New Interaction Region designs

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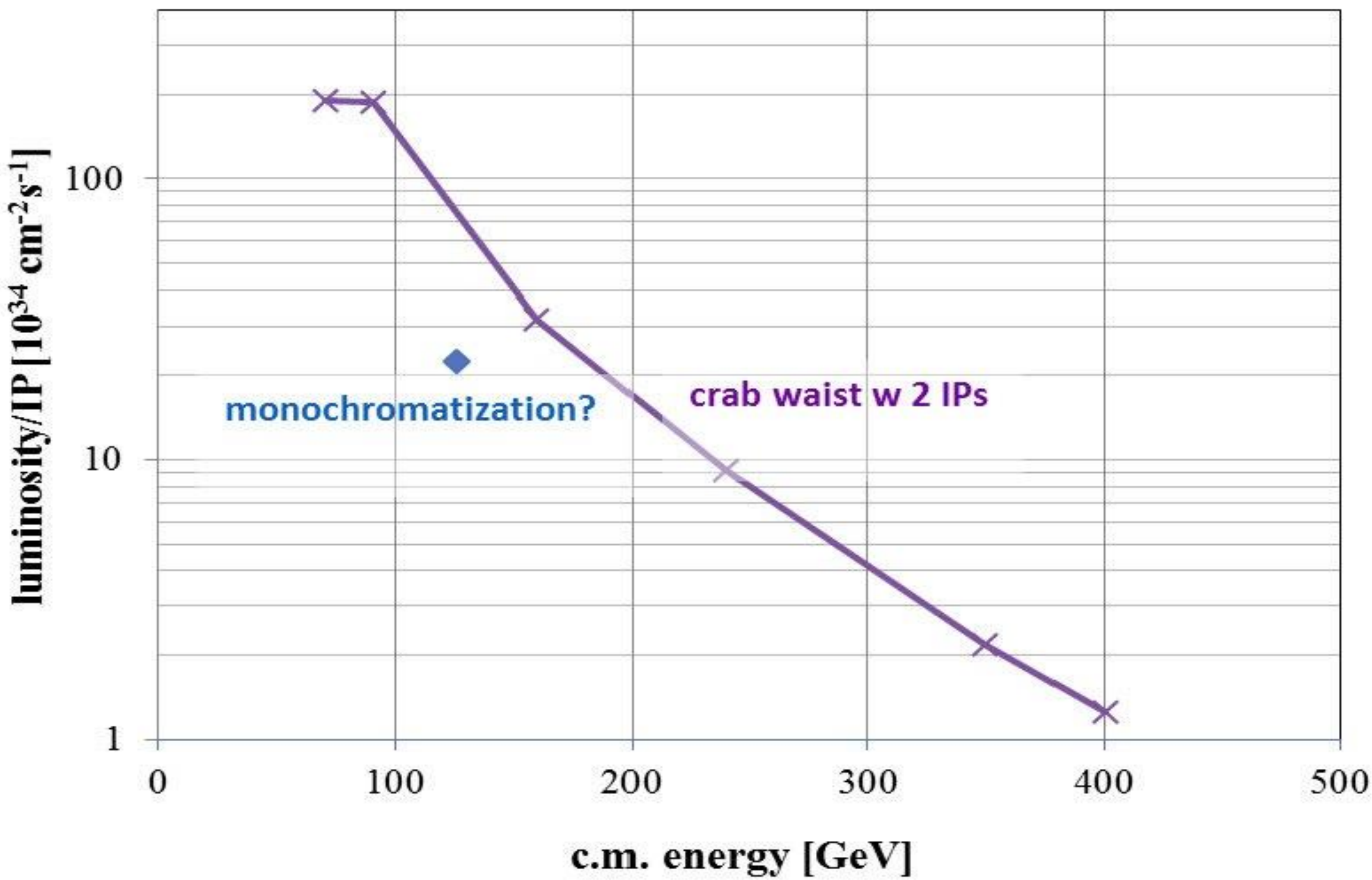
Many thanks to M. Benedikt, H. Burkhardt, B. Haerer,
B. Holzer, M. Koratzinos, F. Zimmermann

Luminosity vs c.m. energy
(F. Zimmermann)



Luminosity vs beam energy
(estimations, might change)

	Z	W	H	tt
Energy [GeV]	45	80	120	175
Perimeter [km]	100			
Emittance hor. [nm]	0.14	0.44	1	2.1
Emittance ver. [pm]	1	2	2	4.3
β_x^*/β_y^*	0.5/0.001			
Crossing angle [mrad]	30			
Luminosity / IP $[10^{34} cm^{-2} s^{-1}]$	212	36	9	1.3
Crossing angle [mrad]	26			
Luminosity / IP $[10^{34} cm^{-2} s^{-1}]$	255	43	10	1.4

