# $\beta$-beating measurement and understanding
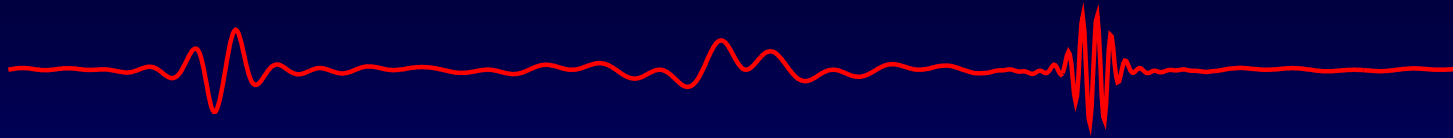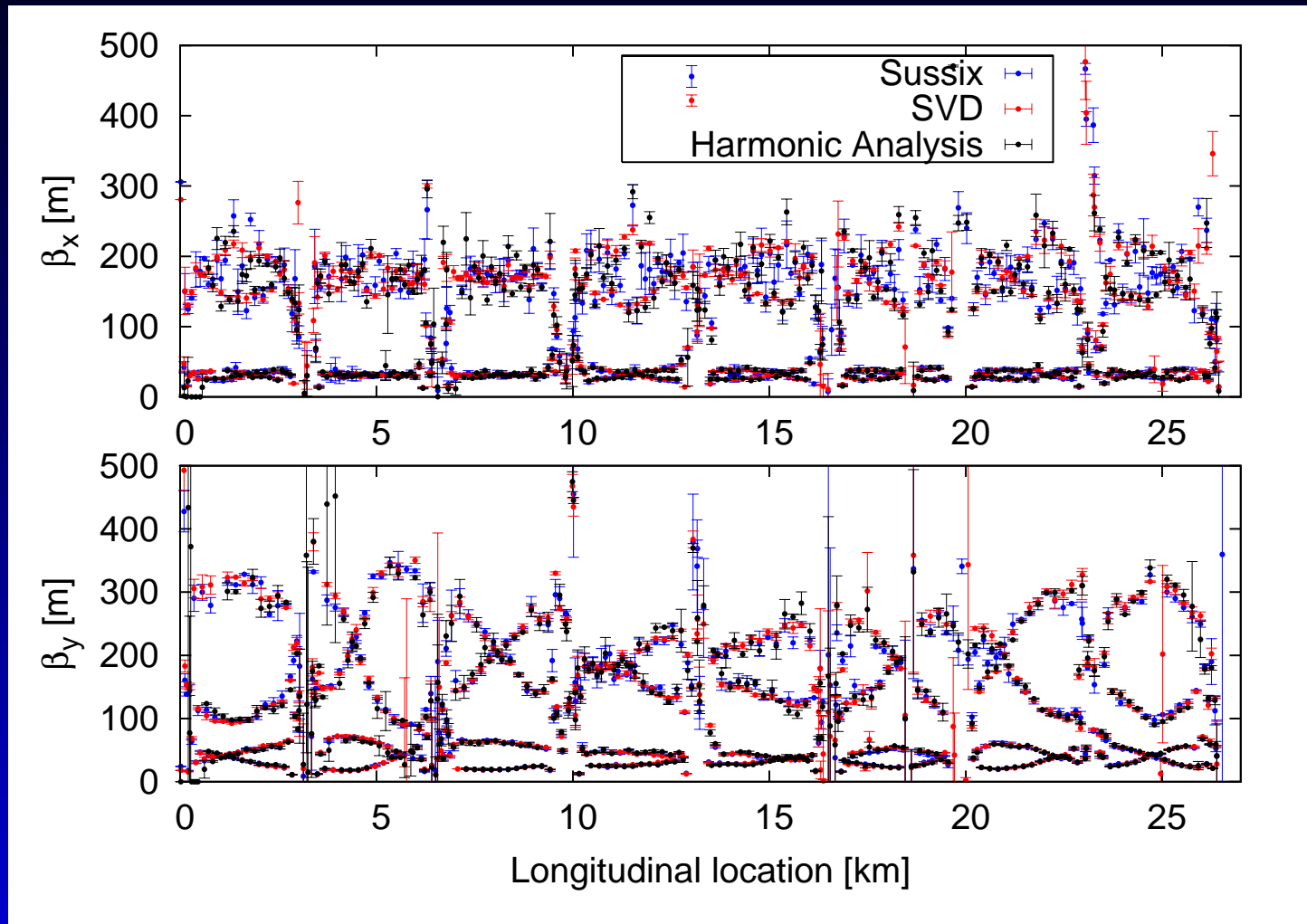
M. Aiba, R. Calaga, M. Giovannozzi, V. Kain,
F. Roncarolo, R. Tomás, G. Vanbavinckhove,
J. Wenninger

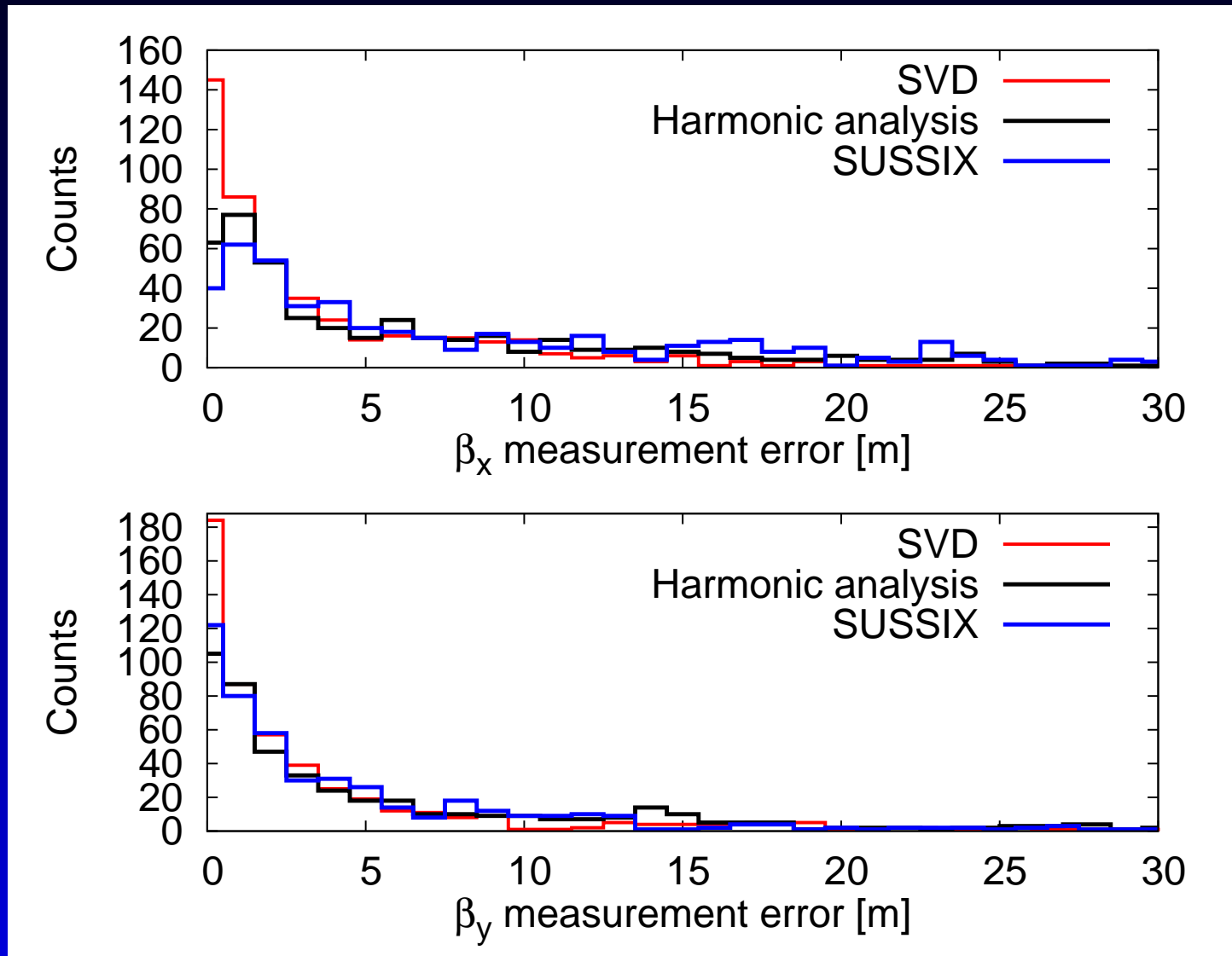Thanks to I. Agapov, S. Fartoukh, M. Lamont and
F. Schmidt

