

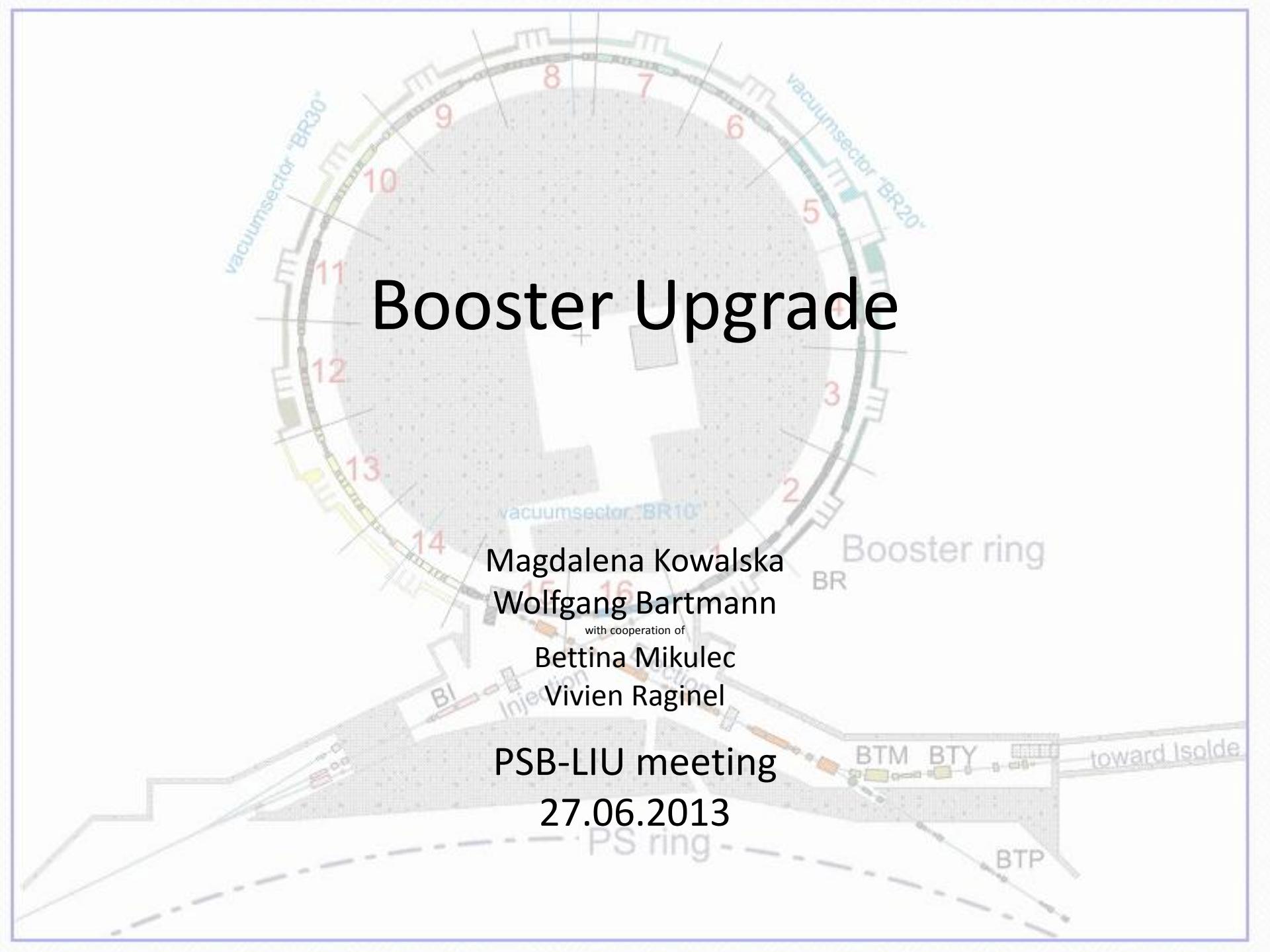
Booster Upgrade

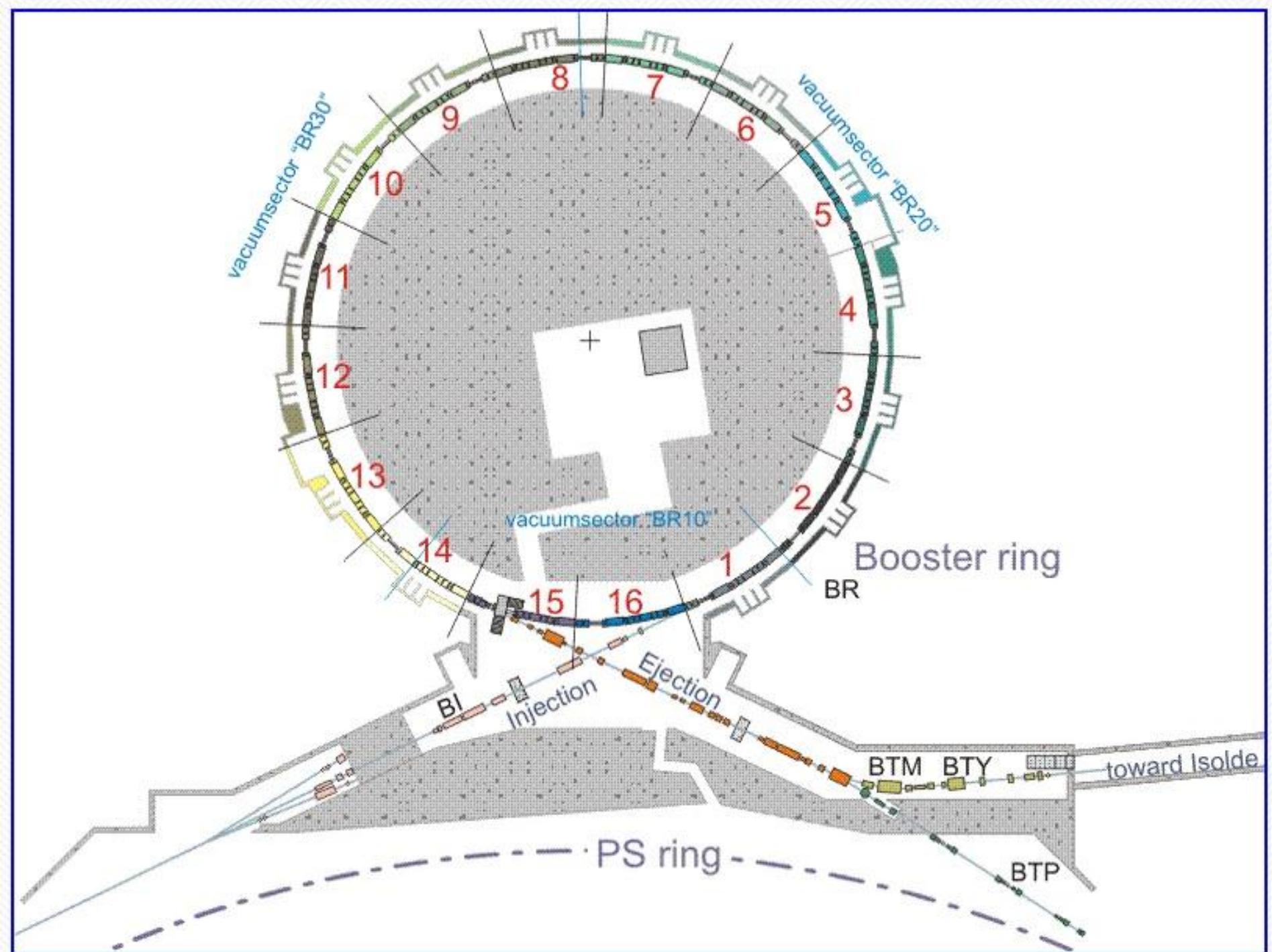
Magdalena Kowalska
Wolfgang Bartmann

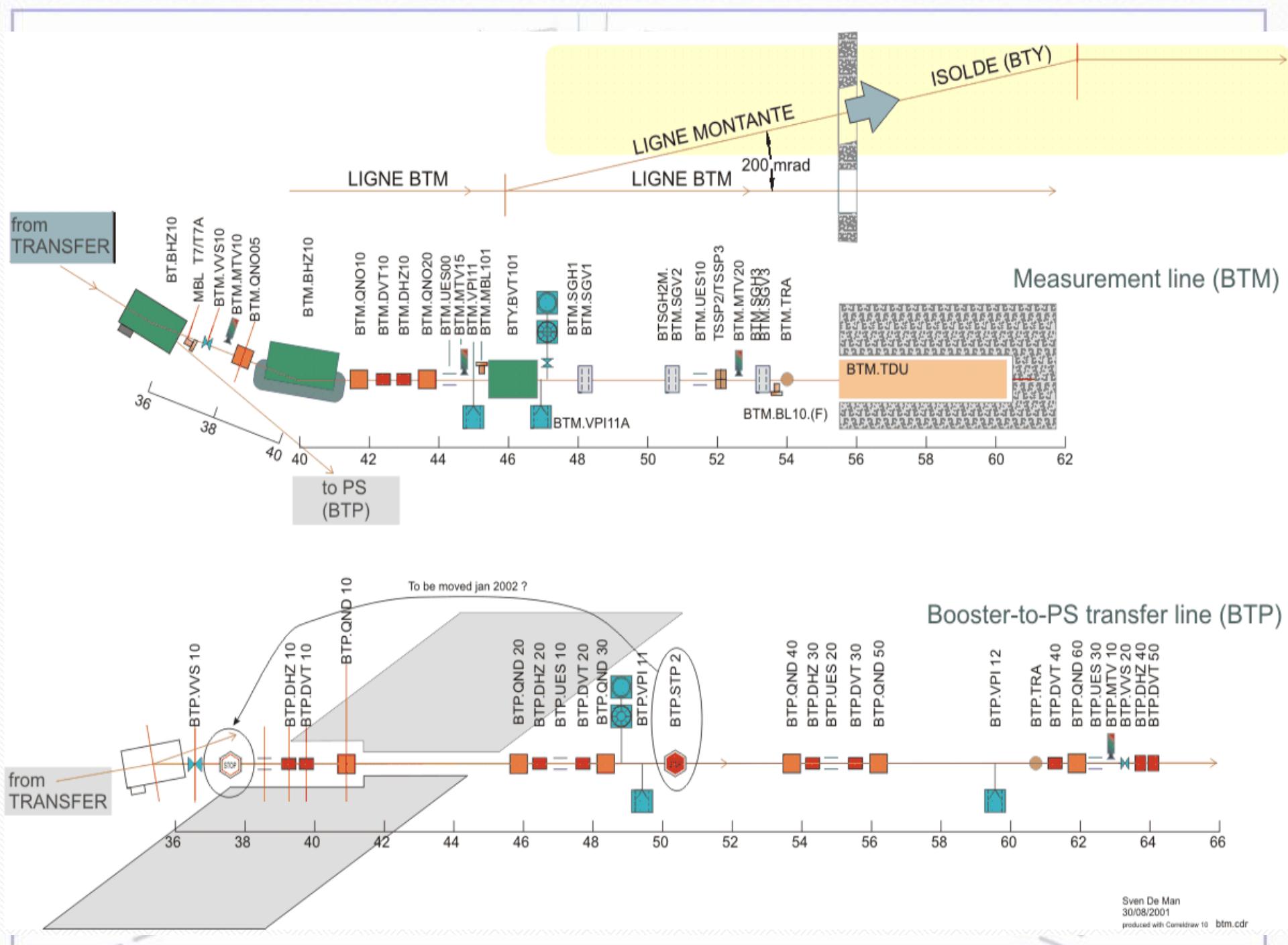
with cooperation of

Bettina Mikulec
Vivien Raginec

PSB-LIU meeting
27.06.2013







BTM.QNO05 – quadrupole

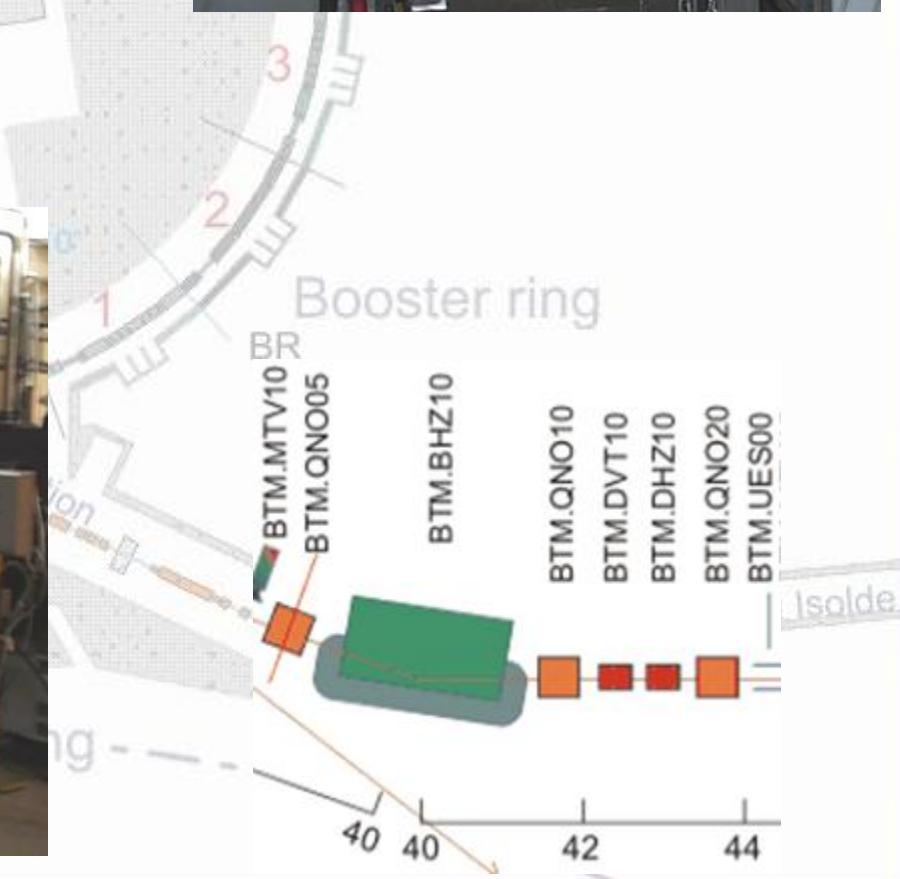
BTM.BHZ10 – bending magnet

BTM.QNO10 – quadrupole

BTM.DVT10 – V corrector

BTM.DHZ10 - H corrector

BTM.QNO20 – quadrupole



BTM.QNO05 – quadrupole

BTM.BHZ10 – bending magnet

BTM.QNO10 – quadrupole

BTM.DVT10 – V corrector

BTM.DHZ10 – (H) + V corrector

BTM.QNO20 – quadrupole

Step 1: Remove the **BTM.DVT10** to liberate some space
 $(30\text{cm}+16\text{cm}=46\text{cm})$

