



Project Progress Review (PPR) 4-2025

WP-02 : Dynamique faisceau

Présenté par: J. Michaud, pour toute l'équipe dynamique faisceau

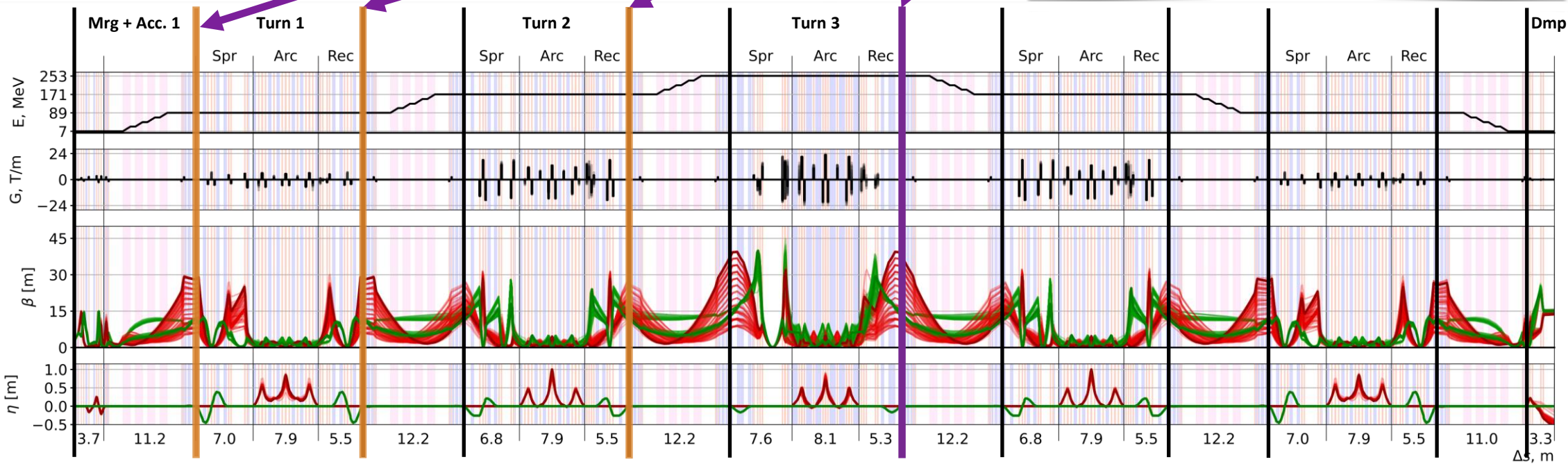
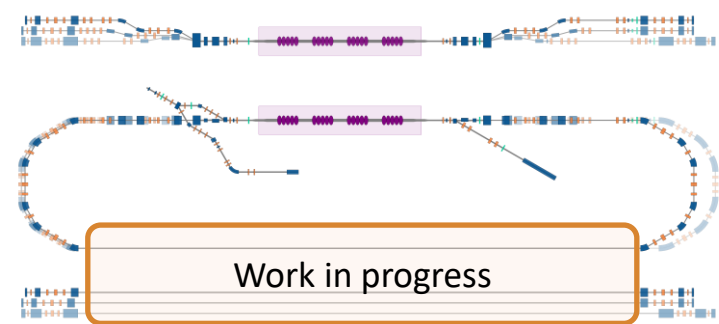
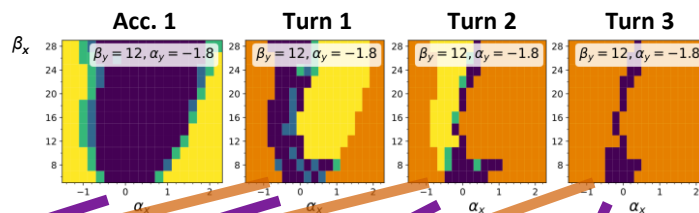
26 Juin 2026