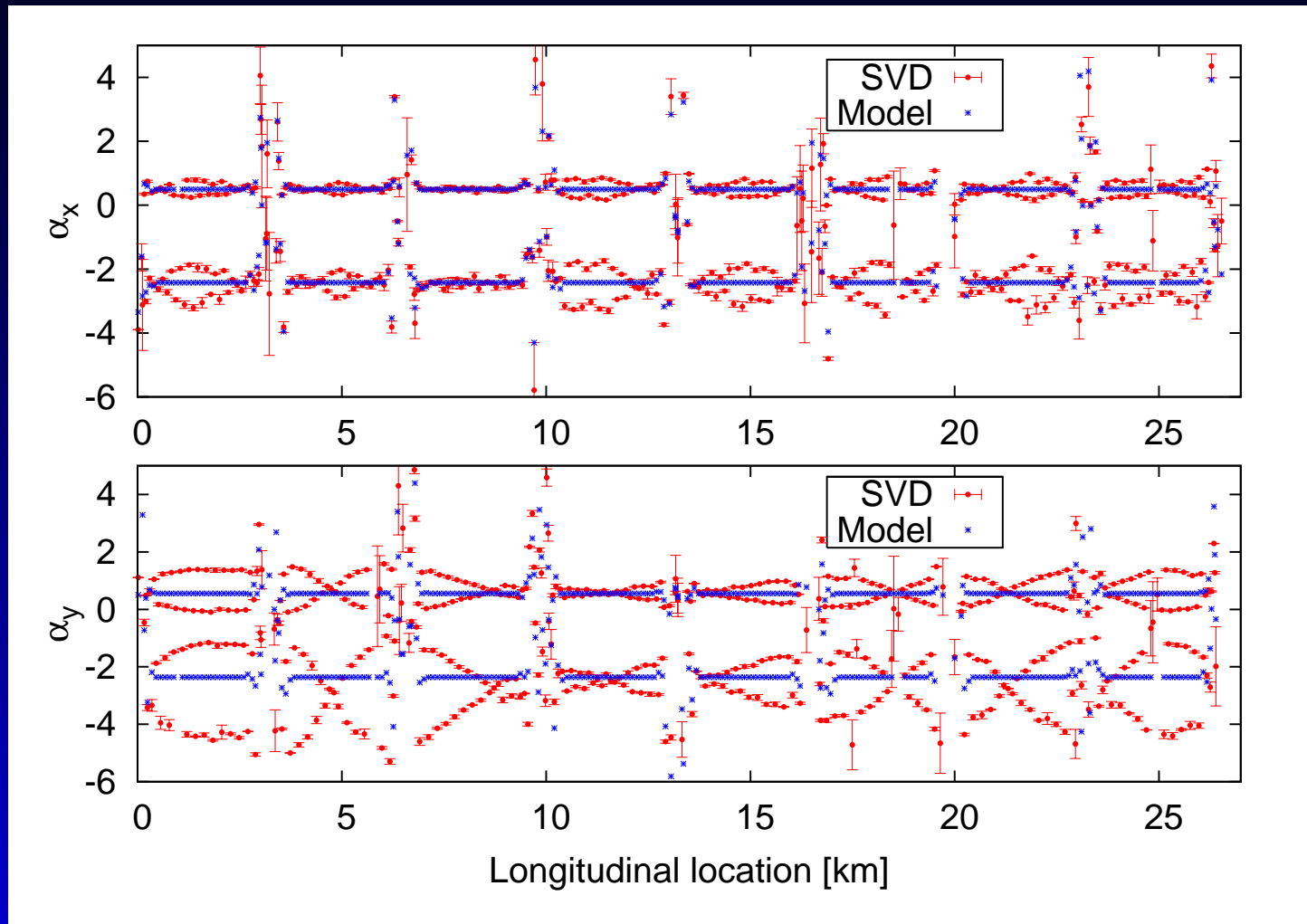LCU - January 2009

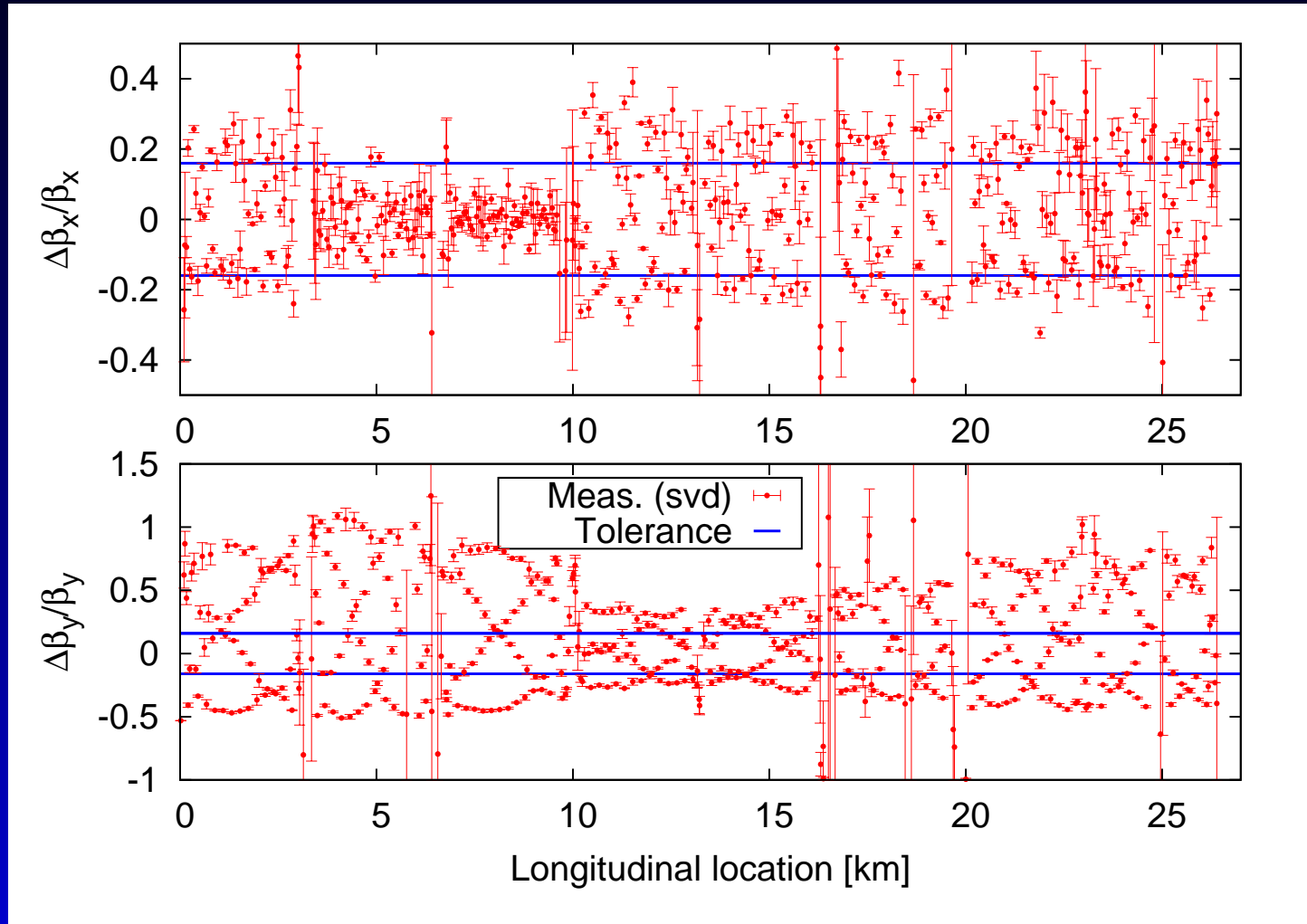# The measurement: 3 algorithms

# Performance comparison



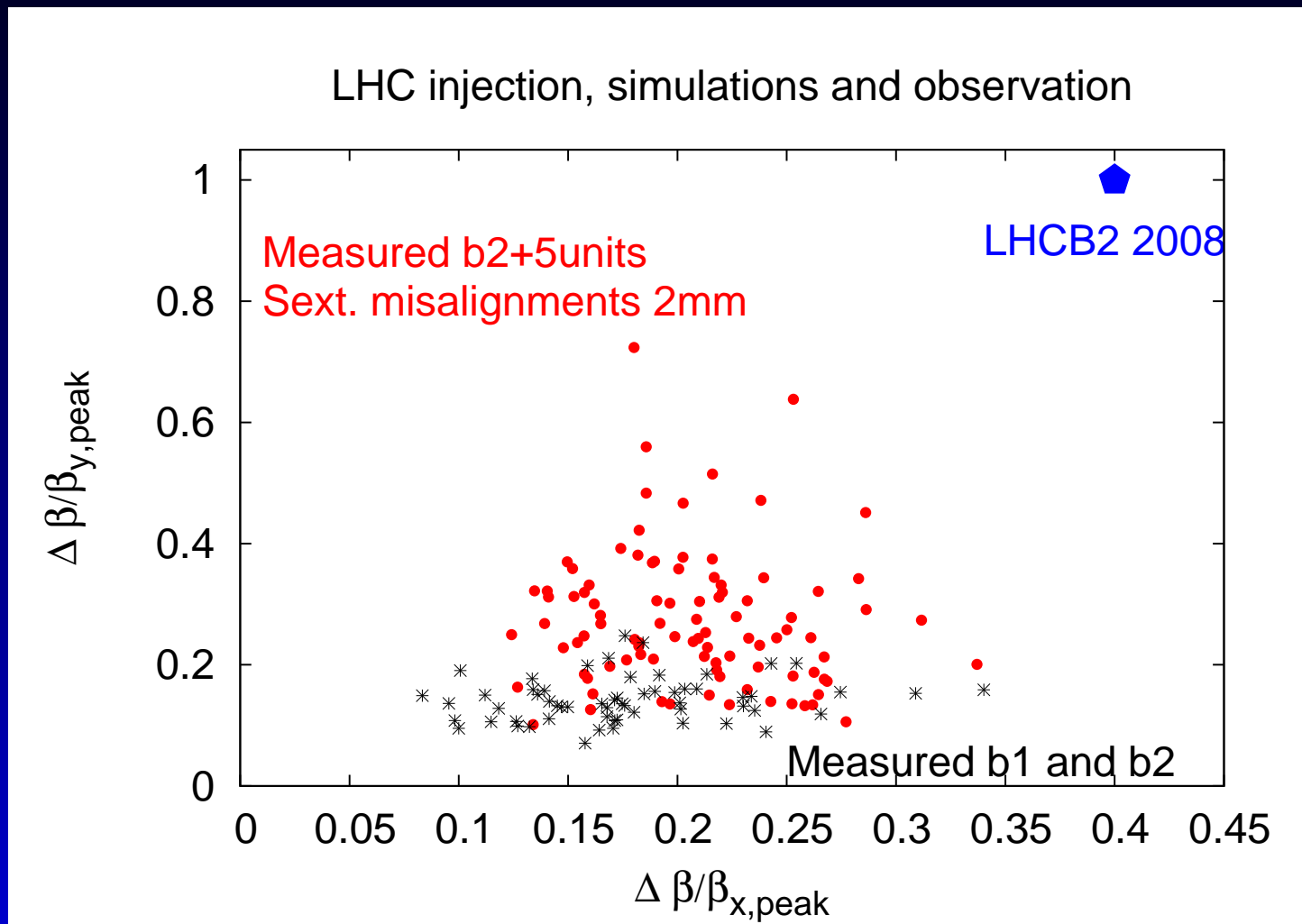SVD wins (Rama's thesis)

# The measurement of $\alpha$



$\alpha$ is measured as $\beta$ but typically ignored.

