RHIC 2001–2 Linear Lattice Issues

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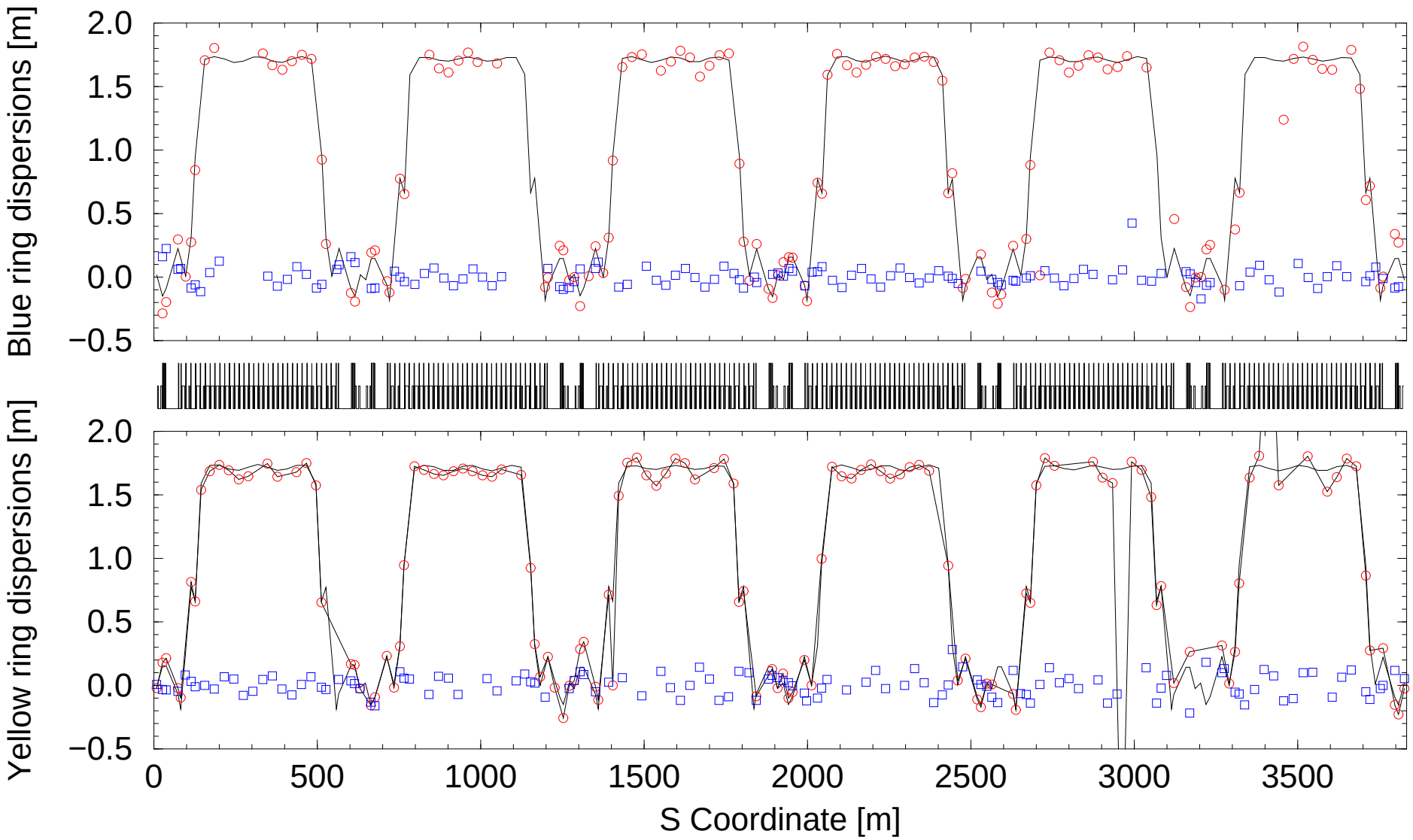
- Optics Inventory
- Dispersion
- Beta Measurement Methods
- Beta Measurement Results
- Comments and Observations
- Recommendations

RHIC 2001–2 Optics Inventory			
Species	**Dates**	**Description ($\beta^\star$)**	**Ramp id**
Au-Au	May 24–Aug 13	10 m $\rightarrow$ 5 m	ramp9
Au-Au	Aug 14–Oct 5	10 m $\rightarrow$ 5 m	ramp19
Au-Au	Oct 6–Oct 30	10 m $\rightarrow$ 2 m	ramp20
Au-Au	Nov 1–Nov 25	10 m $\rightarrow$ 2 m (IP8 1m)	ramp21
Au-Au	Nov 25–Nov 26	3 m (injection only)	spin1
$\vec{p}$-$\vec{p}$	Nov 30–Jan 23	3 m $\rightarrow$ 3 m	spin2
$\vec{p}$-$\vec{p}$	Jan 23–Jan 24	3 m $\rightarrow$ 3 m (IP2 10m)	spin4