Current status

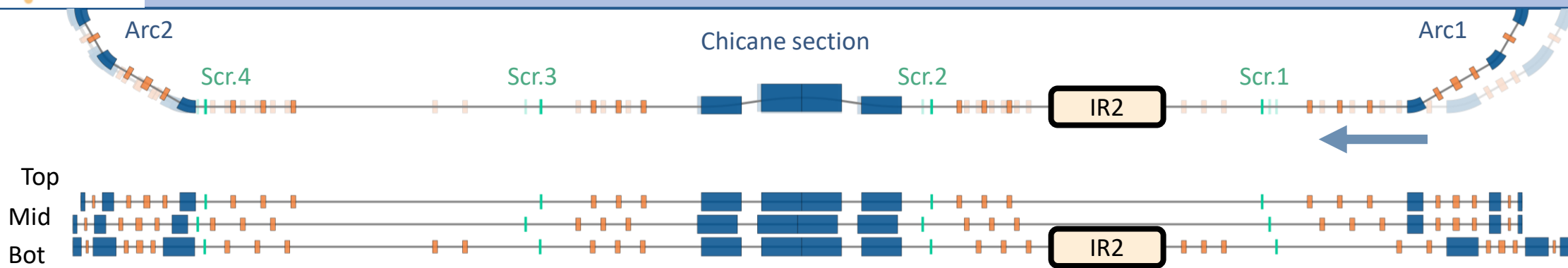
- 3 turn optics (no Straight sec.) matched with flexibility: found all solution respecting major constraints

Ongoing:

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



Lattice Design — Three Straight sections

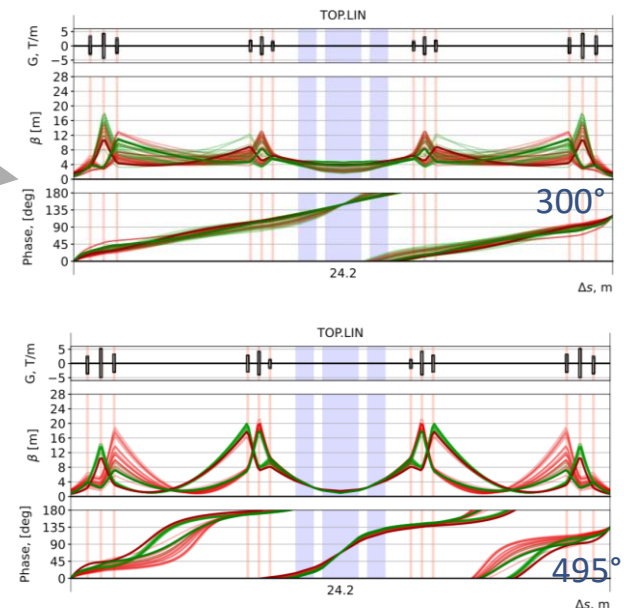
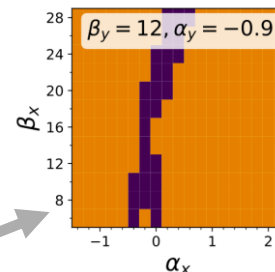


Structure

- Top.Lin (89 MeV) : symmetric, 4 quadrupole triplets → **12 quads**
- Mid.Lin (171 MeV) : symmetric, 4 quadrupole triplets → **12 quads**
- Bot.Lin (89, 253 MeV) : 2 + 3 + 3 + 3 + 2 + 3 → **16 quads**
- All Lines : chicane sections + 4 screens → **9 dipoles + 16 screens**

