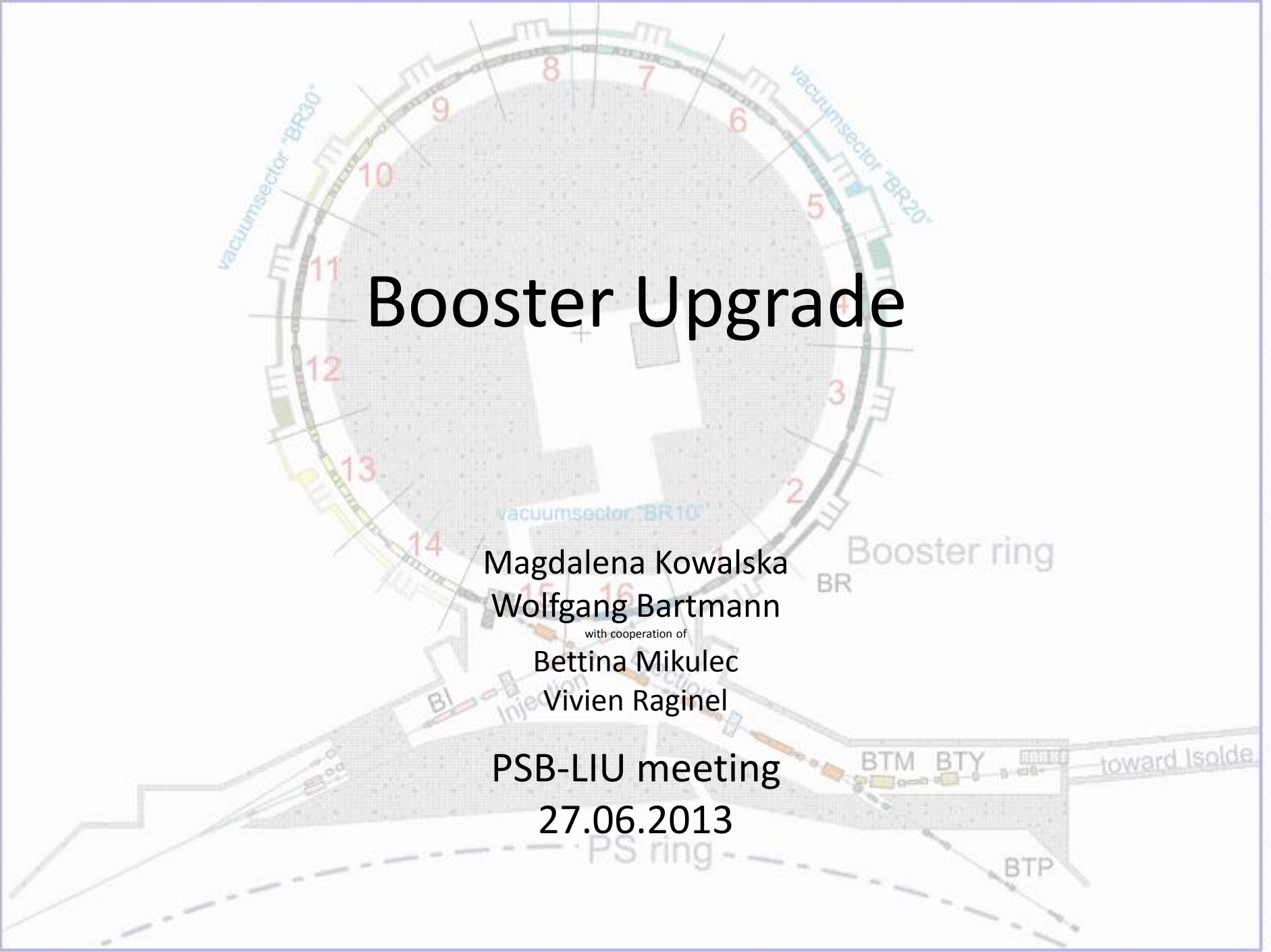


The diagram shows a circular Booster ring (BR) with 16 numbered sectors (1-16) around its perimeter. Three specific vacuum sectors are highlighted: 'BR30' (sectors 10-12), 'BR20' (sectors 5-7), and 'BR10' (sector 14). The sectors are color-coded: 1-4 are red, 5-8 are green, 9-12 are yellow, and 13-16 are blue. Below the BR, the PS ring is shown as a dashed line. Various components are labeled: BI (Injection Beam Line), BTM, BTY, BTP, and a path 'toward Isolde'.

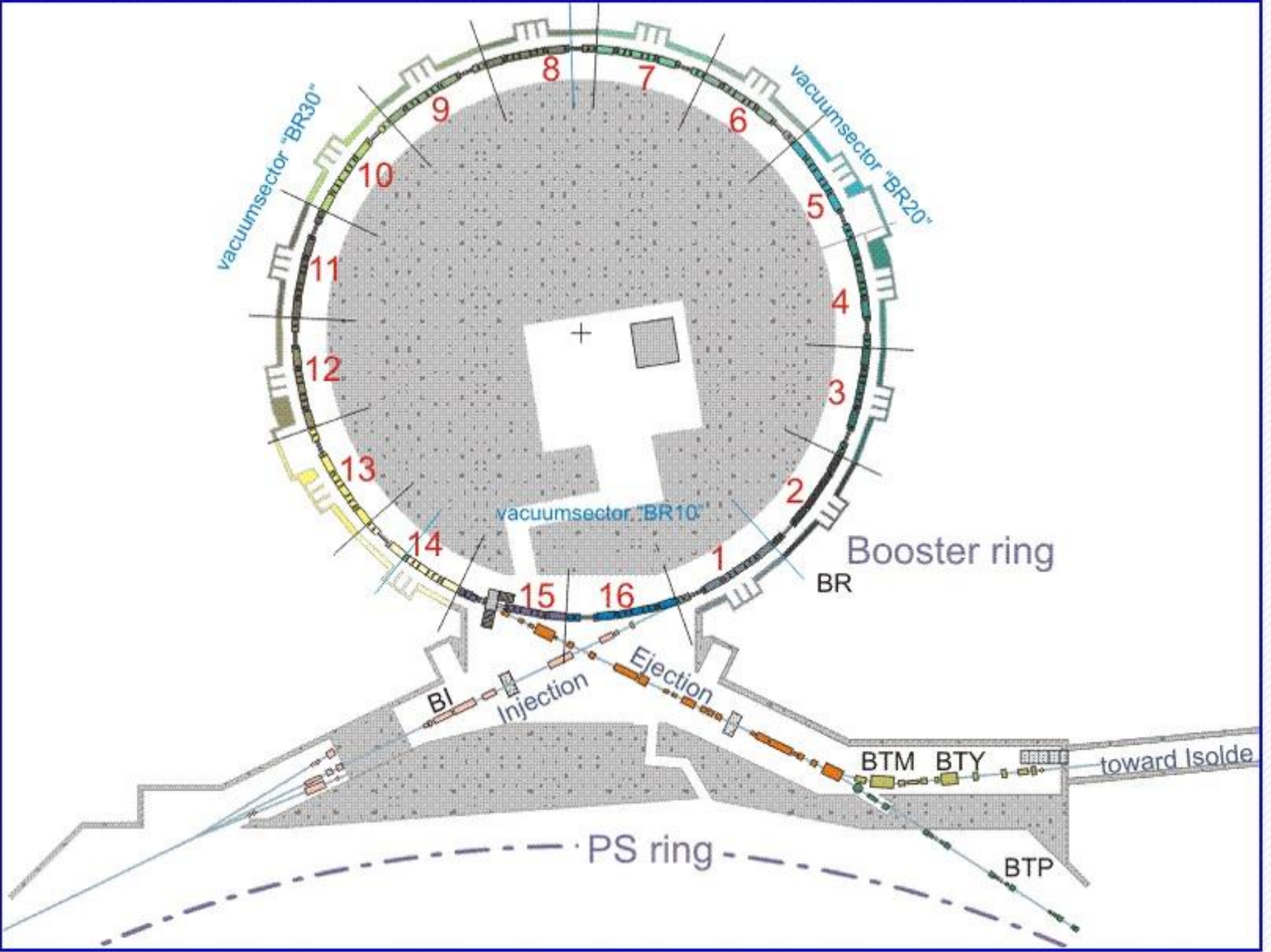
Booster Upgrade

Magdalena Kowalska
Wolfgang Bartmann

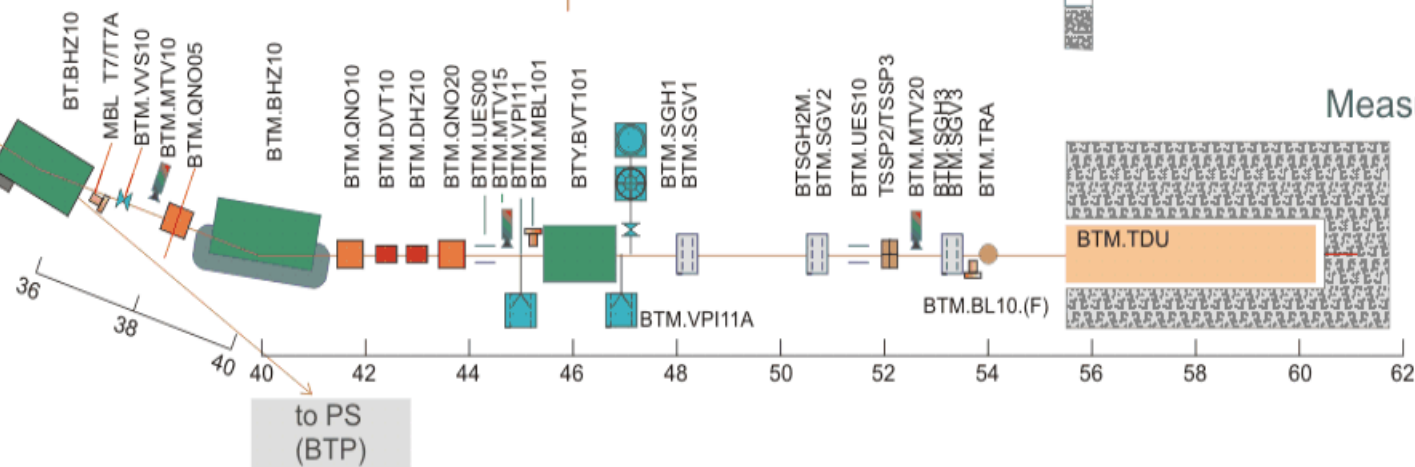
with cooperation of

Bettina Mikulec
Vivien Raginel

PSB-LIU meeting
27.06.2013

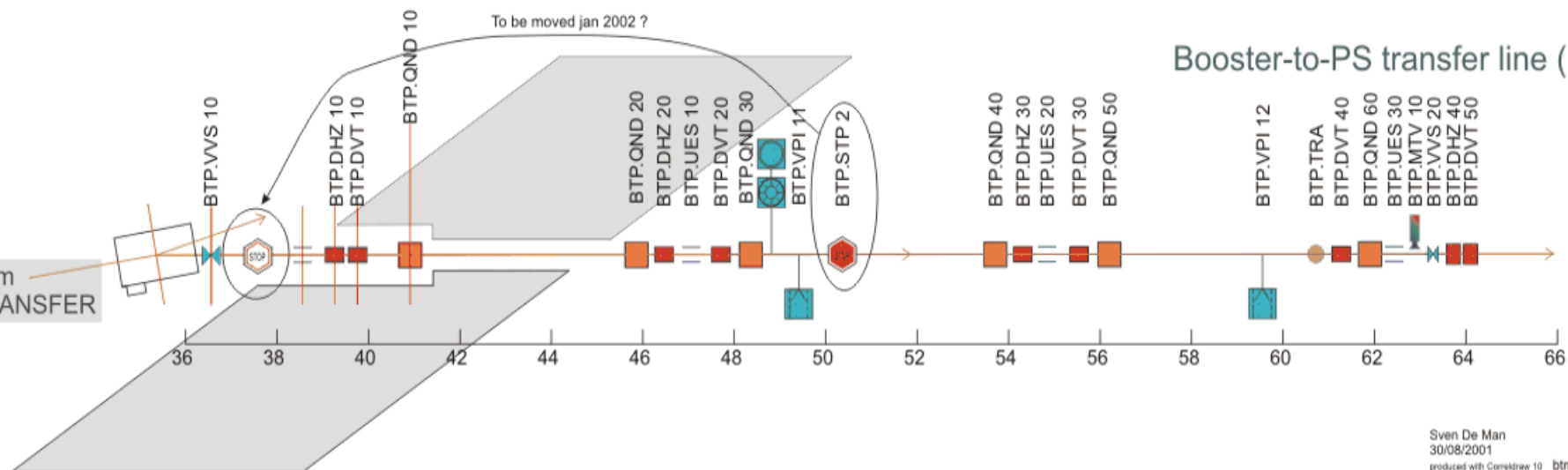


from
TRANSFER



Measurement line (BTM)

from
TRANSFER



Booster-to-PS transfer line (BTP)