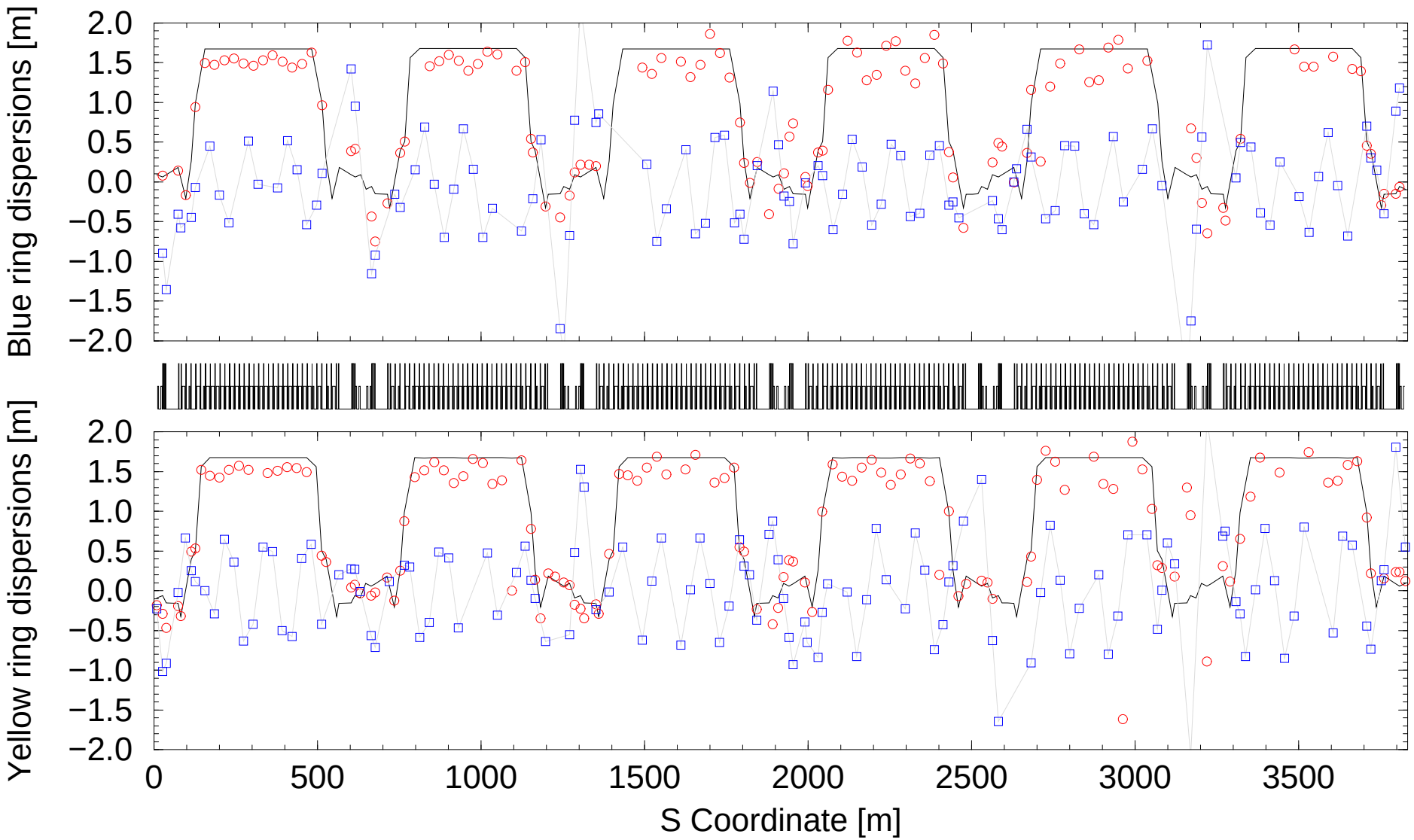
Linear Lattice Issues: Injection Dispersion

- **Oct 18 (Blue), Oct 30 (Yellow)** ($\beta^\star$=10m)



Linear Lattice Issues: Storage Dispersion

- **Oct 31 Beam Studies** ($\beta^\star$=2m, IP8=1m)