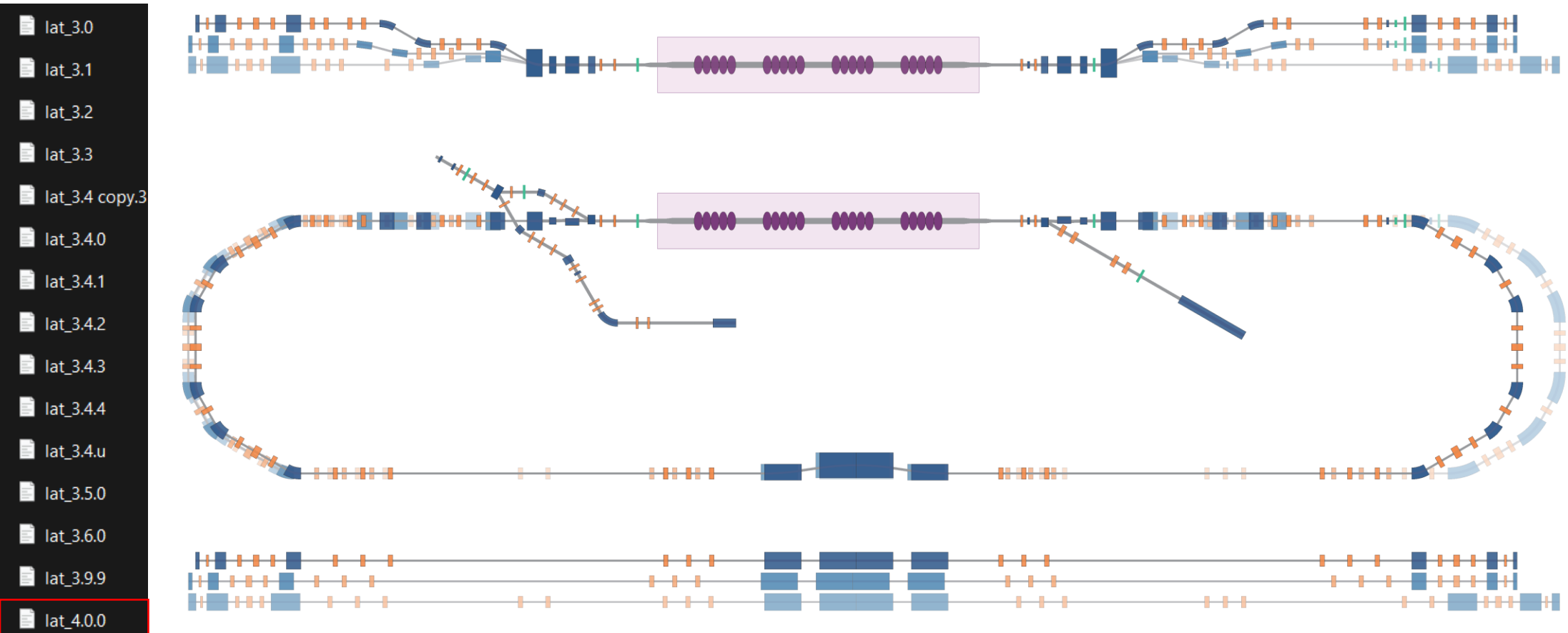
Capabilities:

- Flexible matching for **all valid compact-section optics solutions**
- **Transverse phase control** : full 180° rotation in x/y planes → beam **tomography** + **transmission** optimization
- **Longitudinal phase control** : $\pm 20^\circ$ (± 20.8 mm) → beam optimization for **transmission and experiments**