BTM.QNO05 – quadrupole

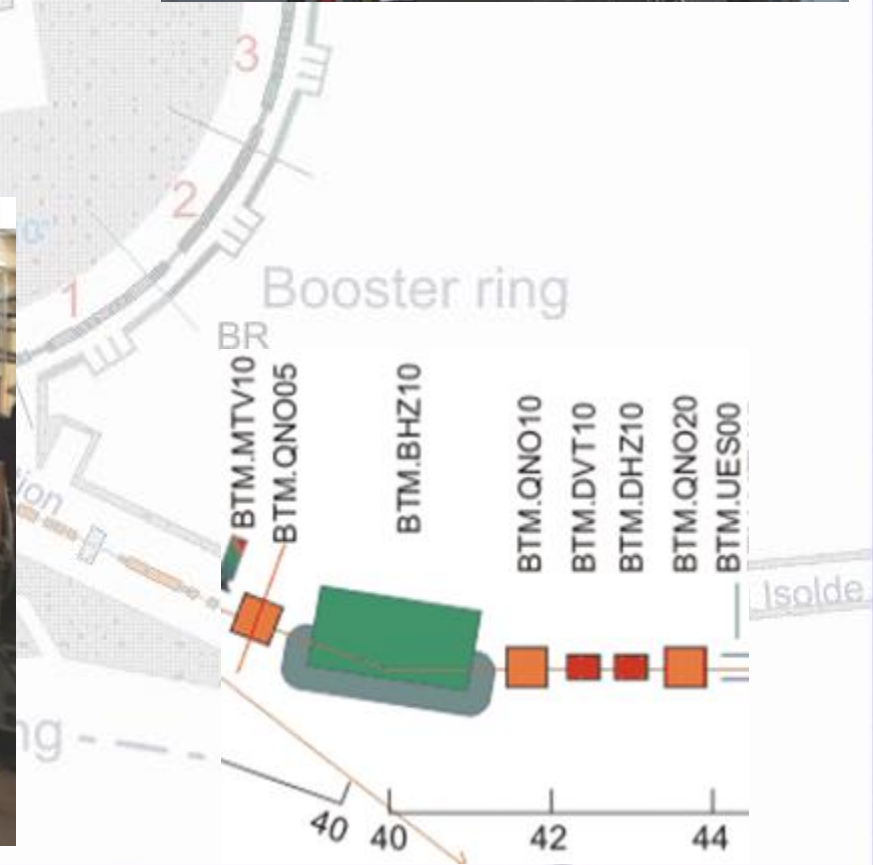
BTM.BHZ10 – bending magnet

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

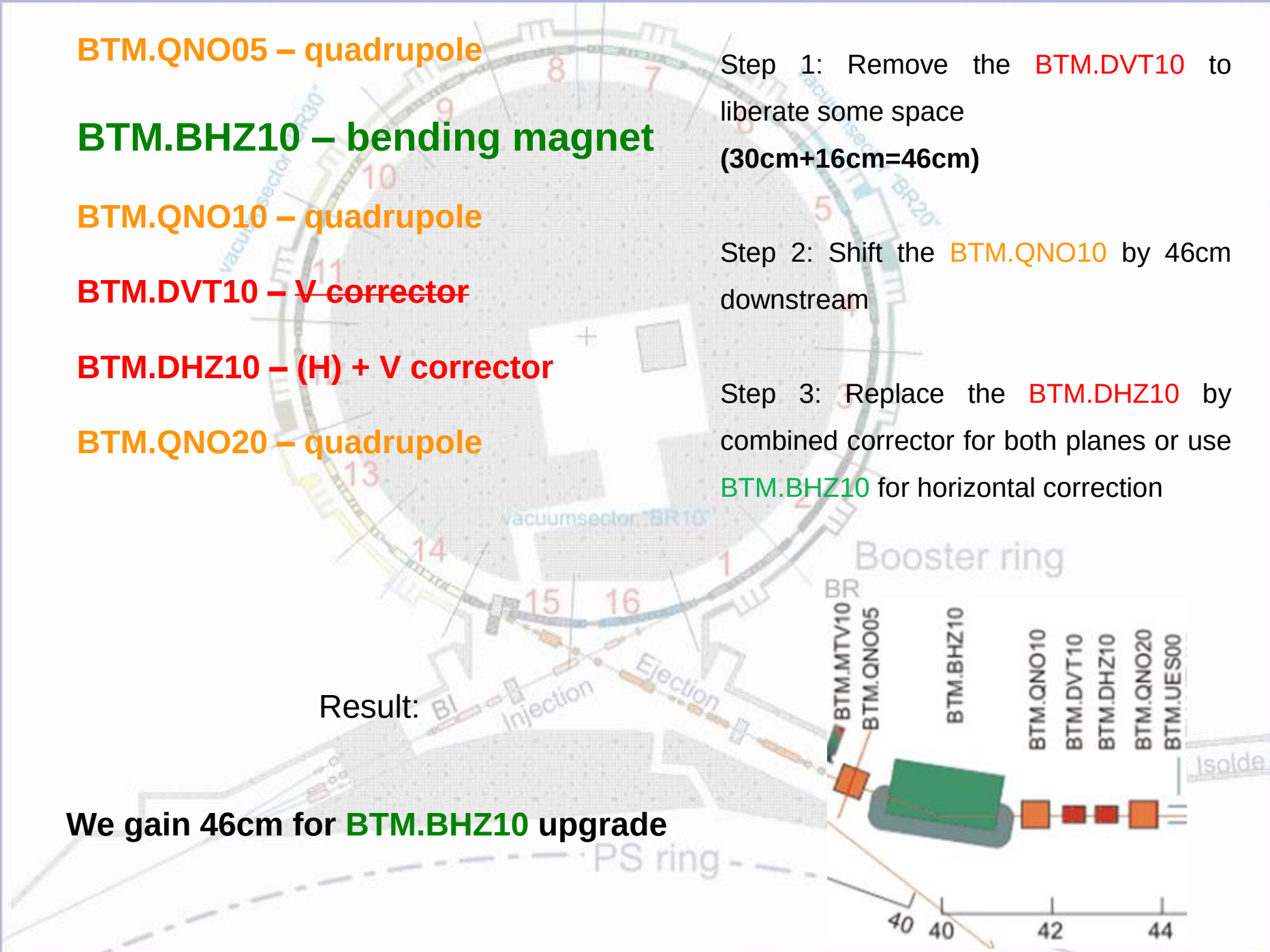
Step 1: Remove the **BTM.DVT10** to liberate some space
($30\text{cm} + 16\text{cm} = 46\text{cm}$)

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

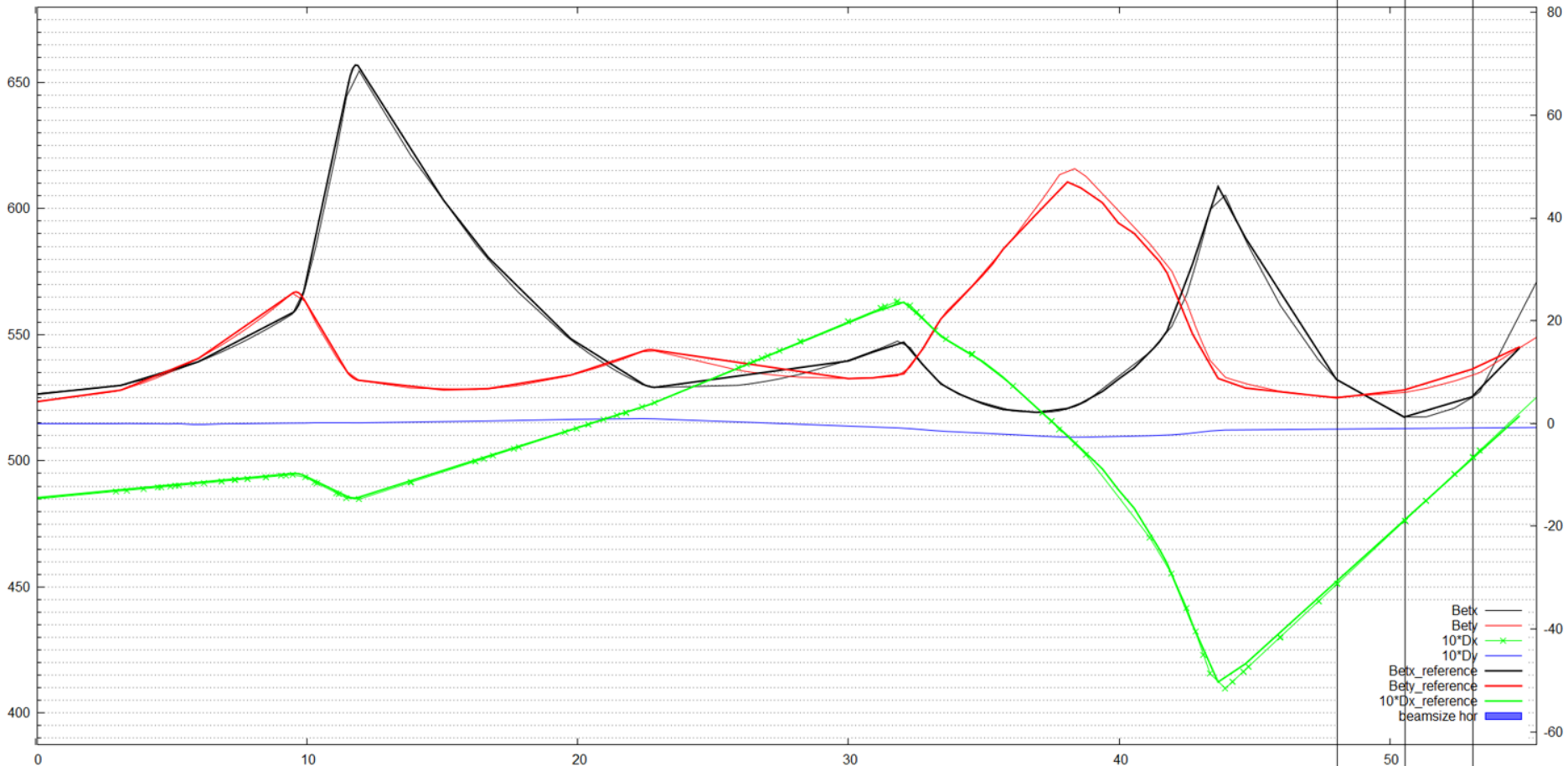
Result:

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



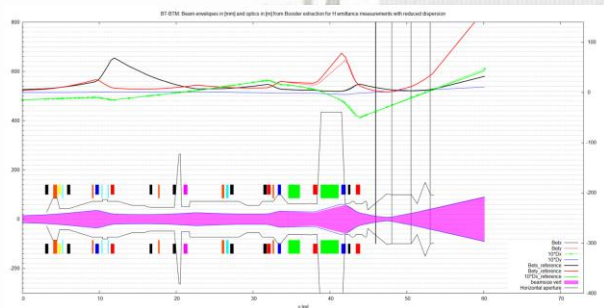
The task of our group was to perform the optics study...

