β* optics with PP (250 and 100 GeV)

- Previous Proposals
- 250GeV low beta
- 100GeV
  - Low Beta
  - 20m β*
- Summary

Beam Experiment Proposal

Experiment Number: 03-01

Beam Experiment Title: Test of optics with betastar=0.5m (pp at 100 GeV)

Spokesperson(s): F. Pilat

Status: Resubmit

Team: P. Cameron, A. Drees, F. Pilat, V. Ptitsyn, T. Satogata, S. Tepikian, D. Trbojevic, J. VanZeijts

Experiment Goal: To verify optics, power supply settings, ramp to betastar=0.5m To characterize the optics (measure of orbit, betas and dispersion, tune shifts, luminosity, lifetime, nonlinear effects)

Benefits: Luminosity increase at IP8 (Phenix) Operational flexibility Test of machine upgrade options (beta star reduction) Measurement of enhanced non-linear effects

Experiment Description:

The experiment can be performed in 2 ways: squeeze to beta star =0.5 on the ramp (similarly to what has been done for all configurations at RHIC so far) or at flattop, squeezing in IP8 from 1m to 0.5m. The latter is the preferred choice if a ramp with constant beta-star is planned for the polarized proton run. Once the squeeze is achieved the following quantities should be measured at flattop to characterize the optics: orbit, tunes, coupling, betas, dispersion. Performance assessed by measurement of lifetime and determination of luminosity. After tune, orbit and coupling adjustments, nonlinear effects measurements with IR bumps in 7 and 8 o`clock (blue and yellow) and online corrections.

First, essential the logging of all data and correlations Analysis of beta, dispersion and tune by comparison with betastar=2m and 1m data, comparison with online model Analysis of nonlinear effects again by comparison of beam data with betastar = 1 and 2 m, and comparison with the offline model.

Beam Experiment Proposal

Experiment Number: 03-37

Beam Experiment Title: Optics and Transport for pp2pp

Spokesperson(s): T. Satogata, W. Guryn

Status: Completed

Team: Todd Satogata, Mei Bai, Peter Cameron, Angelika Drees, Steve Tepikian

Experiment Goal: Demonstrate accurate (c. 1-5%) betatron function and transport matrix measurements in the IR2 Q4-Q4 area, for pp2pp setup as well as feasibility of routine machine operations optics measurements.

Benefits: This experiment directly benefits both pp2pp operations (an accurate measure of their transport is required), and routine RHIC operations if optics measurements are demonstrated that do not destroy beam stability. One side effect of this experiment is the best measure of the IP2 beta* as present in the run.

Experiment Description:

A. Measure beta functions at outgoing quads by tweaking quads and measuring changes in tunes with the PLL system. Variations in quads will be such that tunes change by up to 0.01, with 5-7 settings per quad. This requires perhaps 10 minutes per quad once we`re set up. PLL has to be working, and we`d prefer six bunches in the machine, though it can be done at the end of a store if necessary. Pete Cameron and Todd/ Angelika could be involved. B. AC dipole measurements, similar to Mei`s that are already collected, but we should tweak a quad and have two baseline measurements so we can calibrate the optics calculations. Mei and Todd are probably the appropriate people for this.

Beam Experiment Proposal

Experiment Number: 08-40

Beam Experiment Title: Optics for Beta* = 20m, (pp2pp at 100GeV)

Spokesperson(s): S. Tepikian, W. Guryn

Status: Proposed

Team: A. DellaPena, W. Guryn, F. Pilat, V. Ptitsyn, T. Satogata, S. Tepikian

Experiment Goal:

A test to achieve large Beta* optics for the pp2pp experiments. Study aperture limitations, basic optics (dispersion, orbit, tune shifts, and transfer matrix) at Roman Pot (RP). Furthermore, nonlinear effects from the triplets will be addressed.