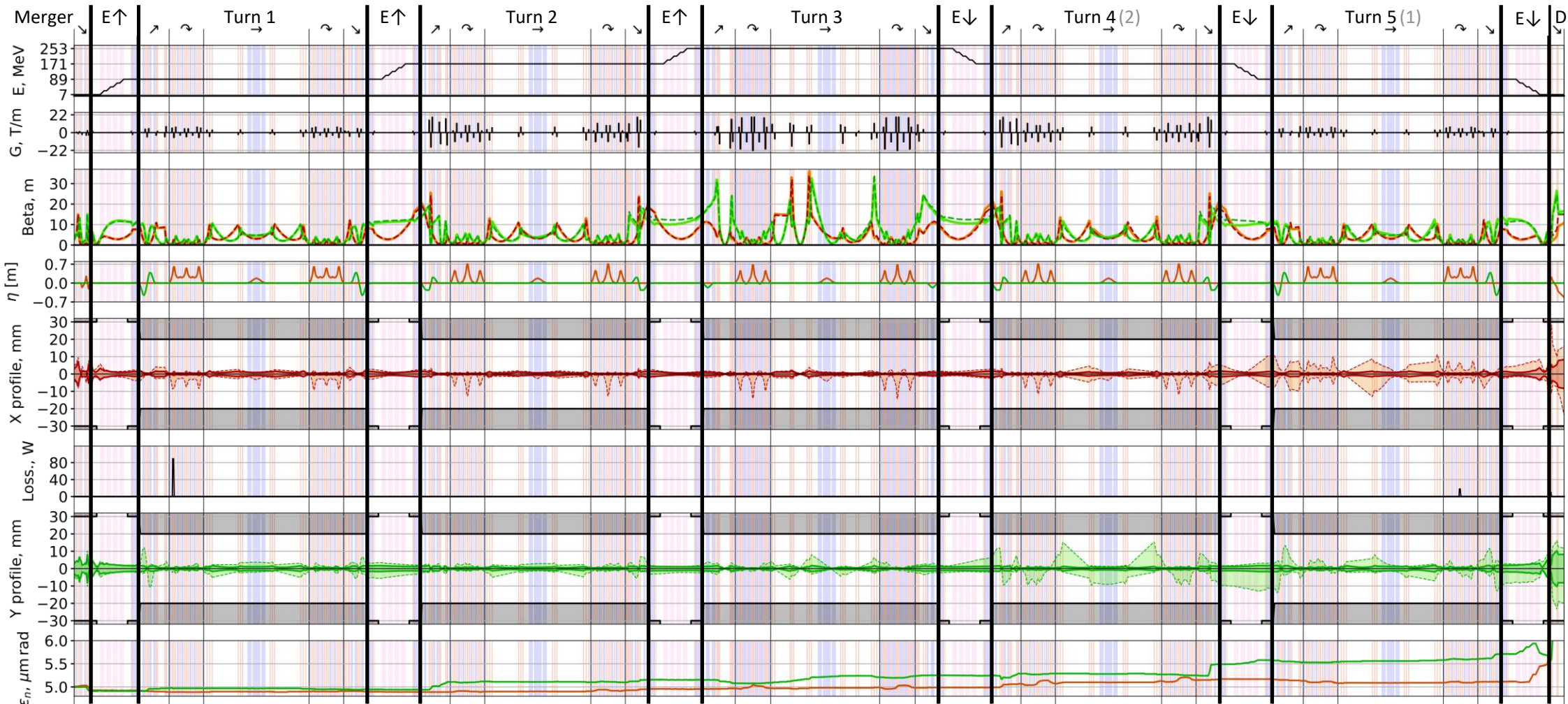


Avancement du lattice – version 4.0



Version finale du lattice → vérification **finale** avec la méca

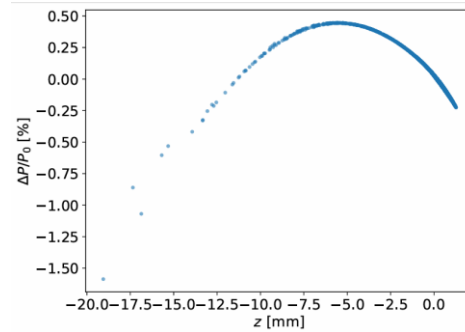
PERLE Lattice v4.0.0 — BMAD Tracking



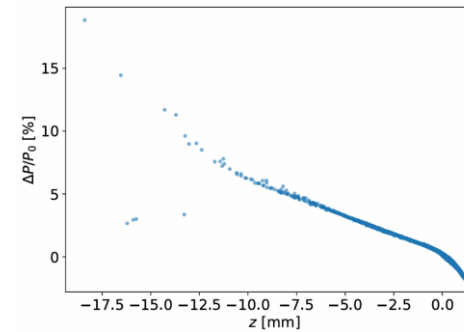


Absolute Time-Tracking:

After deceleration:
Without Time tracking



After deceleration:
With Time tracking



Ongoing Studies:

Adjusting path length
leading to deceleration

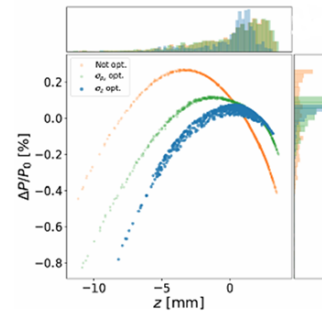
Longitudinal matching at IPs (1 Tour machine) :

- Done with absolute Time tracking
- Introduced a chirp through cavity phase
- Added R56 by Tuning quadrupoles in the merger and arc sections

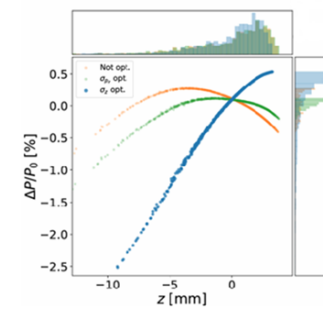
Future studies :

- Longitudinal matching for 3 tour machine
- RF field maps

IP1

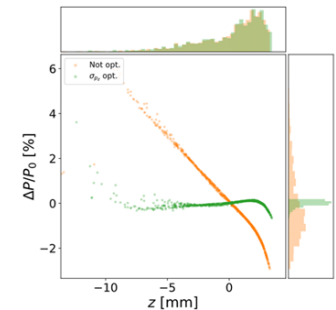


IP2



$\sigma_x: 3\text{mm} \rightarrow 2.73\text{mm}$
 $\sigma_{pz}: 0.2\% \rightarrow 0.17\%$

After Deceleration





Objectif : Étudier l'impact des non-linéarités des aimants du merger sur la formation du halo et les pertes de faisceau dans l'accélérateur.