BT-BTM: Beam envelopes in [mm] and optics in [m] from Booster extraction to BTM Dump



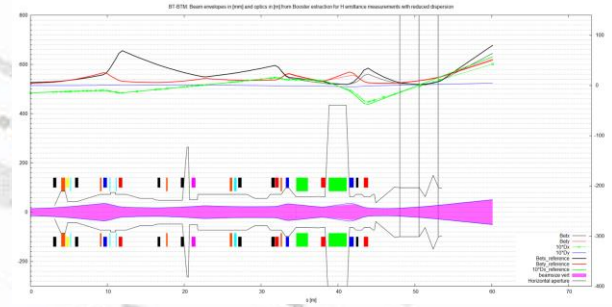
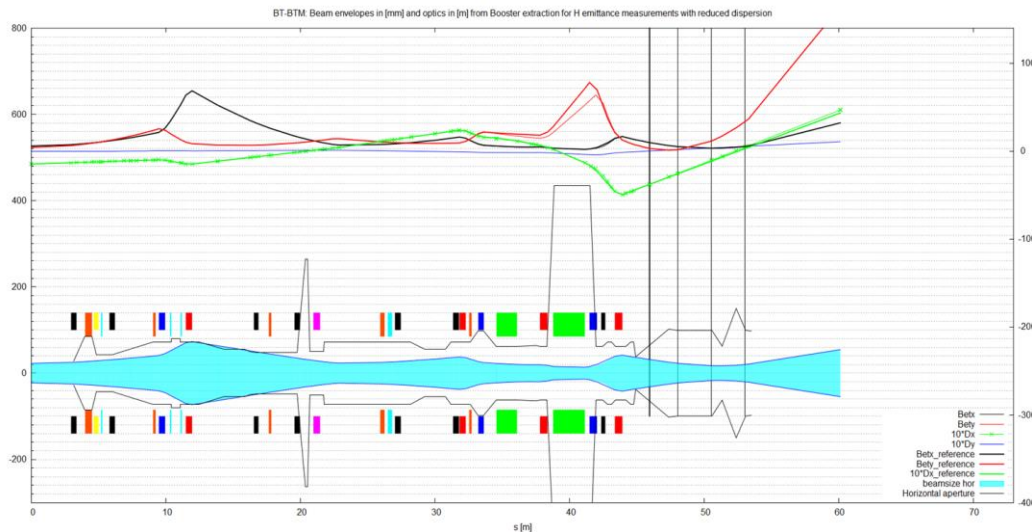
...for 4 different beam type...

- Beam going to dump and Isolde



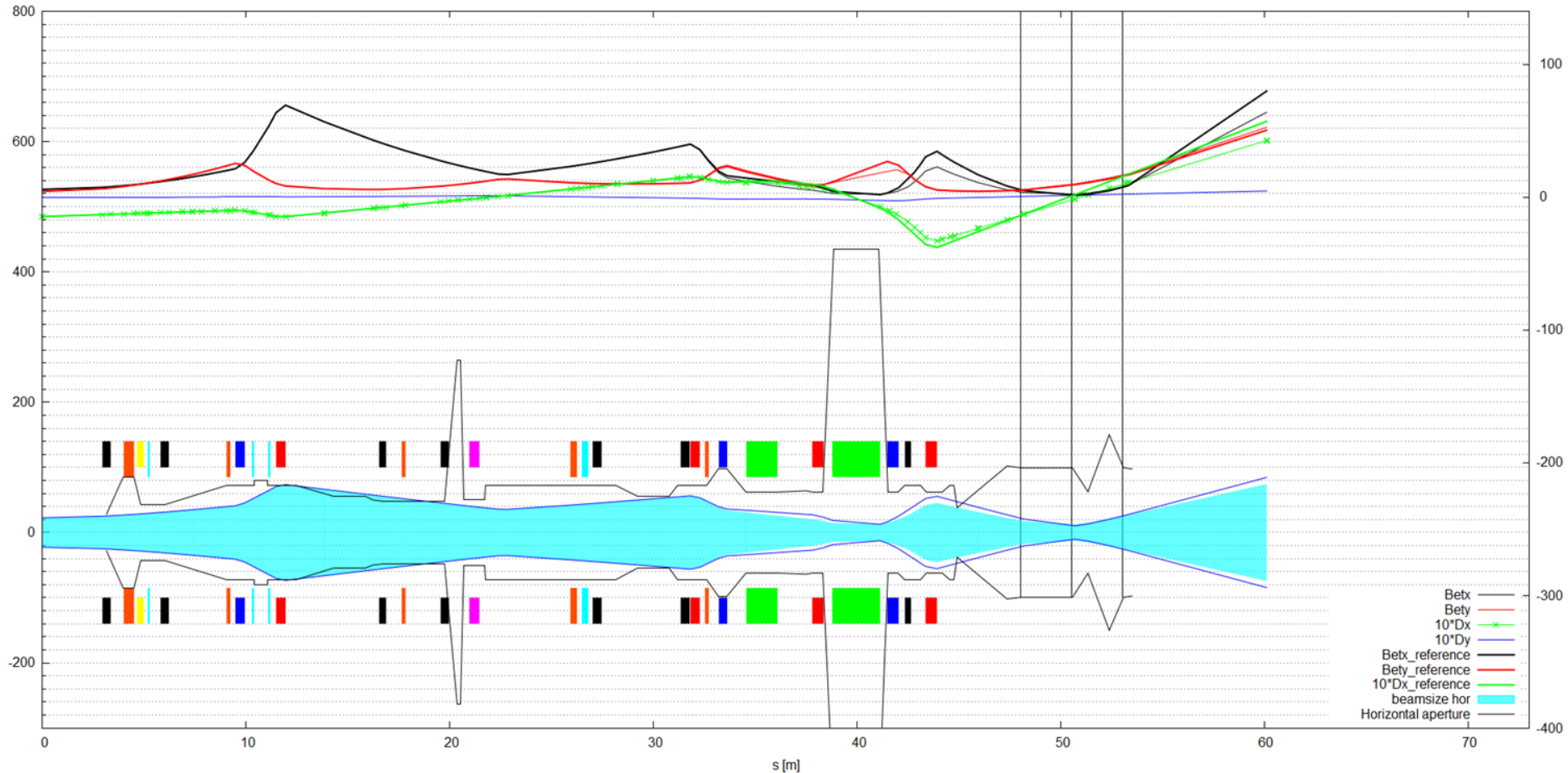
- Beam for emittance measurements

- Horizontal emittance with normal dispersion
- Horizontal emittance with reduced dispersion
- Vertical emittance