Step 2: Shift the **BTM.QNO10** by 46cm downstream

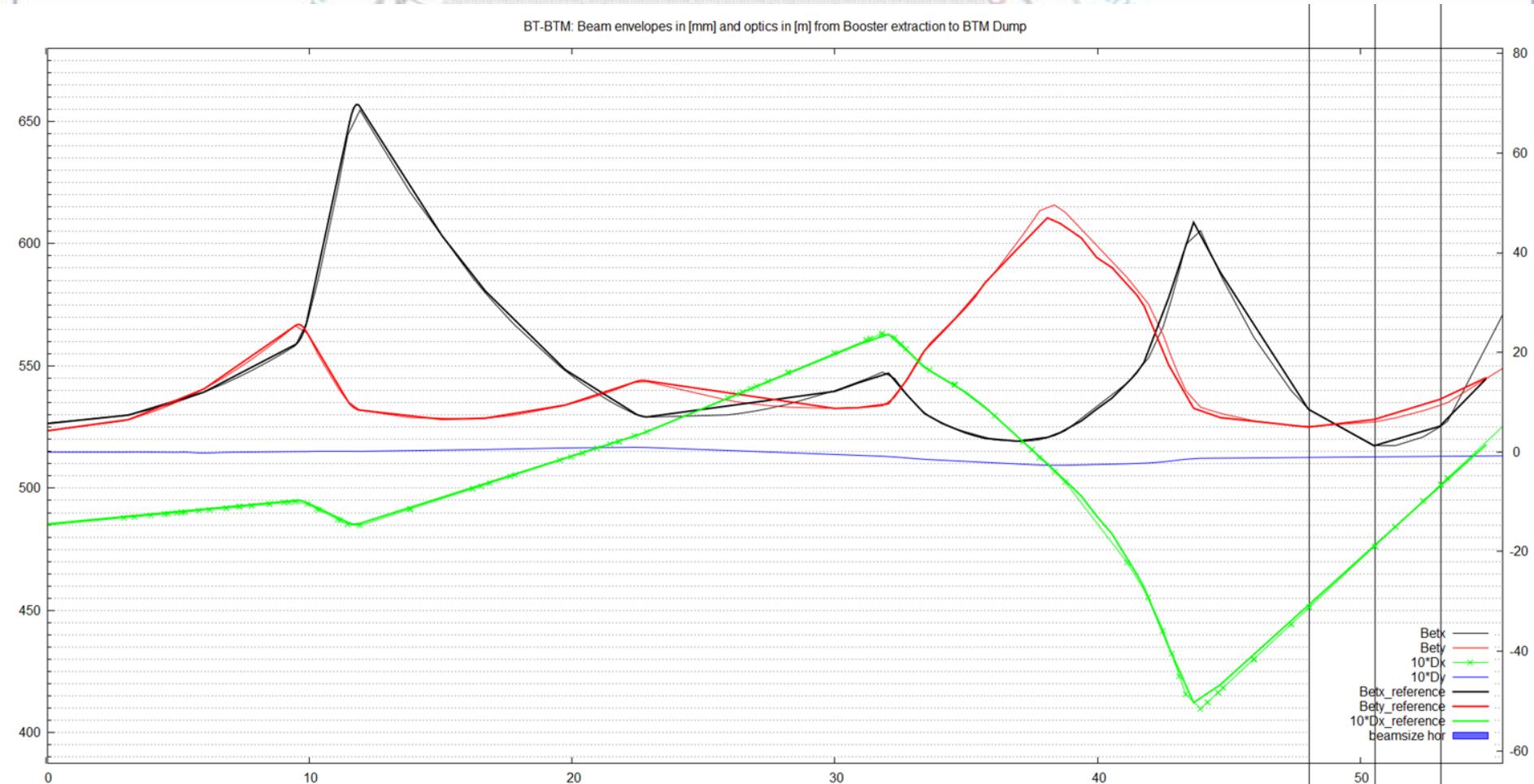
Step 3: Replace the **BTM.DHZ10** by combined corrector for both planes or use **BTM.BHZ10** for horizontal correction

Result:

We gain 46cm for **BTM.BHZ10** upgrade

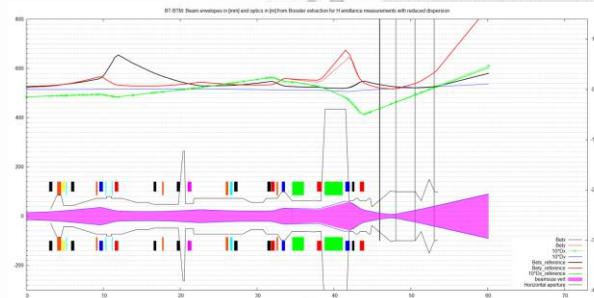
40 40 42 44

The task of our group was to perform the optics study...

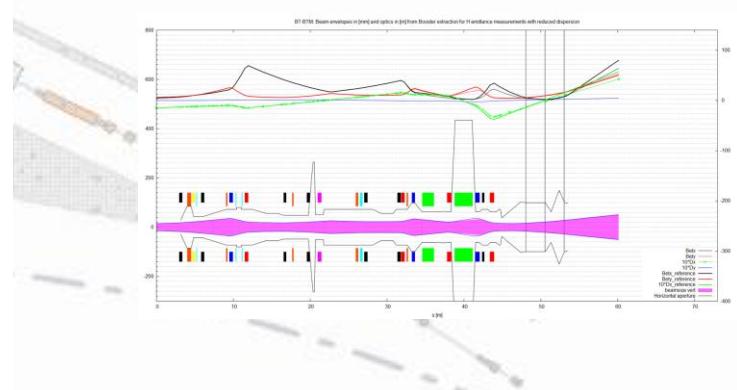
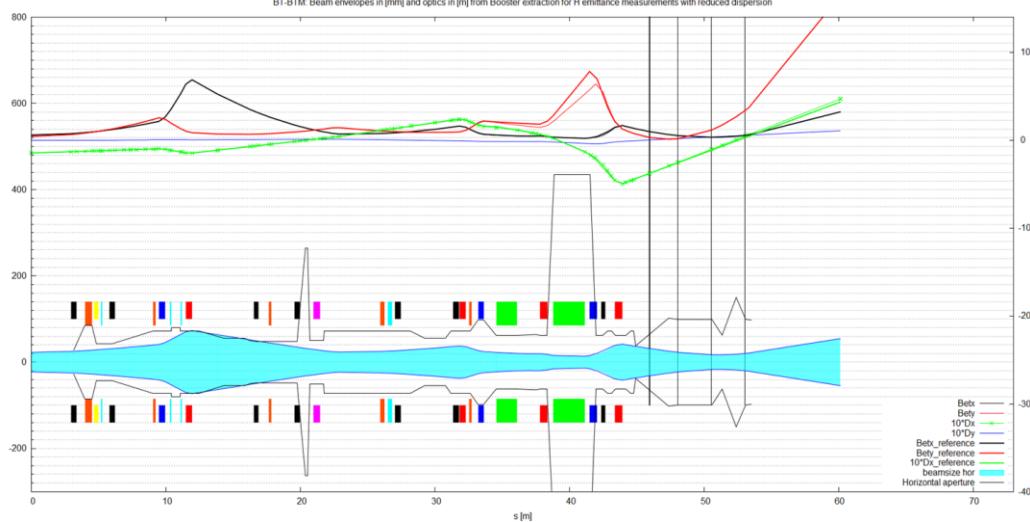


...for 4 different beam type...

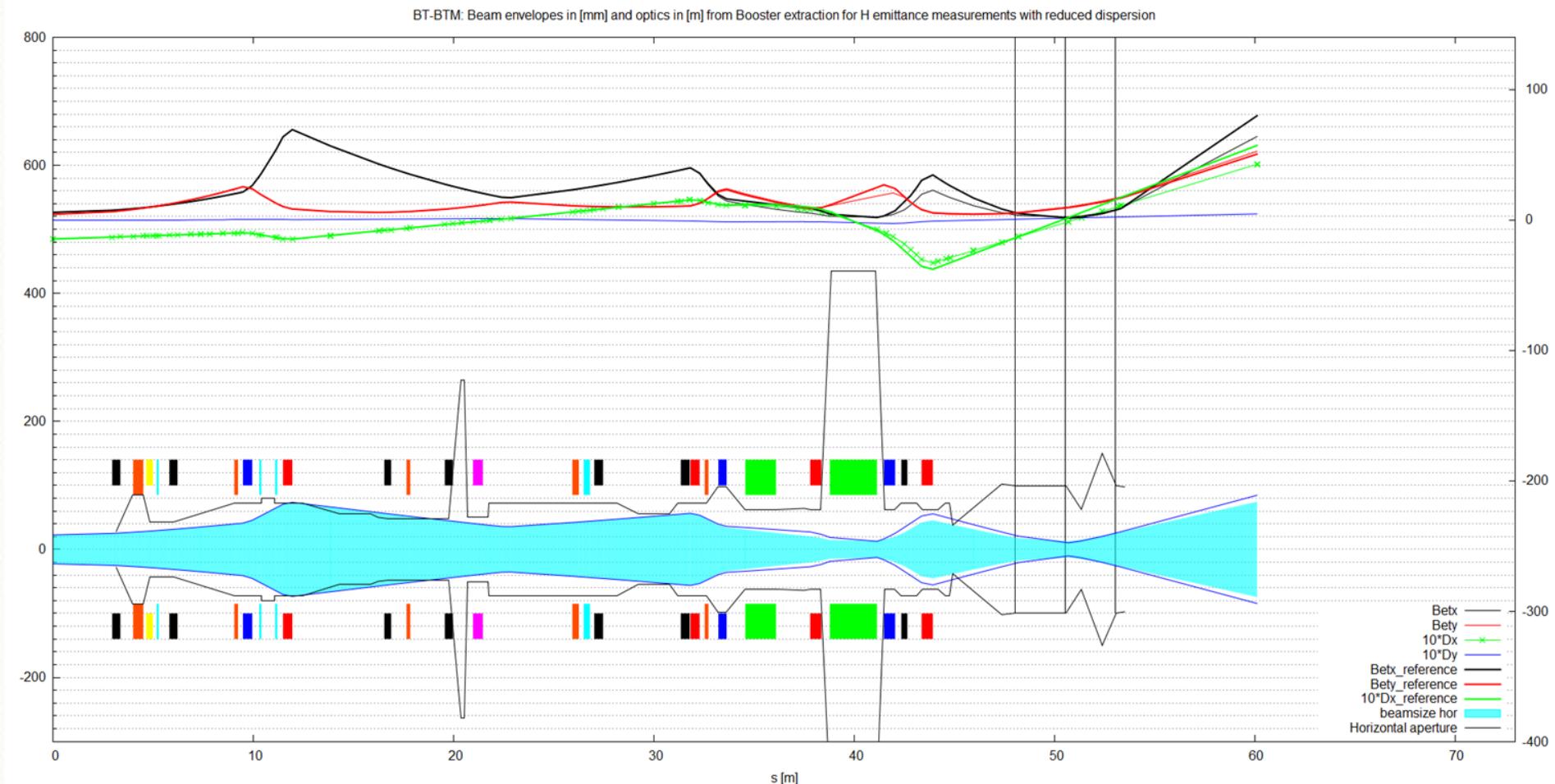
- Beam going to dump and Isolde



- Beam for emittance measurements
 - Horizontal emittance with normal dispersion
 - Horizontal emittance with reduced dispersion
 - Vertical emittance