- **Remplacer les modèle de quadrupole par des cartes de champ (FM)**

- > Faire correspondre optiquement le model Bmad et la FM
- > Retuner le merger avec les quad Bmad équivalent FM
- > Lancer le tracking avec les FM et observer les formation de Halo via le Hfactor
- (-> Réaliser ensuite l'étude avec des mauvais alignements du booster)

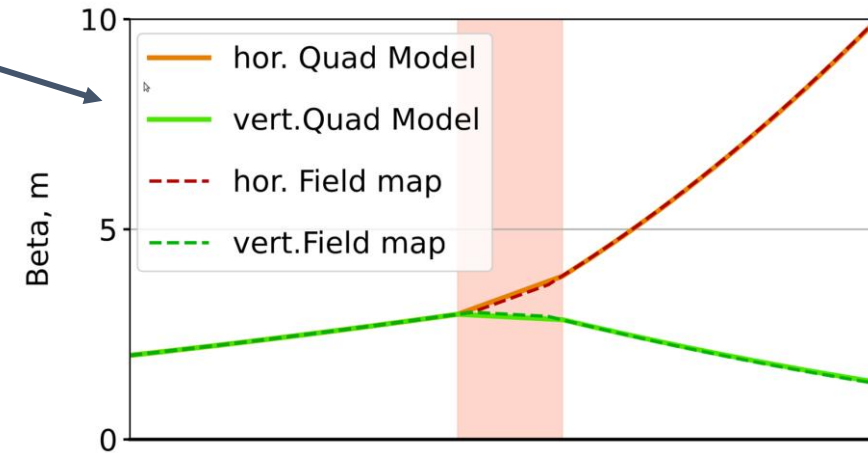