# The $\beta$-beating

# Simulations versus observation



LHC injection, simulations and observation

Measured b2+5units
Sext. misalignments 2mm

LHCB2 2008

Measured b1 and b2

Red has uncorrelated misalignments

Black has correlated orbit → big difference → Blue?

# Impact of closed orbit
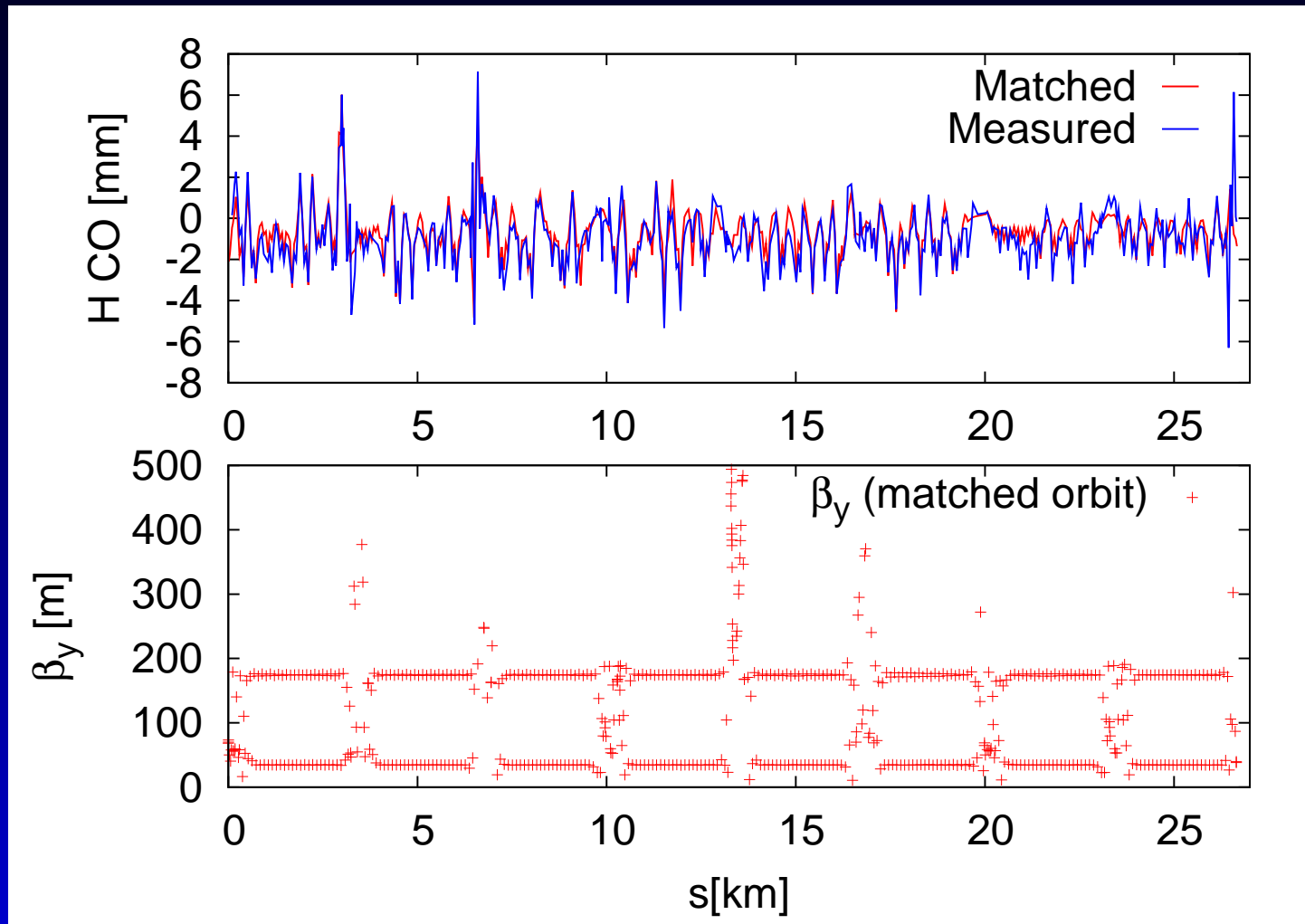


Indeed the impact of the measured closed orbit in the beta-beating is negligible.

