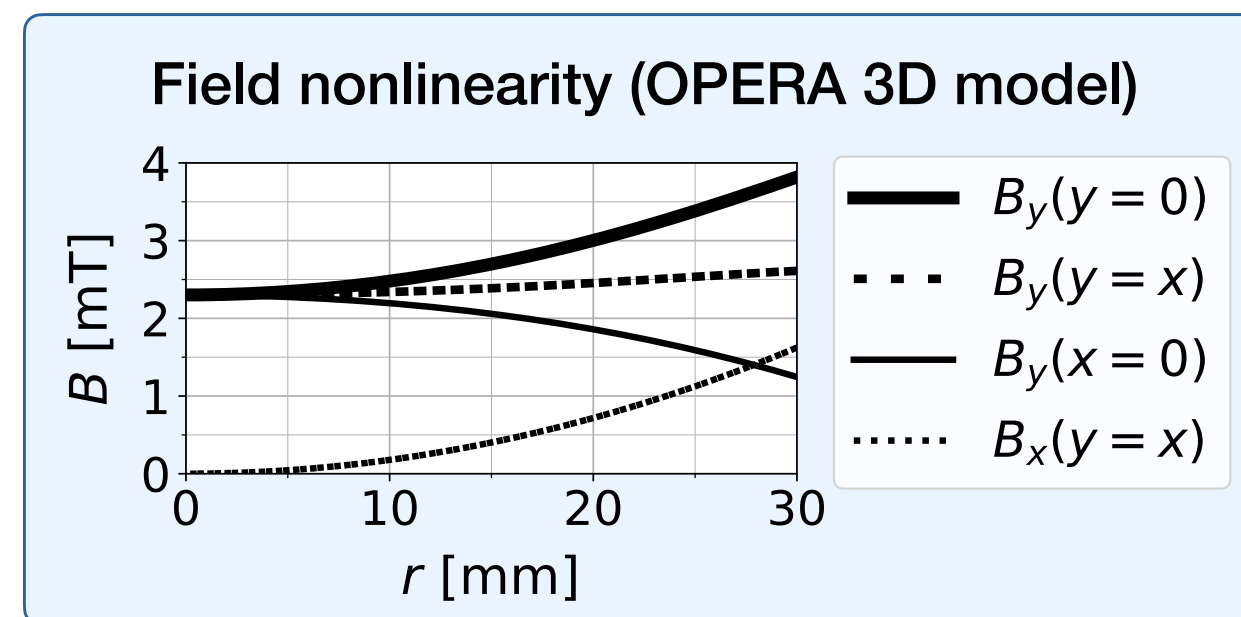
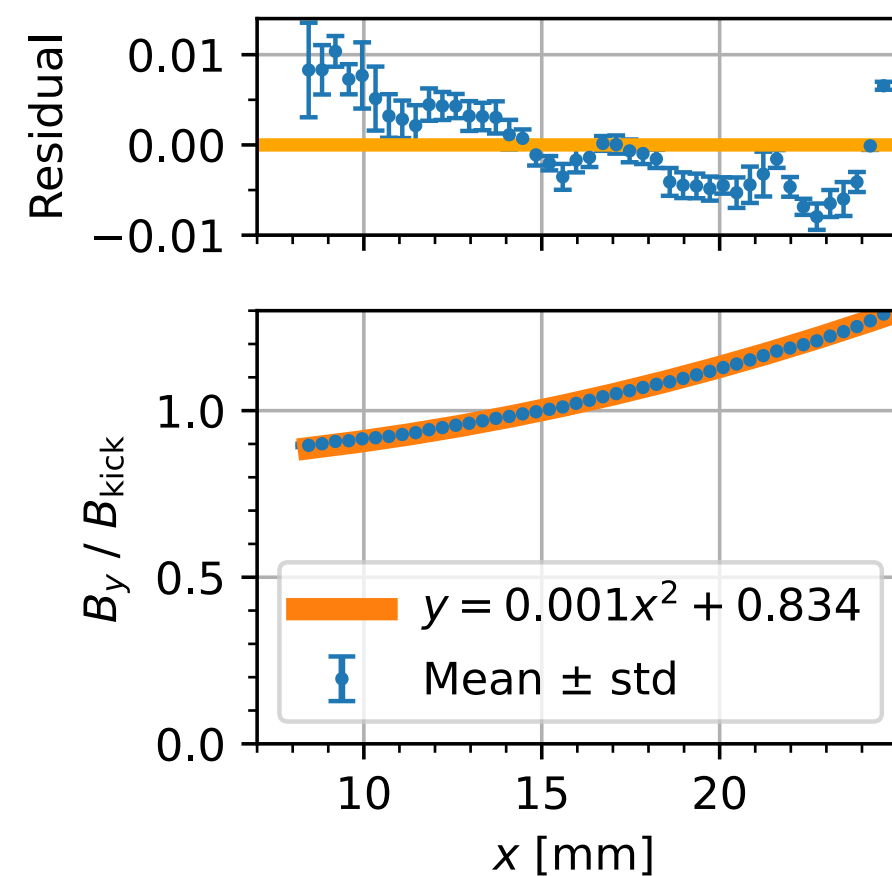
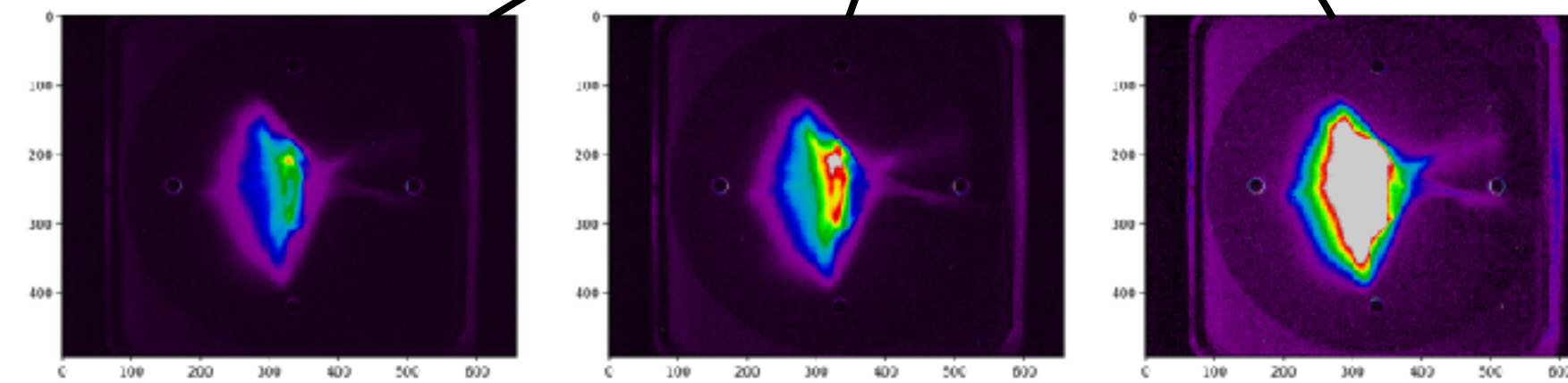
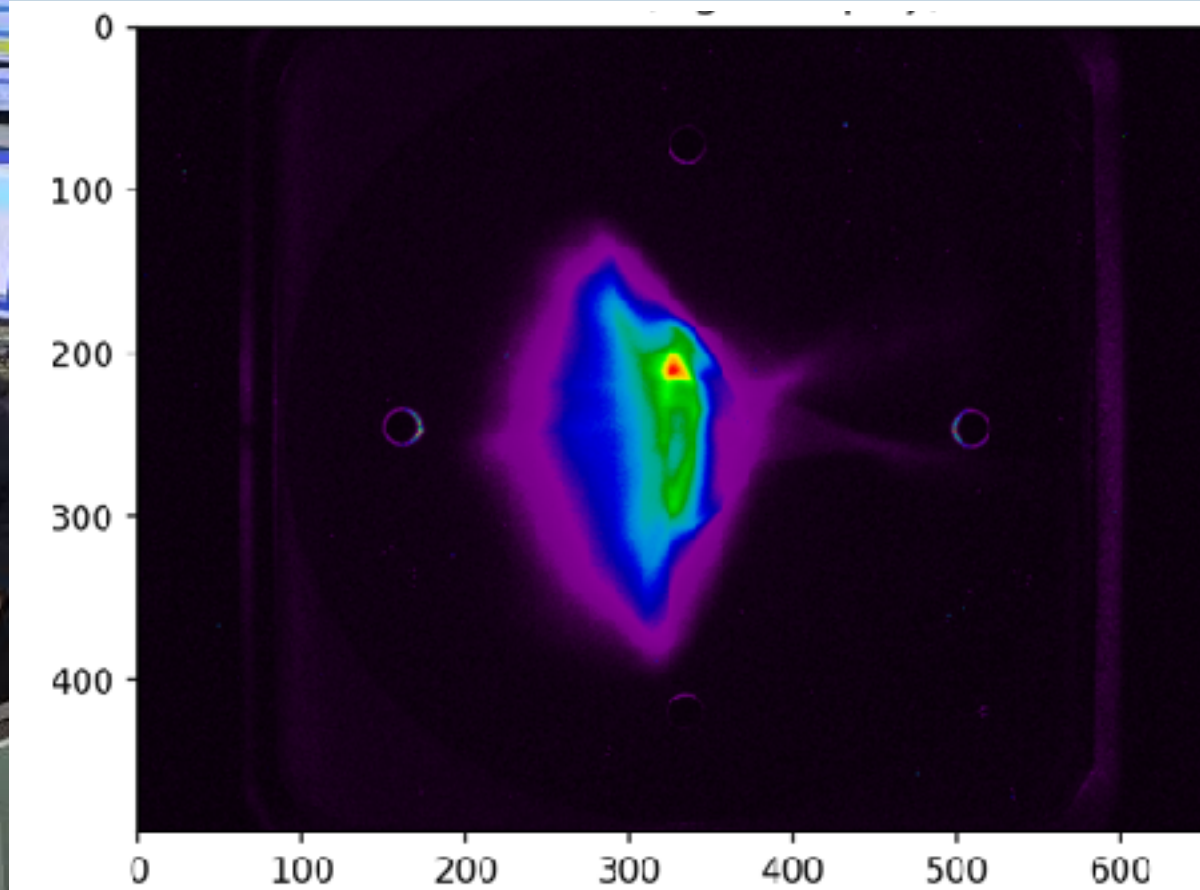
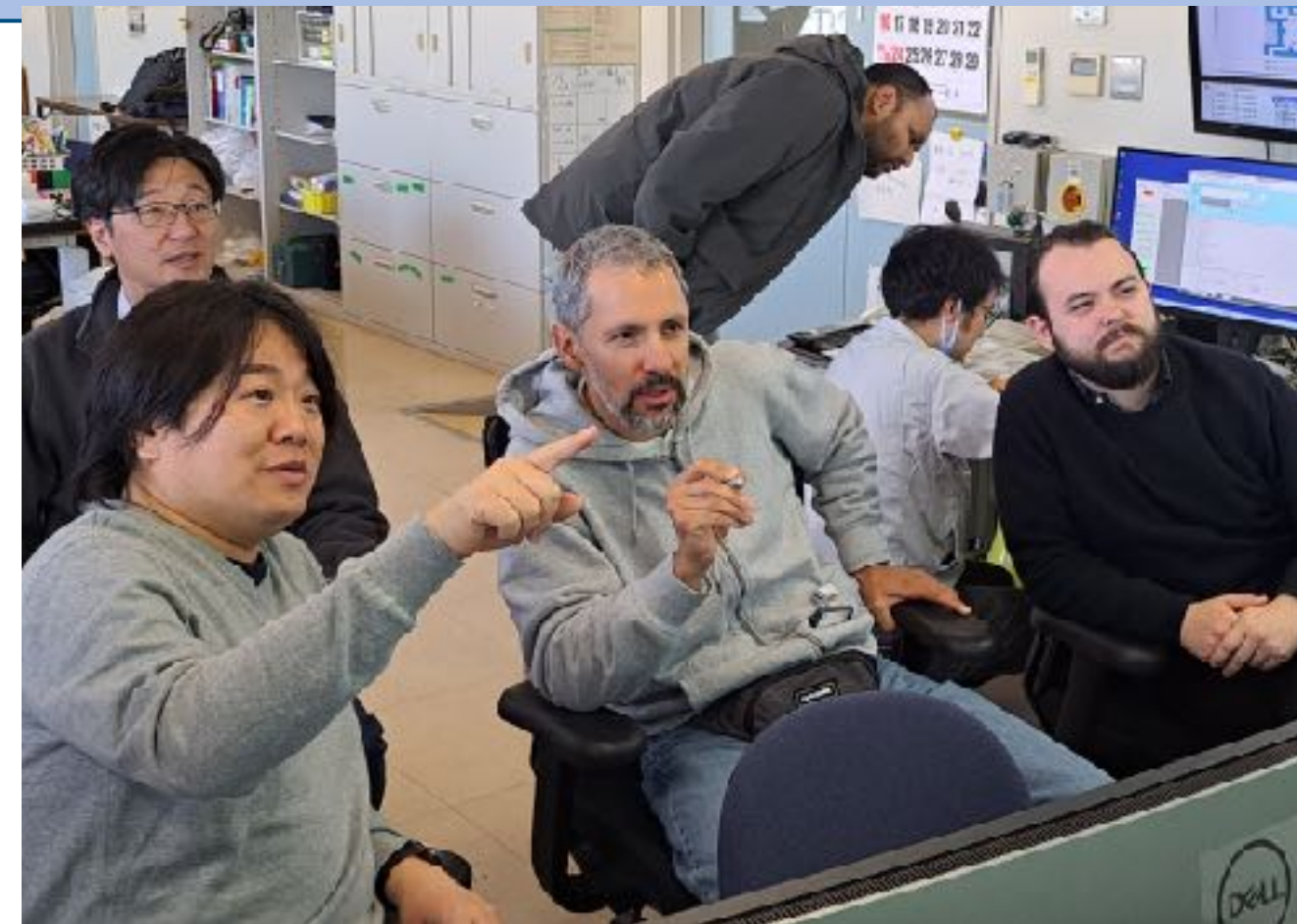
JP → FR:

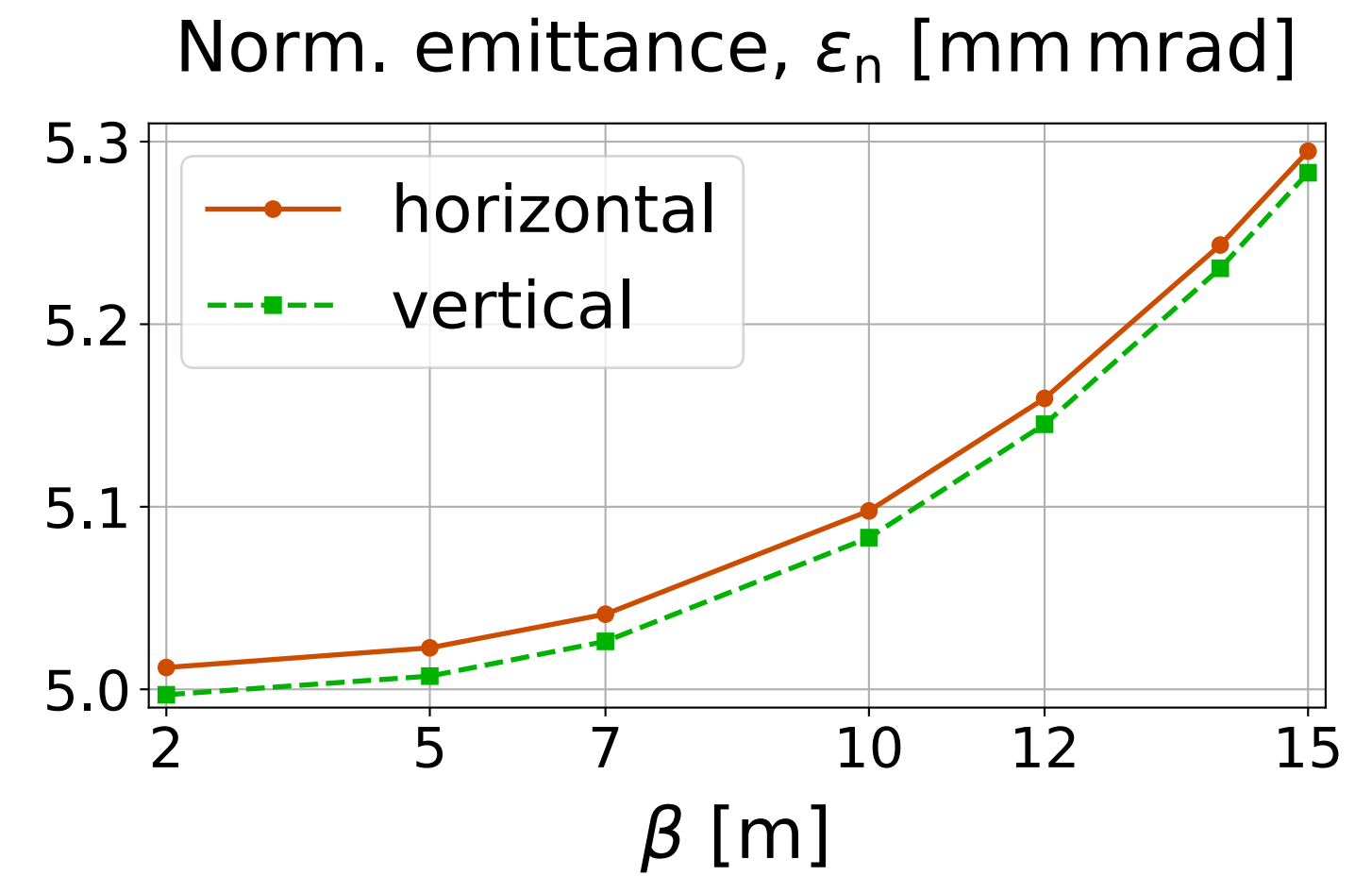
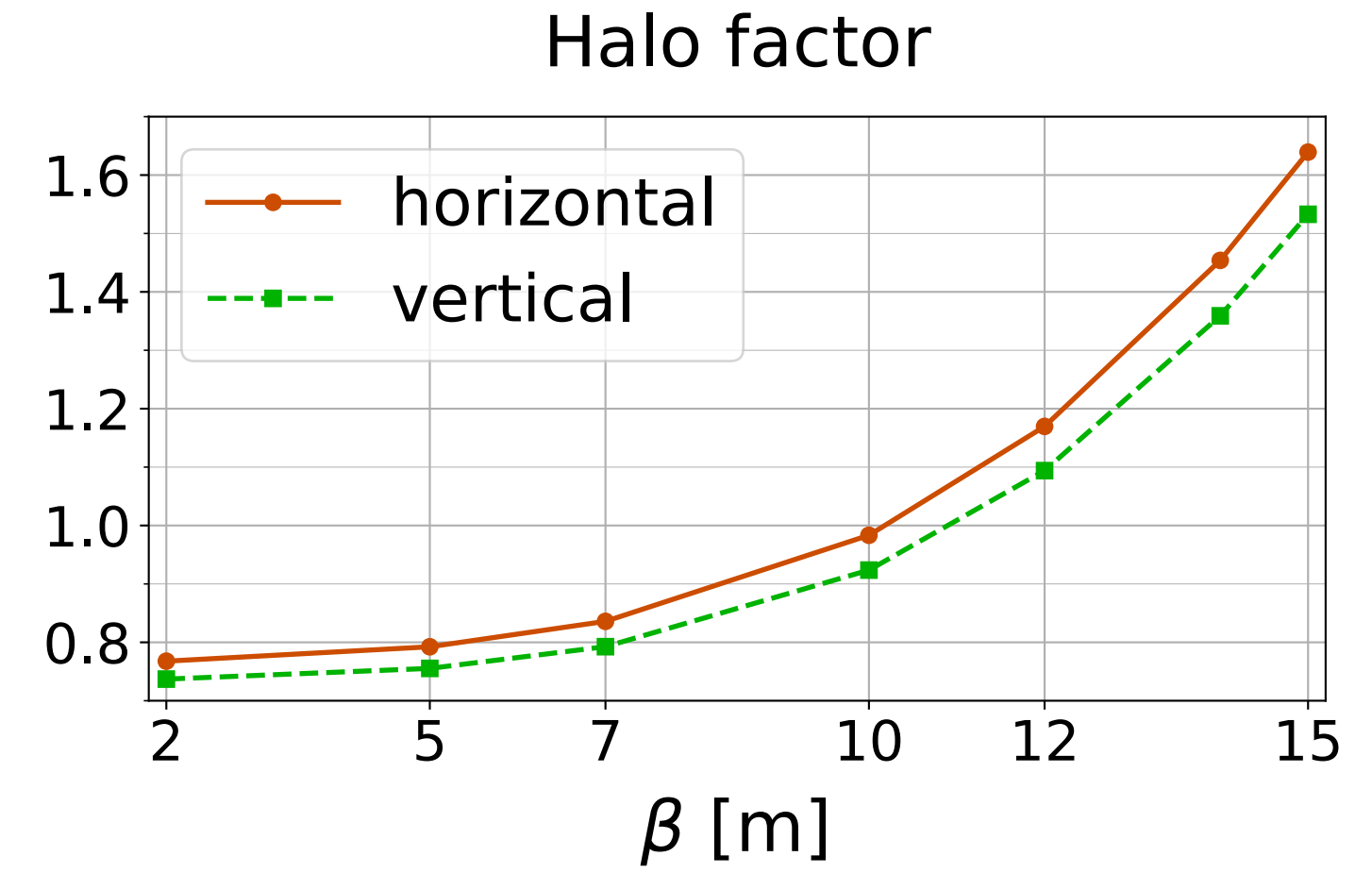
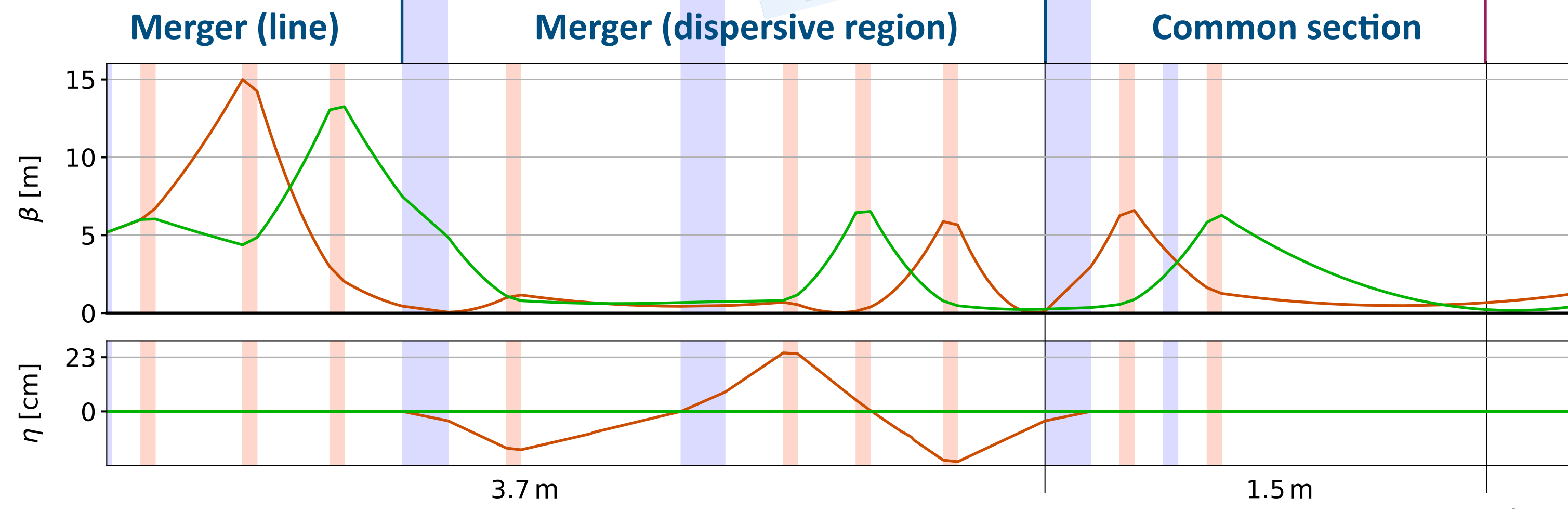
