South East European International Institute for Sustainable Technologies

# Beam lines optics - status

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# Beam properties at extraction vs. clinical requirements

Twiss at M-septum:

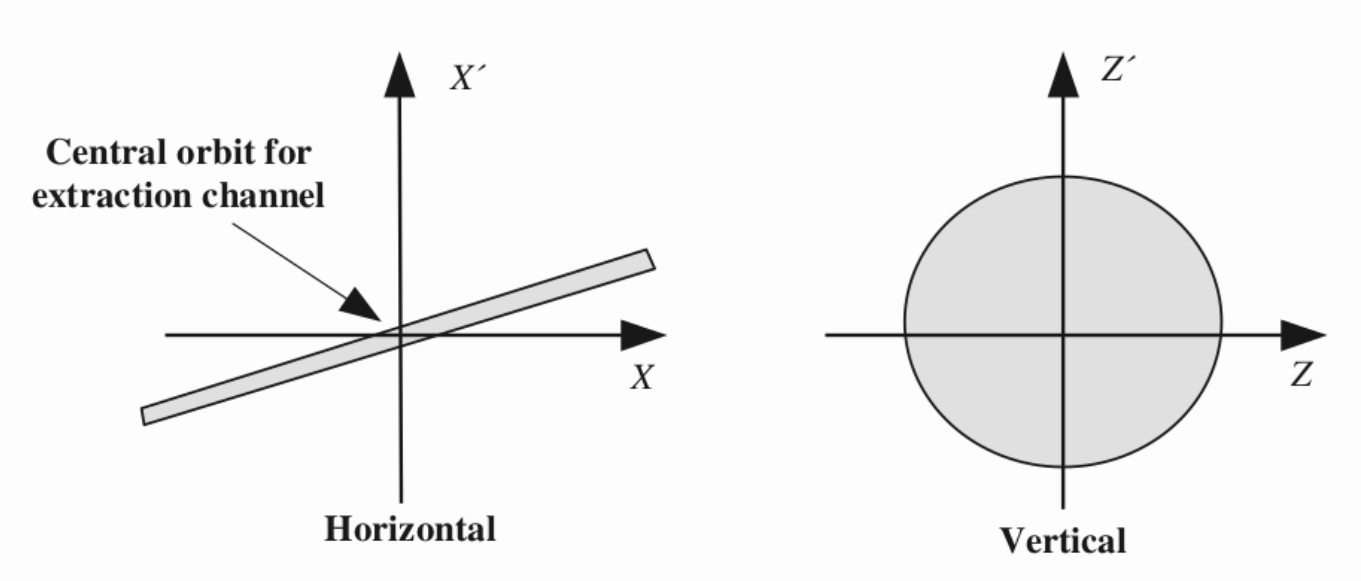
- BETX = 19.695 m,
- ALFX = -0.9411,
- BETY = 3.829 m,
- ALFY = 0.0096,
- DX = 4.208 m,
- DPX = 0.48927
- EX = 5 $\pi$ mm*mrad (unfilled ellipse)
- EY = 1.43-0.67 $\pi$ mm*mrad

Twiss parameters from PIMMS report part II, Appendix DD, pages 324 and 325

At patient:

- beam spot size 4-10 mm (FWHM)
- $|\mathrm{DX}| = 0$ m, $|\mathrm{DPX}| = 0$
- or relaxed ($|\mathrm{DX}| < 0.2$ m, $|\mathrm{DPX}| < 1.2$, range straggling dominant (M. Pavlovic *et al*, Journal of Electrical Eng., Vol 58, No 1, 2007, 33–38)