# Error reconstruction methods

- **Standard matrix inversion correction**: Not satisfactory

- **Iterative (model) correction**$^{new}$: Iterate correction subtracting model betas to measured betas at every step (implemented by Masamitsu).

- **Segment-by-segment**$^{new}$: Use of measured ($\beta$,$\alpha$) as initial conditions to split the LHC into segments and reduce problem dimensions (presently under development by me).
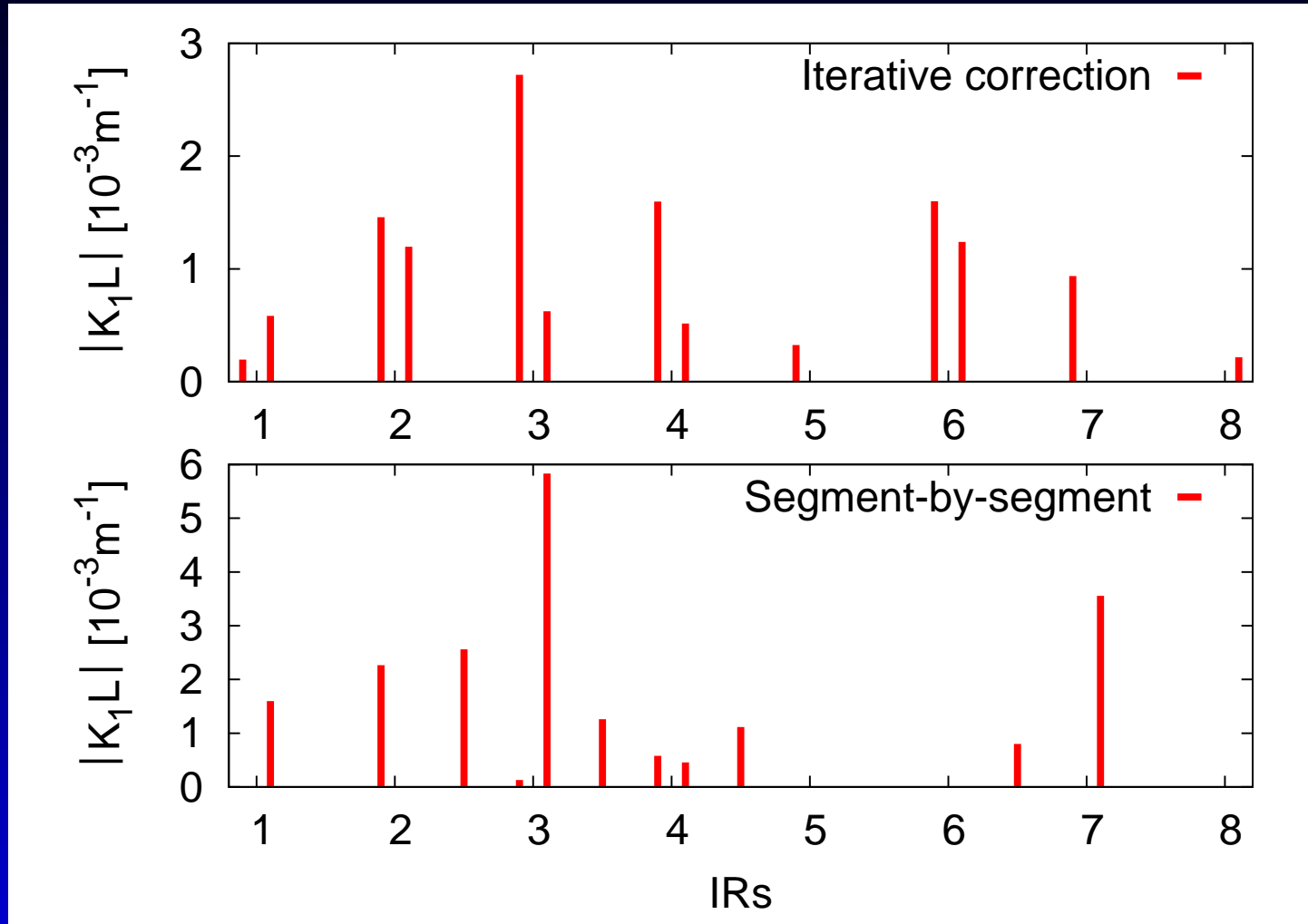
# Iterative (model) correction
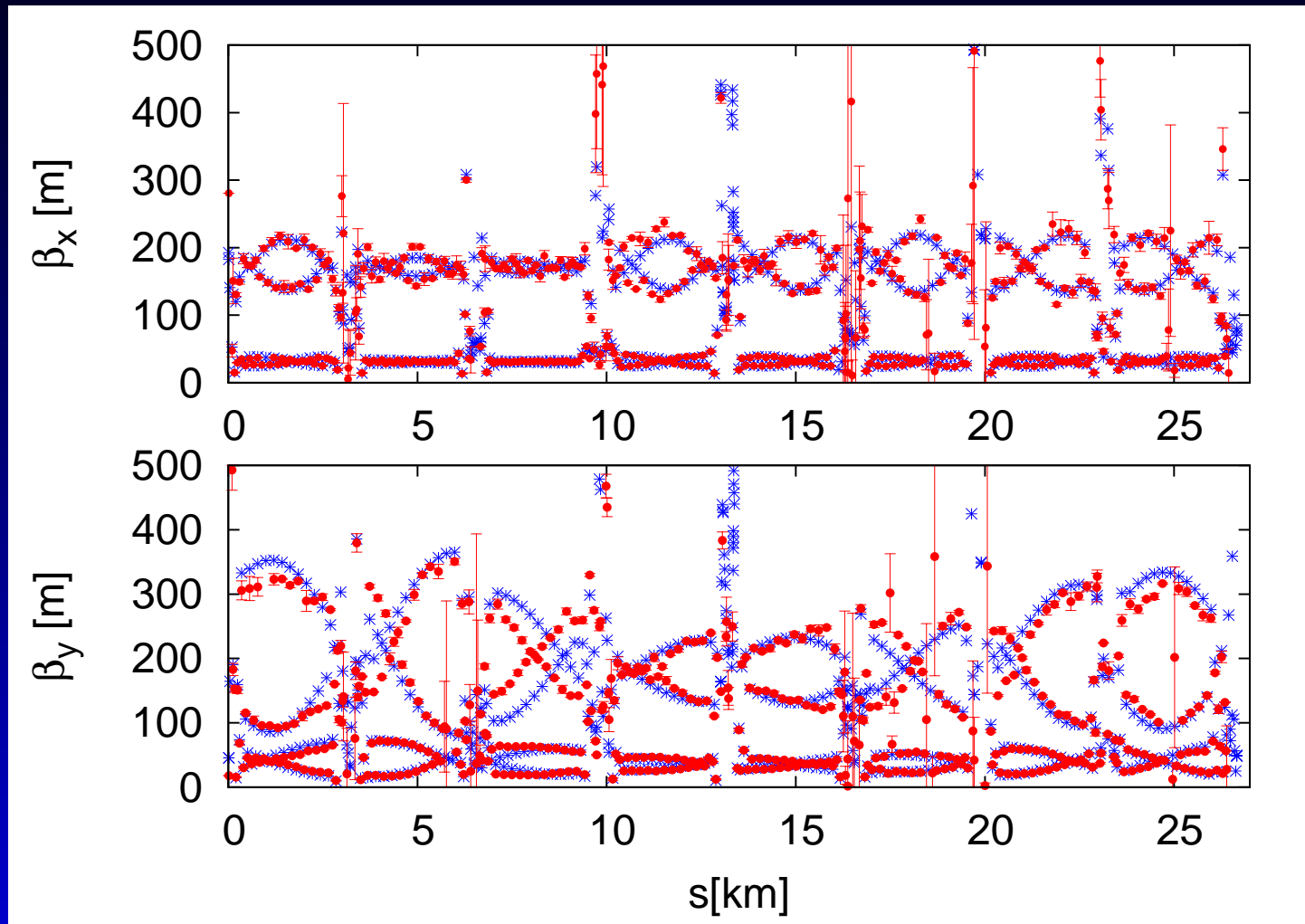


6 iterations yielded quite a nice agreement!