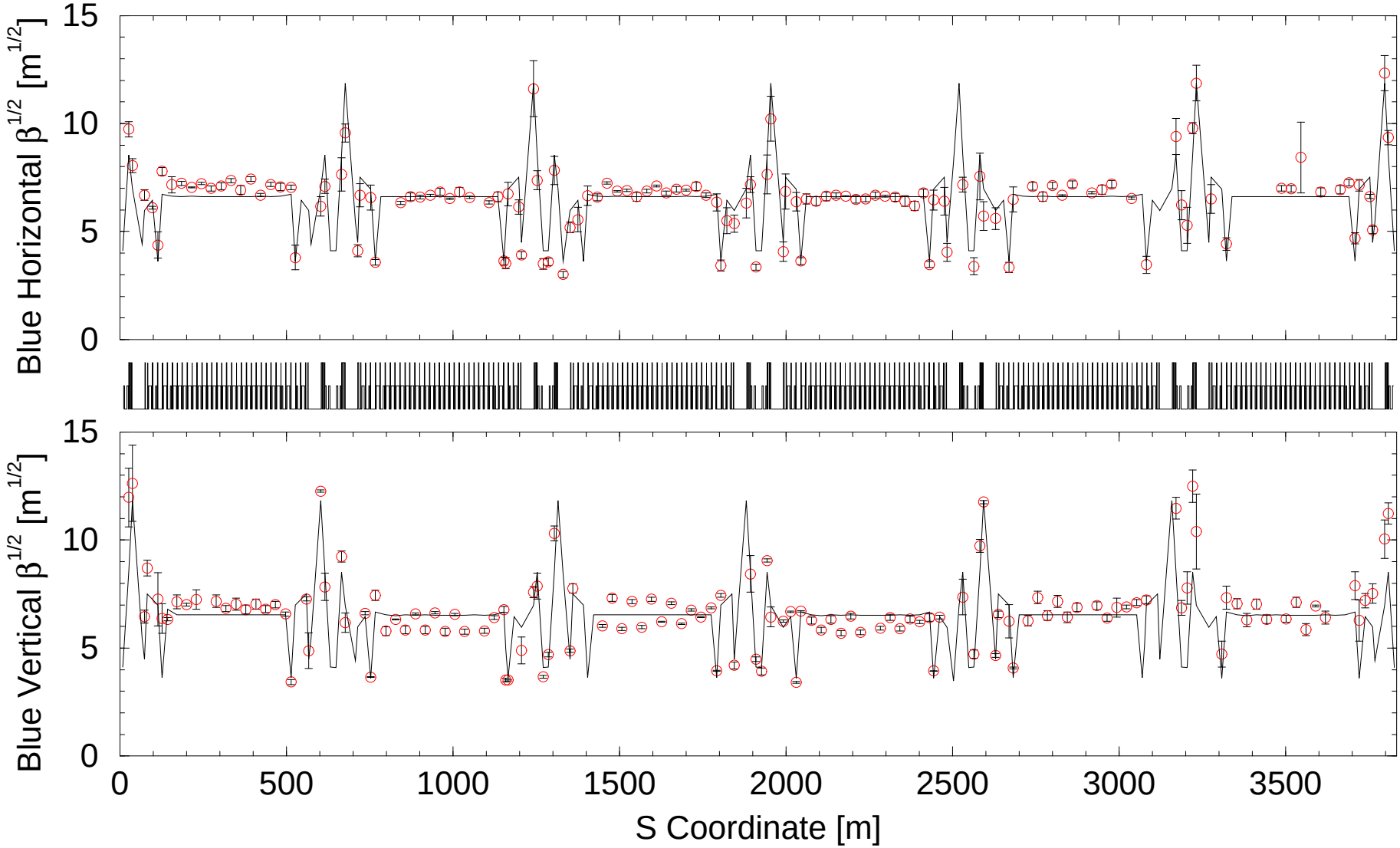


Linear Lattice Issues: Beta Methods

- **Difference Orbits** (some data, Javier Cardona)
  - ✓ *Moderate speed, excellent signal-to-noise, injection/flattop*
  - ✗ *Position domain, susceptible to BPM cals, not parasitic*
- **Injection Oscillation** ($\sim$450 orbits each Au/$\vec{p}$-$\vec{p}$)
  - ✓ *Fast, quite robust, good signal, parasitic*
  - ✗ *Only works at injection, decoherence issues*
- **Tune Kicker** ($\sim$100 orbits each Au/$\vec{p}$-$\vec{p}$)
  - ✓ *Fast, parasitic on ramp, at storage*
  - ✗ *Multiple kicks required for good signal, decoherence issues*
- **Quadrupole Response** (IP8 $\beta^\star$=1m, pp2pp)
  - ✓ *Good for triplet optics verification, great with PLL*
  - ✗ *Slow, very dedicated, susceptible to tune space/beam loss, only triplets*
- **AC Dipole** (one data set, Mei Bai)
  - ✓ *Best response in TBT analysis, no decoherence*
  - ✗ *Slow, requires extensive setup, not parasitic*
- **Many methods!** All susceptible to coupling; attack both together