# Approach to beam size

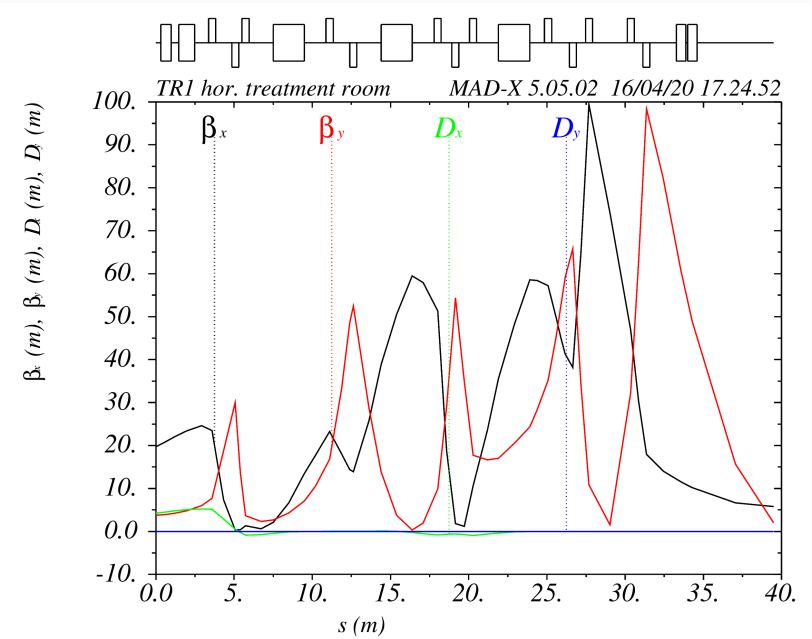


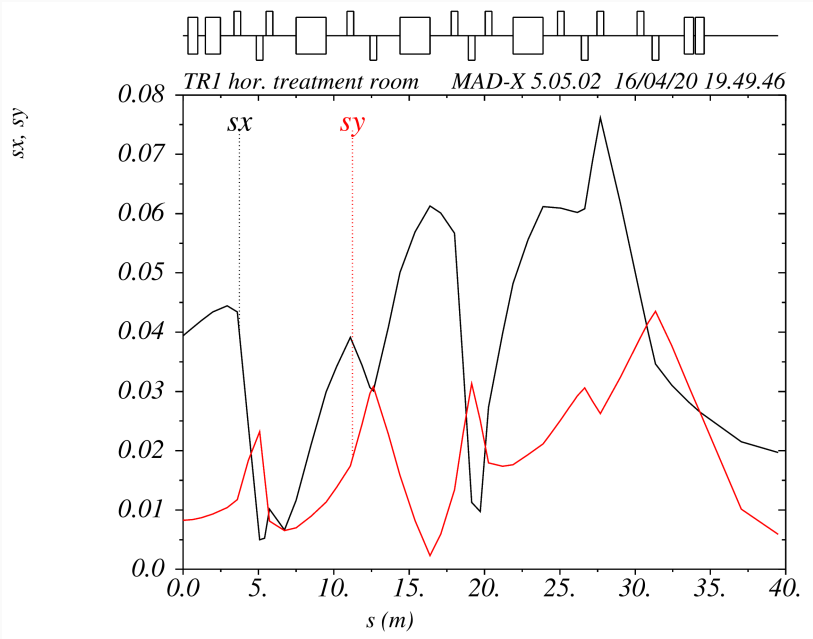

- vertical beam size: regulated by focusing ($\beta_{\mathrm{y}}$)
- horizontal beam size:
  - horizontal emittance is does not depend on energy
  - bar of charge at E-septum ($\beta_H = 5\ m$): horizontal, size 10 mm
  - PIMMS approach: rotate the bar of charge (change phase $\mu_x$)
  - discussion with Marco Pullia:

    - it is much easier to $\mu_{\mathrm{x}} = \mathrm{N}\pi$, $\alpha_{\mathrm{x}} = 0$ and change $\beta_{\mathrm{x}}$