# Segment-by-segment approach
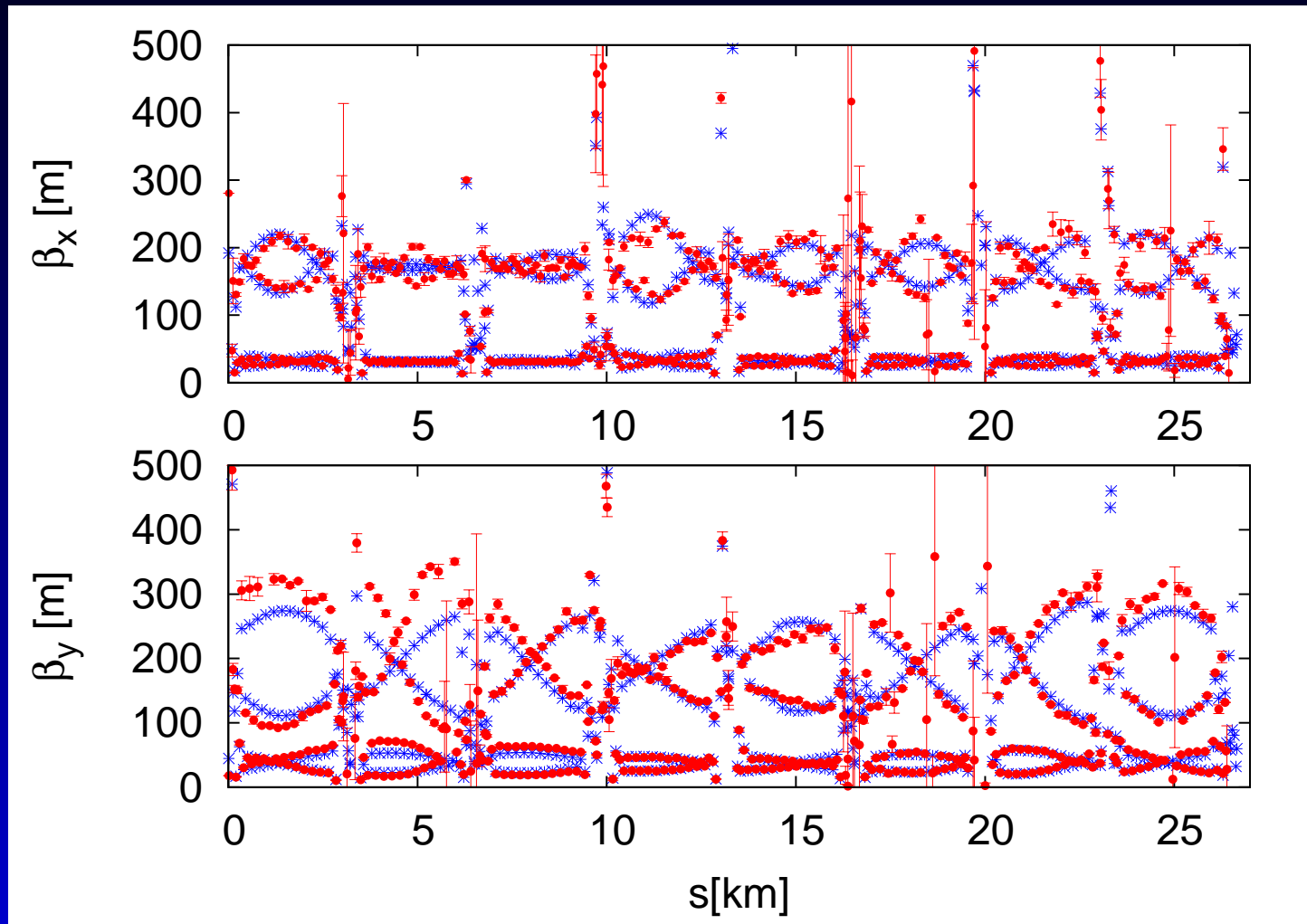


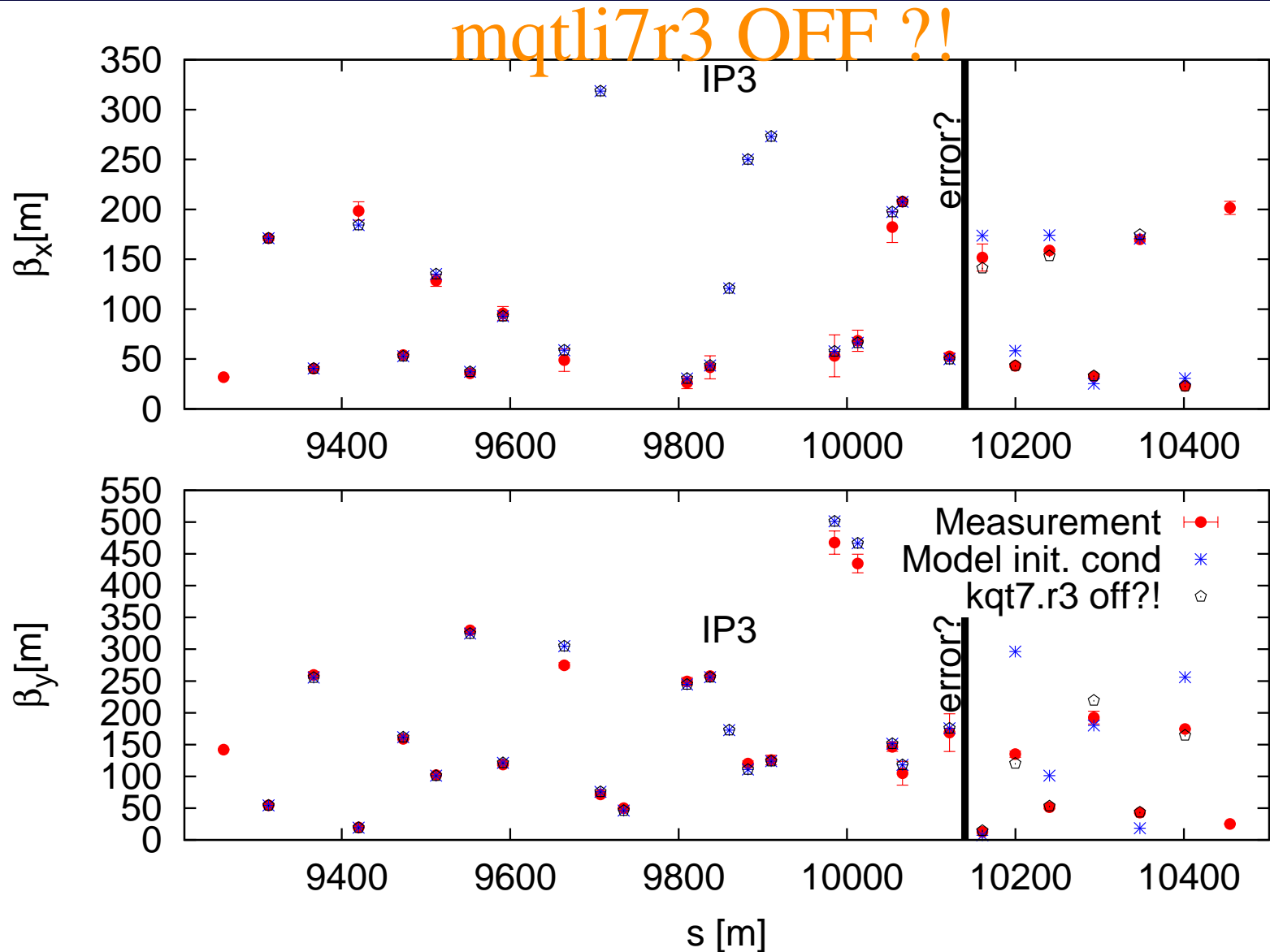Maybe not so good agreement on the closed solution but...

