South East European International Institute for Sustainable Technologies

Horizontal beam line for therapy - applying undesign method

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CERN, February 28, 2020

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Exercise

Beam line design is an iterative process.

- PIMMS horizontal beamline: 25 quadrupoles, 76 m length
- HIT horizontal beamline: 6 quadrupoles, 35 m length
- Take realistic PIMMS lattice (MedAustron) with real magnets
- Start cutting away, see what is happening

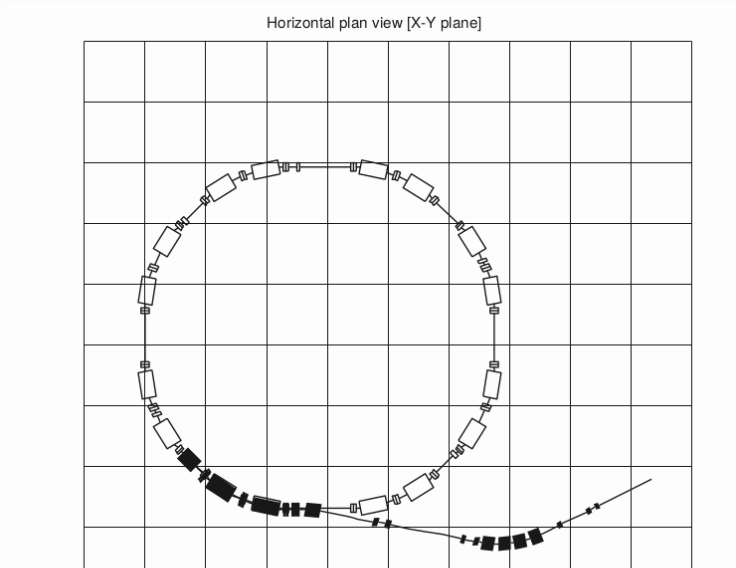
(...) the best part is no part. (...) It weighs nothing, costs nothing, can't go wrong. (...) The thing I'm most impressed with, when I have the design meetings at SpaceX, is ,,What did you undesign?" Undesigning is the best thing. Just delete it. That's the best thing.

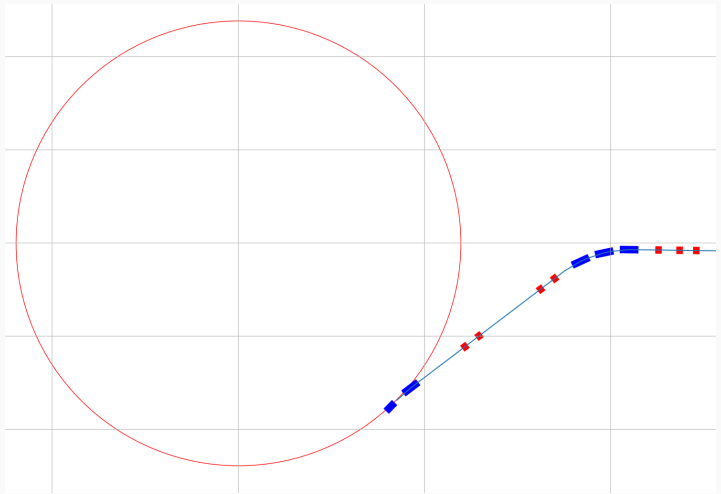
Magnets

- Dipoles are 1 meter long, 12.67 deg (first version of MedAustron)
- Quadrupoles are 35 cm long, maximum $k_1 = 2.8m^{-2}$ (verify)
- Magnetic Extraction septum is actuall made of two magnets:
  (-) thin MES, 65-cm long, 50 mrad,
  (-) thick MES, 1-meter long, 150 mrad

First iteration

- Remove *Phase shifter-stepper* (6 quadrupoles, 13.6 m long)
- Correct geometry such that it fits our baseline
- Match disperion DX and dispersion derivative DPX at the end of *matching section*
- Match β_H, β_V, $\alpha_H = 0, \alpha_V = 0$, $D_H = 0, D'_H = 0$ on patient
- Check how it fits to our current layout
- (remark: used layout is already slightly different from PIMMS report)