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

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



Calculation of the beam size

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

$A_{xy}/2$

$N_s = 3$

$k_b = 1.2$

β_{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

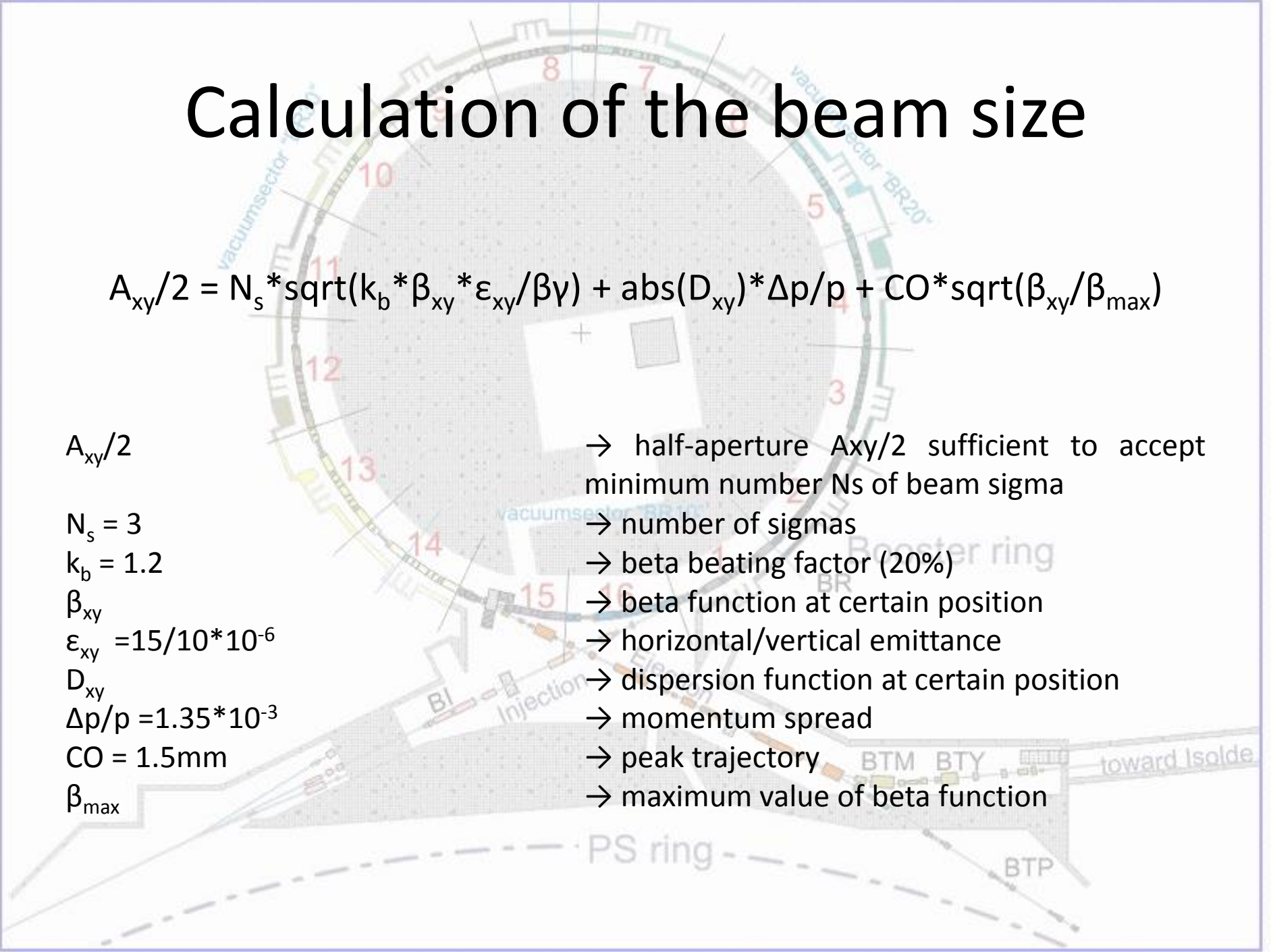
→ horizontal/vertical emittance

→ 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

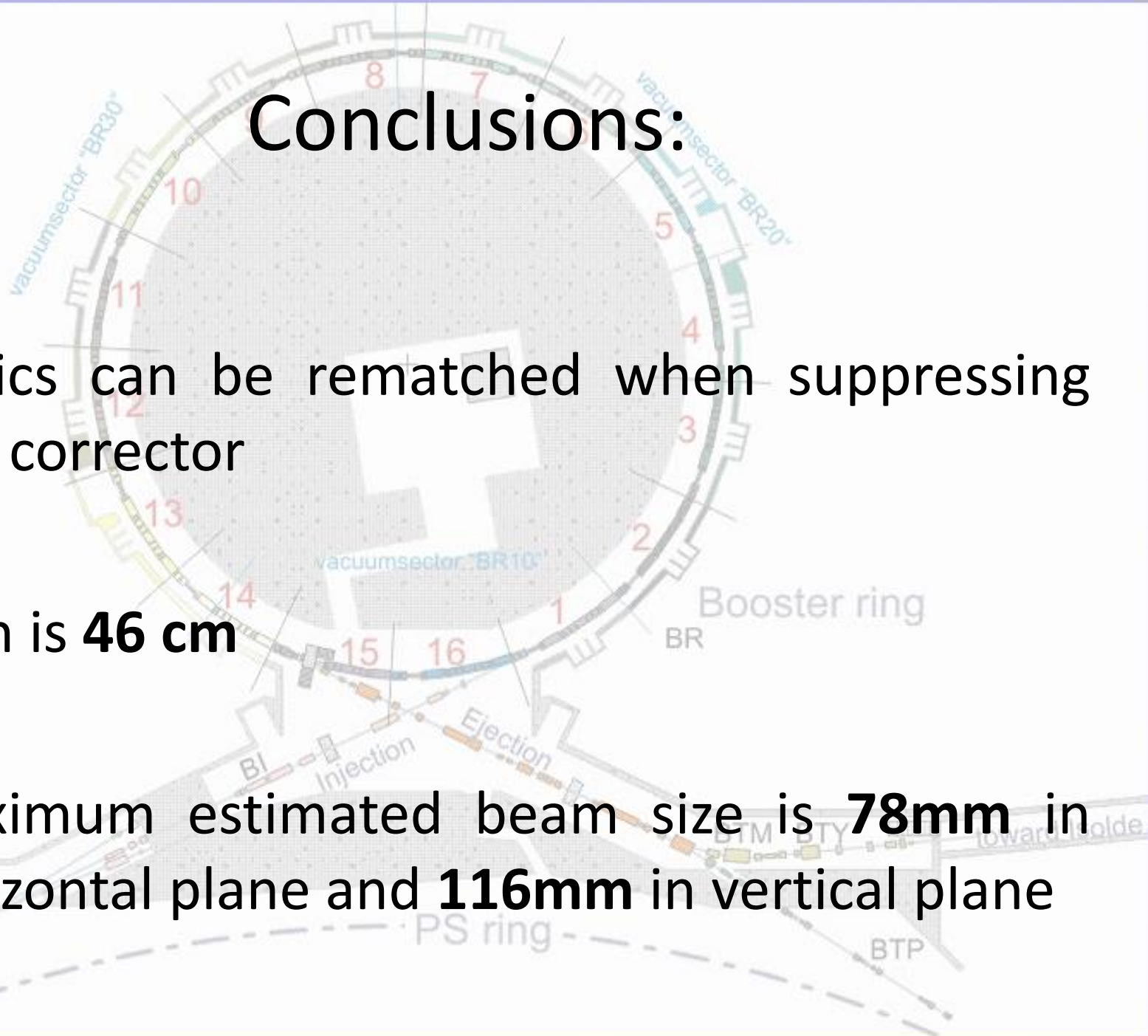
** The maximum half beam sizes for the existing bend are:

35 mm in horizontal plane

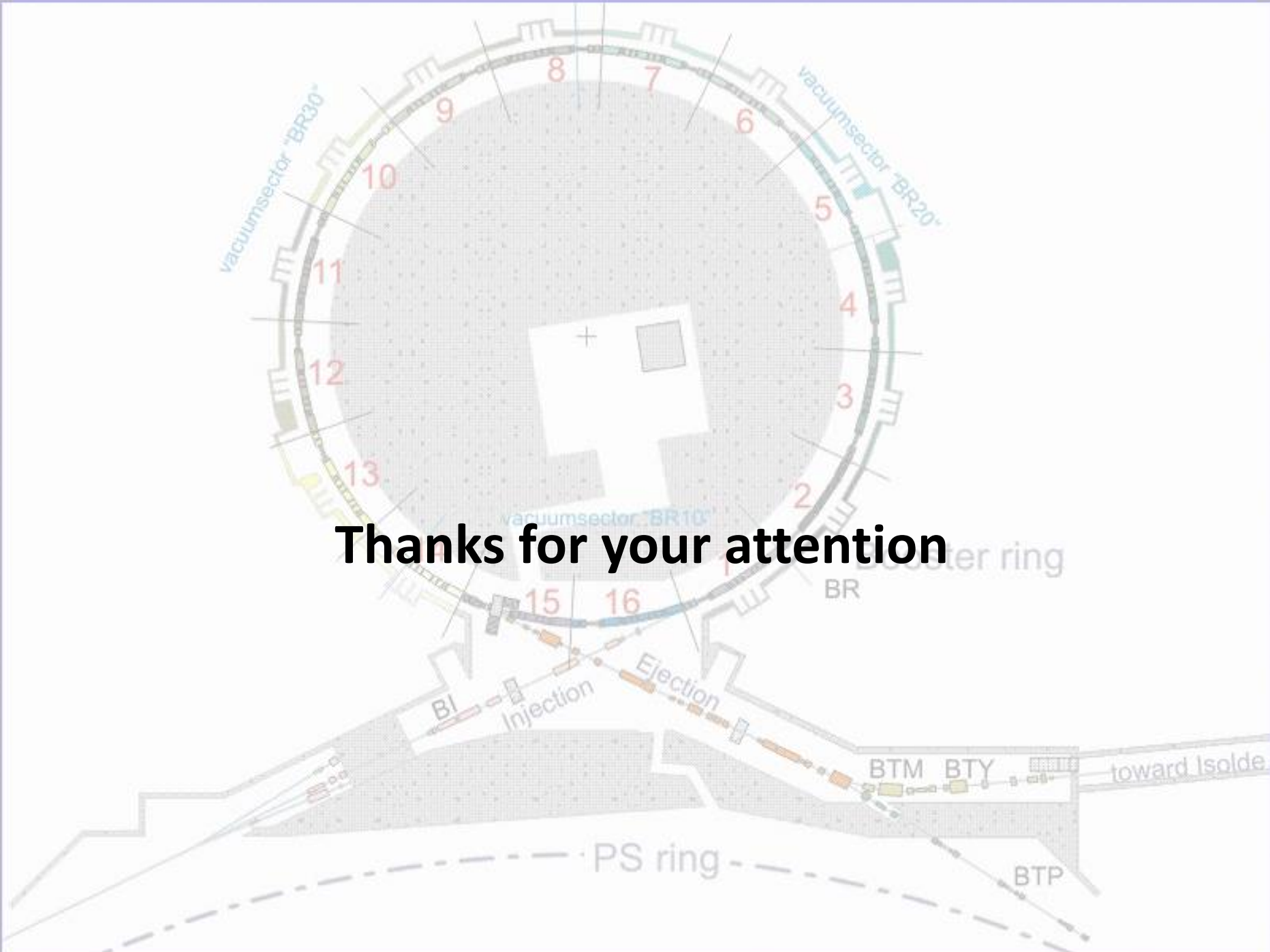
60 mm in vertical plane

Conclusions:

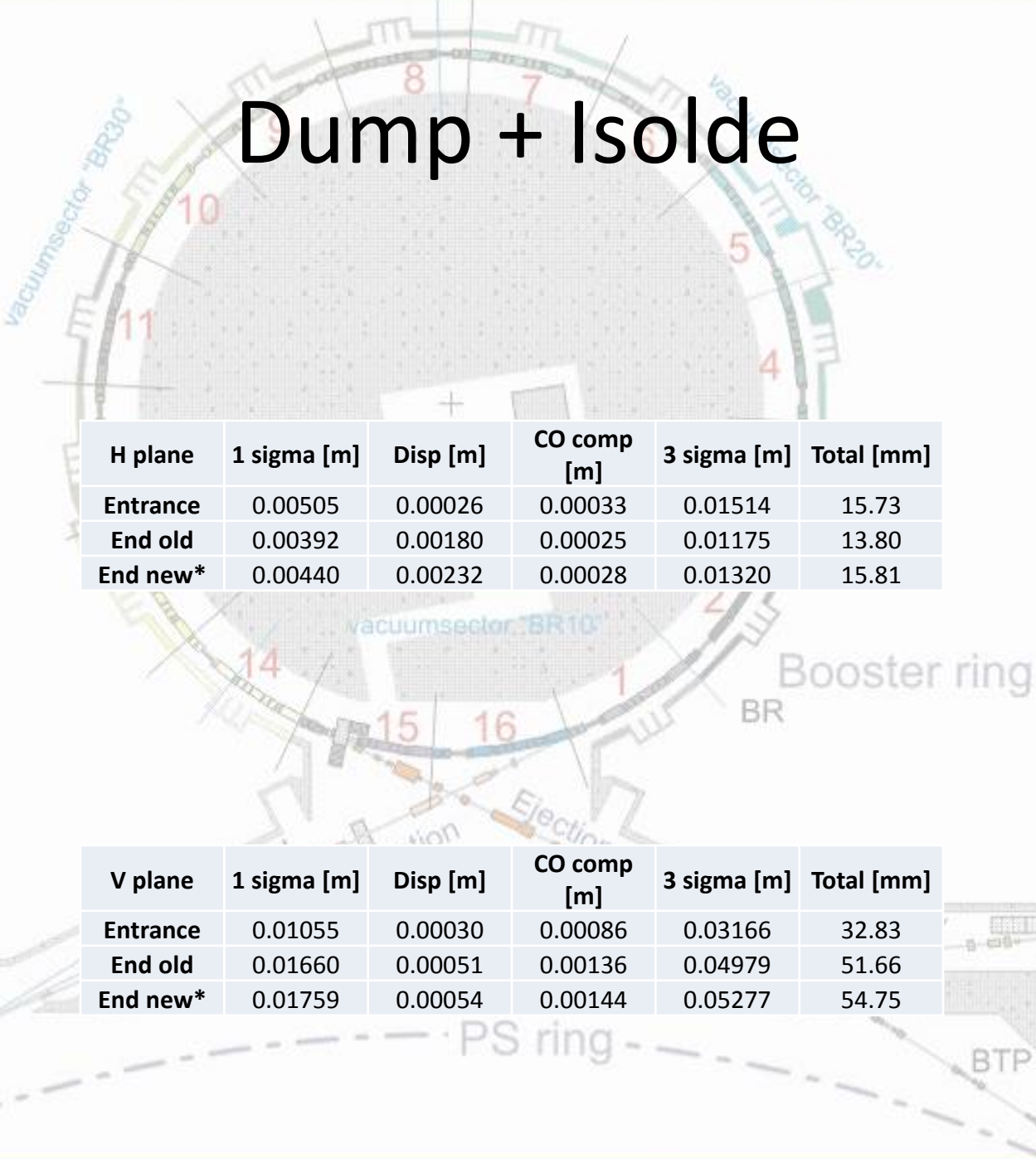
- Optics can be rematched when suppressing one corrector
- Gain is **46 cm**
- Maximum estimated beam size is **78mm** in horizontal plane and **116mm** in vertical plane