Both methods see a big error in IR3 and

approx. no error in IR5 and IR8!

# The power of segment-by-segment
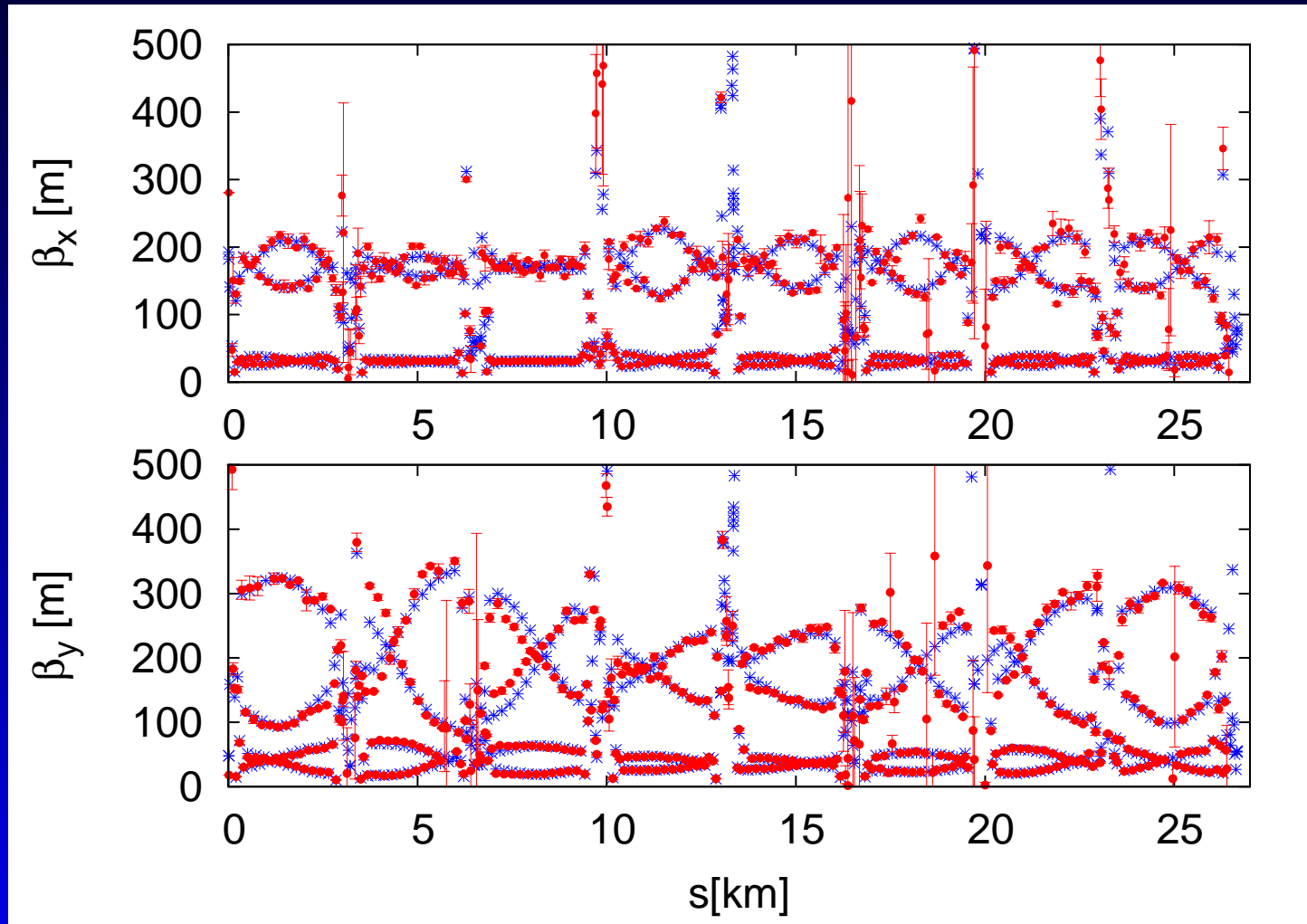
## with measured $(\beta,\alpha)$ as initial conditions

# The power of Iterative correction

## after identifying mqtli.7r3.b2 being off!

# Summary & outlook

- Orbit was not the beta-beating source

- 2 new powerful methods implemented or under development to localize errors and correct

- mqtli.7r3.b2 (or mq.7r3.b2) clearly identified as error location (mqtli.7r3.b2 off?) via the segment-by-segment approach and as the leading error of the machine

- IR2 &IR7 seem to host the next leading errors (in this order)

- IR2 and the arc23 need further investigation

- IR1, IR4, IR5, IR6 and IR8 seem to be free of big errors
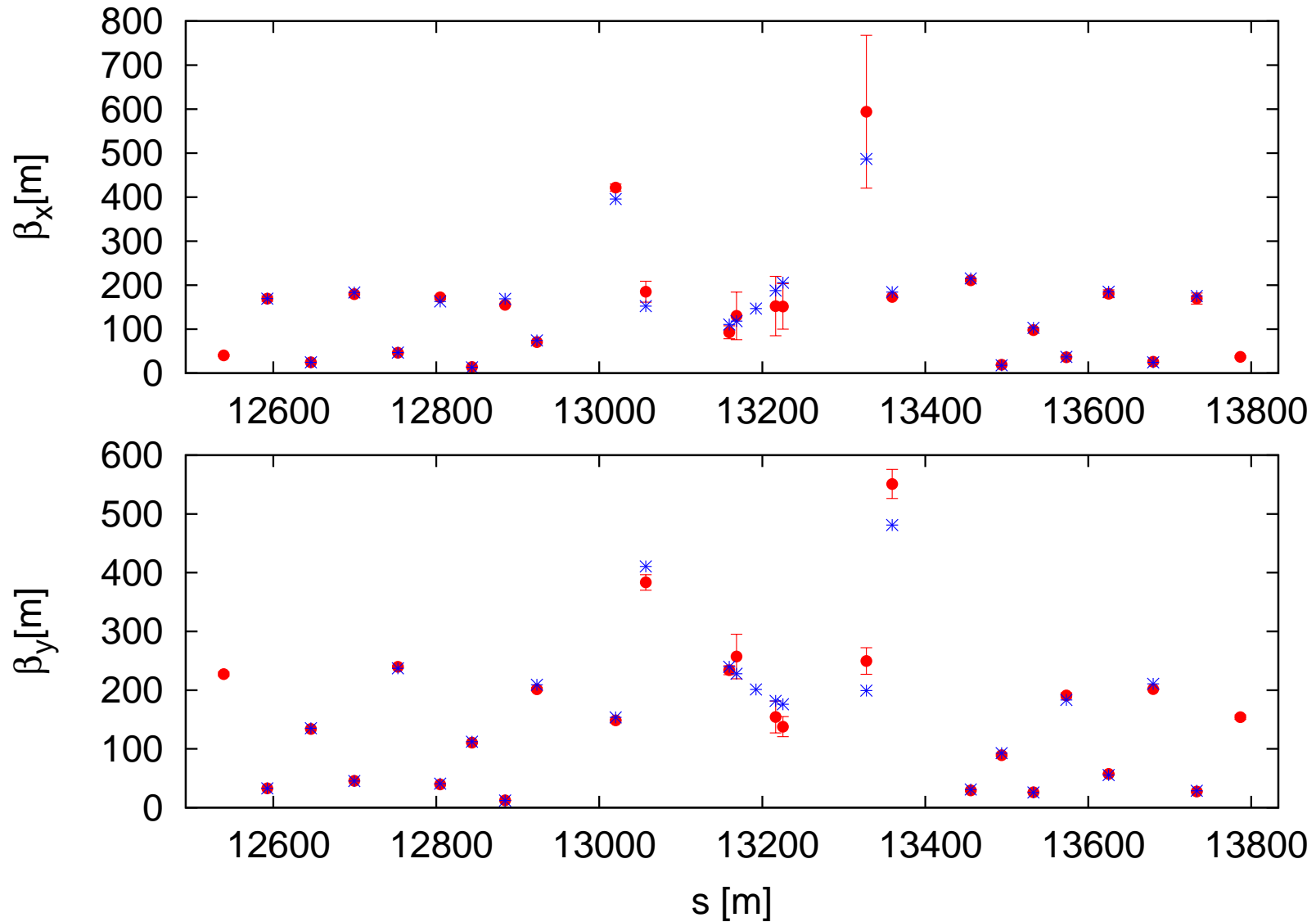
- Lots to do...