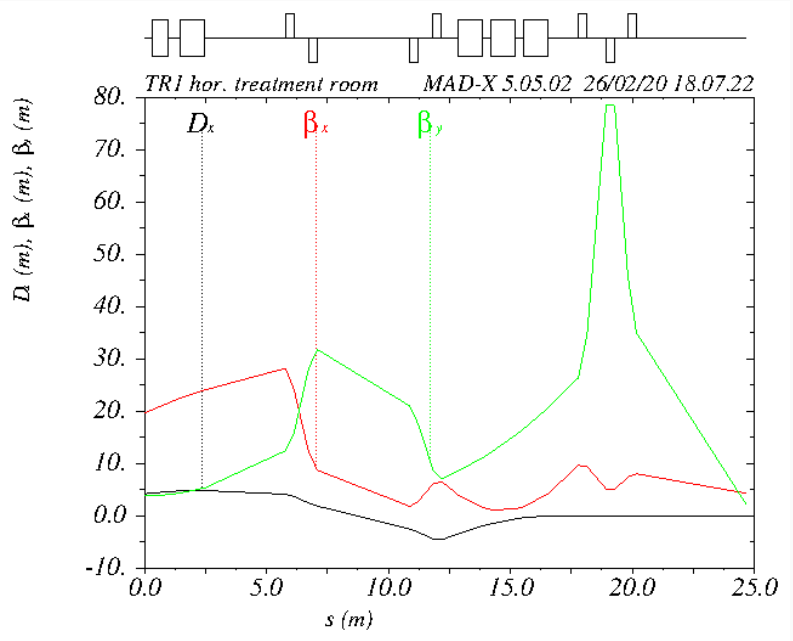




Matching dispersion

Twiss at extraction:

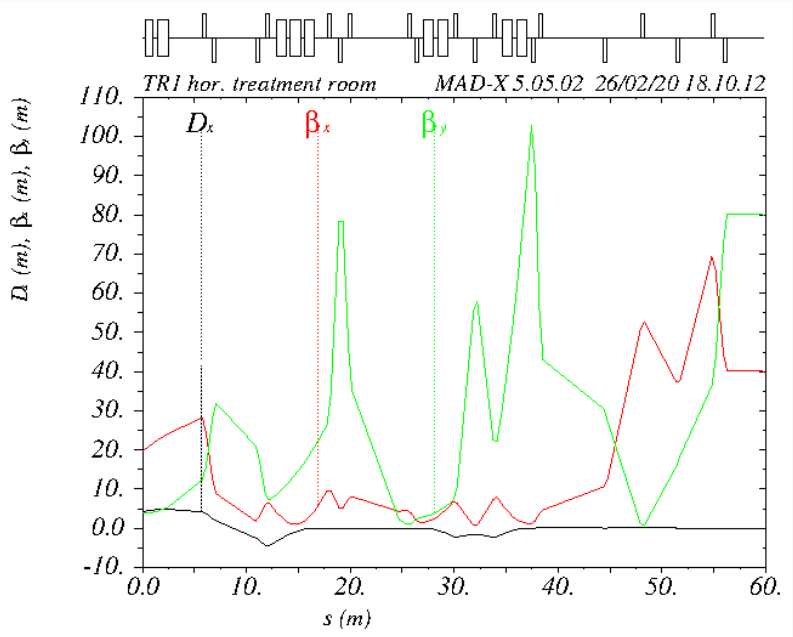
- BETX = 19.695,
- ALFX = -0.9411,
- BETY = 3.829,
- ALFY = 0.0096,
- DX = 4.208,
- DPX = 0.48927;



Calculation starts at the entrance to the first Magnetic Septum - this is where ring optics has no more influence on the beam.