...for the option with shifted quadrupole for line 3



Calculation of the beam size

$$A_{xy}/2 = N_s * \sqrt{k_b * \beta_{xy} * \epsilon_{xy} / \beta\gamma} + \text{abs}(D_{xy}) * \Delta p/p + CO * \sqrt{\beta_{xy} / \beta_{\max}}$$

$$A_{xy}/2$$

$$N_s = 3$$

$$k_b = 1.2$$

$$\beta_{xy}$$

$$\epsilon_{xy} = 15/10 * 10^{-6}$$

$$D_{xy}$$

$$\Delta p/p = 1.35 * 10^{-3}$$

$$CO = 1.5\text{mm}$$

$$\beta_{\max}$$

- half-aperture $A_{xy}/2$ sufficient to accept minimum number N_s of beam sigma
- number of sigmas
- beta beating factor (20%)
- beta function at certain position
- horizontal/vertical emittance
- dispersion function at certain position
- momentum spread
- peak trajectory
- maximum value of beta function

Maximum beam size for 4 optics options on BTM.BHZ10

* For extended bend by 46cm

| Maximum half beam size | Dump + Isolde | H emittance | H emittance reduced D | V emittance |
|------------------------|---------------|--------------|-----------------------|-------------|
| Horizontal | 16 mm | 39 mm | 16 mm | 27 mm |
| Vertical | 58 mm | 53 mm | 35 mm | 37 mm |

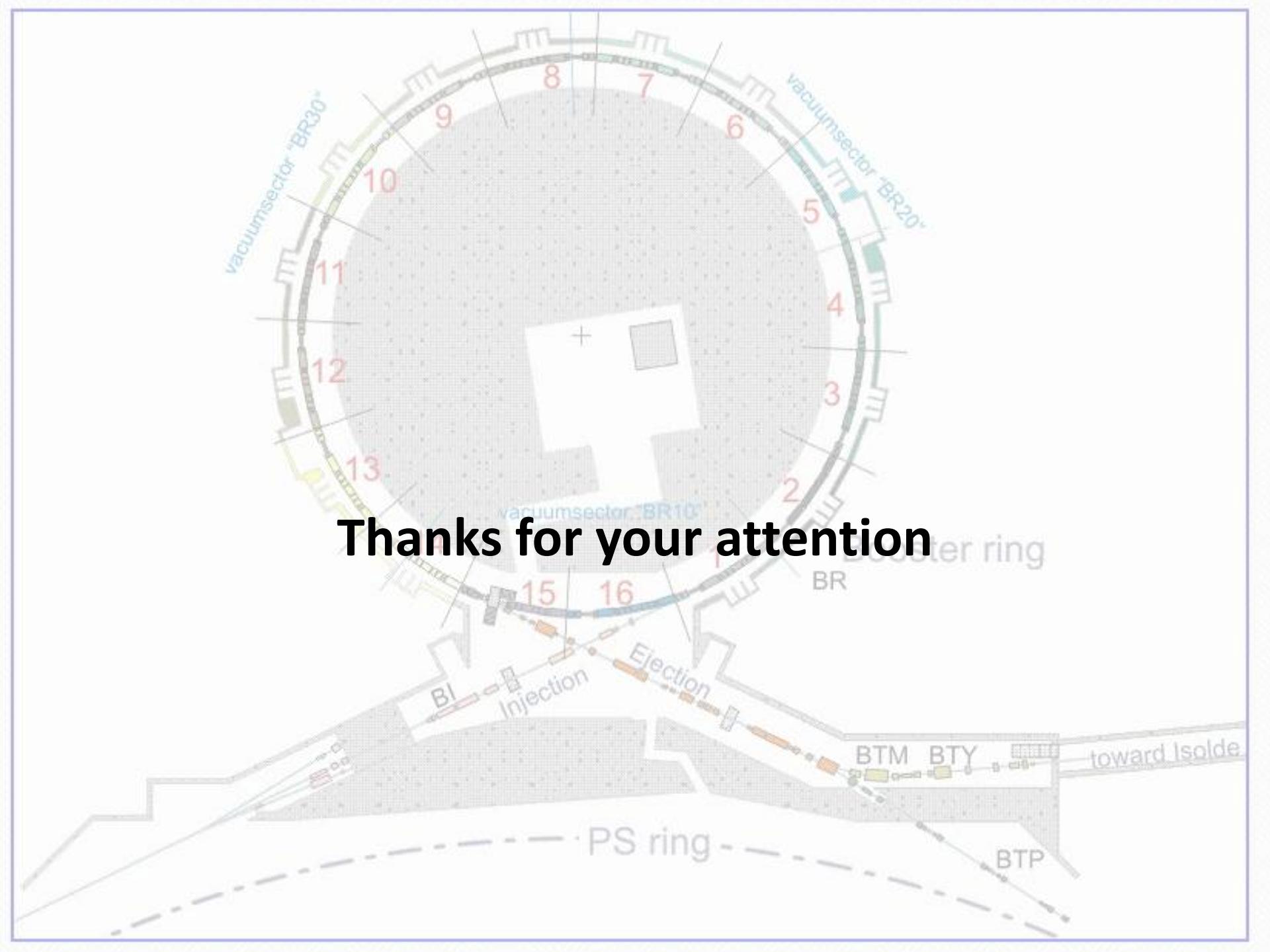
** The maximum half beam sizes for the existing bend are:

35 mm in horizontal plane

60 mm in vertical plane

Conclusions:

- Optics can be rematched when suppressing one corrector
- Gain is **46 cm**
- Maximum estimated beam size is **78mm** in horizontal plane and **116mm** in vertical plane



The diagram illustrates a circular particle accelerator ring divided into 16 numbered sectors (1 through 16) around its perimeter. The sectors are color-coded: green for sectors 1-4, yellow for 5-8, red for 9-12, and blue for 13-16. Two specific sectors are labeled "vacuumsector 'BR30'" (yellow-green) and "vacuumsector 'BR20'" (blue). The ring is labeled "Booster ring" and "BR". Below the ring, several beam lines are shown: "BI" (Beam Injection), "B" (Beam), "Injection", "Ejection", "BTM", "BTY", and "BTP". A dashed line labeled "PS ring" extends from the bottom left towards the center. The text "toward Isolde" is also visible on the right side.