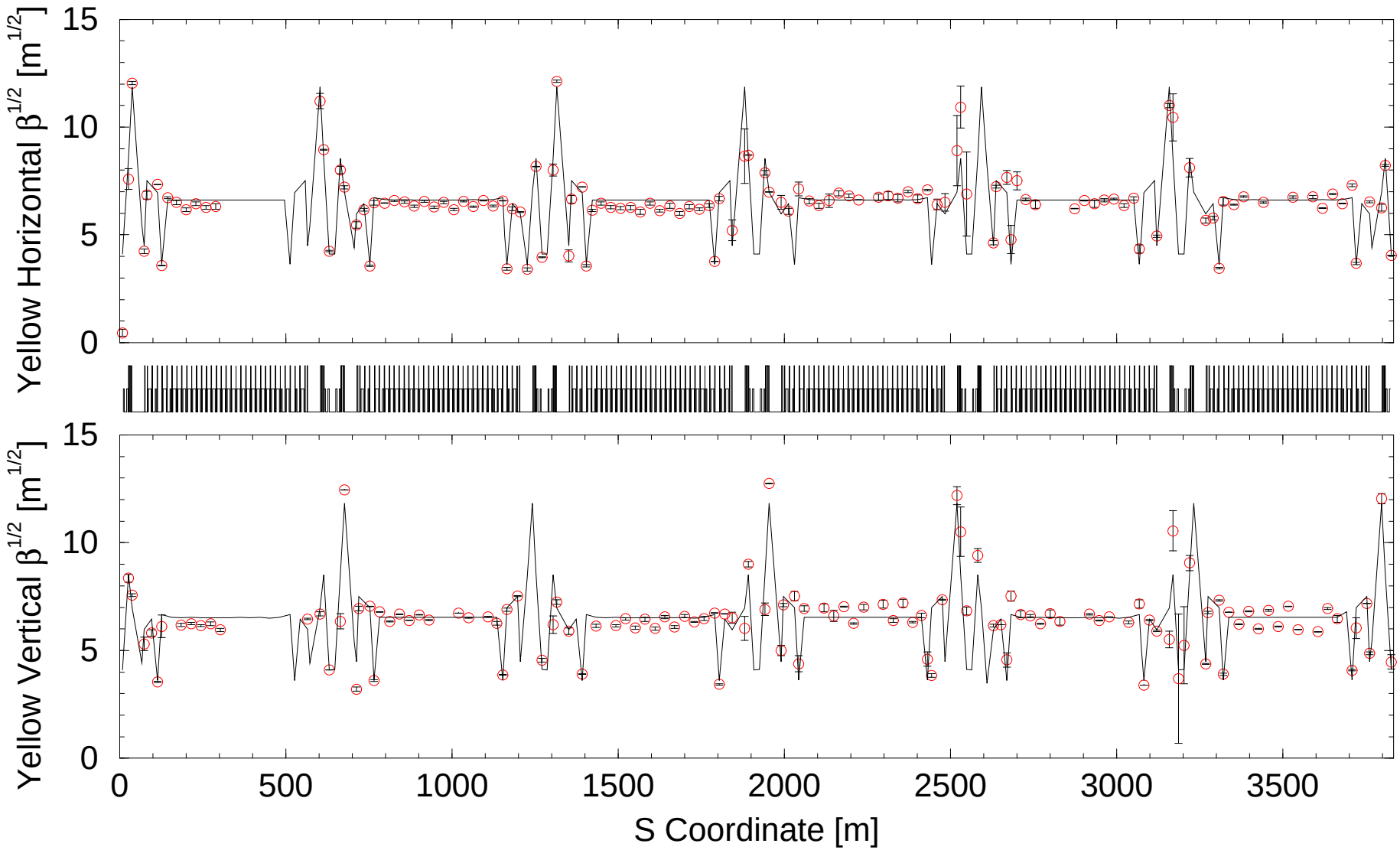
Linear Lattice Issues: Beta at Injection

- **Oct 25 Beam Studies** ($\beta^\star$=10m, Blue ring, 4 injections, store 01475)