- **Comparer les FM avec des modèles multipolaires**

- > Objectif : simuler la lattice réelle plus rapidement qu'avec les FM

- **Comprendre les différences entre le modèle et les**

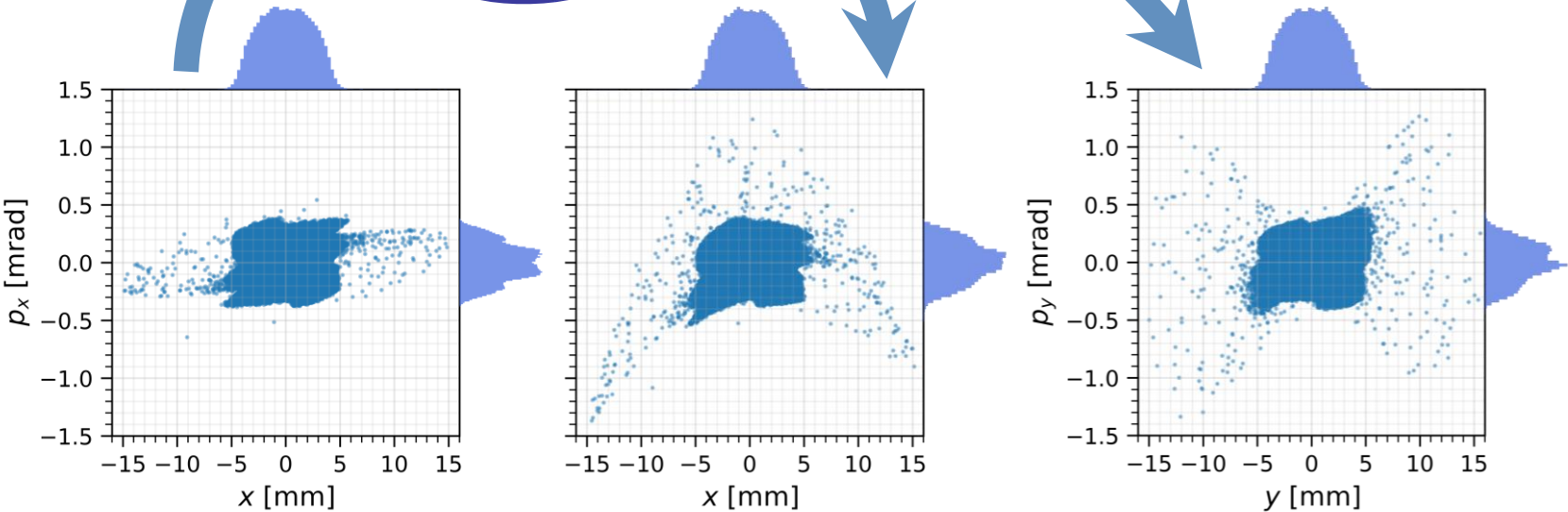
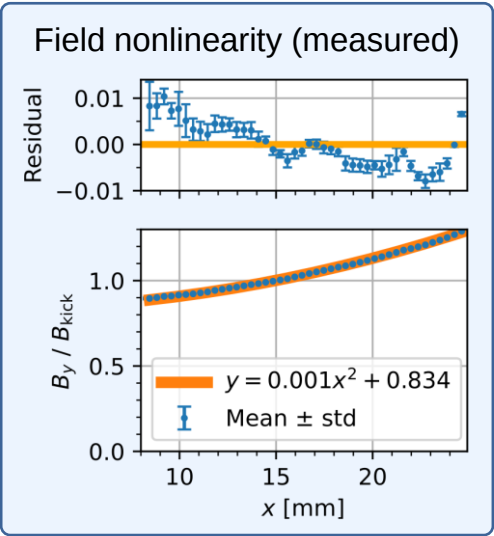
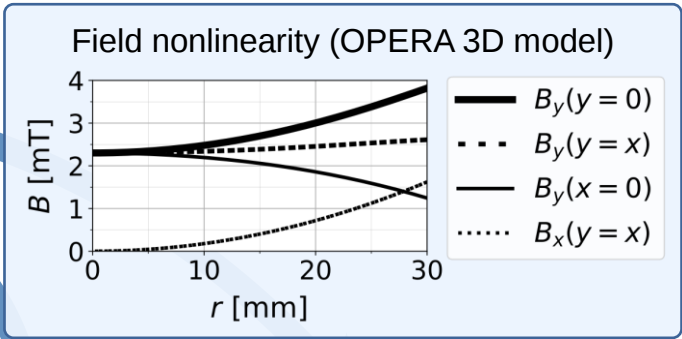
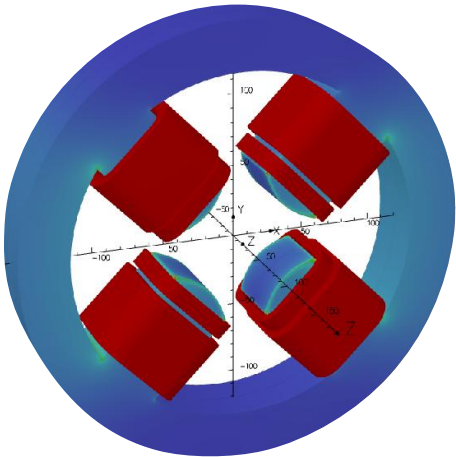
- **données fournies par Rasha**