Thanks for your attention



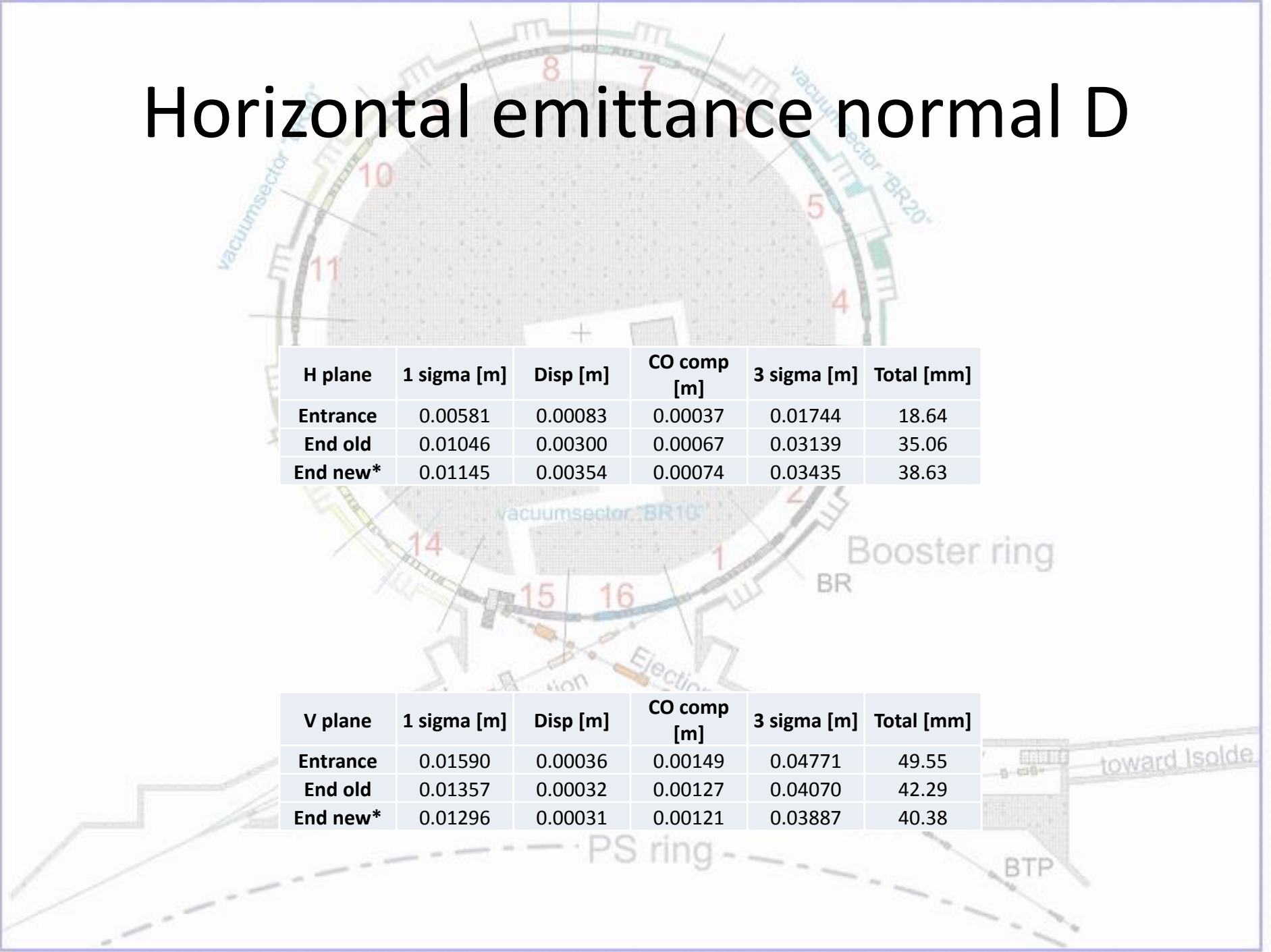
Dump + Isolde



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

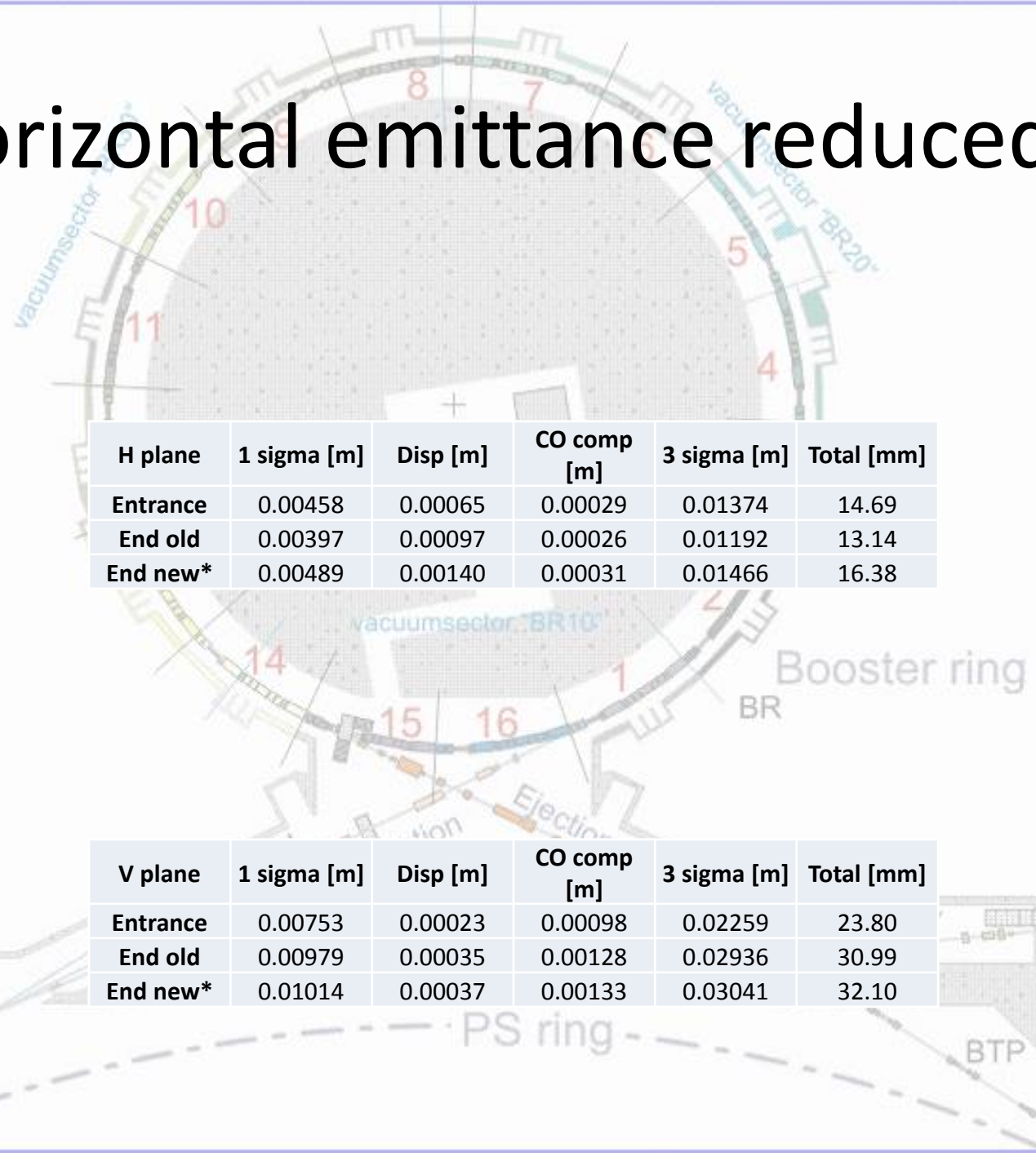
Horizontal emittance normal D



The background image is a schematic diagram of a particle accelerator ring. It shows a circular path with several vacuum sectors labeled 'vacuumsector "BR20"', 'vacuumsector "BR10"', and 'BR'. The ring is divided into segments numbered 1 through 16. A dashed line represents the 'PS ring'. A label 'toward Isolde' points to the right, and 'BTP' is labeled at the bottom right. The diagram also shows 'Ejection' points and a 'Booster ring'.