Benefits:

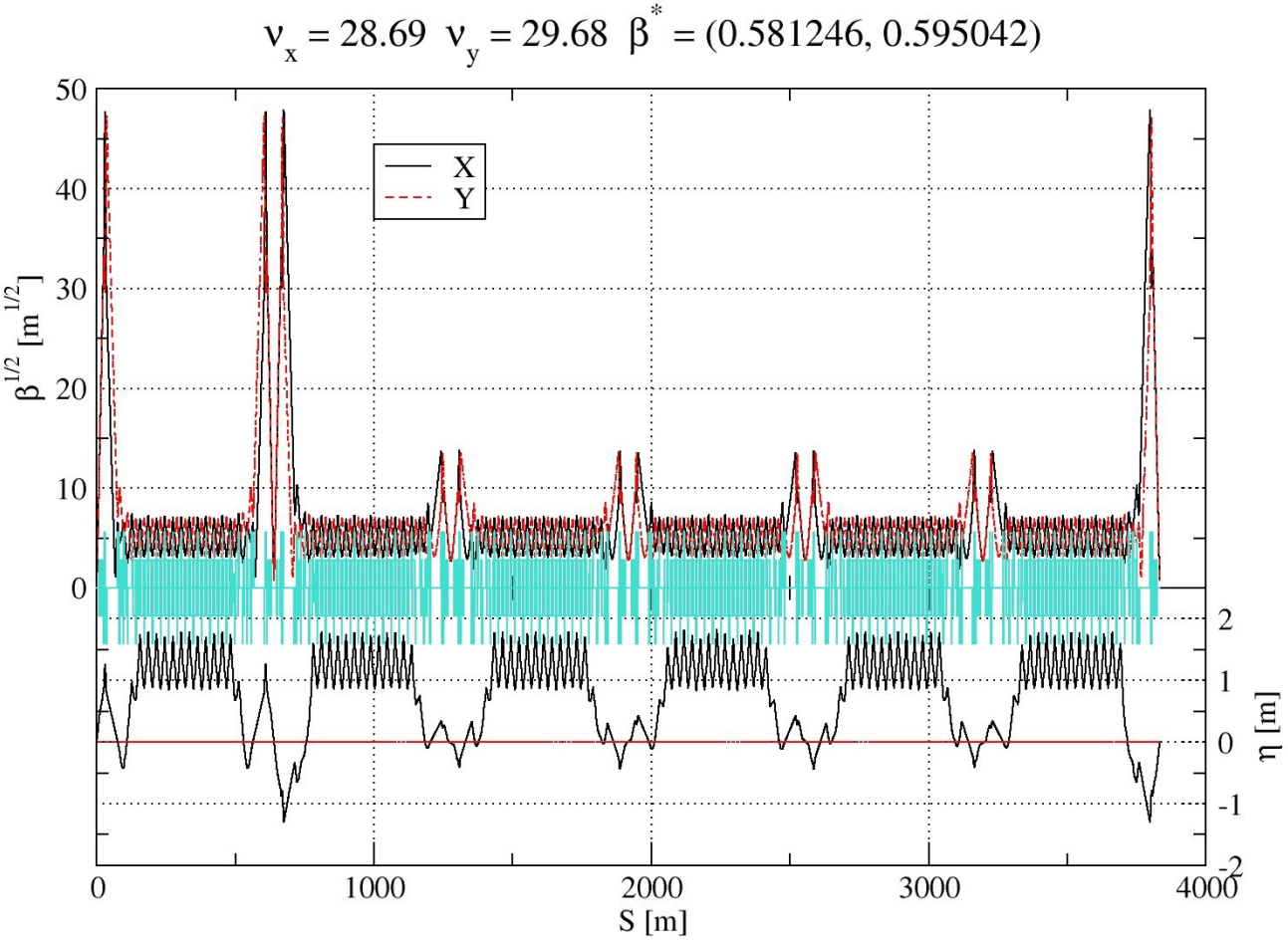
This experiment is to achieve a large Leff of ~27.5m at the Roman Pot used by pp2pp in Run 2008-2009. Beta functions of ~90m in the triplets. Long term benefits is to understand large aperture beam behavior in the triplets, needed for a future Beta* = 0.5m operation.