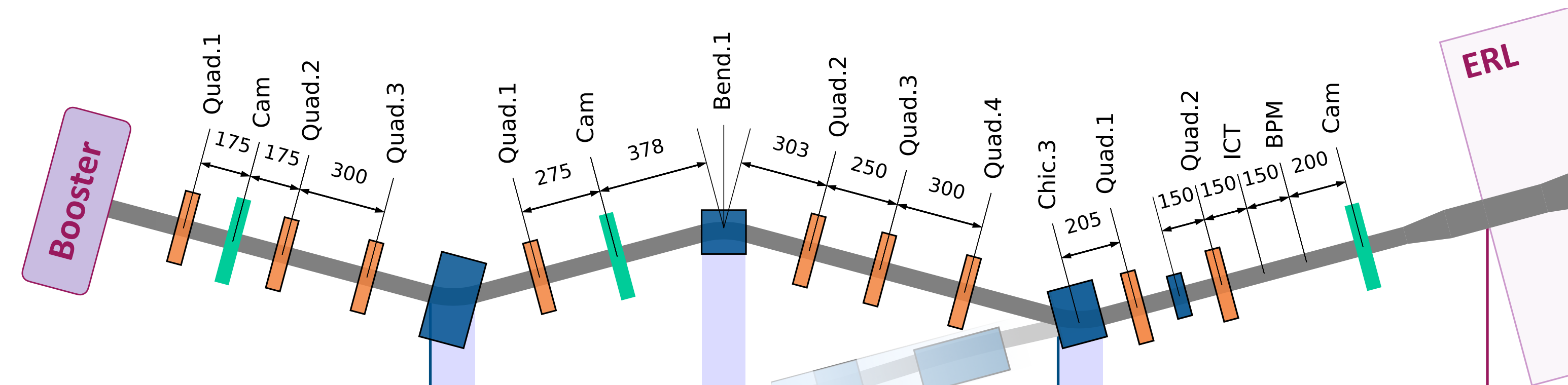
- Participation in **ERL'26** and **PhASE26**
- validation of **photocathode preparation recipe transfer**
- **surface analysis at XPS** (IJCLab)



Participation in cERL commissioning (2025)

- **One-month** visit of **Alex Fomin** and PhD student **Connor Monaghan** to KEK for **participation in cERL beam commissioning**.