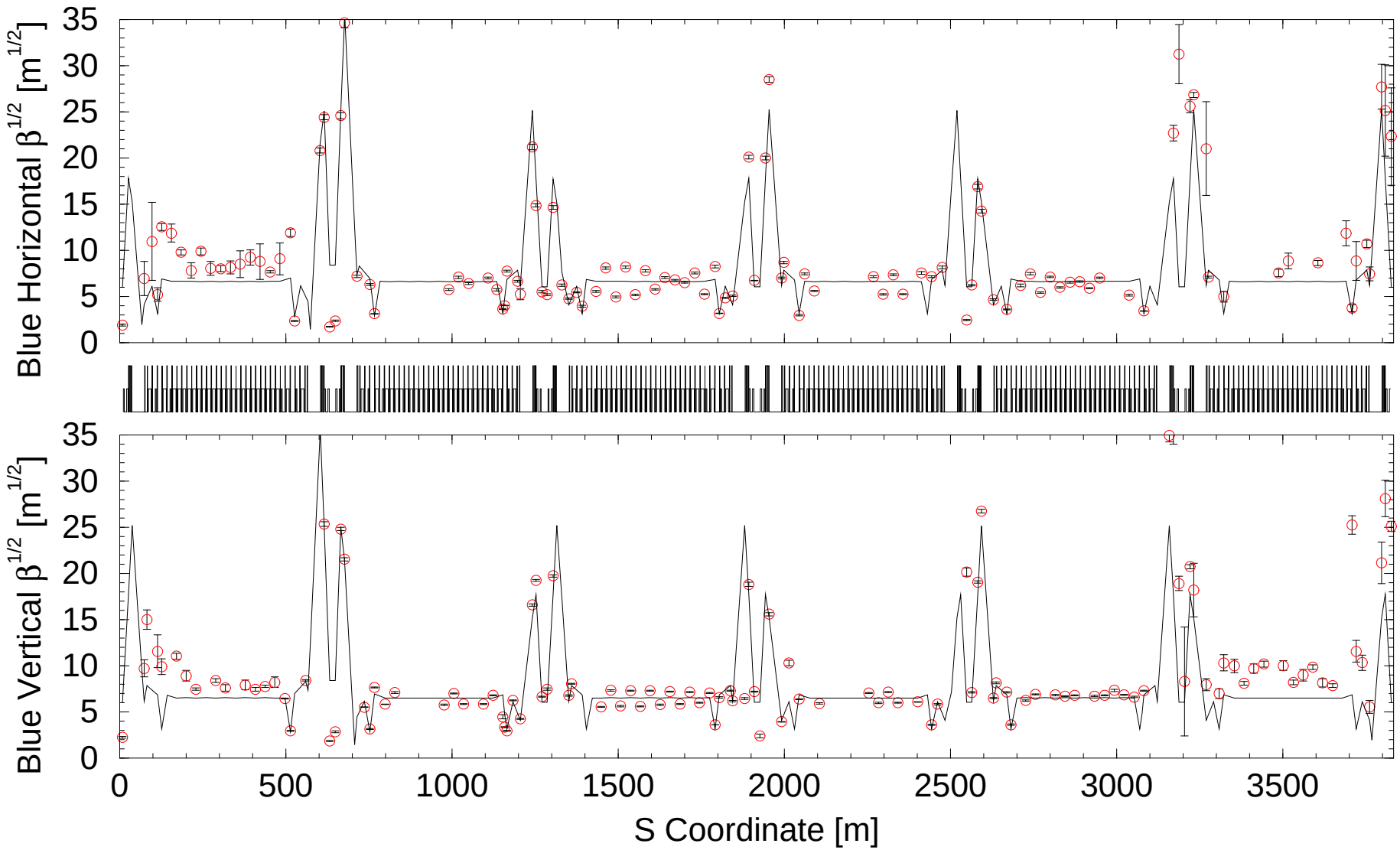
Linear Lattice Issues: Beta at Injection

- **Oct 25 Beam Studies** ($\beta^\star$=10m, Yellow ring, 3 injections, store 01475)



Linear Lattice Issues: Beta at Storage

- **Nov 16 Operations** ($\beta^{\star}$=2/1m, Blue ring, store 01770)