Experiment Description:

The normal pp80 optics squeezes the optics from Beta*=10m at injection to Beta*=2m at flattop, then down to Beta*=0.9m at beta0p9 stone. For this experiment, we will unsqueeze IP6 from Beta*=2m at flattop to Beta*=20m at the beta0p9 stone. Thus, we only have to develop this ramp from flattop through store. The ramp will be a 100GeV ramp. When at store, measure the on axis transfer matrix, then measure off-axis nonlinear effects using the IRBump application.

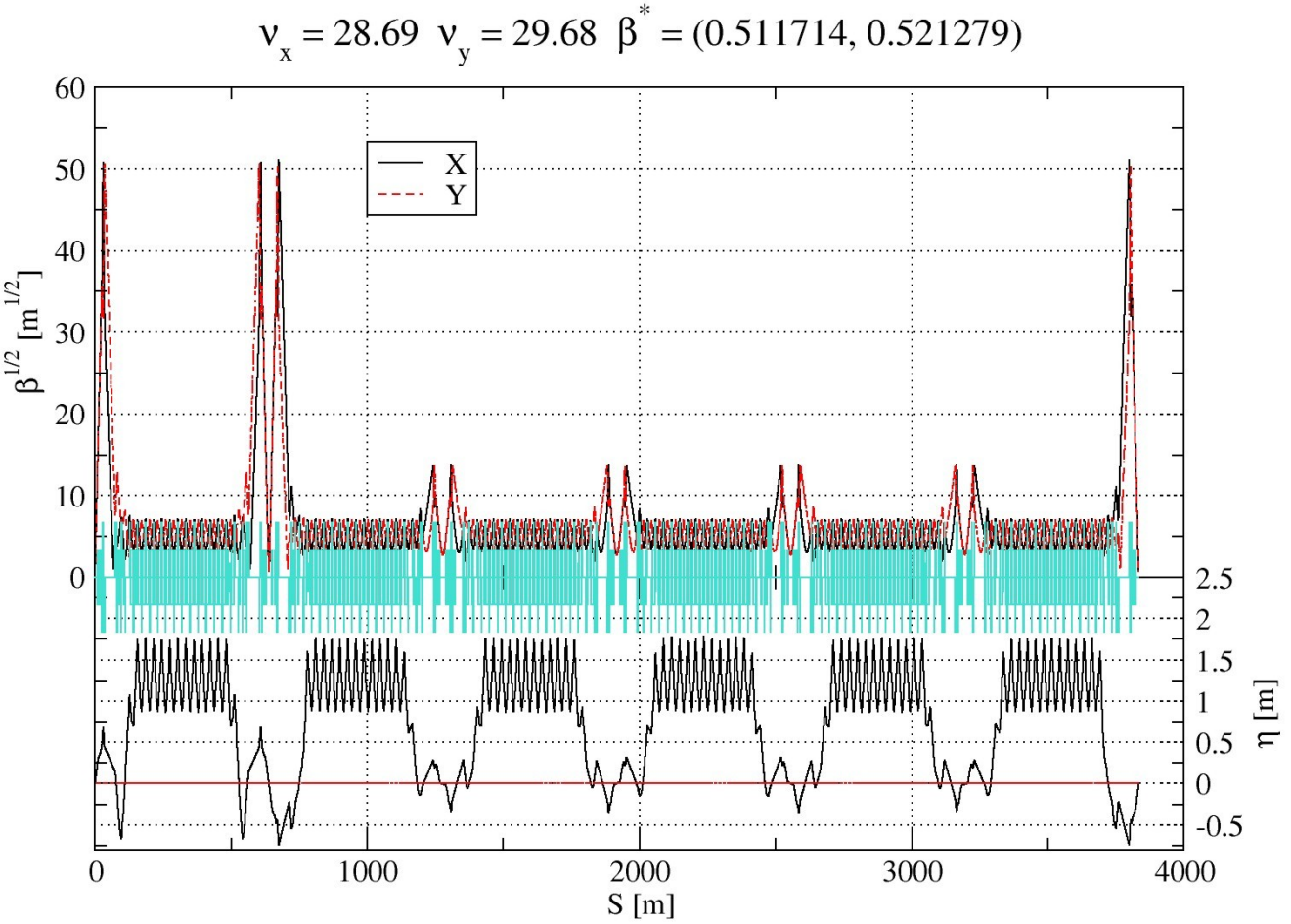
β* optics with PP (250 and 100 GeV)