- **Experimental study of injector beam halo formation** under space-charge dominated conditions relevant for PERLE.
- Transverse beam profile measurements performed at several locations in the injector and merger sections.
- Application of **high dynamic range imaging** techniques to characterize beam halo formation and its **sensitivity to machine tuning parameters**.
- **Beam-based magnetic field mapping** of a quadrupole magnet with embedded correctors at cERL.
- **Comparison** of measured magnetic field with **simulations** for the corresponding **PERLE magnet**.
- Follow-up studies at IJCLab, first **simulations for the PERLE lattice** using the **new magnet design**.





- **Participants (preliminary):** Alex Fomin, Rasha Abukeshek, Arnaud Cieplak, Janine Issa
- next run expected from around **mid-November** (TBA in **September**) + potentially one-month beam operation around February or March 2027
- Gain practical experience in **beam tuning, diagnostics, beam alignment**, and optics commissioning for PERLE.
- Possible dedicated **cERL beam time for PERLE-related studies** (preliminary accepted):
 - **longitudinal beam dynamics,**
 - **beam halo formation** and mitigation using **collimation** systems.
- **Co-funding support** for 1 month in Japan.



EAJADE
Europe-America-Japan Accelerator
Development Exchange Programme

PERLE Lattice

- Matching of 3 Straight section (5 days)
- Tree-turn Optics → TDR (mid-June)
- Merger update:
 - 4→1 dedicated corrector — transition to corrector-integrated quadrupoles
 - reserving the space for collimator
- Mirror diagnostic line

Beam dynamics studies

- Longitudinal matching for 3 Turns
- Studies of the effect field nonlinearities of the magnets on beam quality
- Simulation of collimation system at injector