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



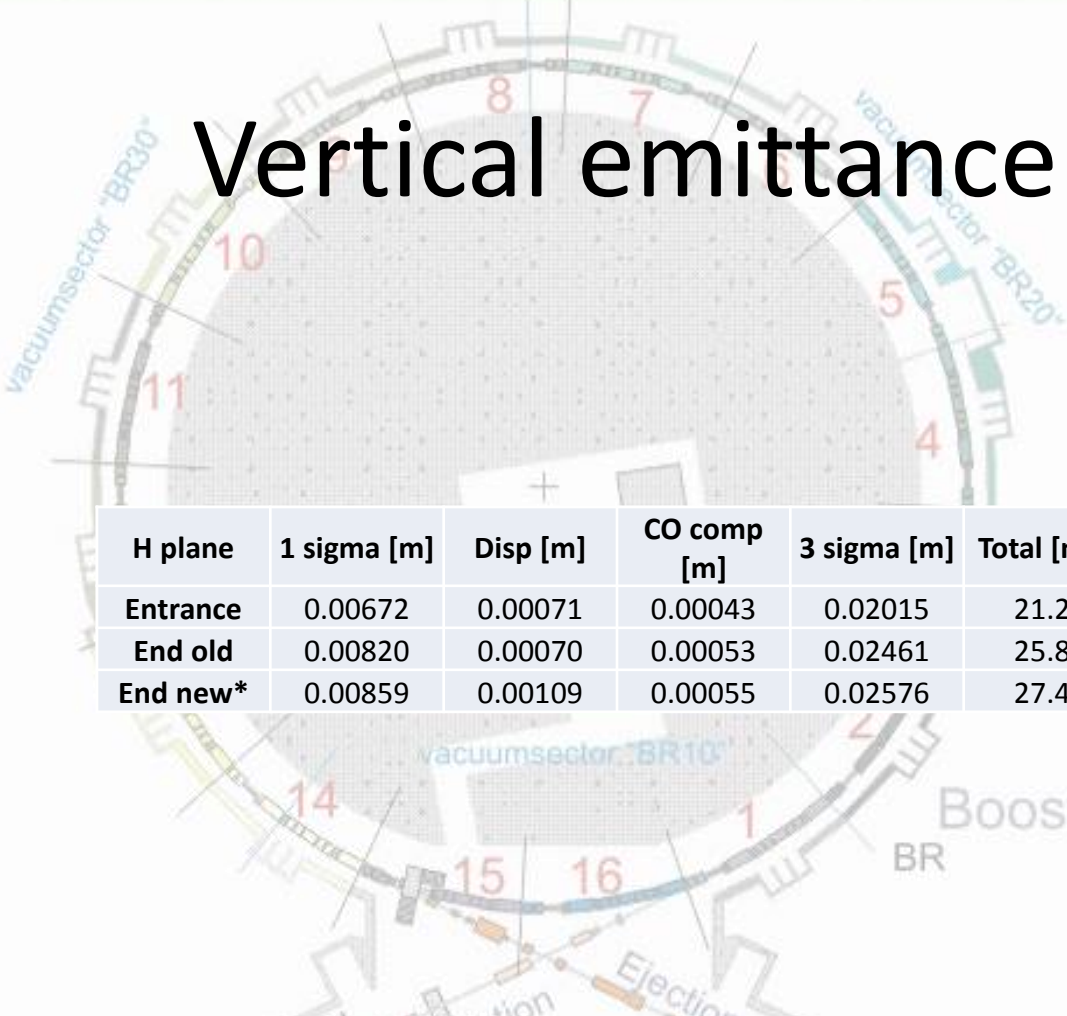
Horizontal emittance reduced

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

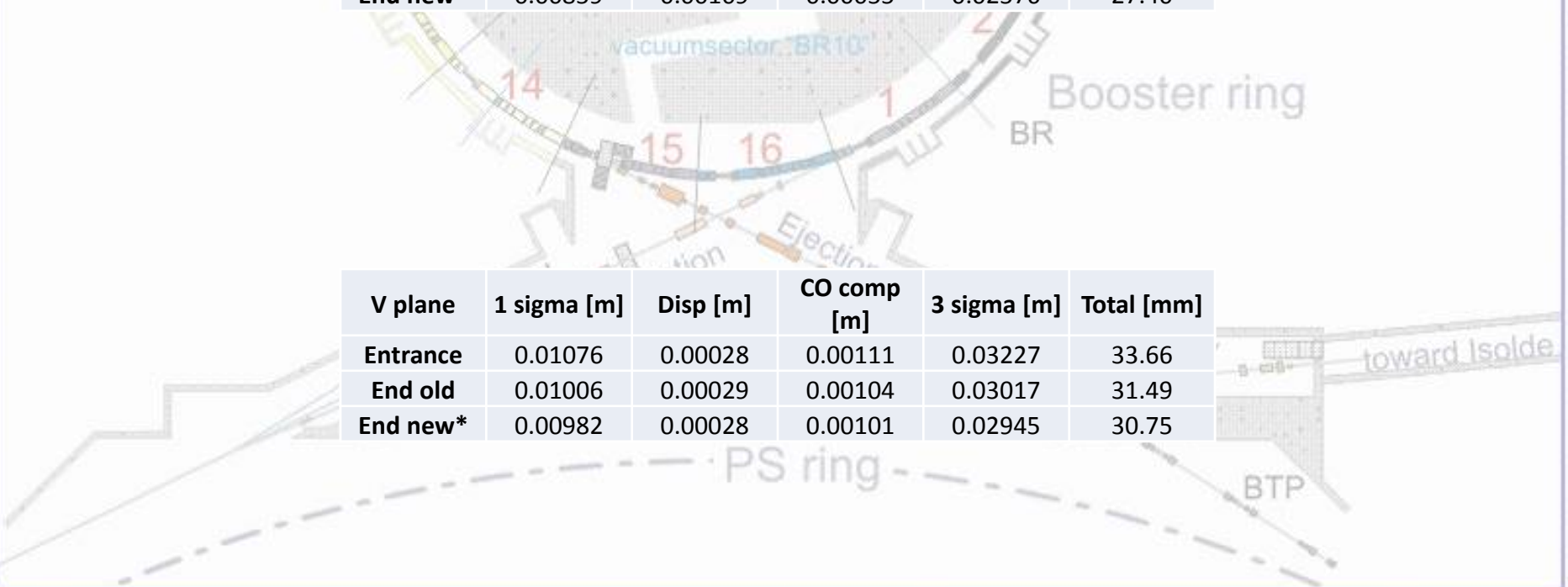
V plane	1 sigma [m]	Disp [m]	CO comp [m]	3 sigma [m]	Total [mm]
Entrance	0.00753	0.00023	0.00098	0.02259	23.80
End old	0.00979	0.00035	0.00128	0.02936	30.99
End new*	0.01014	0.00037	0.00133	0.03041	32.10

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



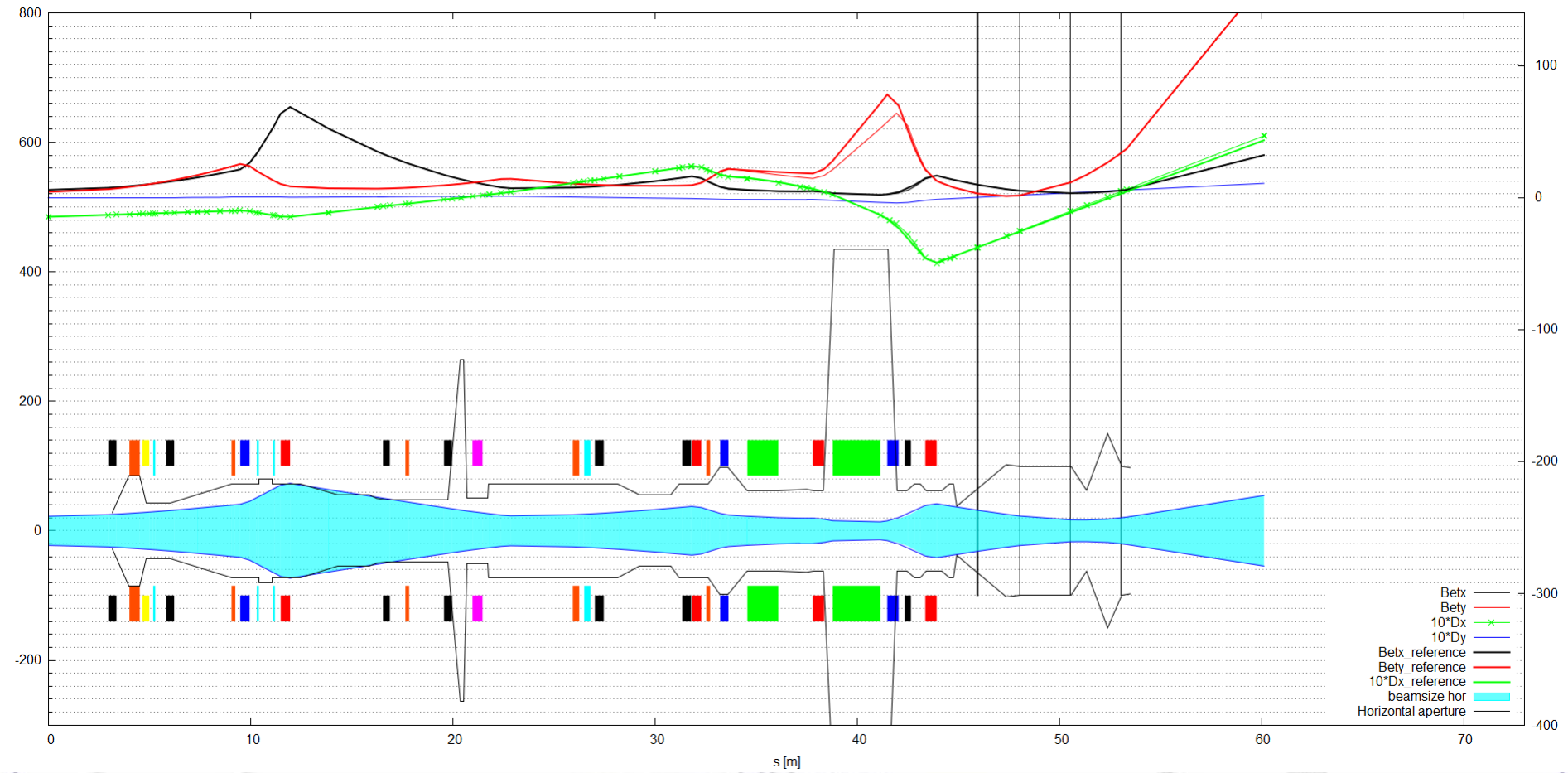
H plane	1 sigma [m]	Disp [m]	CO comp [m]	3 sigma [m]	Total [mm]
Entrance	0.00672	0.00071	0.00043	0.02015	21.29
End old	0.00820	0.00070	0.00053	0.02461	25.84
End new*	0.00859	0.00109	0.00055	0.02576	27.40