- 250GeV pp
- Requested 0.5m β*
- Limited by the trim quad power supplies and the Q89 bipolar supply
- Large dispersion in the triplets



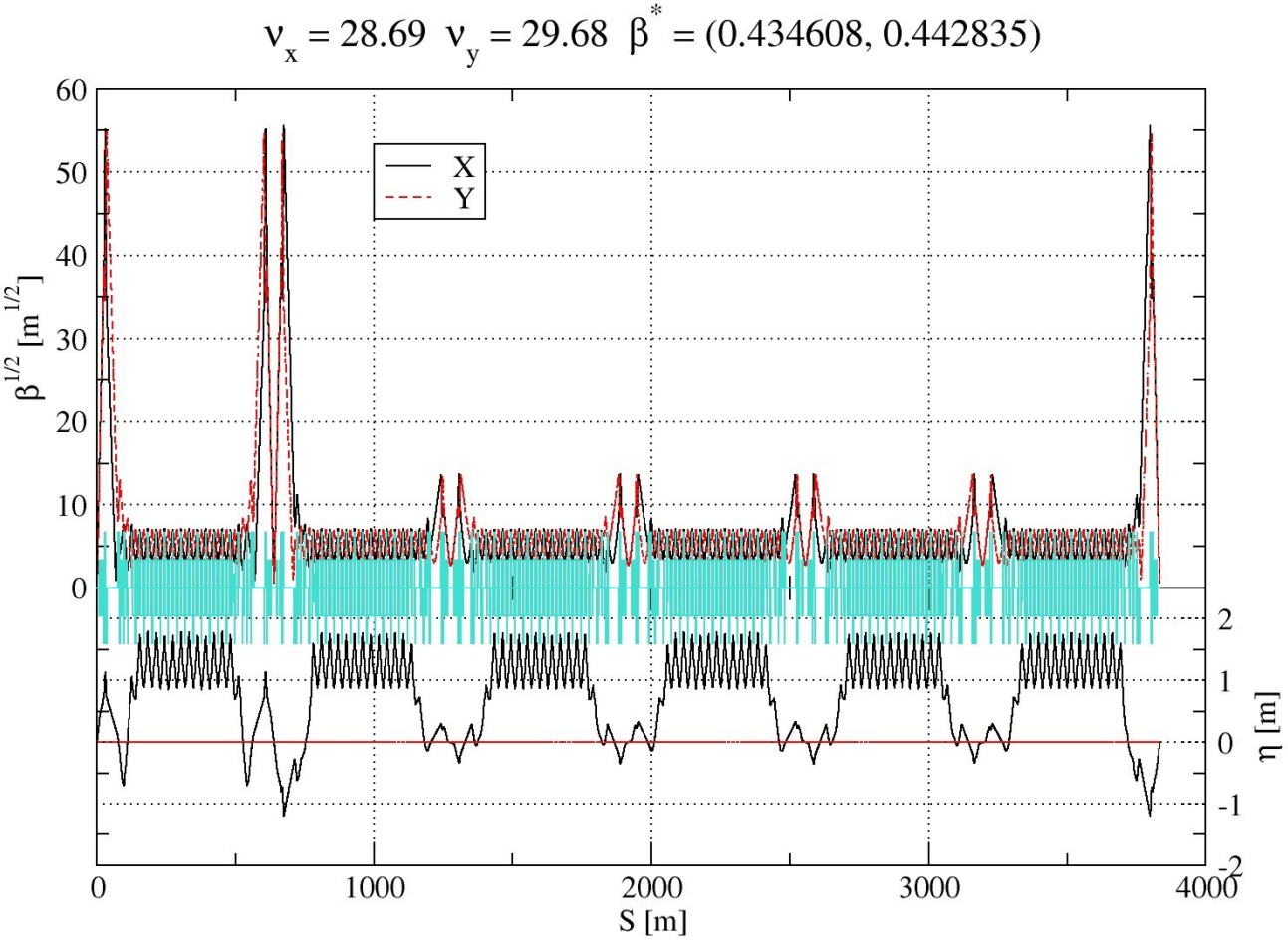
β* optics with PP (250 and 100 GeV)