# IR1, segment-by-segment
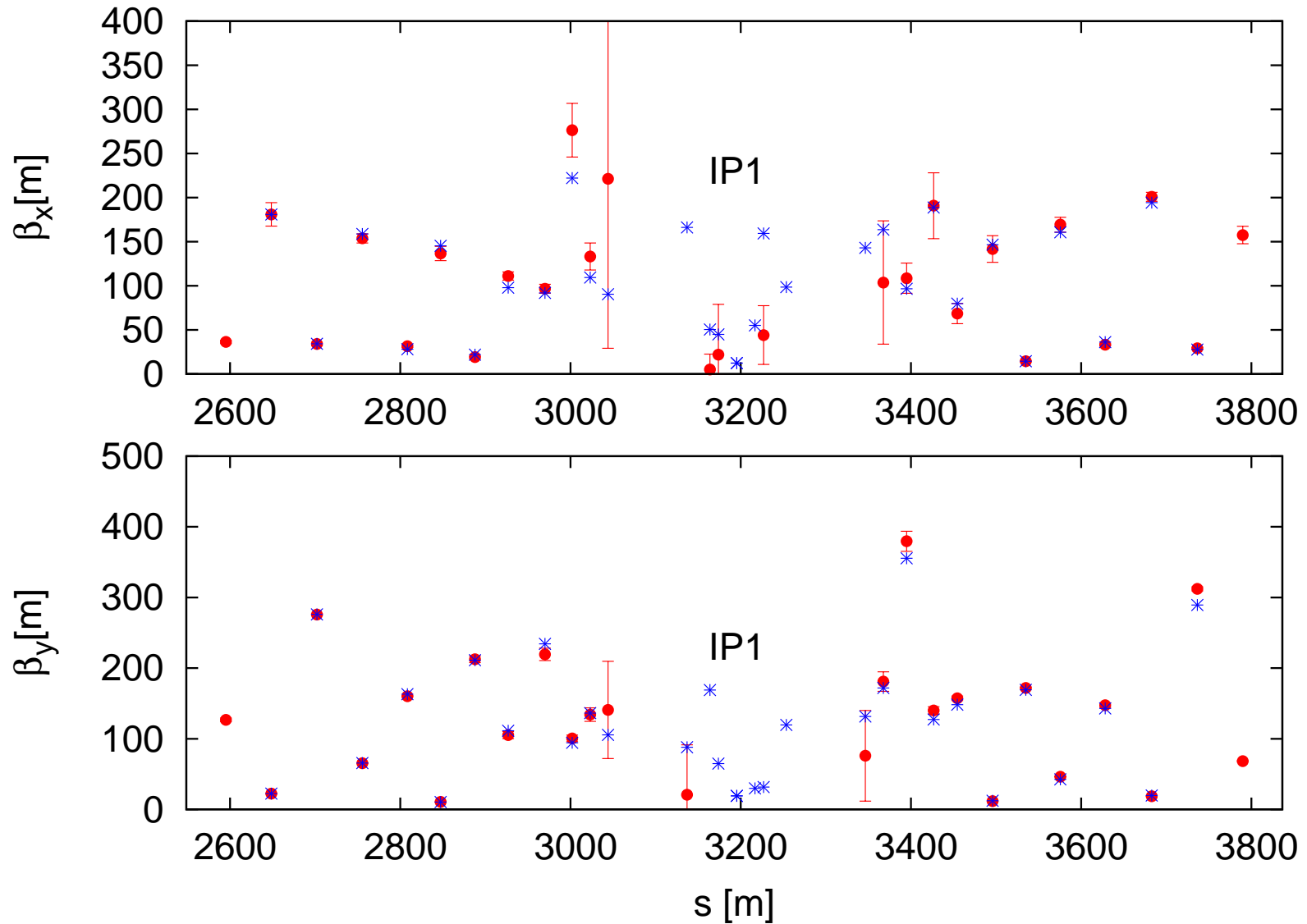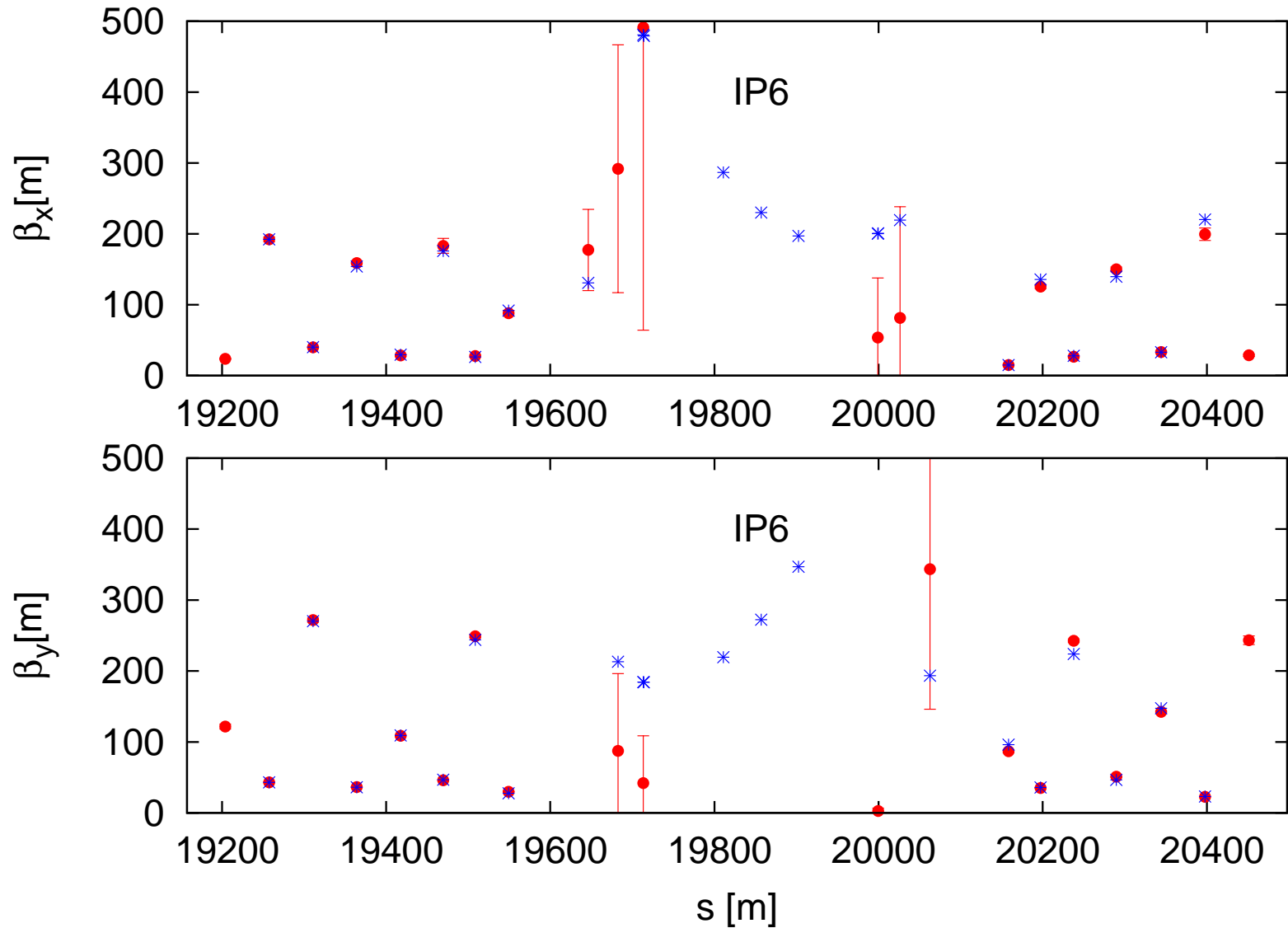


No important error

# IR2, segment-by-segment
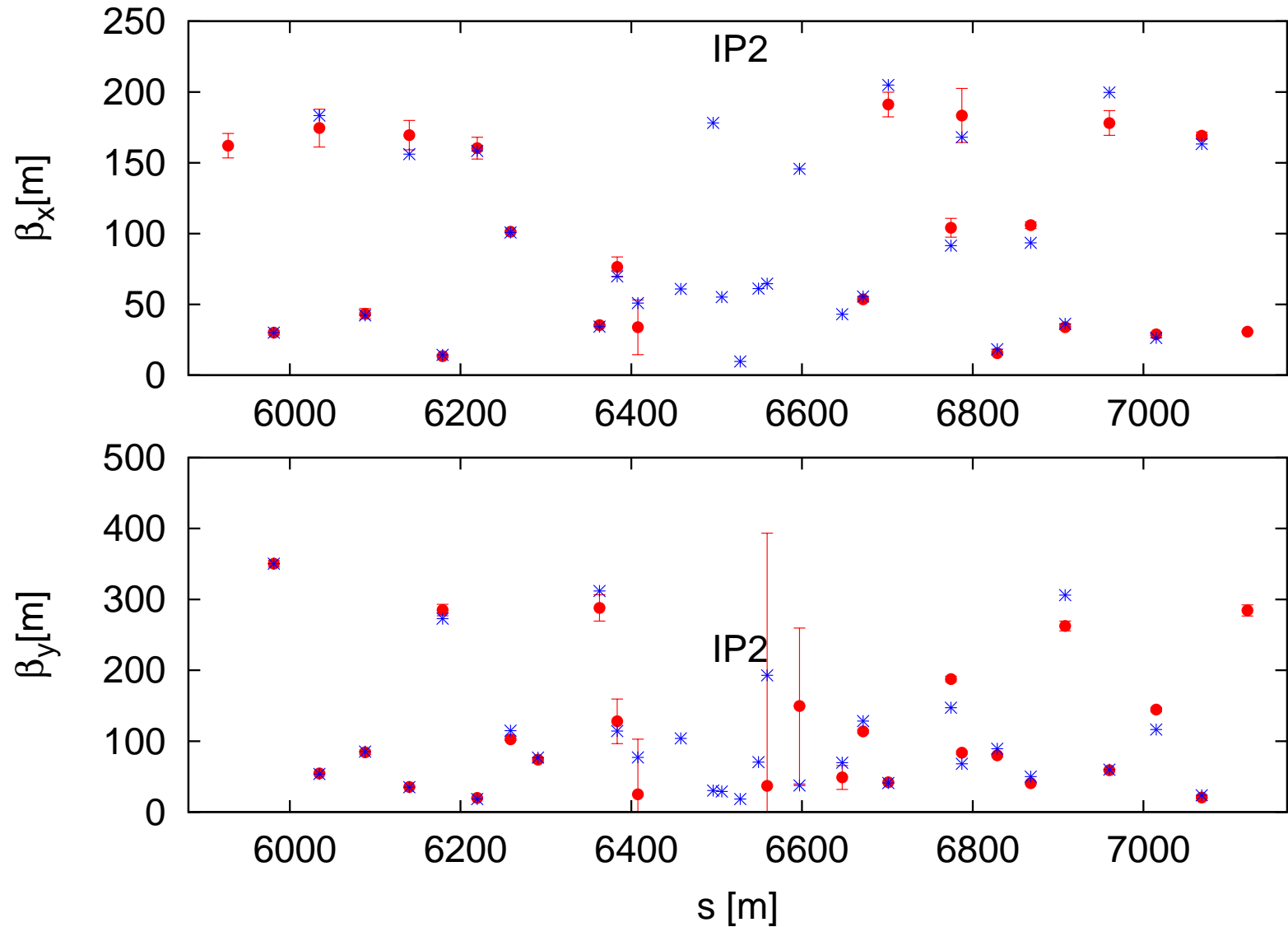