- > Longueur du modèle quad ~ 7 cm, et 8.46 cm fournie par Rasha



Reproduction de la field map avec un modèle de quadrupole de Bmad
-> écart de l'ordre de 10^{-5} dans le plan horizontal et de 3% dans le plan vertical.

- 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





ERL 2026

International Workshop on Advanced Beam Dynamics for
Energy Recovery LINACS

14.-18. Sept. 2026

Mainz, Germany

Topics

- Beam Dynamics
- Sources
- Superconducting RF
- Applications
- Facilities
- Sustainability

REGISTRATION IS OPEN

Deadlines

Abstract Submission: **27.06.2026**
Early Bird Registration: **27.07.2026**

WP2 contributions :

- **R. Abukeshek** : *Design and Operational Flexibility of the PERLE Injection Chicane for Multi-Energy Operation*
- **A. Cieplak** : *Halo formation and beam losses*
- **A. Fomin** : *Optics Flexibility and Diagnostics in the PERLE Lattice Design*
- **J. Issa** : *Longitudinal Matching and Timing Control Studies for the Three-Turn PERLE ERL*
- **J. Michaud, invited** : *PERLE beam dynamics studies*



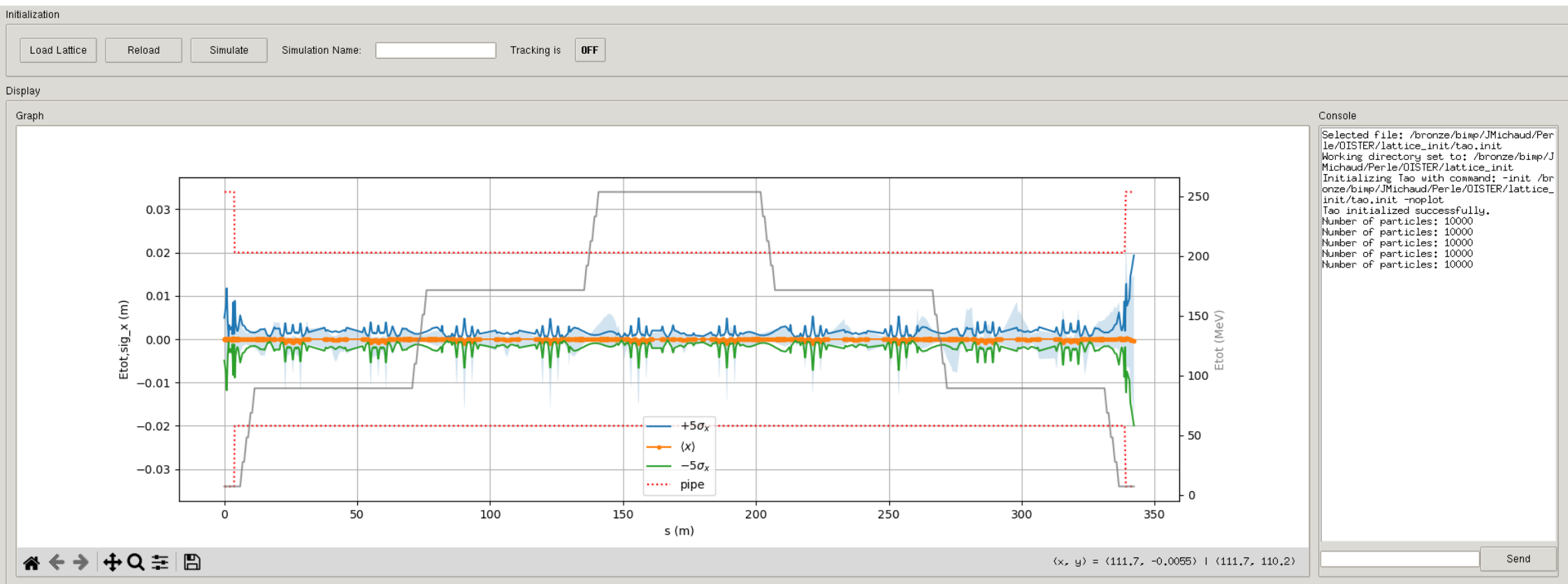
OISTERs : *O*rsay-based *I*nterface and *S*imulation *T*oolkit for *E*nergy *R*ecovery *S*ystems

- Simulation (bmad)
- Analyse
- Visualisation
- User-friendly
- Fonctionne pour toutes les machines (PERLE, ThomX...)