- 100GeV pp
- Requested β* 0.5m
- Moderate Dispersion in the triplets



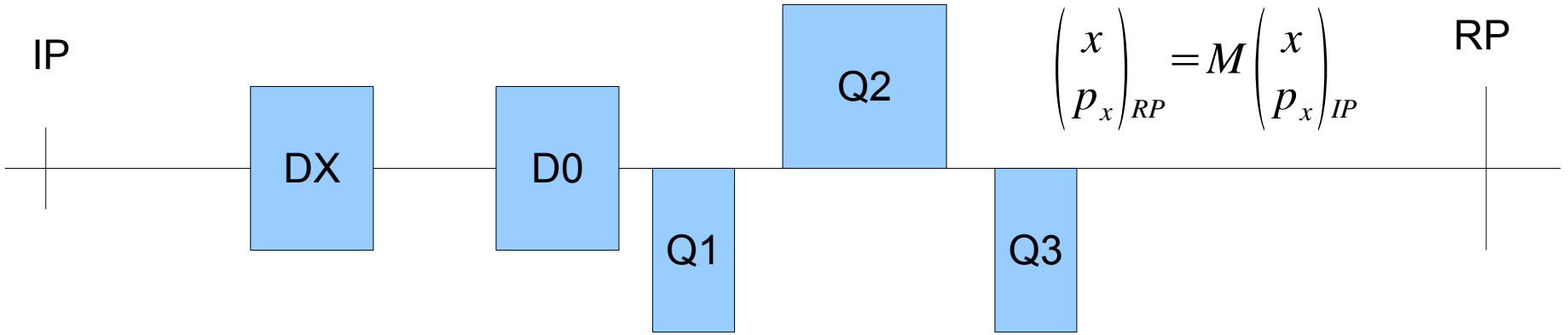
β* optics with PP (250 and 100 GeV)

- 100GeV pp
- Requested β* 0.4m
- Large Dispersion in the triplets



β* optics with PP (250 and 100 GeV)