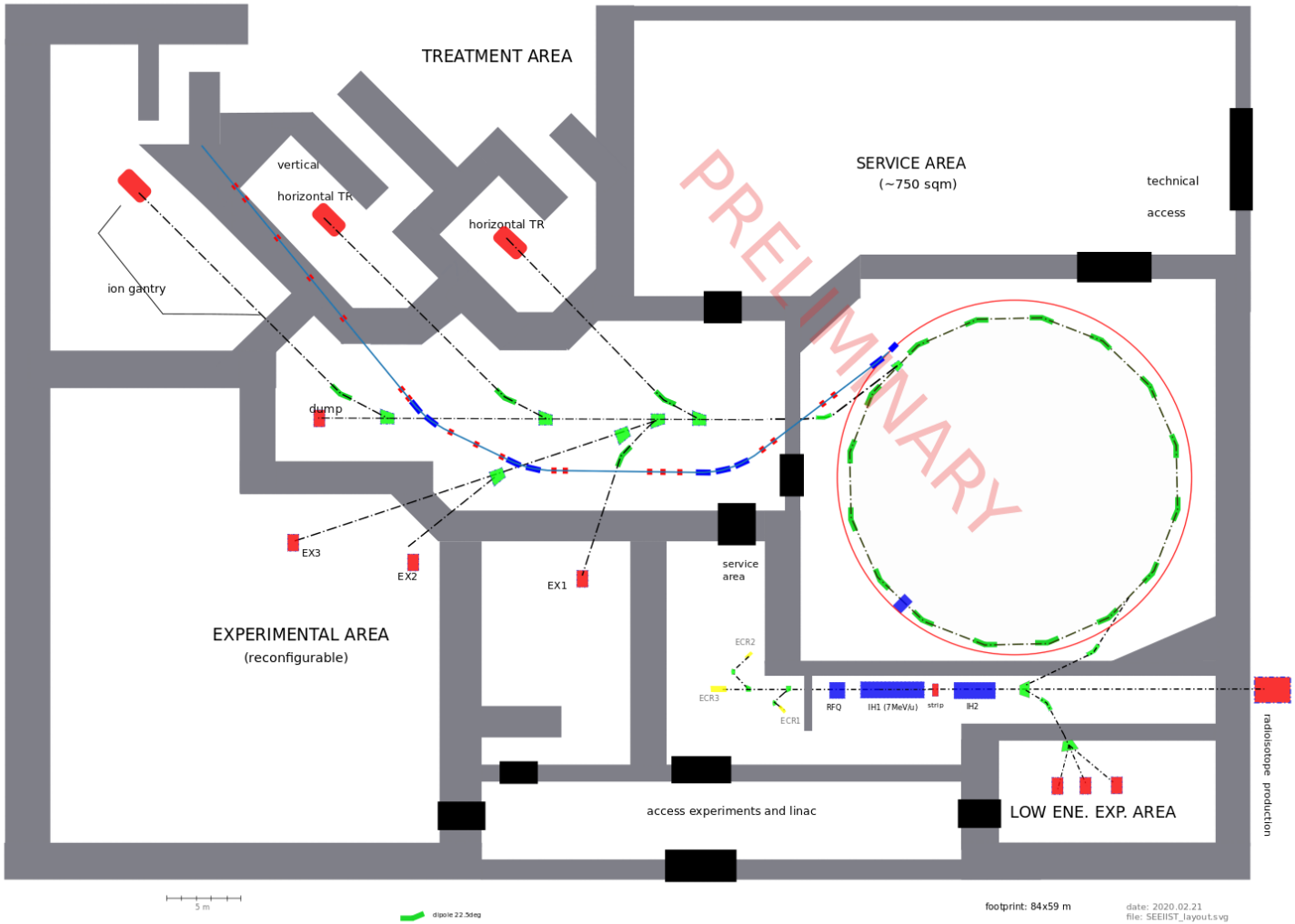
Matching on the patient

- β_H, β_V - various beam sizes
- α_H, α_V, D_H, D'_H all 0
- example: match
  $\beta_H = 40\ m, \beta_V = 80\ m$
- tested for several extreme combinations
- there is enough flexibility



Comparison to the last layout

- For the moment it does not fit...



Summary

- Can do matching on the patient without *phase shifter-stepper* (19 quadrupoles instead of 25, 60 m long instead of 76)
- Next steps: use MedAustron dipoles (22.5 deg) and quadrupoles
- *Undesign* more magnets, shorten the beam line
- Survey visualisation script, prepared by summer student, needs some rework
- Final outcome (for CDR?): preliminary design of all beam lines, will take 2-3 more weeks