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

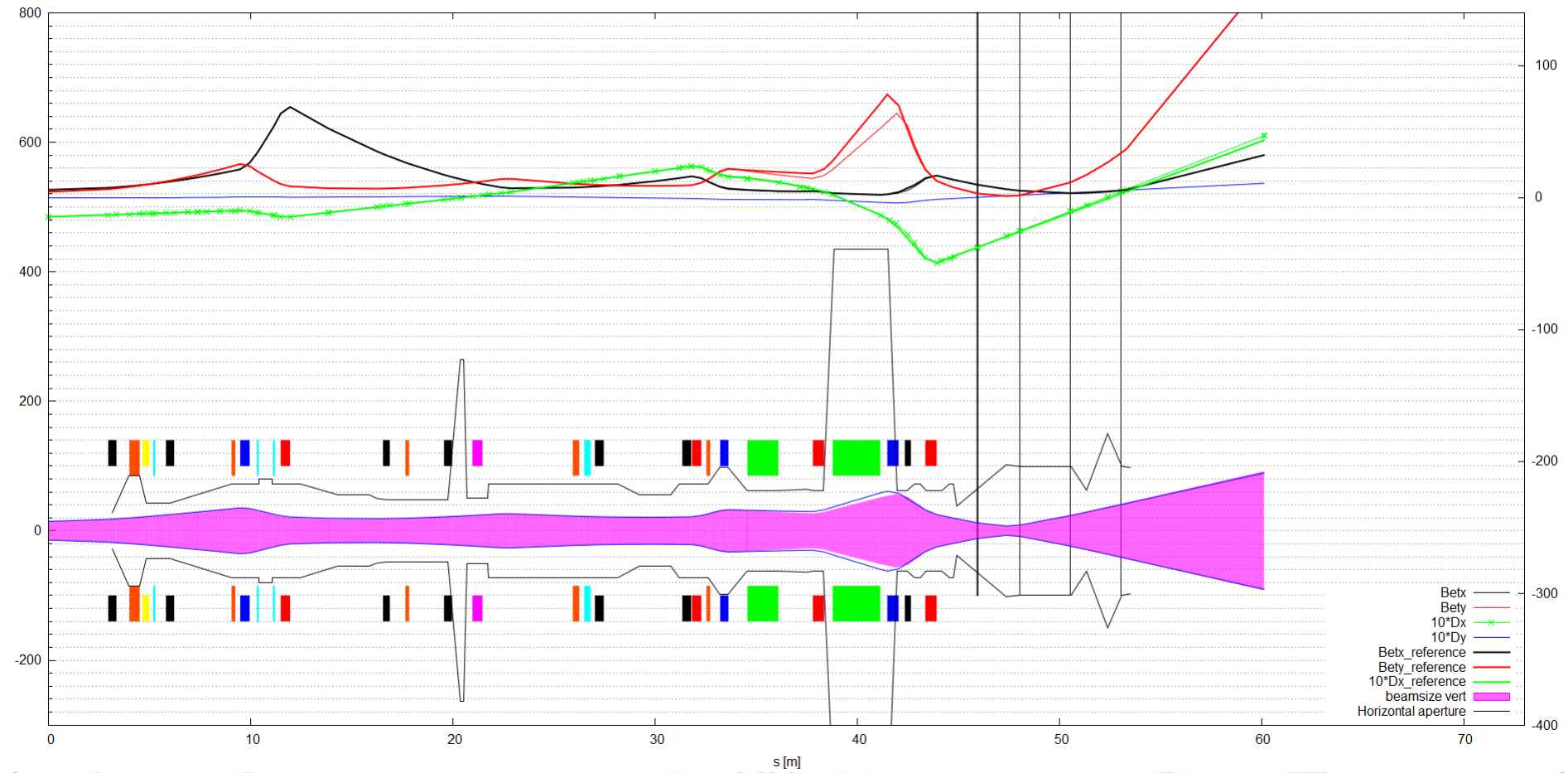
Dump + Isolde, H plane

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

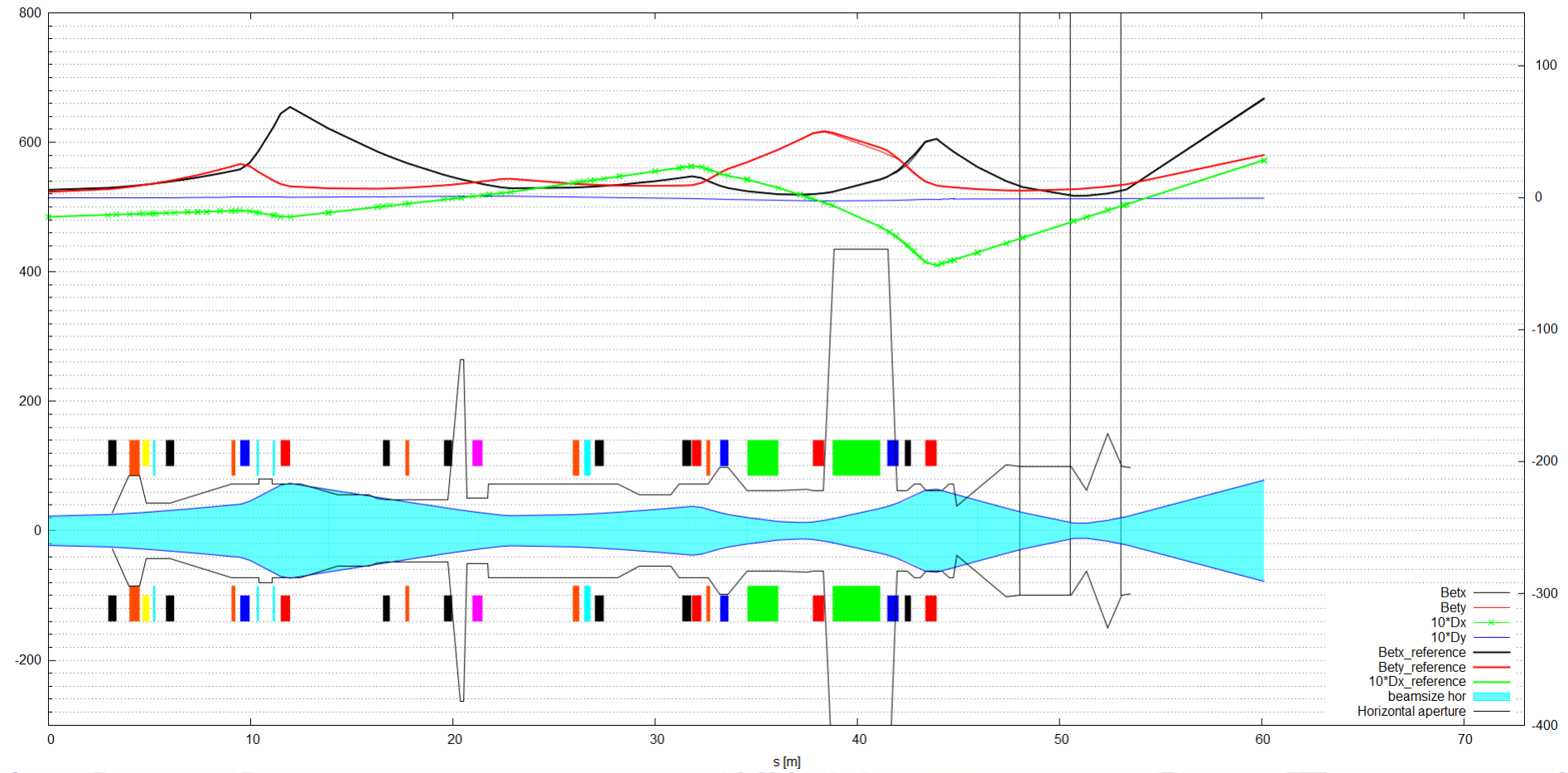


PS ring

BTP

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

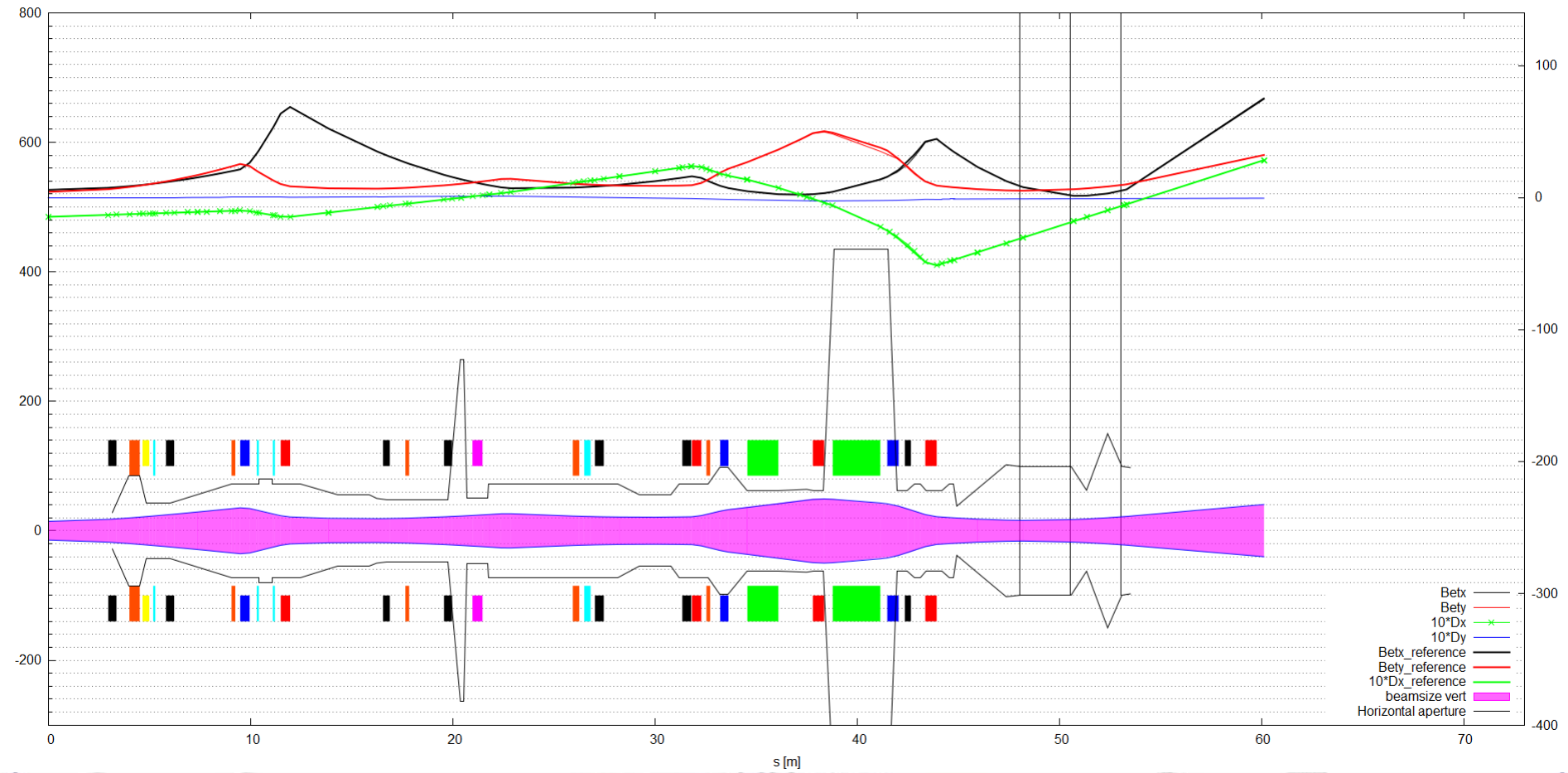


PS ring

BTP

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

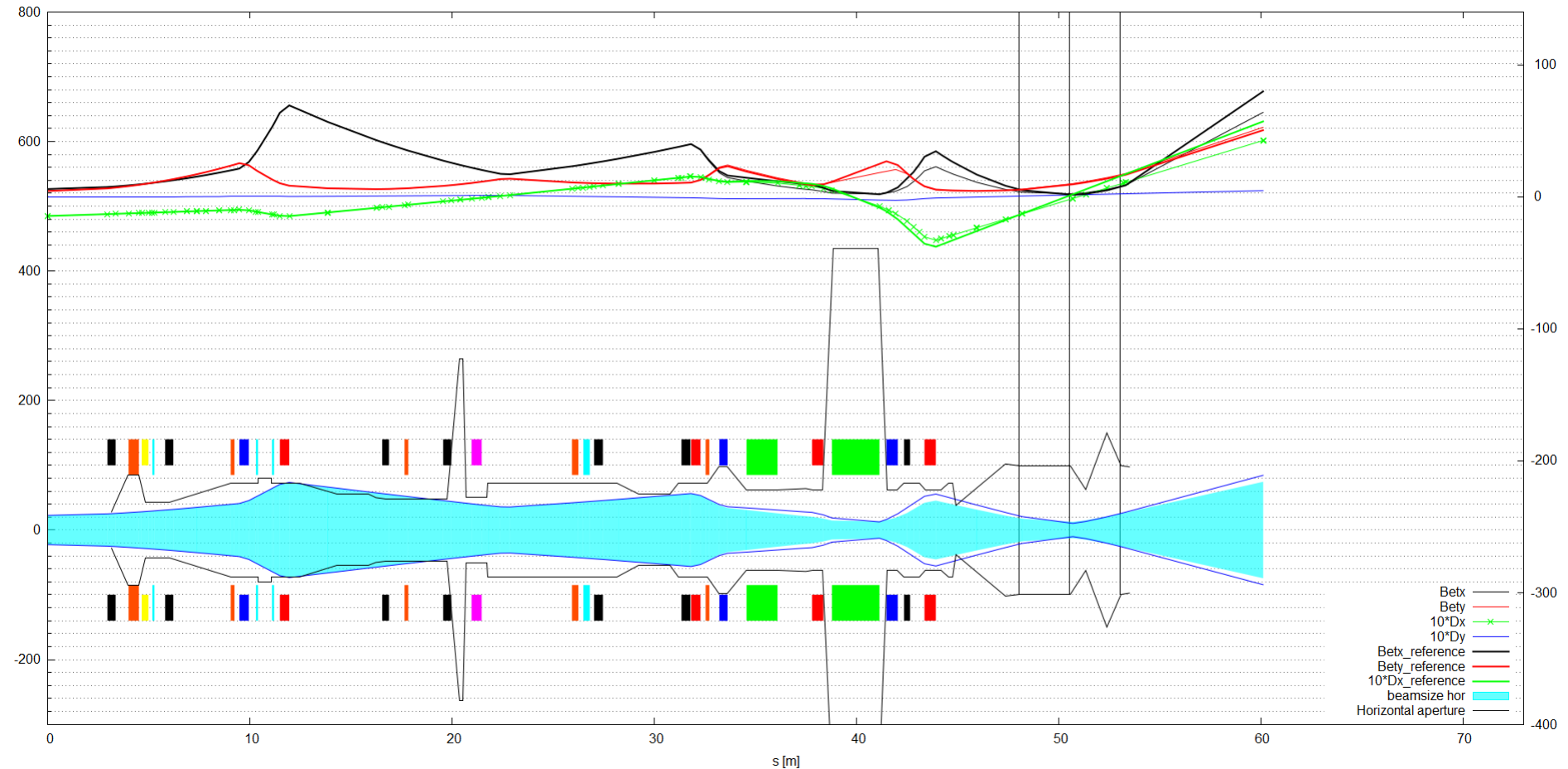