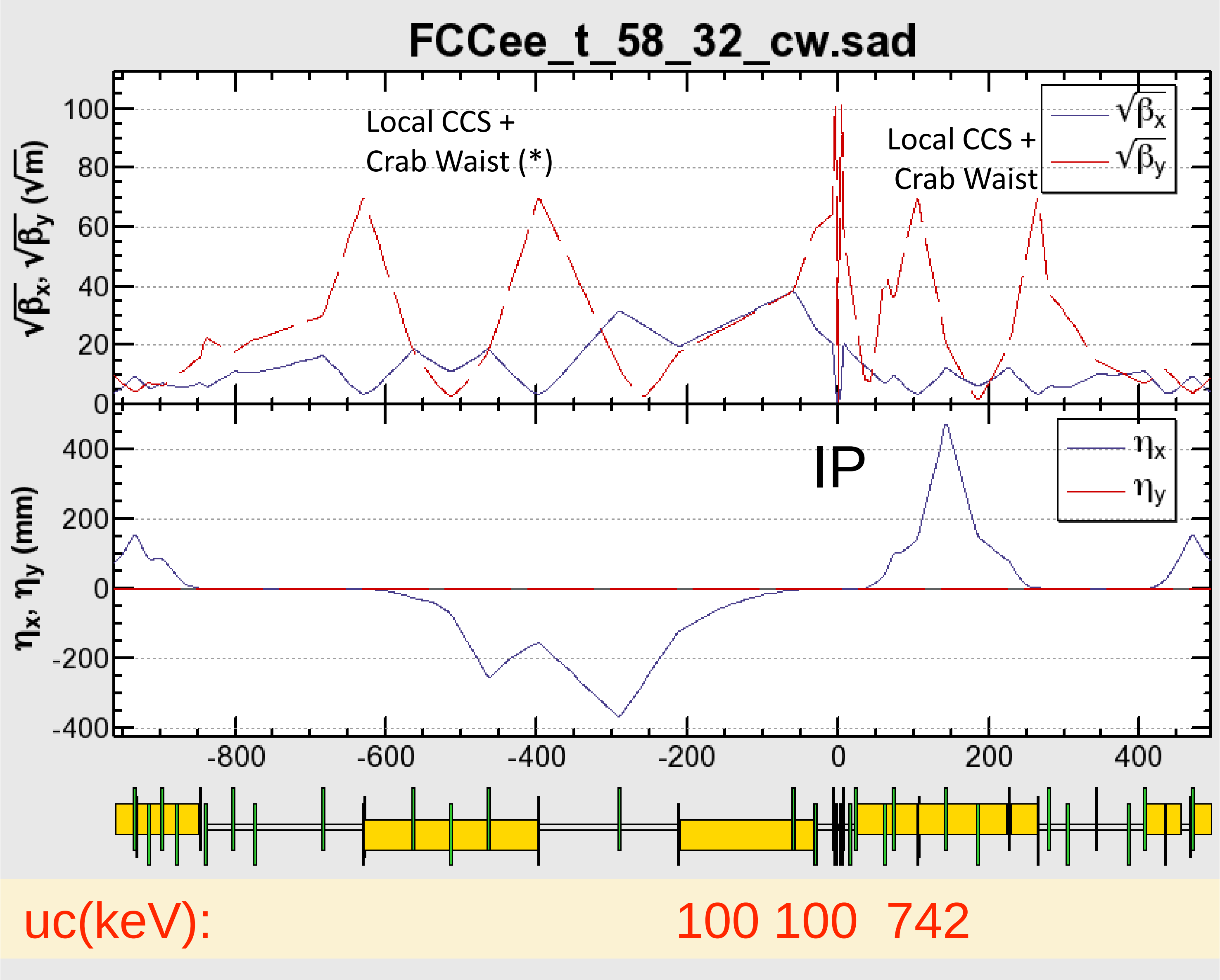
Requirements

1. Must fit hadron collider tunnel. Perimeter 100 km.
2. Two interaction points (defined by FCC-hh and price).
3. $\beta_x^*/\beta_y^* = 0.5m/0.001m(1m/0.002m)$.
4. Vertical emittance is less or equal than 1 pm at 45 GeV.
5. Horizontal emittance is 1-2 nm at 175 GeV.
6. Energy acceptance $\pm$2%.
7. $E_{\gamma,c} < 100$ keV within $\pm$250 m from IP (Helmut Burkhardt)