Visualisation efficacy





User-friendly

Importe le lattice. Choix de l'élément puis affichage

Simulation Lattice

Update calculated elements Draw lattice

SBend Quadrupole Lcavity Drift Monitor Marker

MERGER PASS_1 PASS_2 PASS_3 PASS_4 PASS_5 PASS_6

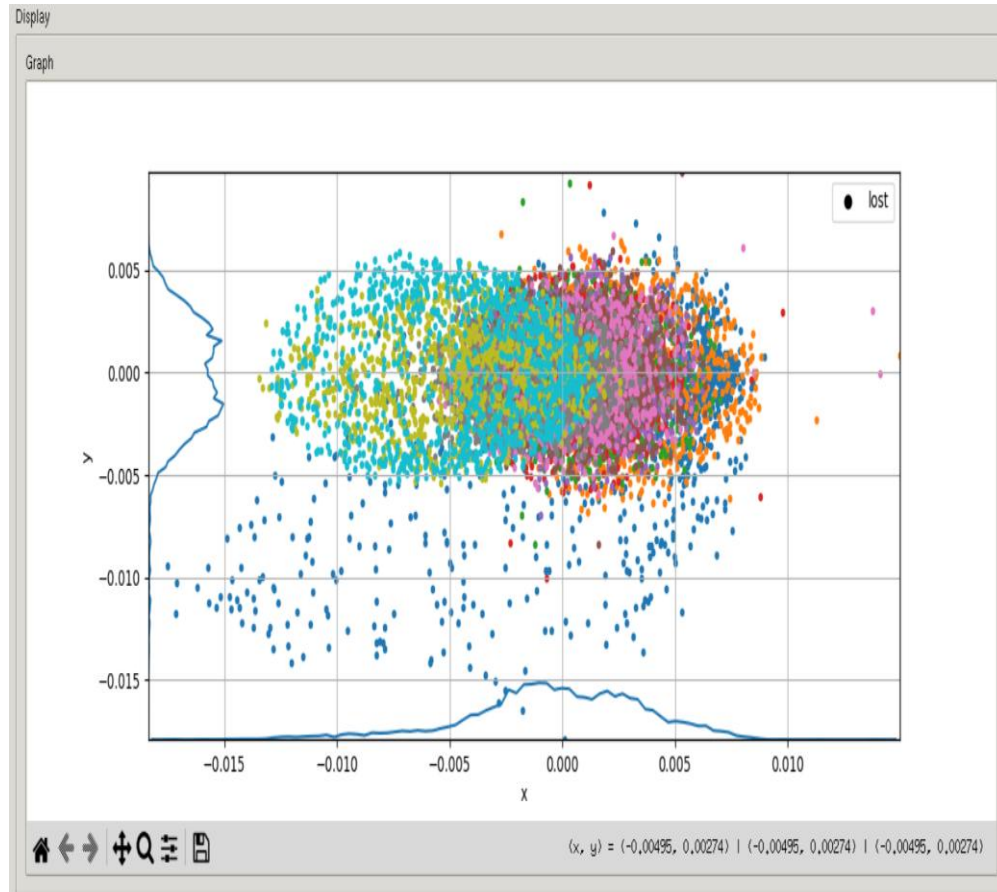
COM SPR ARC1 LIN ARC2 REC

☐ IGUI.PASS_3.COM Marker	☐ ICOM_P3 Marker	☐ COM.IN.0 Drift	☐ COM.IN.CHIC.12 SBend	☐ COM.IN.CHIC_12 Drift	☐ COM.IN.CHIC.22 SBend	☐ COM.IN.CHIC_22 Drift	☐ COM.IN.CHIC.32 SBend	☐ COM.IN.CHIC_3 Drift	☐ COM.IN.QUAD.1 Quadrupole
☐ COM.IN.QUAD_1 Drift	☐ COM.IN.COR.1 Drift	☐ COM.IN.COR_1 Drift	☐ COM.IN.QUAD.2 Quadrupole	☐ COM.IN.QUAD_2 Drift	☐ COM.IN.ICT.1 Monitor	☐ COM.IN.ICT_1 Drift	☐ COM.IN.BPM.1 Monitor	☐ COM.IN.BPM_1 Drift	☐ COM.IN.CAM.1 Monitor
☐ COM.IN.CAM_1 Drift	☐ TAP.60MM Monitor	☐ COM.IN.TAP_1 Drift	☐ TAP.100MM Monitor	☐ COM.IN.TAP_2 Drift	☐ ICRYO_P3 Marker	☐ ICRYO_SRT Monitor	☐ CMI Marker	☐ TAP.100MM_ Marker	☐ COM.ACC.0 Drift
☐ TAP.100MM_ Marker	☐ COM.ACC.TAP.1 Drift	☐ TAP.130MM_ Marker	☐ COM.ACC.TAP_1 Drift	☐ COM.ACC.RCAV.13 Lcavity	☐ COM.ACC.RCAV_1 Drift	☐ COM.ACC.RCAV.23 Lcavity	☐ COM.ACC.RCAV_2 Drift	☐ COM.ACC.RCAV.33 Lcavity	☐ COM.ACC.RCAV_3 Drift
☐ COM.ACC.RCAV.43 Lcavity	☐ COM.ACC.RCAV_4 Drift	☐ TAP.130MM_ Marker	☐ COM.ACC.TAP_2 Drift	☐ TAP.100MM_ Marker	☐ COM.ACC.TAP_2 Drift	☐ CMO Marker	☐ ICRYO_END Monitor	☐ COM.OUT.0 Drift	☐ TAP.100MM Monitor
☐ COM.OUT.TAP_1 Drift	☐ TAP.60MM Monitor	☐ COM.OUT.TAP_2 Drift	☐ COM.OUT.ICT.1 Monitor	☐ COM.OUT.ICT_1 Drift	☐ COM.OUT.QUAD.1 Quadrupole	☐ COM.OUT.QUAD_1 Drift	☐ COM.OUT.COR.1 Kicker	☐ COM.OUT.COR_1 Drift	☐ COM.OUT.QUAD.2 Quadrupole
☐ COM.OUT.QUAD_2 Drift	☐ COM.OUT.CHIC.13 SBend	☐ COM.OUT.CHIC_13 Drift	☐ COM.OUT.CHIC.23 SBend	☐ COM.OUT.CHIC_23 Drift	☐ COM.OUT.BPM.13 Monitor	☐ COM.OUT.BPM_13 Drift	☐ COM.OUT.CHIC.33 SBend	☐ COM.OUT.CHIC_3 Drift	☐ COM.OUT.CAM.1 Monitor
☐ COM.OUT.CAM_1 Drift	☐ TAP.60MM Monitor								



Simulation/visualisation/analyse

x/y at dump



z/E at DESTIN