Thanks for your attention

Dump + Isolde

| H plane | 1 sigma [m] | Disp [m] | CO comp [m] | 3 sigma [m] | Total [mm] |
|----------|-------------|----------|-------------|-------------|------------|
| Entrance | 0.00505 | 0.00026 | 0.00033 | 0.01514 | 15.73 |
| End old | 0.00392 | 0.00180 | 0.00025 | 0.01175 | 13.80 |
| End new* | 0.00440 | 0.00232 | 0.00028 | 0.01320 | 15.81 |

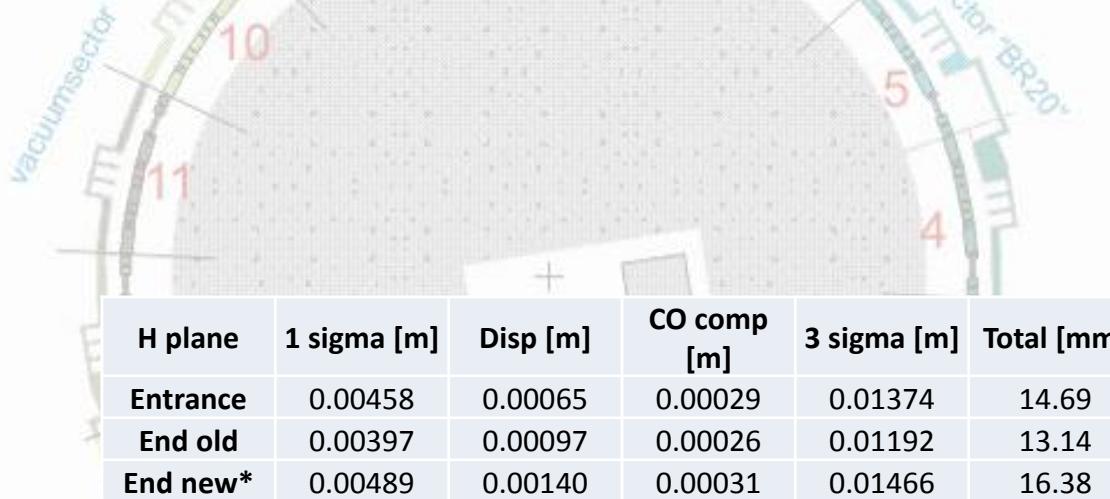
| V plane | 1 sigma [m] | Disp [m] | CO comp [m] | 3 sigma [m] | Total [mm] |
|----------|-------------|----------|-------------|-------------|------------|
| Entrance | 0.01055 | 0.00030 | 0.00086 | 0.03166 | 32.83 |
| End old | 0.01660 | 0.00051 | 0.00136 | 0.04979 | 51.66 |
| End new* | 0.01759 | 0.00054 | 0.00144 | 0.05277 | 54.75 |

Horizontal emittance normal D

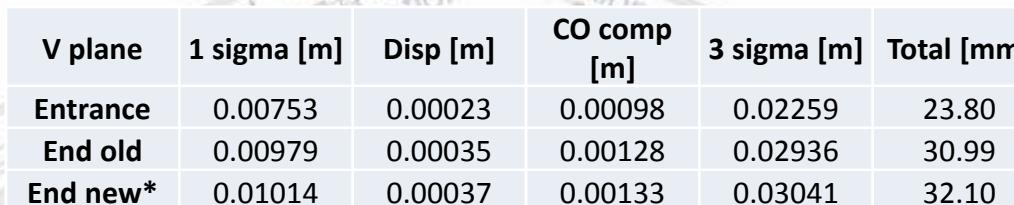
| H plane | 1 sigma [m] | Disp [m] | CO comp [m] | 3 sigma [m] | Total [mm] |
|----------|-------------|----------|-------------|-------------|------------|
| Entrance | 0.00581 | 0.00083 | 0.00037 | 0.01744 | 18.64 |
| End old | 0.01046 | 0.00300 | 0.00067 | 0.03139 | 35.06 |
| End new* | 0.01145 | 0.00354 | 0.00074 | 0.03435 | 38.63 |

| V plane | 1 sigma [m] | Disp [m] | CO comp [m] | 3 sigma [m] | Total [mm] |
|----------|-------------|----------|-------------|-------------|------------|
| Entrance | 0.01590 | 0.00036 | 0.00149 | 0.04771 | 49.55 |
| End old | 0.01357 | 0.00032 | 0.00127 | 0.04070 | 42.29 |
| End new* | 0.01296 | 0.00031 | 0.00121 | 0.03887 | 40.38 |

Horizontal emittance reduced D

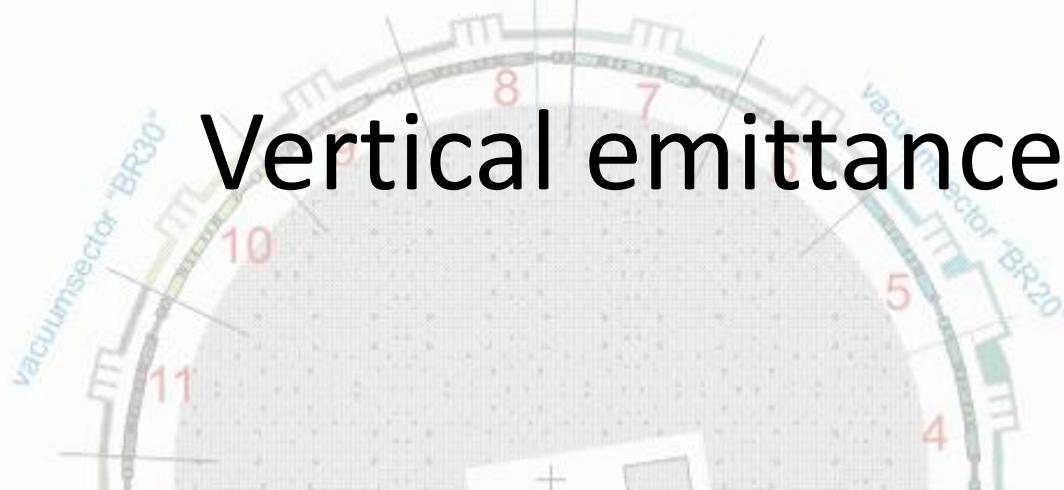


| H plane | 1 sigma [m] | Disp [m] | CO comp [m] | 3 sigma [m] | Total [mm] |
|----------|-------------|----------|-------------|-------------|------------|
| Entrance | 0.00458 | 0.00065 | 0.00029 | 0.01374 | 14.69 |
| End old | 0.00397 | 0.00097 | 0.00026 | 0.01192 | 13.14 |
| End new* | 0.00489 | 0.00140 | 0.00031 | 0.01466 | 16.38 |

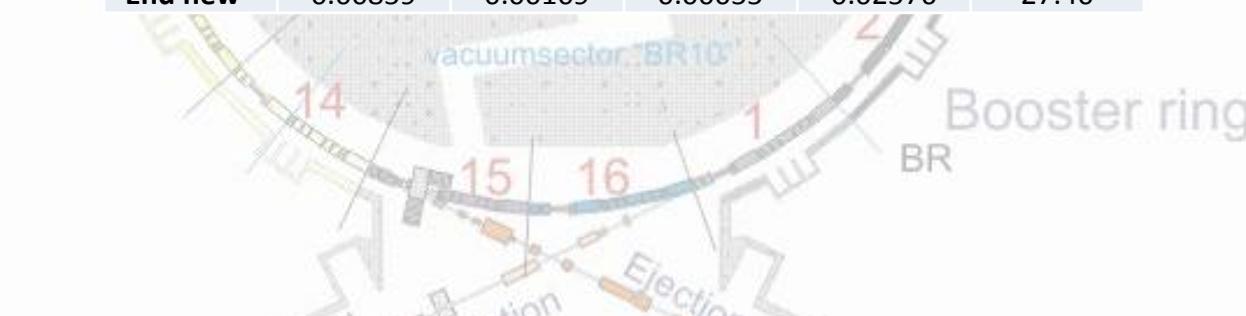


| V plane | 1 sigma [m] | Disp [m] | CO comp [m] | 3 sigma [m] | Total [mm] |
|----------|-------------|----------|-------------|-------------|------------|
| Entrance | 0.00753 | 0.00023 | 0.00098 | 0.02259 | 23.80 |
| End old | 0.00979 | 0.00035 | 0.00128 | 0.02936 | 30.99 |
| End new* | 0.01014 | 0.00037 | 0.00133 | 0.03041 | 32.10 |

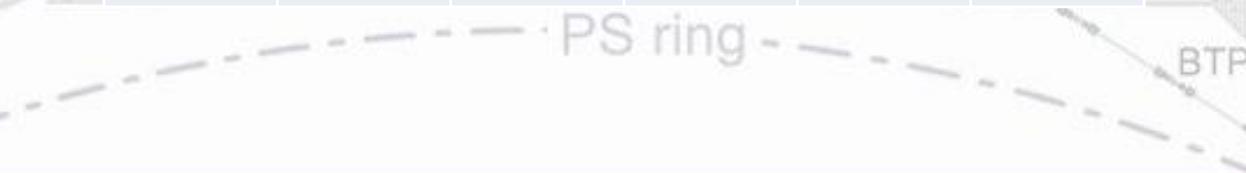
Vertical emittance



| H plane | 1 sigma [m] | Disp [m] | CO comp [m] | 3 sigma [m] | Total [mm] |
|----------|-------------|----------|-------------|-------------|------------|
| Entrance | 0.00672 | 0.00071 | 0.00043 | 0.02015 | 21.29 |
| End old | 0.00820 | 0.00070 | 0.00053 | 0.02461 | 25.84 |
| End new* | 0.00859 | 0.00109 | 0.00055 | 0.02576 | 27.40 |