**Important error**
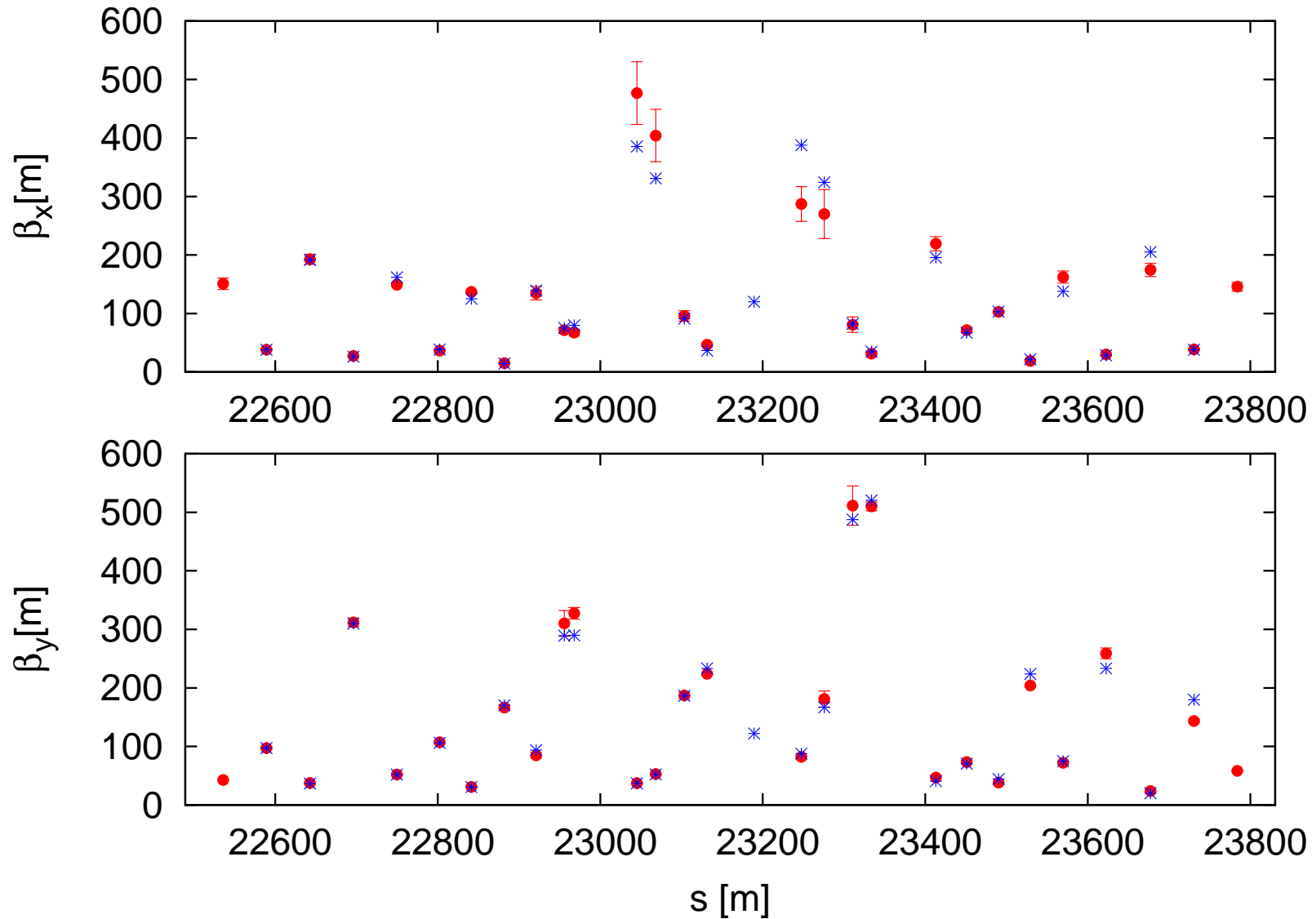
# IR4, segment-by-segment



No error?

# IR6, segment-by-segment



No big error?

# IR7, segment-by-segment



Some error

# Arc 23, segment-by-segment