Linear Lattice Issues: Beta at Storage

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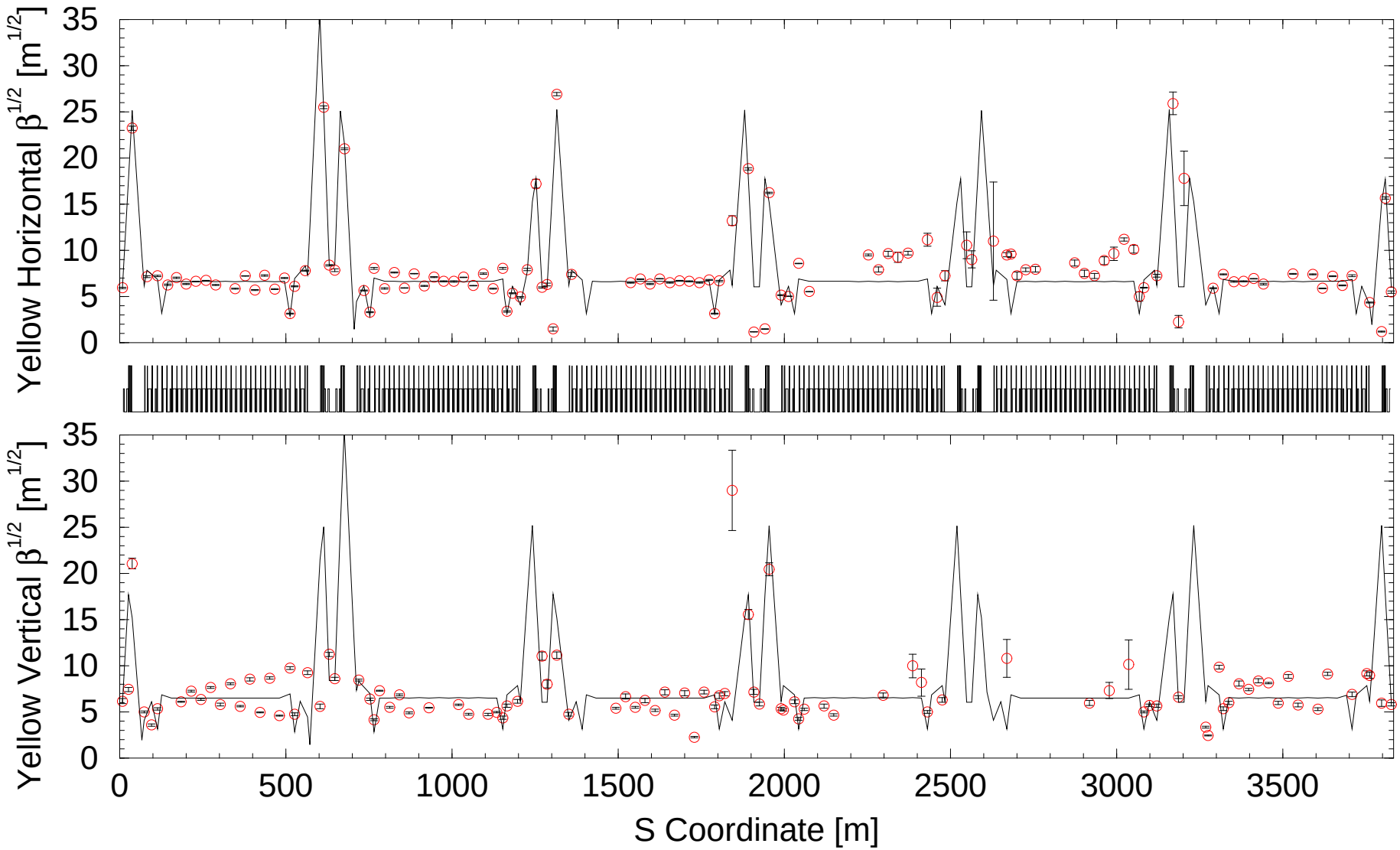