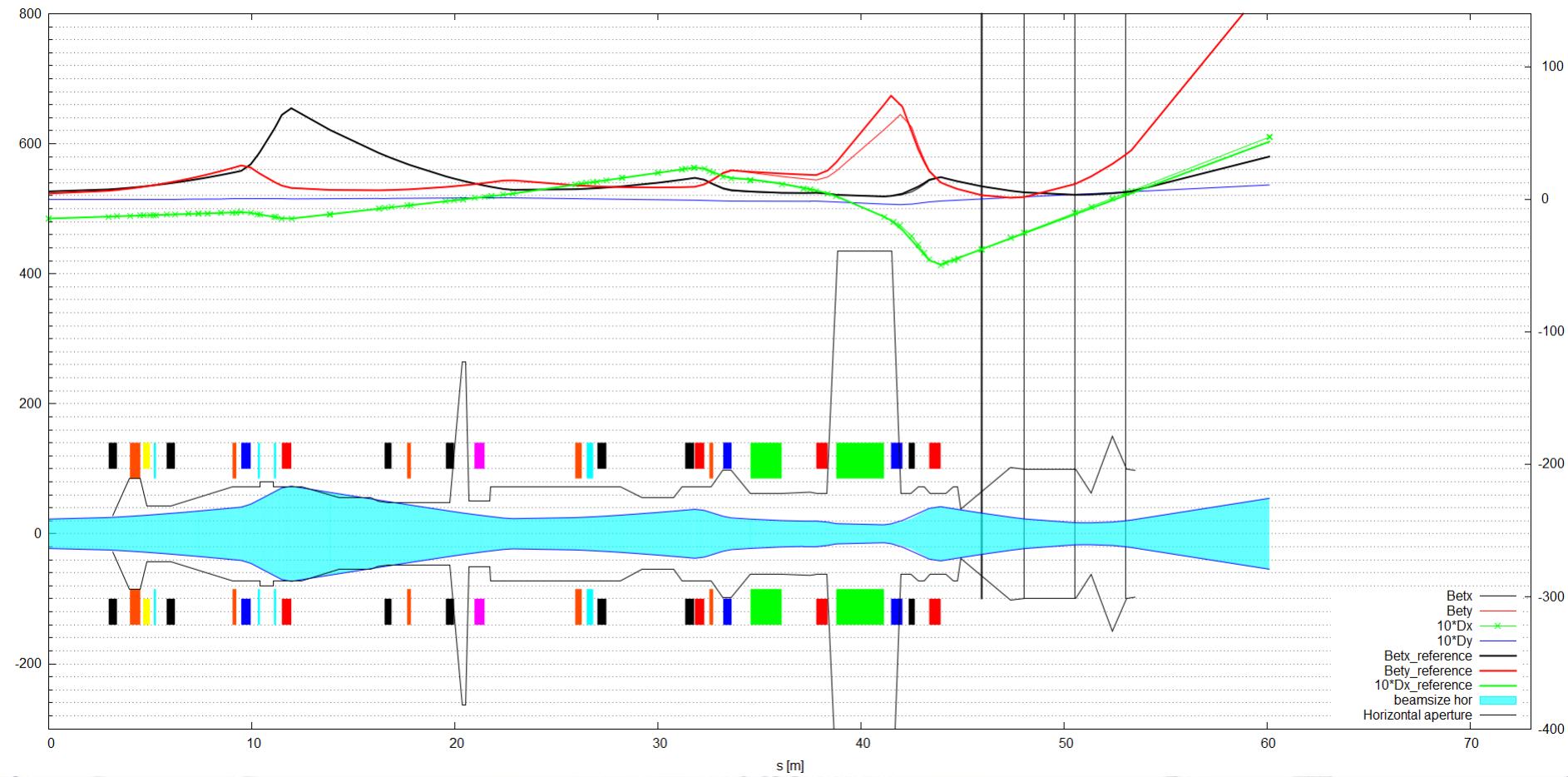


| V plane | 1 sigma [m] | Disp [m] | CO comp [m] | 3 sigma [m] | Total [mm] |
|----------|-------------|----------|-------------|-------------|------------|
| Entrance | 0.01076 | 0.00028 | 0.00111 | 0.03227 | 33.66 |
| End old | 0.01006 | 0.00029 | 0.00104 | 0.03017 | 31.49 |
| End new* | 0.00982 | 0.00028 | 0.00101 | 0.02945 | 30.75 |



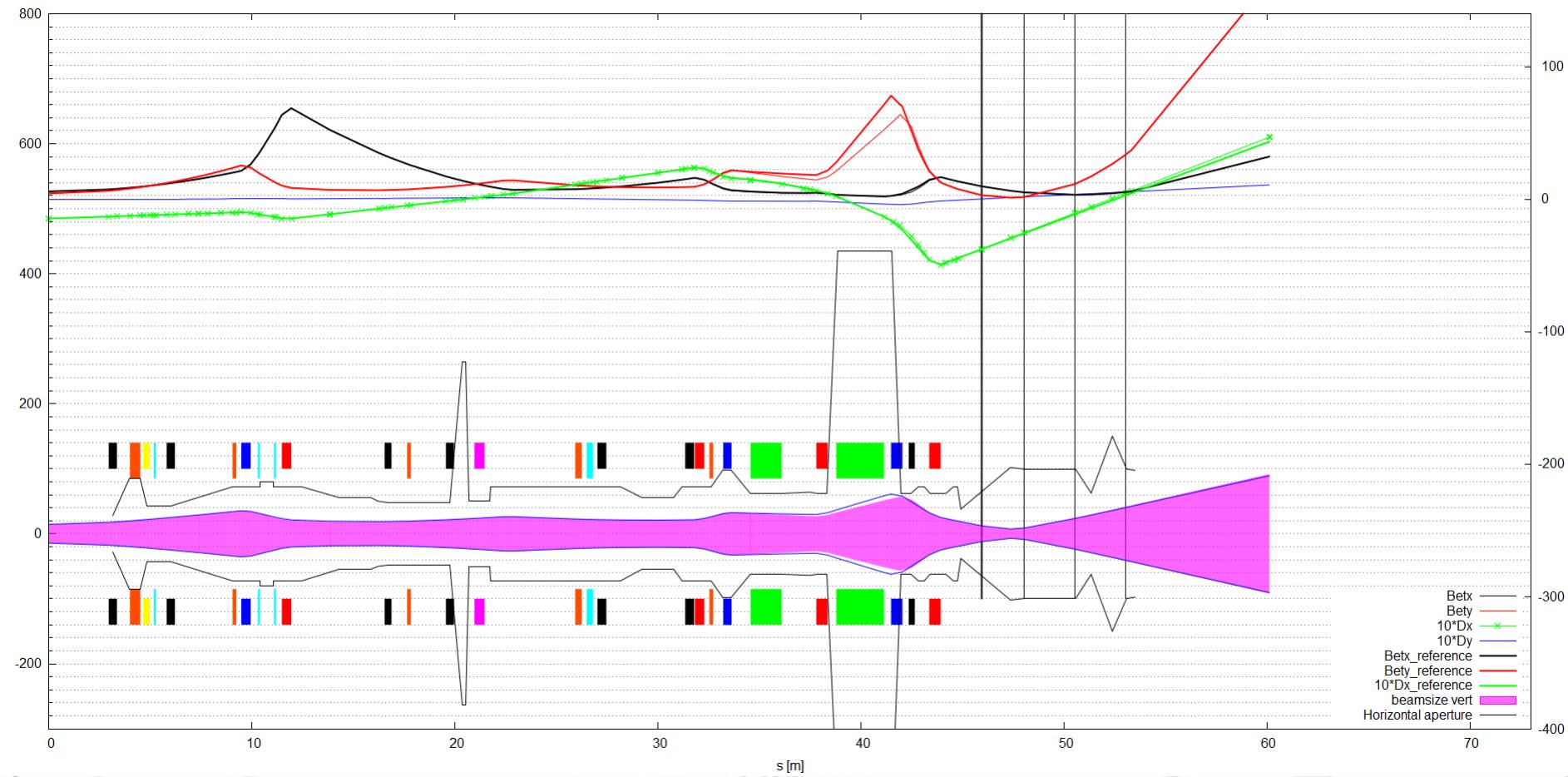
Dump + Isolde, H plane

BT-BTM: Beam envelopes in [mm] and optics in [m] from Booster extraction for H emittance measurements with reduced dispersion