PP2PP – Coulomb (Elastic) scattering experiment

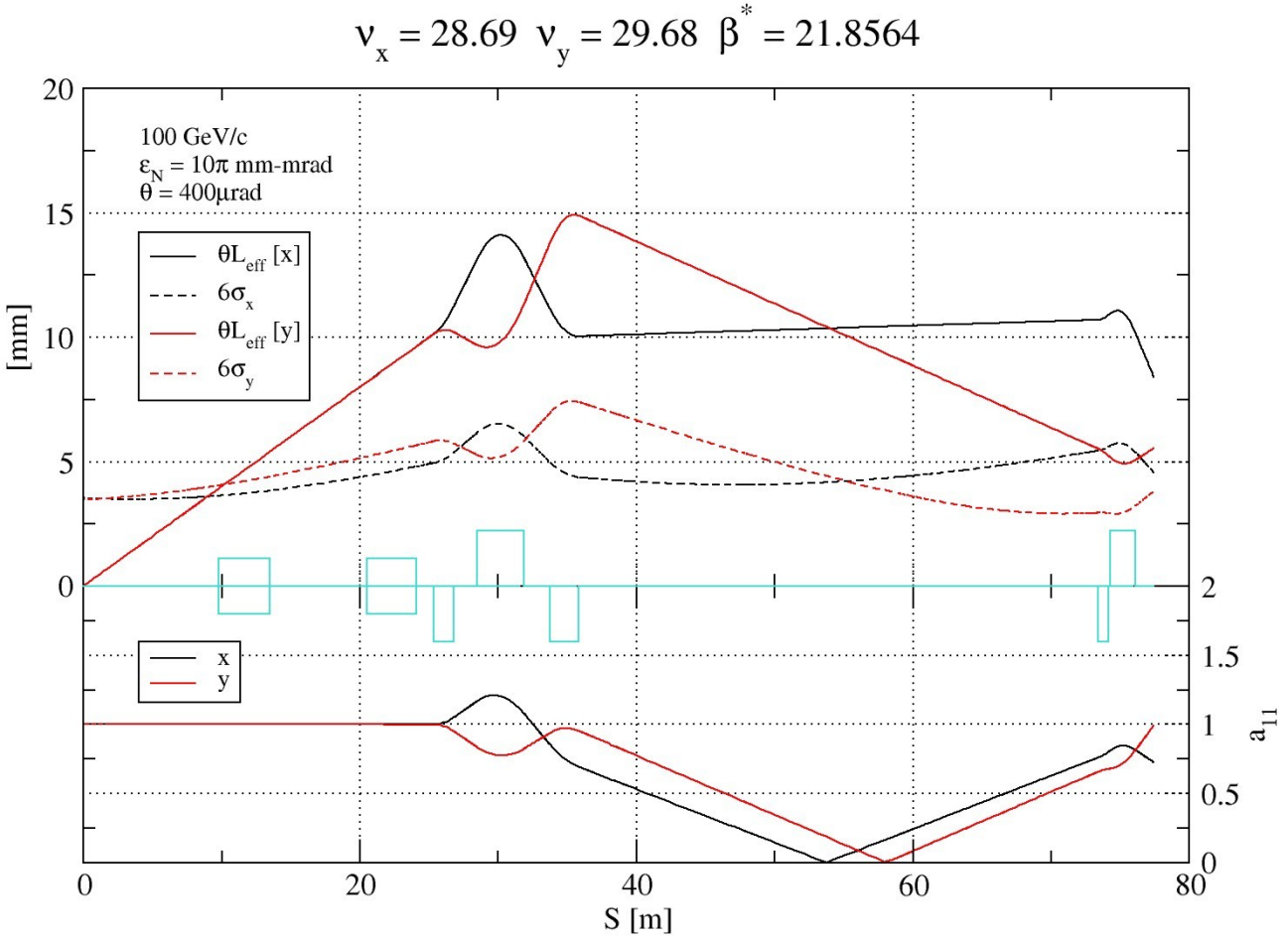


$$M = \begin{bmatrix} a_{11} & L_{eff} \\ a_{21} & a_{22} \end{bmatrix} = \begin{bmatrix} \sqrt{\frac{\beta_{RP}}{\beta_{IP}}}\left(\cos(\Psi)+\alpha_{IP}\sin(\Psi)\right) & \sqrt{\beta_{IP}\beta_{RP}}\sin(\Psi) \\ \frac{(1+\alpha_{IP}\alpha_{RP})\sin(\Psi)+(\alpha_{IP}-\alpha_{RP})\cos(\Psi)}{\sqrt{\beta_{IP}\beta_{RP}}} & \sqrt{\frac{\beta_{IP}}{\beta_{RP}}}\left(\cos(\Psi)-\alpha_{RP}\sin(\Psi)\right) \end{bmatrix}$$

$$a_{11} \approx 0 \quad \Rightarrow \quad \Psi = \frac{\pi}{2} \quad \Rightarrow \quad L_{eff} = \sqrt{\beta_{IP}\beta_{RP}}$$

β* optics with PP (250 and 100 GeV)

- 100GeV PP2PP
- Roman Pots
  - Hor – 55.5m
  - Vert – 58.5m
  - 12 ~ 15σ from beam center
- L_{eff}
  - Hor ~ 26m
  - Vert ~ 23m