Linear Lattice Issues: Comments

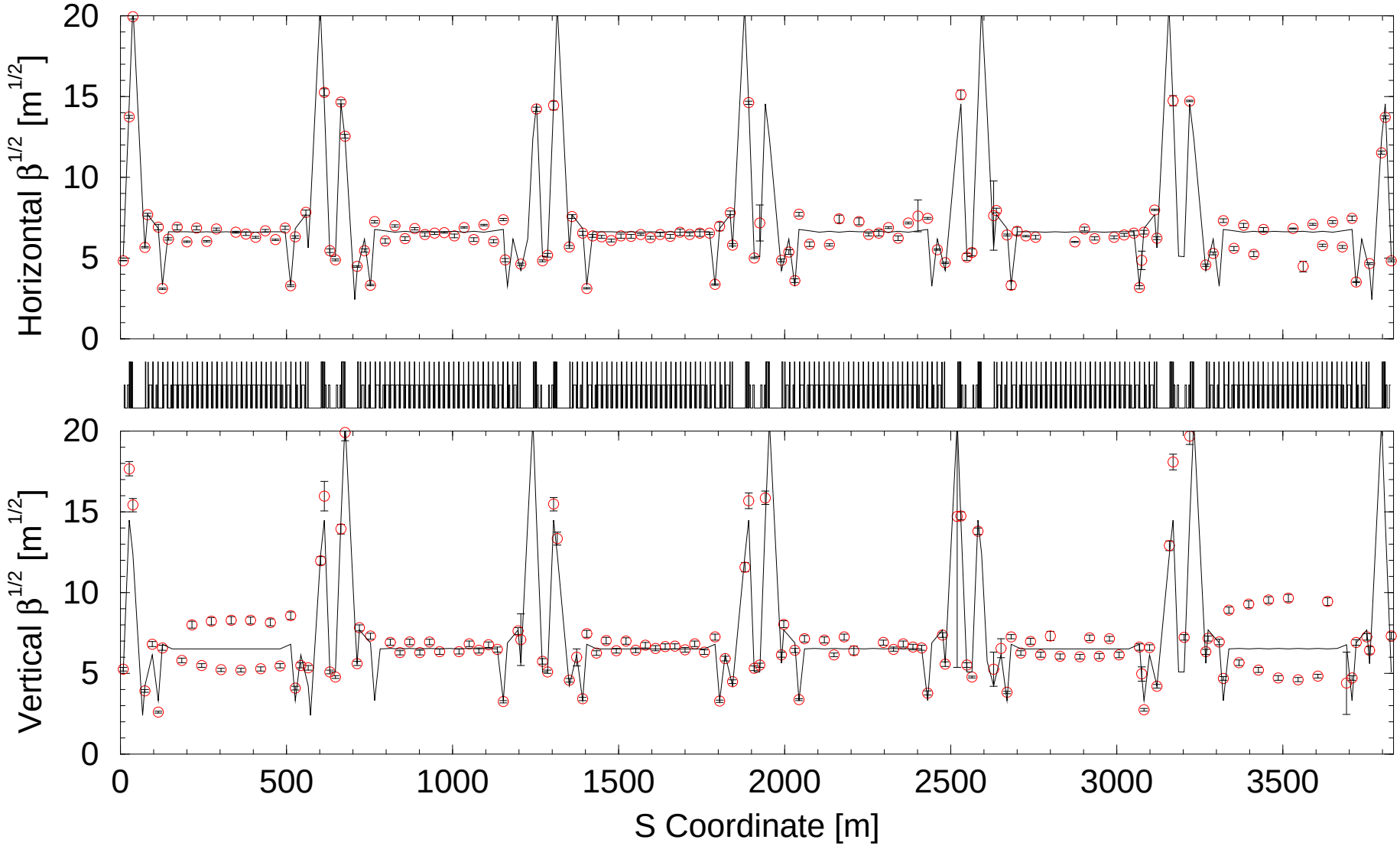
- **Injection Optics Are "Pretty Good"**
  - *Optics "signatures" seem to scale between $\beta^\star$=10 m and $\beta^\star$=3 m*
  - *Blue worse than Yellow (vertical 15-20% β wave in $\beta^\star$=10 m optics)*
  - ✓ *Transverse injection optics matching will be interesting!*
  - ✗ *Aperture issues possible in injection, up ramp (cf. Yellow inj kickers)*
- **Storage Dispersion Needs Work**
  - *Looks like dispersion suppressor leakage, local coupling?*
  - *How to evaluate/correct dispersion suppressors?*
  - *Is there any way to measure dispersions at IPs?*
  - ✓ *Local coupling correction should demonstrate immediate effect*
- **Rough Source Orders of Magnitude**
  - *Rule of Thumb:* $(\beta\ \Delta KL)_{\text{source}} \approx 2\Delta\beta/\beta$
  - *Consider Q2 source (large triplet β), typical KL=0.189* m^{-1}
  - *Consider ≈20% $\Delta\beta/\beta$ wave (reasonable within factor 2)*
  - *$\beta^\star$=10 m: Q2 β=120m* $\Rightarrow\ \Delta KL = 3.3 \times 10^{-3}\ \mathrm{m}^{-1}$ *(1.7%)*
  - *$\beta^\star$=2 m: Q2 β=560m* $\Rightarrow\ \Delta KL = 7.1 \times 10^{-4}\ \mathrm{m}^{-1}$ *(0.4%)*

Linear Lattice Issues: Recommendations

- **Draw Conclusions and Correct Triplet Gradients**
  - *Correction is feasible and straightforward; arcs are good!*
  - *As usual, dispersion at storage with low β is teaching us something*
  - *Faith requires fast user feedback, online analysis*
  - *Don't hesitate to improve the optics as much as possible*
- **Improve Online Analysis Techniques**
  - *A work in progress (*`RhicBpmAnalysis` *etc)*
  - *Integrate analysis into applications, e.g.* `RhicOrbitDisplay`
- **Collect Consistent Data, Use Sequencing**
  - *Sequence canned nonparasitic measurements for reproducibility, speed*
  - *"Automatic" beta/dispersion measurements every store?*
- **Spend Time on the Basics**
  - *More global and local coupling correction (cf. store dispersion)*
  - *Mismatched IP optics can kill a collider program (cf. beam-beam talk)*
  - *Demonstrate IR antisymmetry, proper $\beta^\star$*