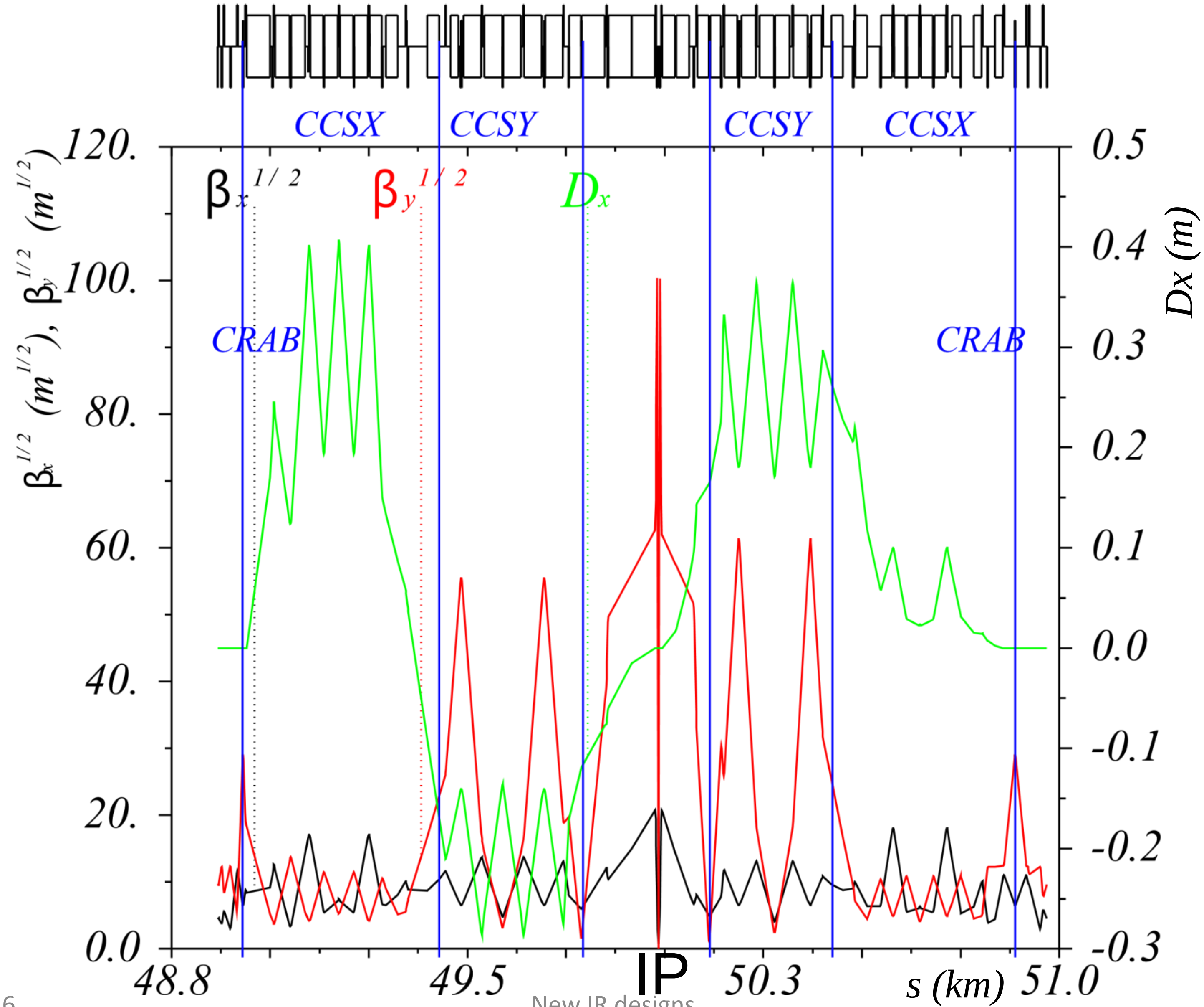
Solutions

1. Strong requirement of $E_{\gamma,c} < 100$ keV within $\pm$250 m from IP and FFC-hh tunnel dictates asymmetric solutions. There are two variants by K. Oide and A. Bogomyagkov.
2. Another solution is to have head-on for 175 GeV by S. Sinyatkin and crab waist for lower energies.
3. Geometry constraints hint about crossing angle optimization (30 mrad or 26 mrad).
4. Small vertical emittance at 45 GeV demands local solenoid compensation.
5. Local chromaticity correction sections (CCS) to provide energy acceptance.