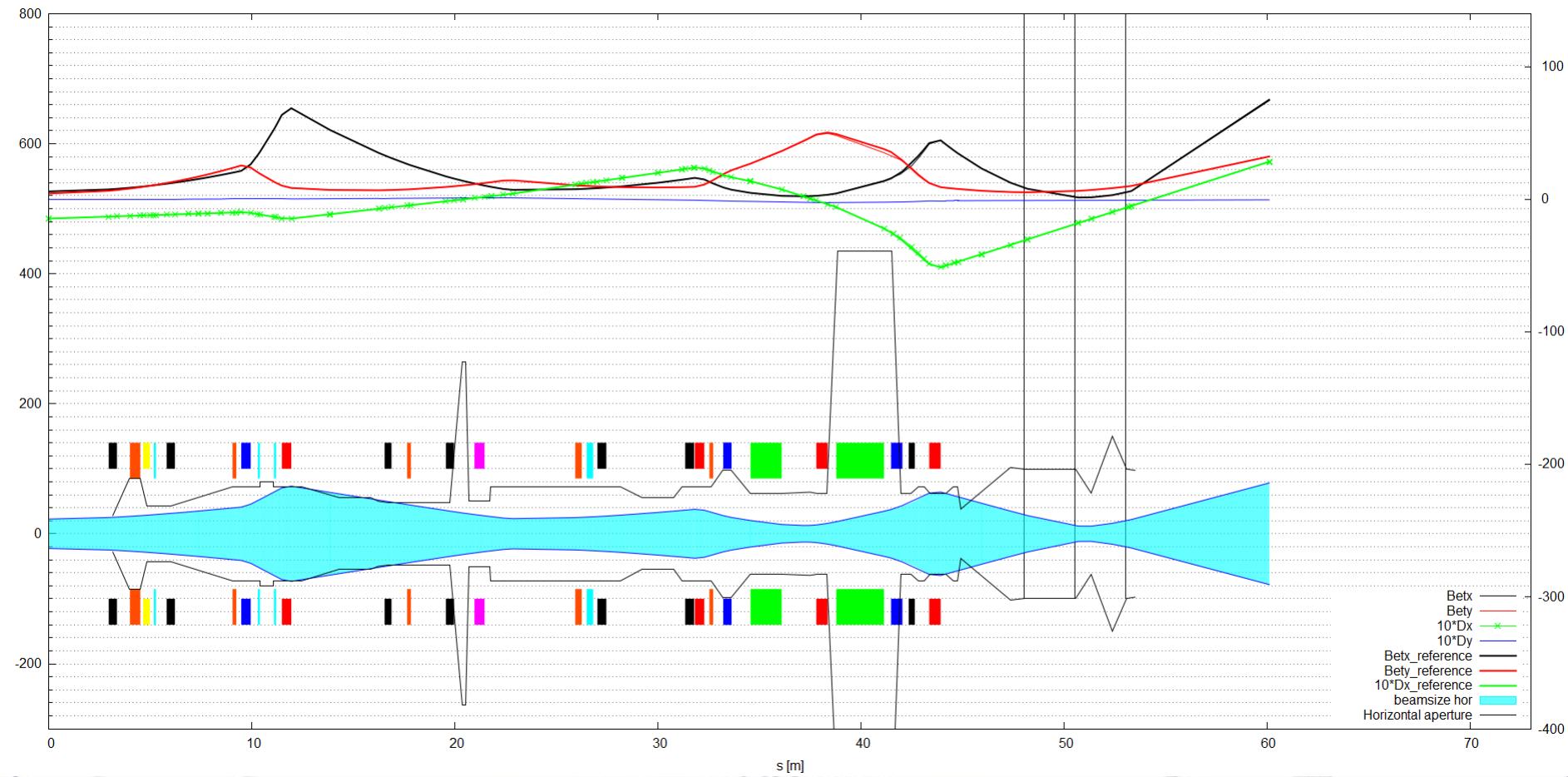
Dump + Isolde, V plane

BT-BTM: Beam envelopes in [mm] and optics in [m] from Booster extraction for H emittance measurements with reduced dispersion



H emittance normal D, H plane

BT-BTM: Beam envelopes in [mm] and optics in [m] from Booster extraction for H emittance measurements with reduced dispersion



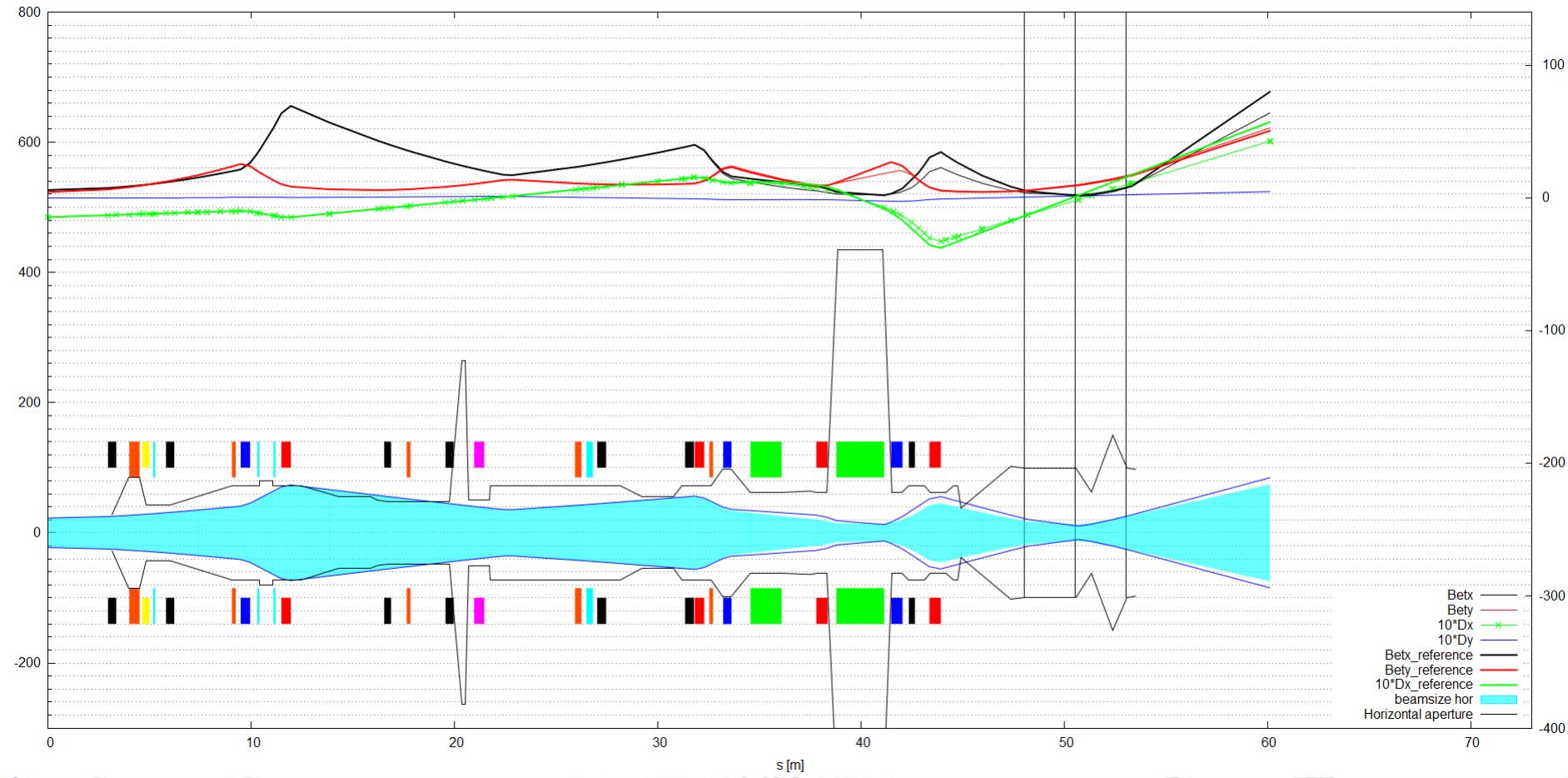
H emittance normal D, V plane

BT-BTM: Beam envelopes in [mm] and optics in [m] from Booster extraction for H emittance measurements with reduced dispersion