# Example, horizontal TR1 (old layout)

constraint, BETX=5.0, **BETY=2.0**, ALFX=0.0, MUX=1.5-0.1986

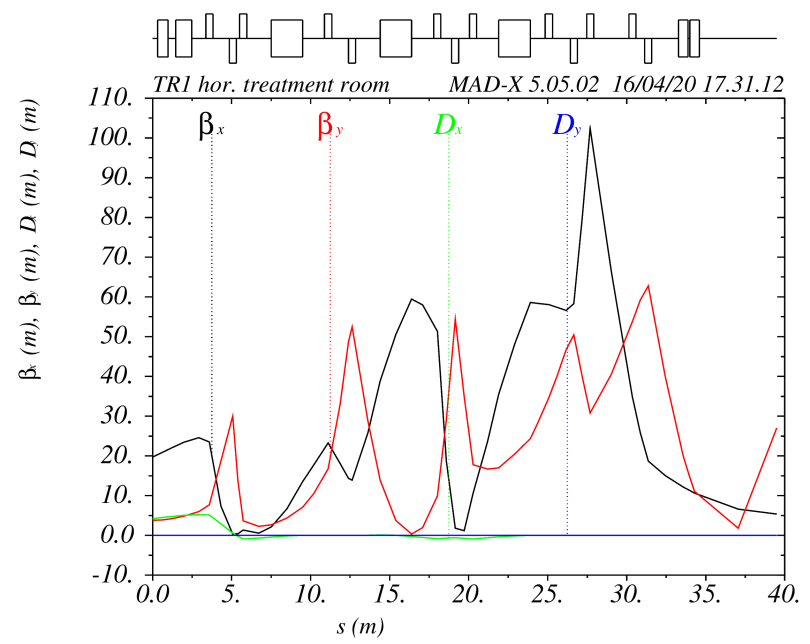


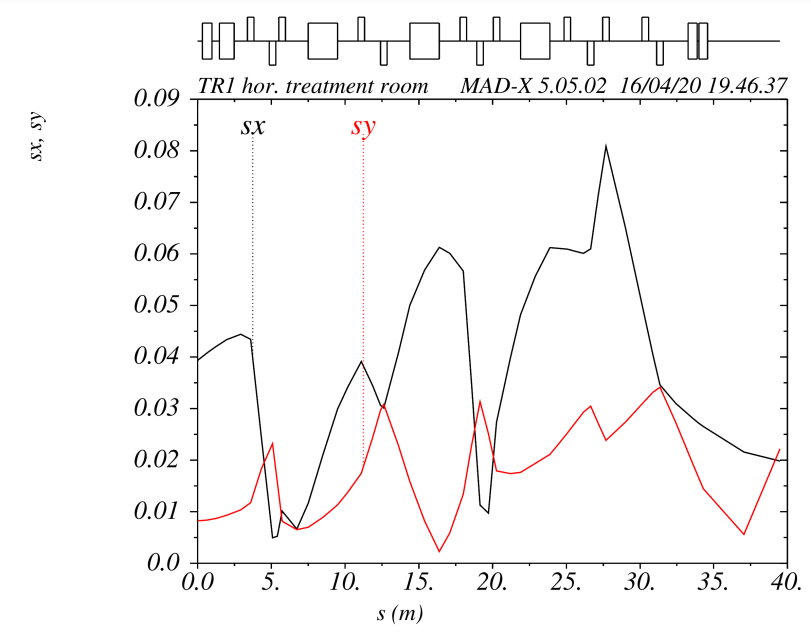




Right plot: $2\sigma$ beam envelopes. Typical aperture 70 mm.

# horizontal TR1

constraint, DX=0.0, BETX=5.0, **BETY=27.0**, MUX=1.5-0.1986



# Summary

- Preliminary layout gives reasonable optics; proof of concept for the shortest line
- Plan
  - a bit more optimization
  - include aperture model
  - include steerers and scintillating screens
  - repeat for all lines
- To have final design, more time and a few more iterations are needed - not the right moment.
- Other works: Frontiers paper, CDR, phone call with i-tech