IR1: assymetric by KO, 30 mrad



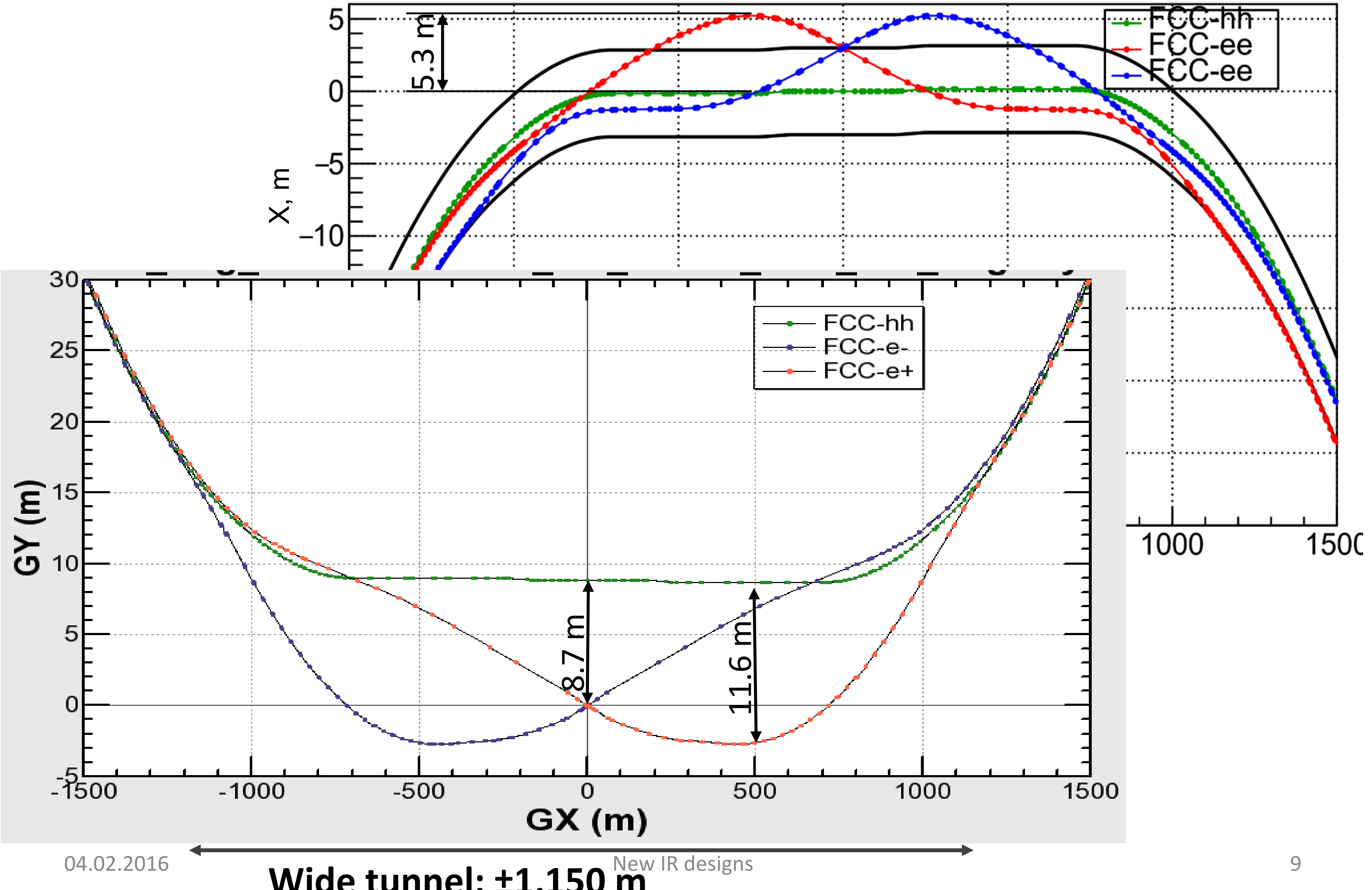
IR2: assymetric AB, 26 mrad



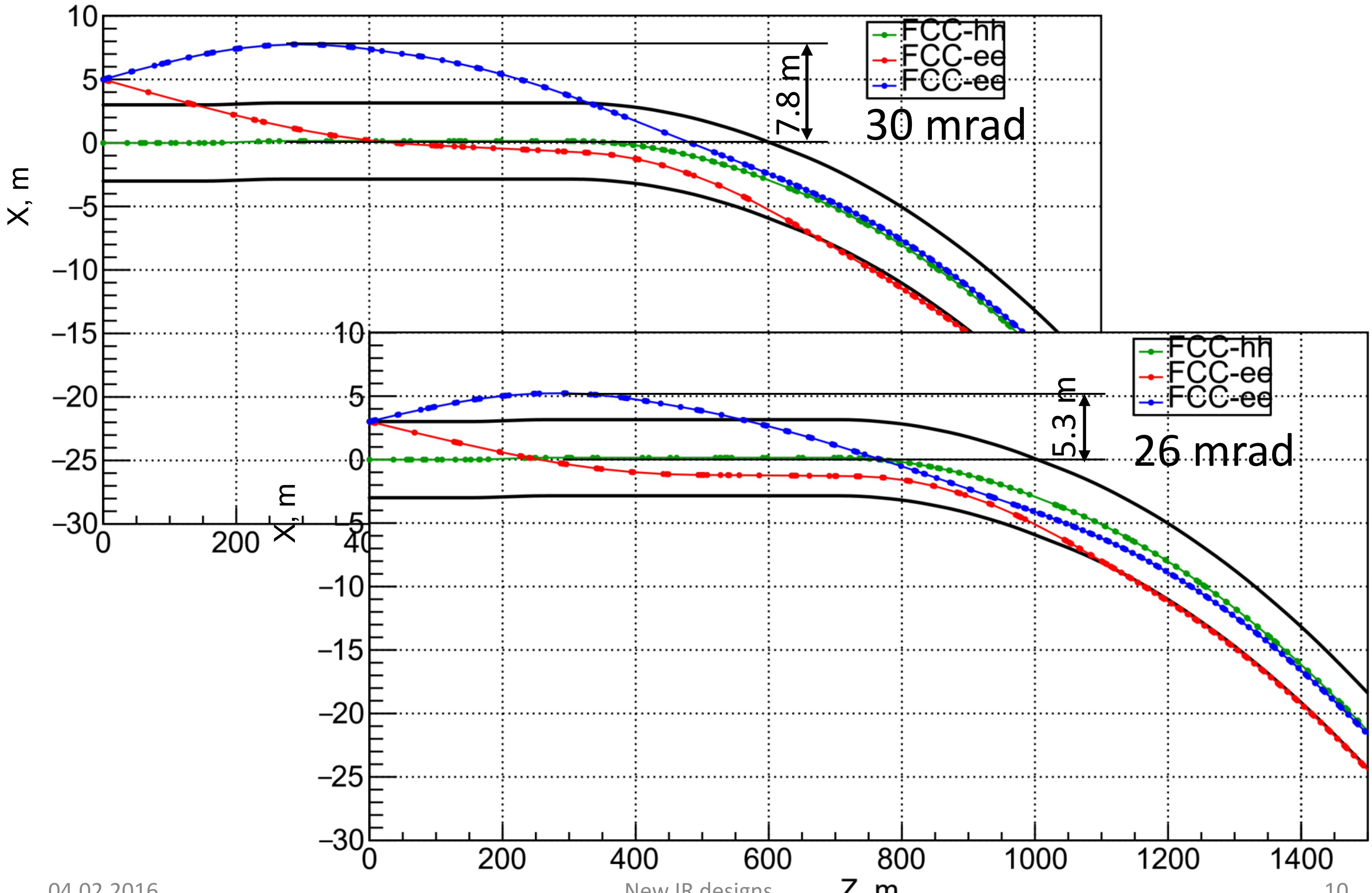
IR2: assymetric AB 26, mrad

Dipole (from IP)	L, m	S(end), m	Ec, keV
B0	59	67.5	100.8
B1	59	127	100.8
B2	59	195.2	201.5
B3	30	226.4	310.5
B4	45	287.2	494