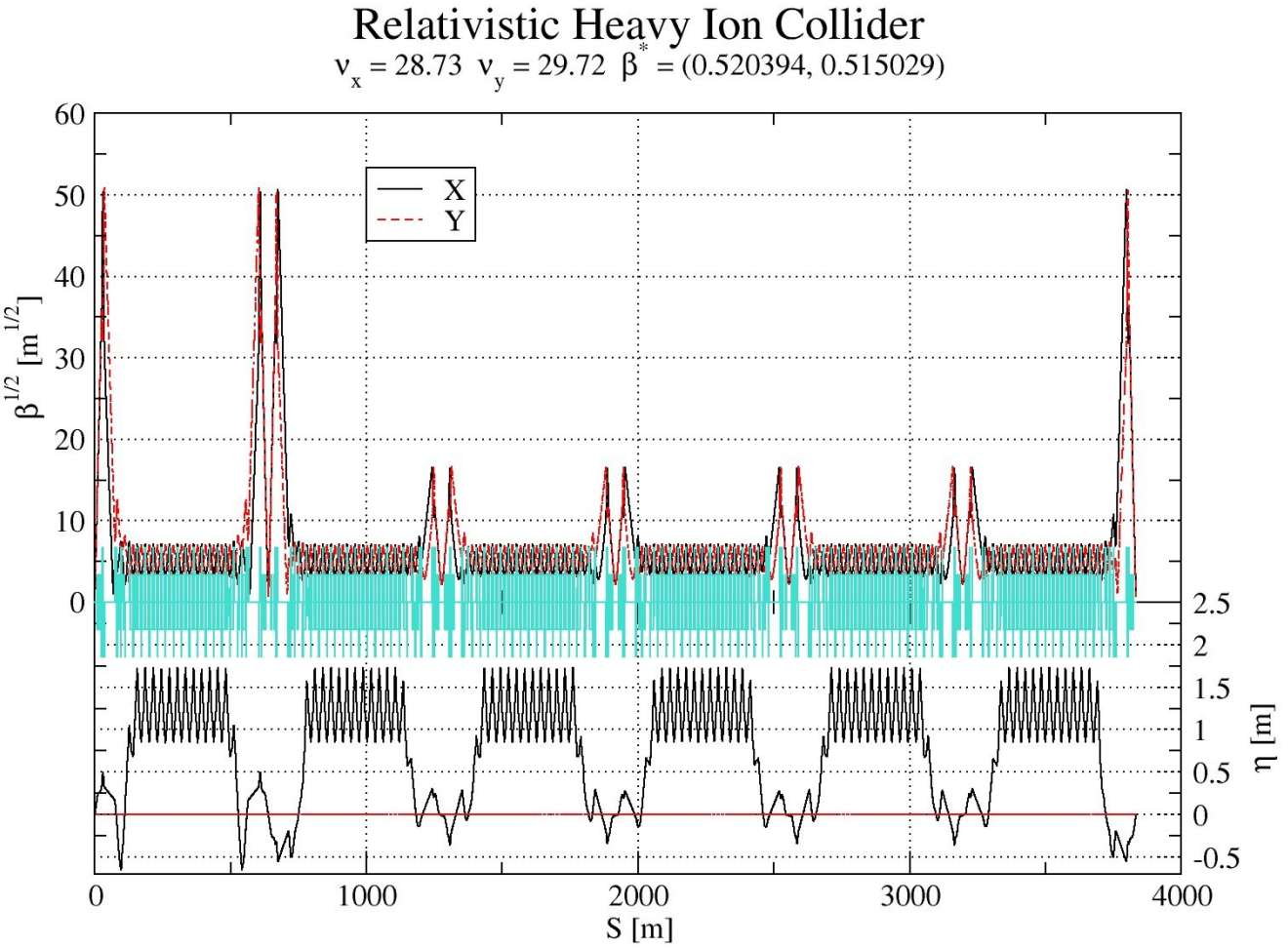


Summary

- Propose low β* experiments
  - 100GeV pp: 0.4m β*
  - 250GeV pp: 0.5m β*
  - Measure the optics functions
  - Determine dynamic aperture
- Propose 20m β* experiments for pp2pp
  - Develop ramp for 20m β*
  - Measuring the beam transfer function from IP to RP

Original Fit

- 100GeV pp
- Requested β* 0.5m
- Older fit with 5m β* in non-colliding IRs.
- Older tunes.
- Low dispersion in the triplets



Original Fit

- 100GeV pp
- Requested β* 0.4m
- Older fit with 5m β* in non-colliding IRs.
- Older tunes.
- Moderate dispersion in the triplets