Linear Lattice Issues: Beta at Injection (pp)

- **Jan 18** *(Yellow $\beta^\star$=3m, 5 injections, store 02256)*



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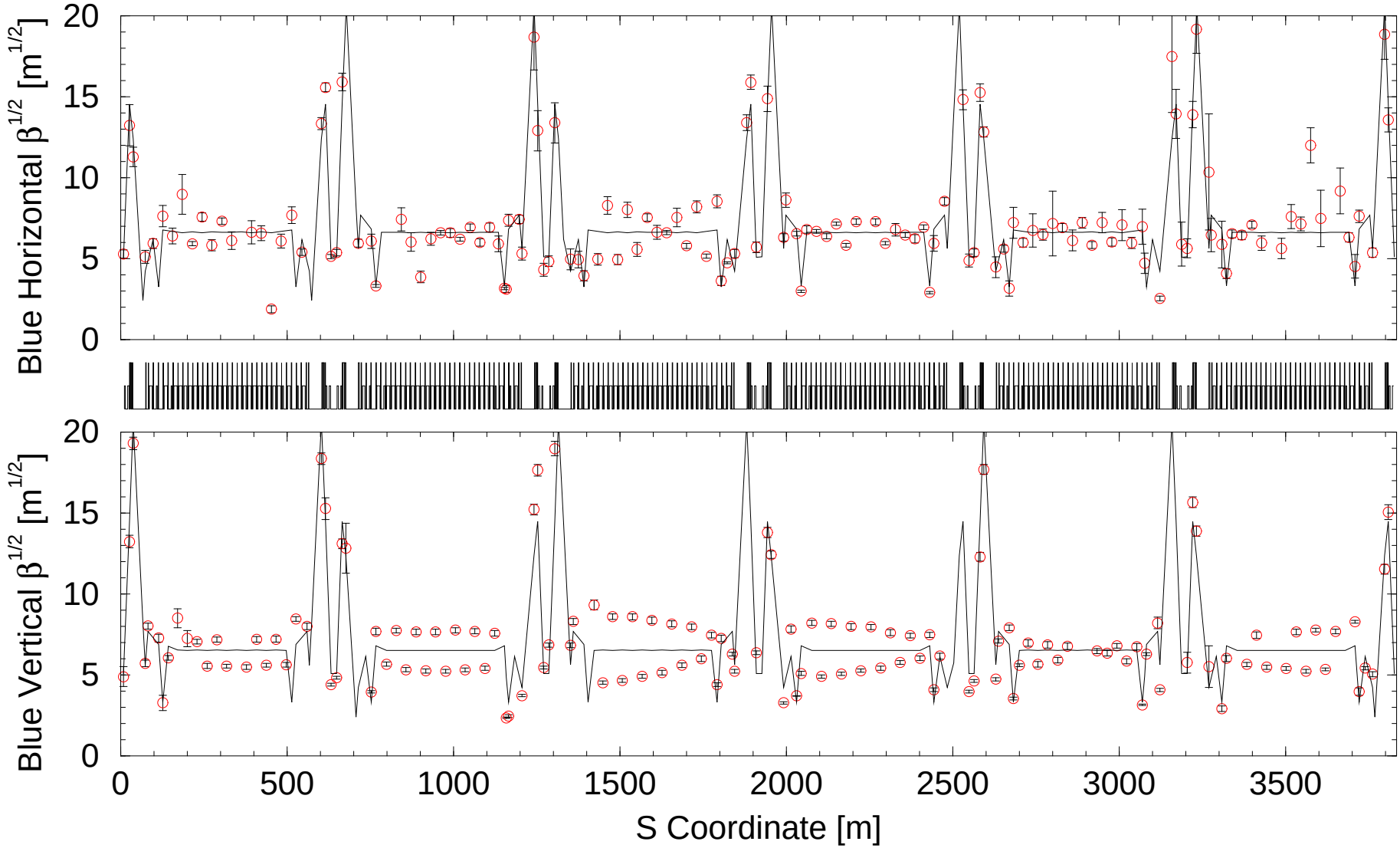
- **Jan 18** *(Blue $\beta^\star$=3m, 5 injections, store 02256)*