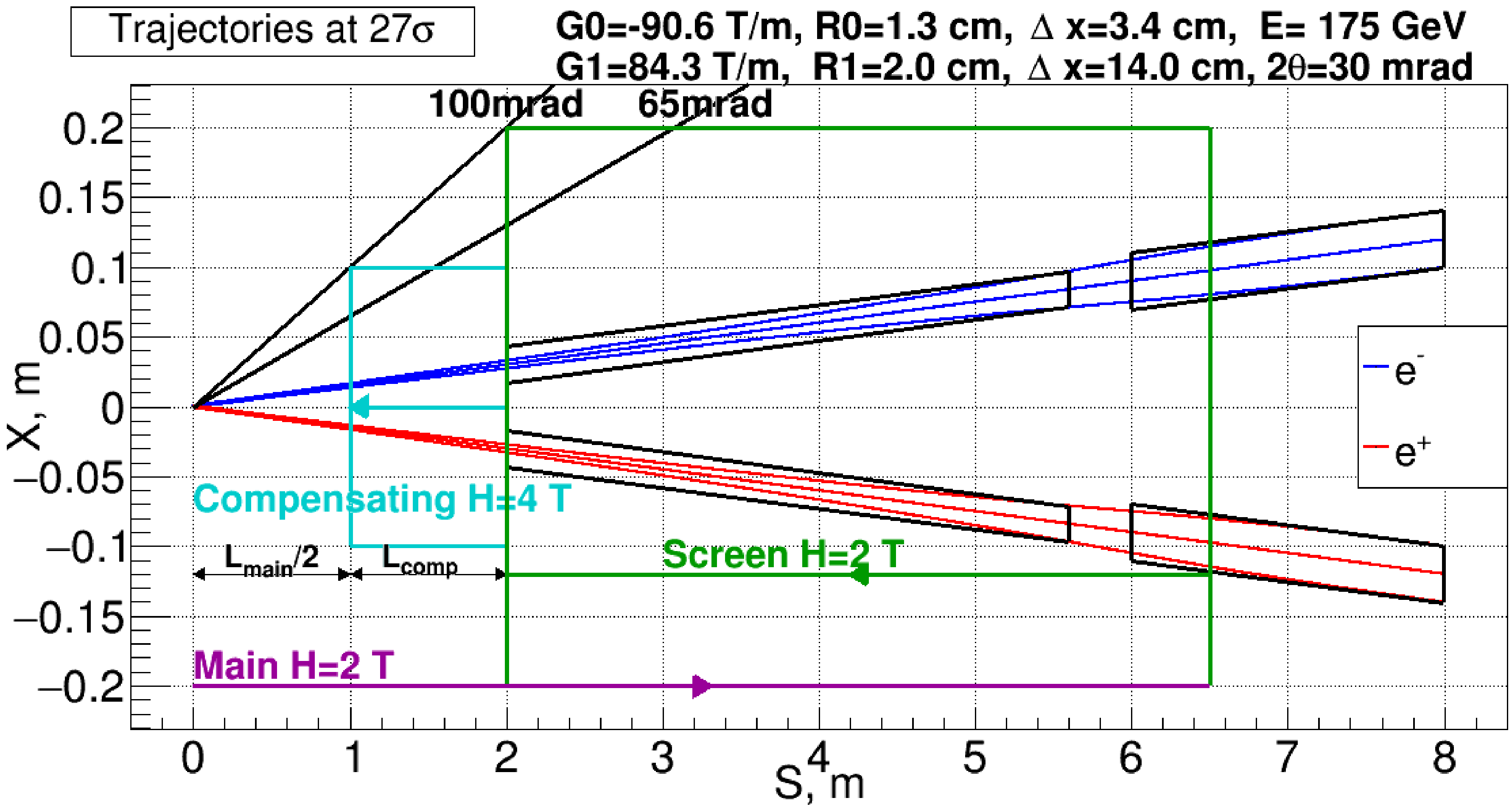
Layout: KO 30 mrad and AB 26 mrad



Layout: AB 30 mrad and AB 26 mrad

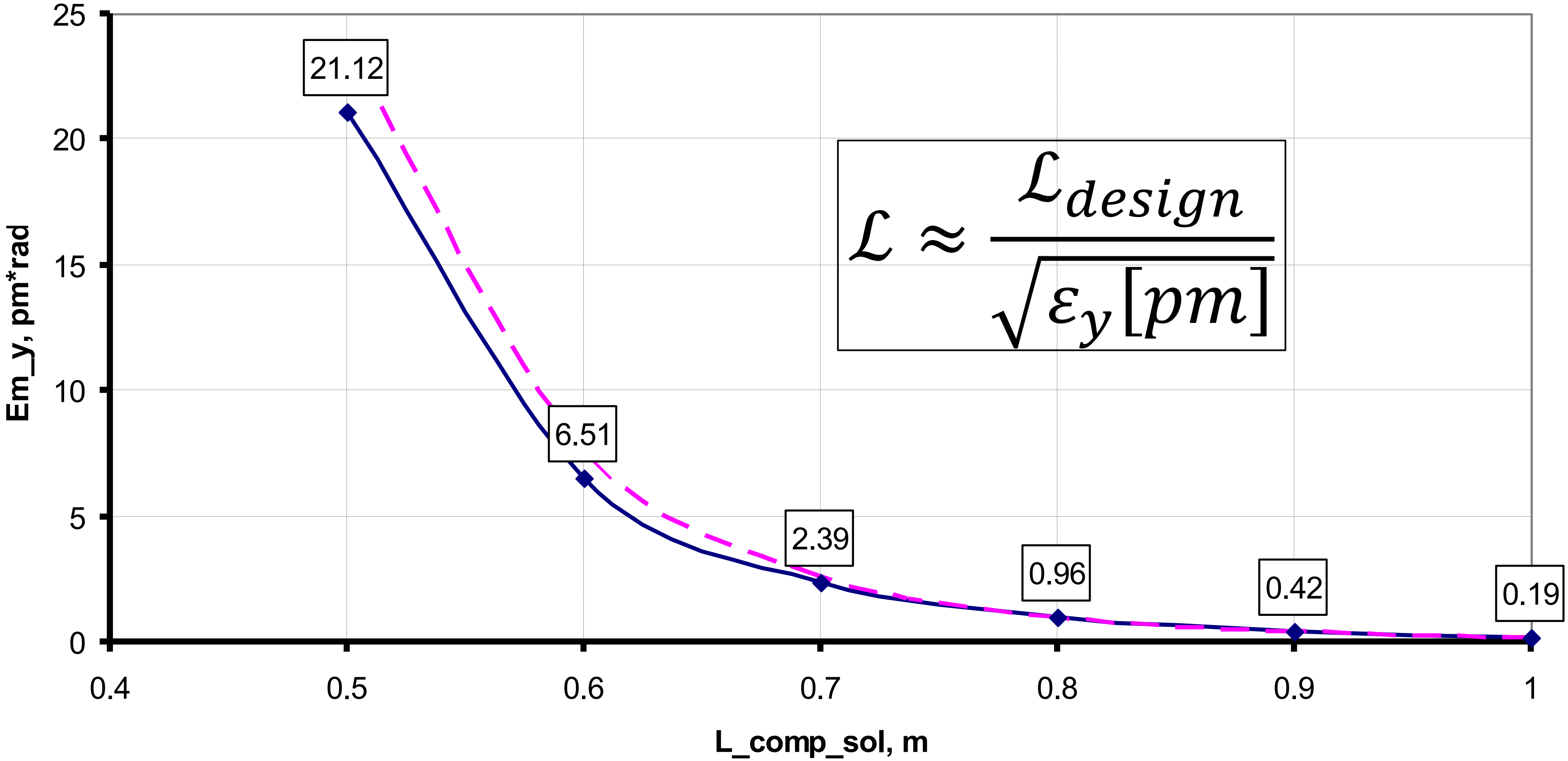


Solenoid compensation



Compensating solenoid R = 0.1 m, screening solenoid R = 0.2 m