PS ring

BTP

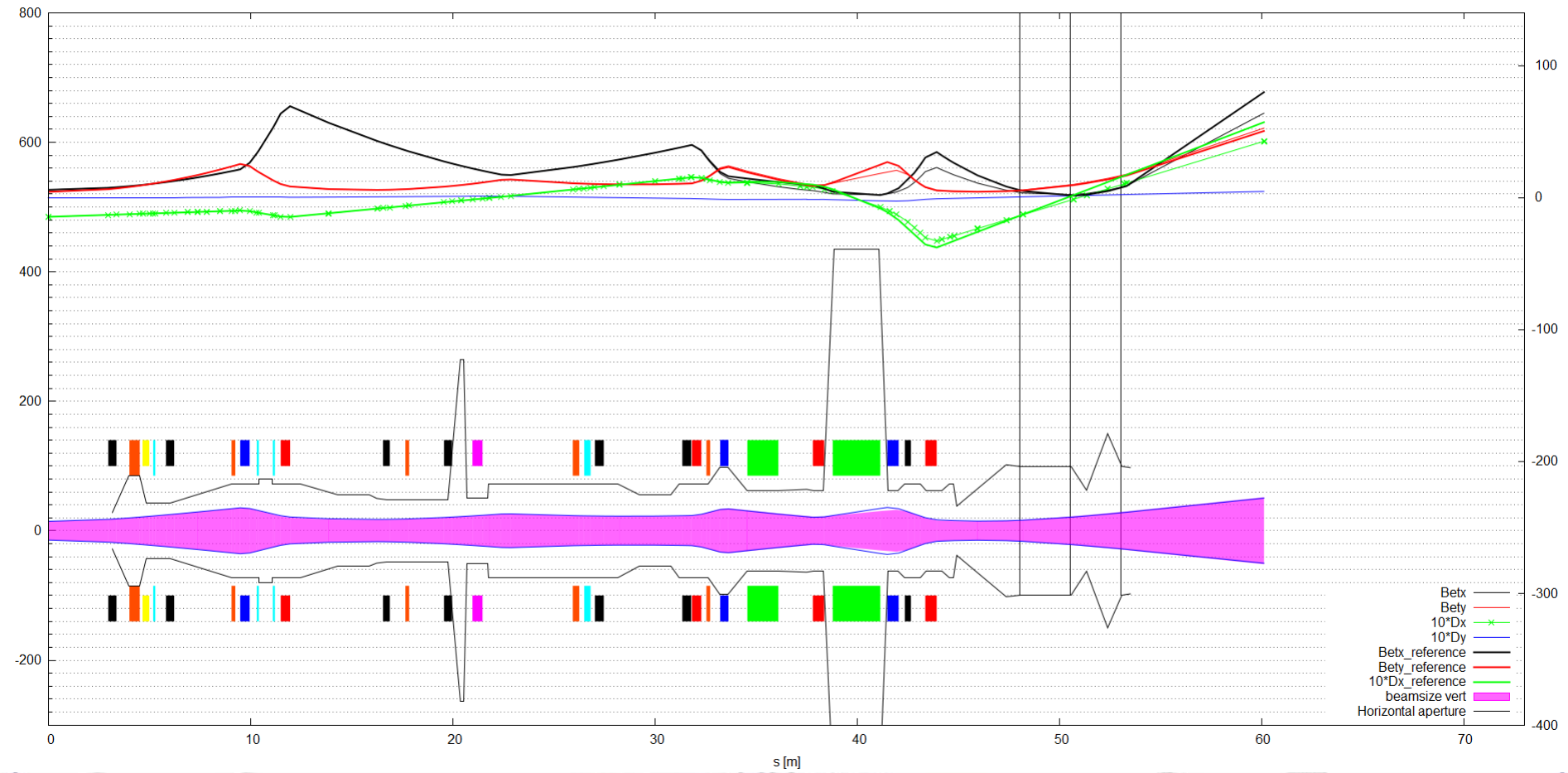
H emittance reduced D, H plane

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



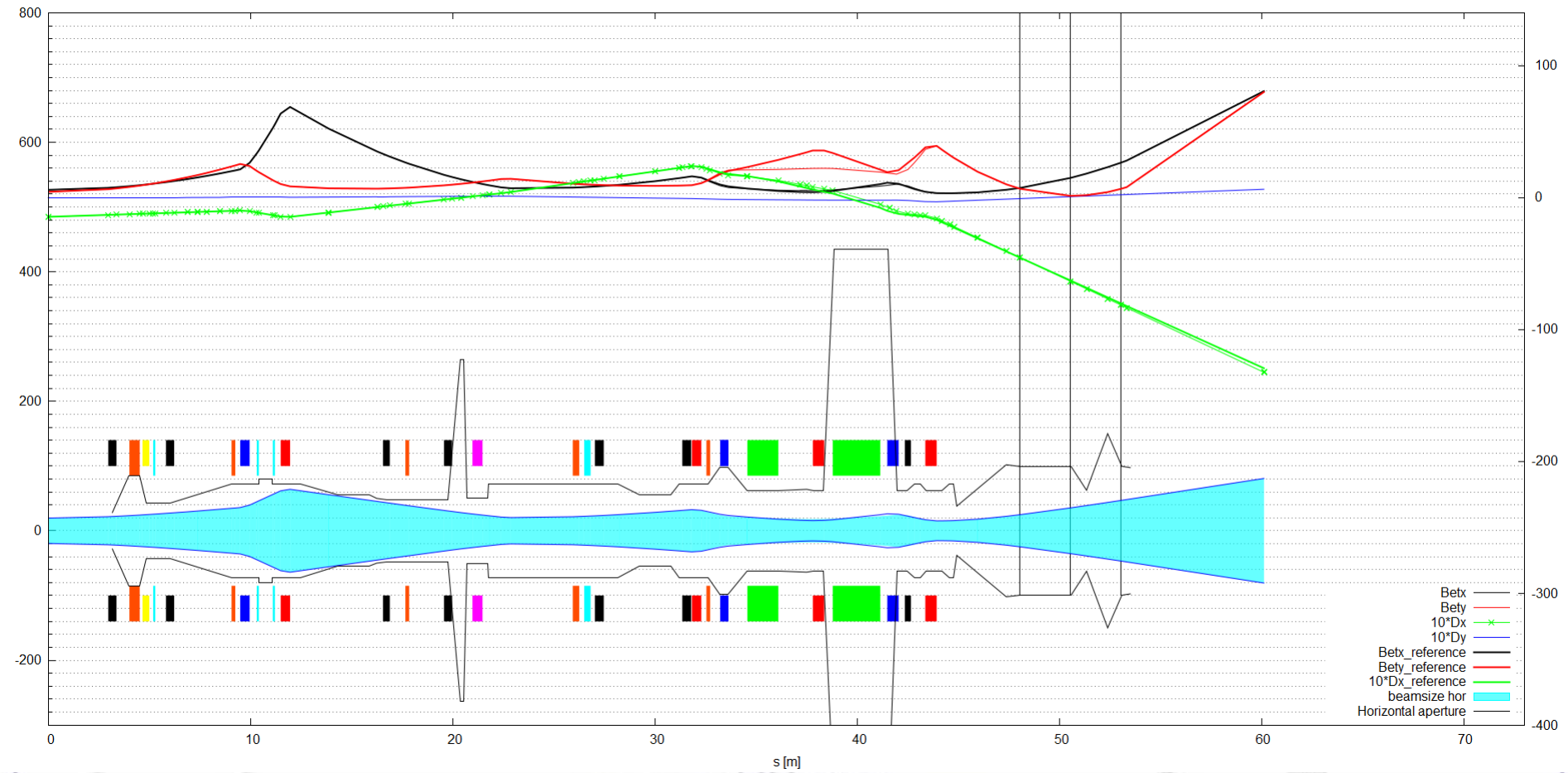
H emittance reduced D, V plane

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

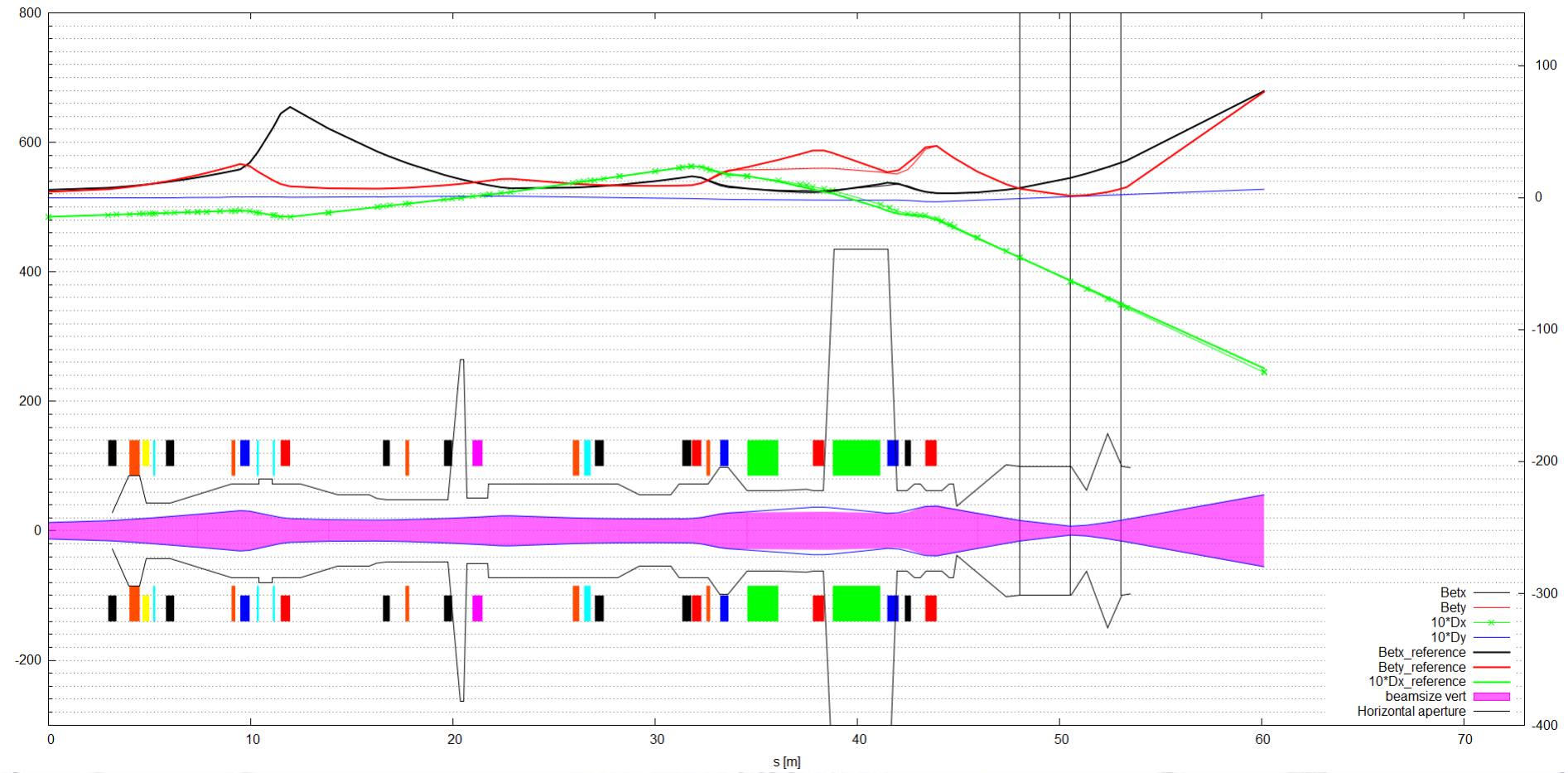


PS ring

BTP

Vertical emittance, V plane

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



PS ring

BTP