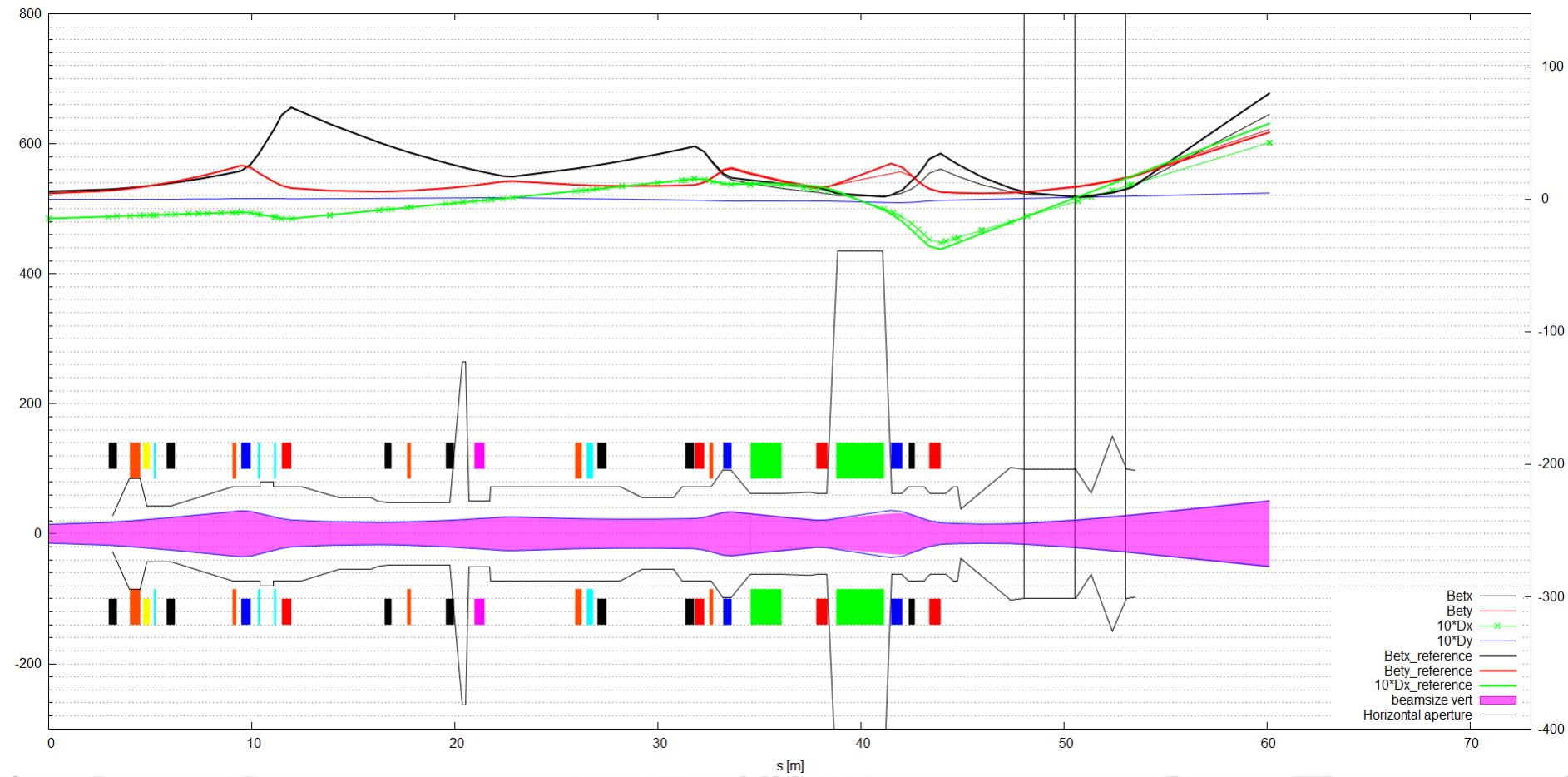
H emittance reduced D, H plane

BT-BTM: Beam envelopes in [mm] and optics in [m] from Booster extraction for H emittance measurements with reduced dispersion



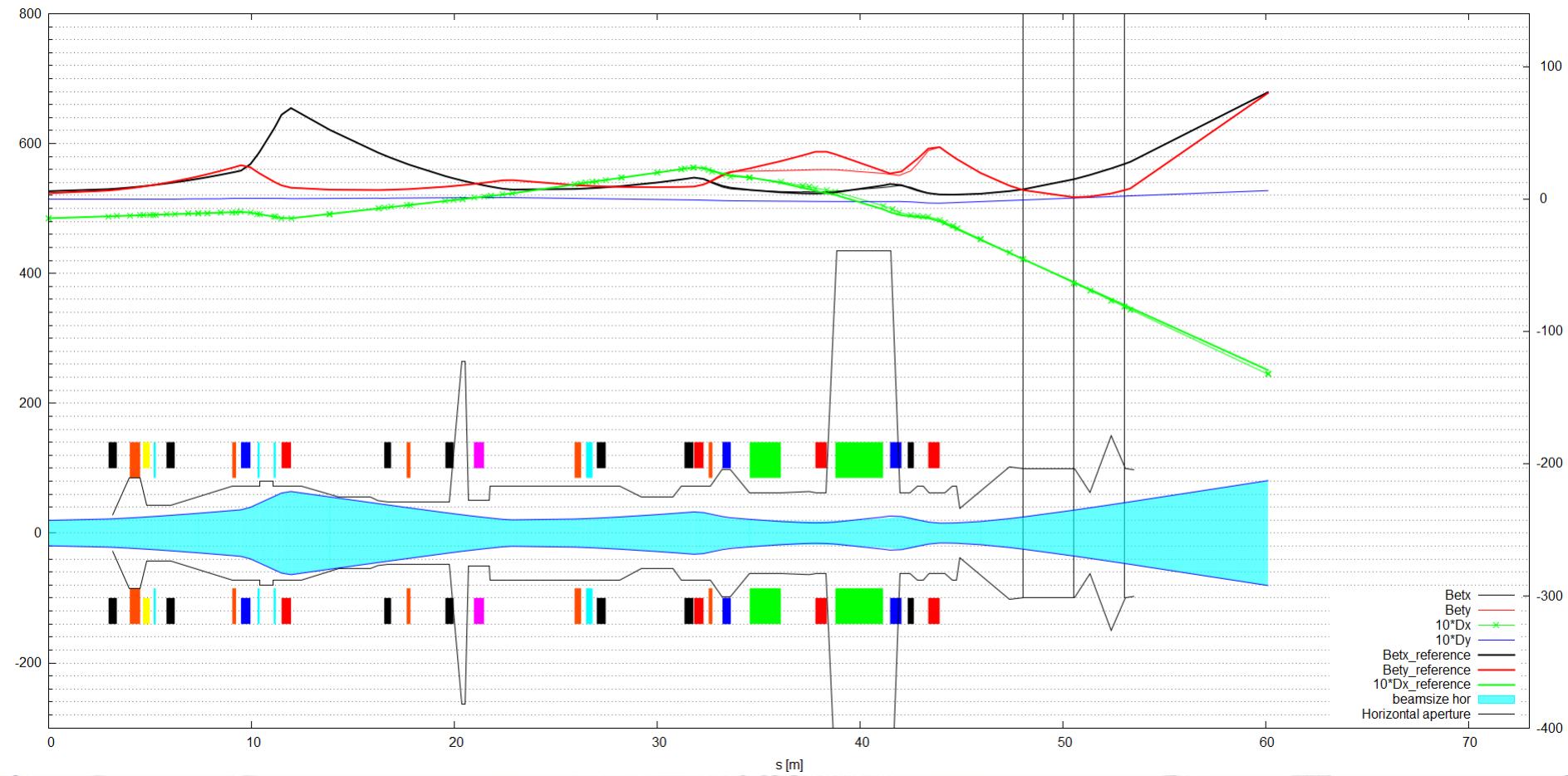
H emittance reduced D, V plane

BT-BTM: Beam envelopes in [mm] and optics in [m] from Booster extraction for H emittance measurements with reduced dispersion



Vertical emittance, H plane

BT-BTM: Beam envelopes in [mm] and optics in [m] from Booster extraction for V emittance measurements



Vertical emittance, V plane

BT-BTM: Beam envelopes in [mm] and optics in [m] from Booster extraction for V emittance measurements