Emittance vs Lcomp at E=45 GeV



$$\mathcal{L} \approx \frac{\mathcal{L}_{design}}{\sqrt{\varepsilon_y[pm]}}$$

Head-on at 175 GeV

Because there is no significant gain in luminosity from crossing angle and crab waist at 175 GeV.

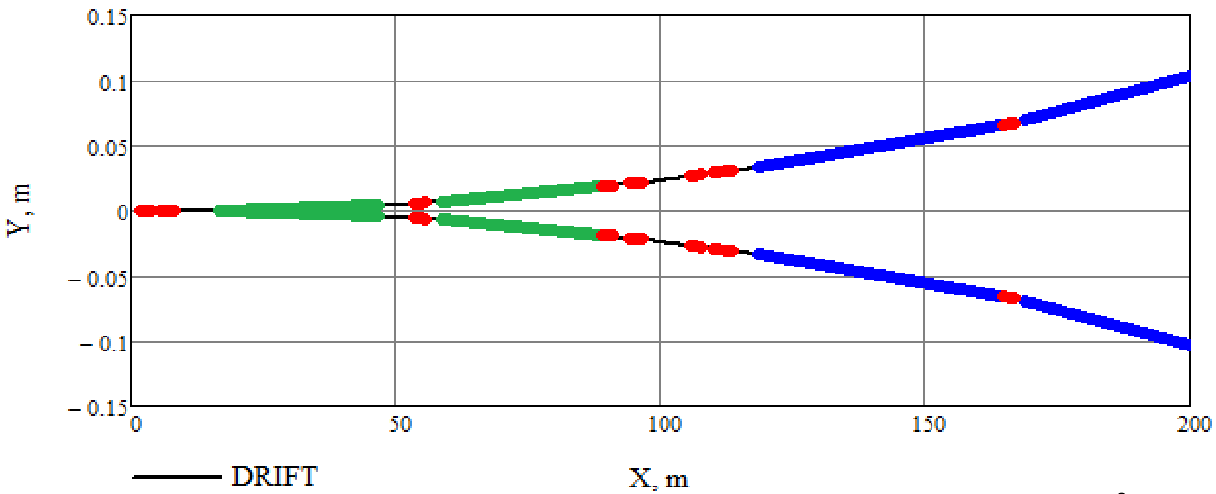
The benefits are:

1. single aperture of final focus elements, magnets are simple,
2. no crab sextupole, therefore IR is shorter,
3. easy to satisfy $E_{\gamma,c} < 100$ keV within $\pm$250 m from IP.

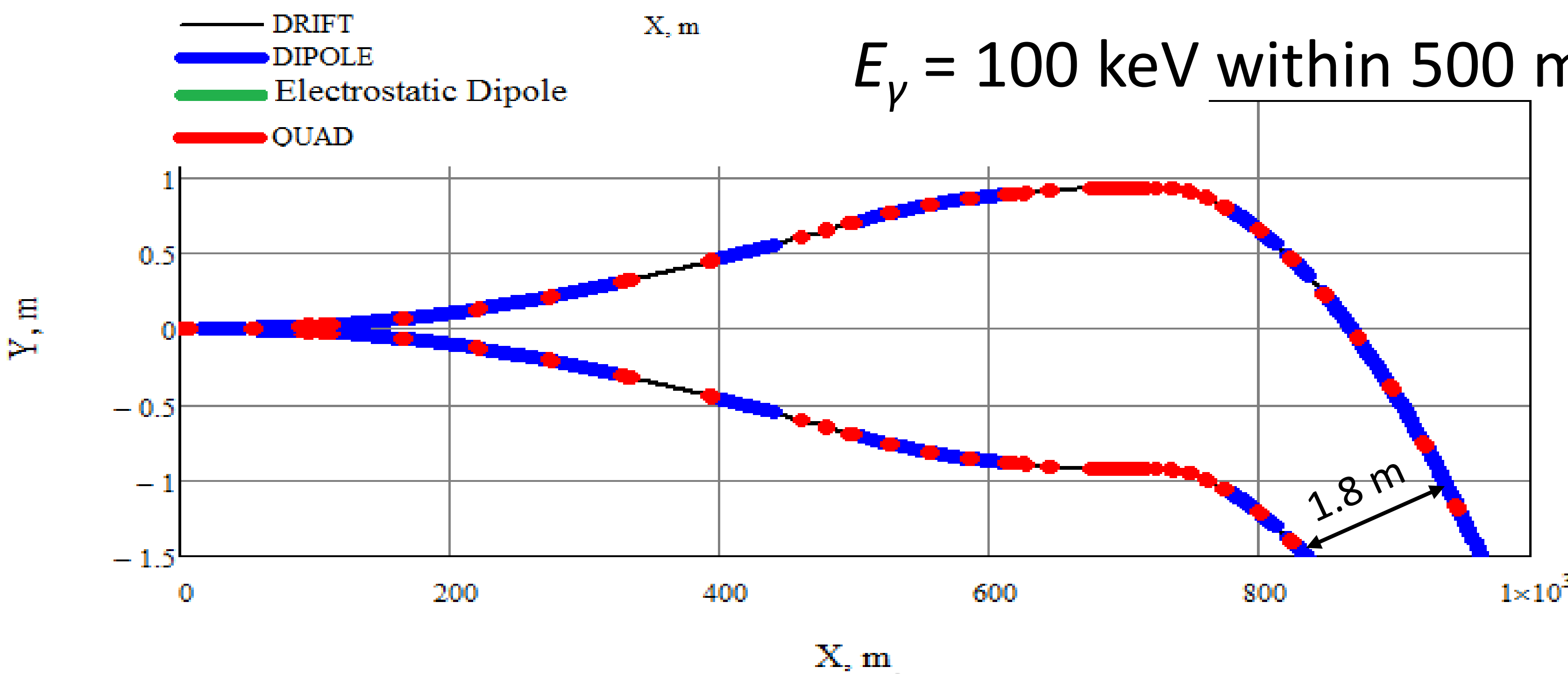
The disadvantage:

1. Rearrange the whole IR.

IR3: head on



E_γ = 100 keV within 500 m.



Conclusion

I. There are two asymmetric IR:
   1. KO with 30 mrad and $E_{\gamma,c} < 100$ keV within $\pm$250 m but wide tunnel or two tunnels,
   2. AB with 26 mrad and smaller tunnel but with $E_{\gamma,c} < 100$ keV within $\pm$130 m, $E_{\gamma,c} < 200$ keV within $\pm$200 m, $E_{\gamma,c} < 300$ keV within $\pm$225 m.

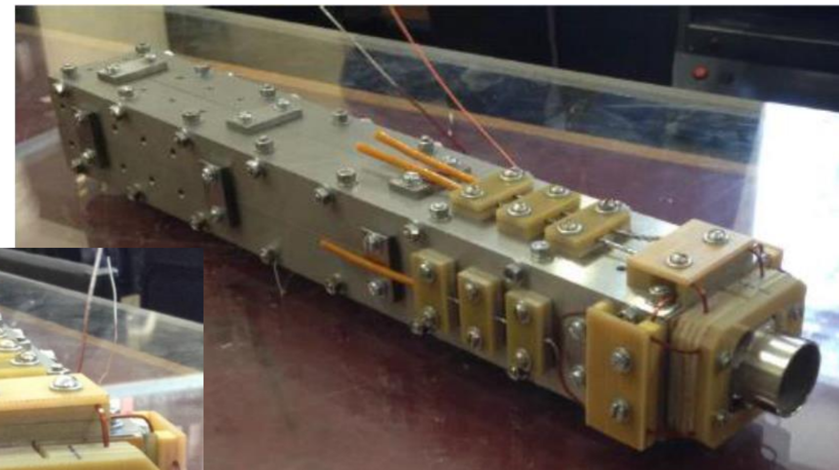
II. Head-on option for 175 GeV, but with complete IR rearrangement.

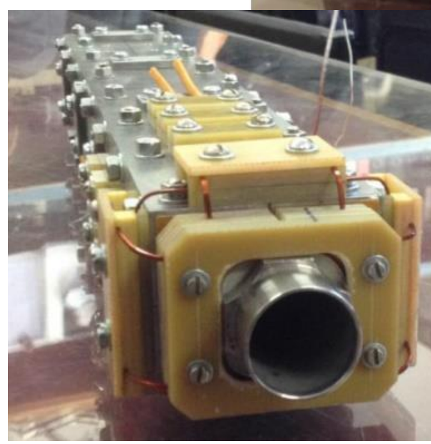
III. A decision should be made which to chose and what to develop more by not only accelerator physicists.
   1. what are the criteria of the choosing? (Do we need to minimize the tunnel?)
   2. what are the priorities?

Another QD0 prototype

New version of QD0 was developed at BINP recently and a single-aperture prototype was manufactured.

Main parameters:
Max.gradient 100 T/m
Max.current 1100 A
Length 40 cm
Aperture 2 cm
NbTi 1.8 x 1.4 mm^2
Saddle-type coils





During the first cryo-test (01.02.16) the current of 1060 A was achieved after 3 quenches.