Energy collimation at injection

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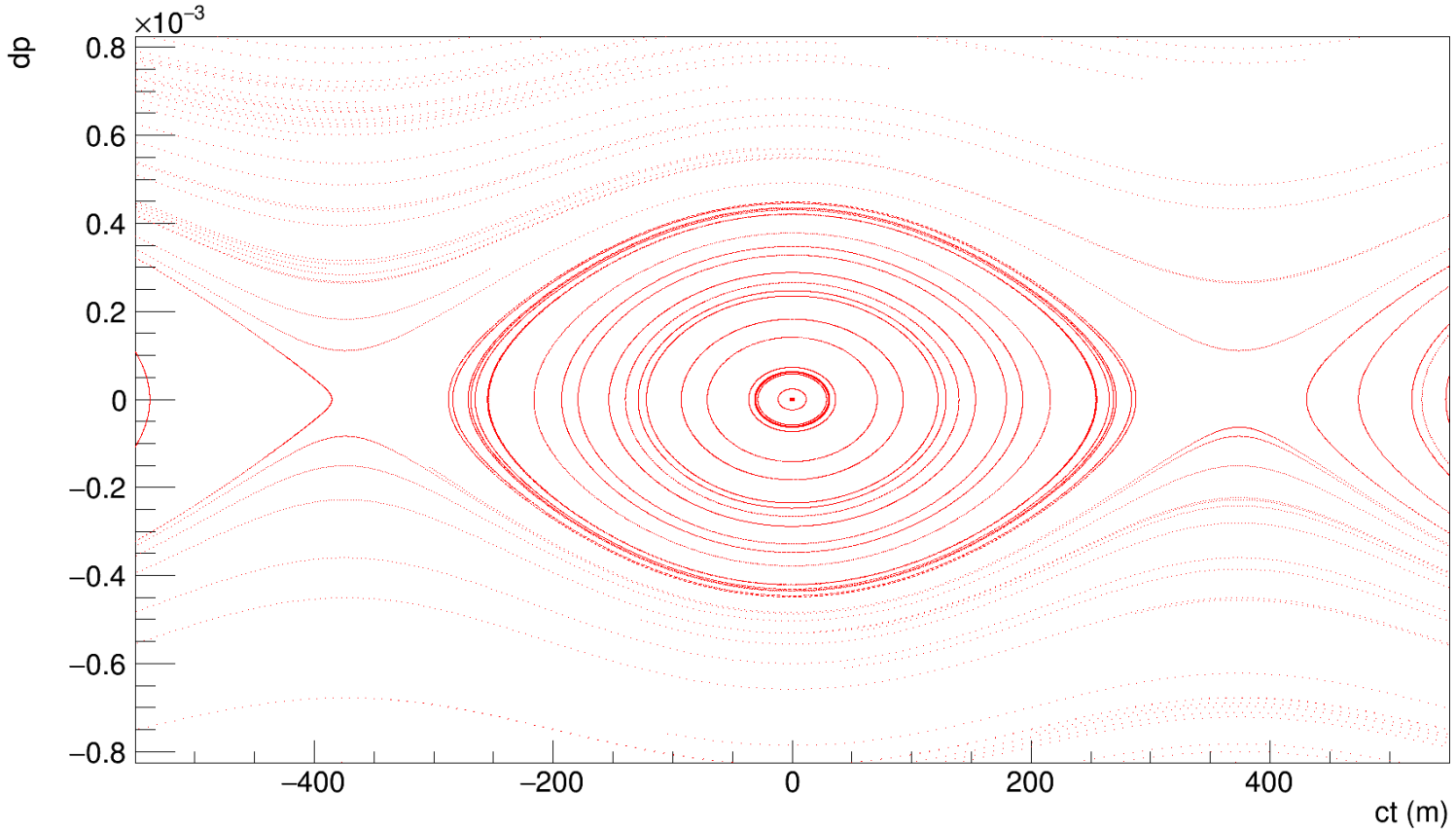
Role of the momentum cleaning system

- Remove off-energy particles from the beam.
- These will not be captured by the RF system and will radiate energy away and hit the aperture eventually.
- It will remove uncaptured beam at injection and the start of the ramp (very important).
- It should protect the cold aperture.
- It can be used as abort gap cleaning.
- Clearly linked to the RF system dynamics.
- Will investigate the performace of the off-momentum cleaning system as it currently exists in the main optics repository.

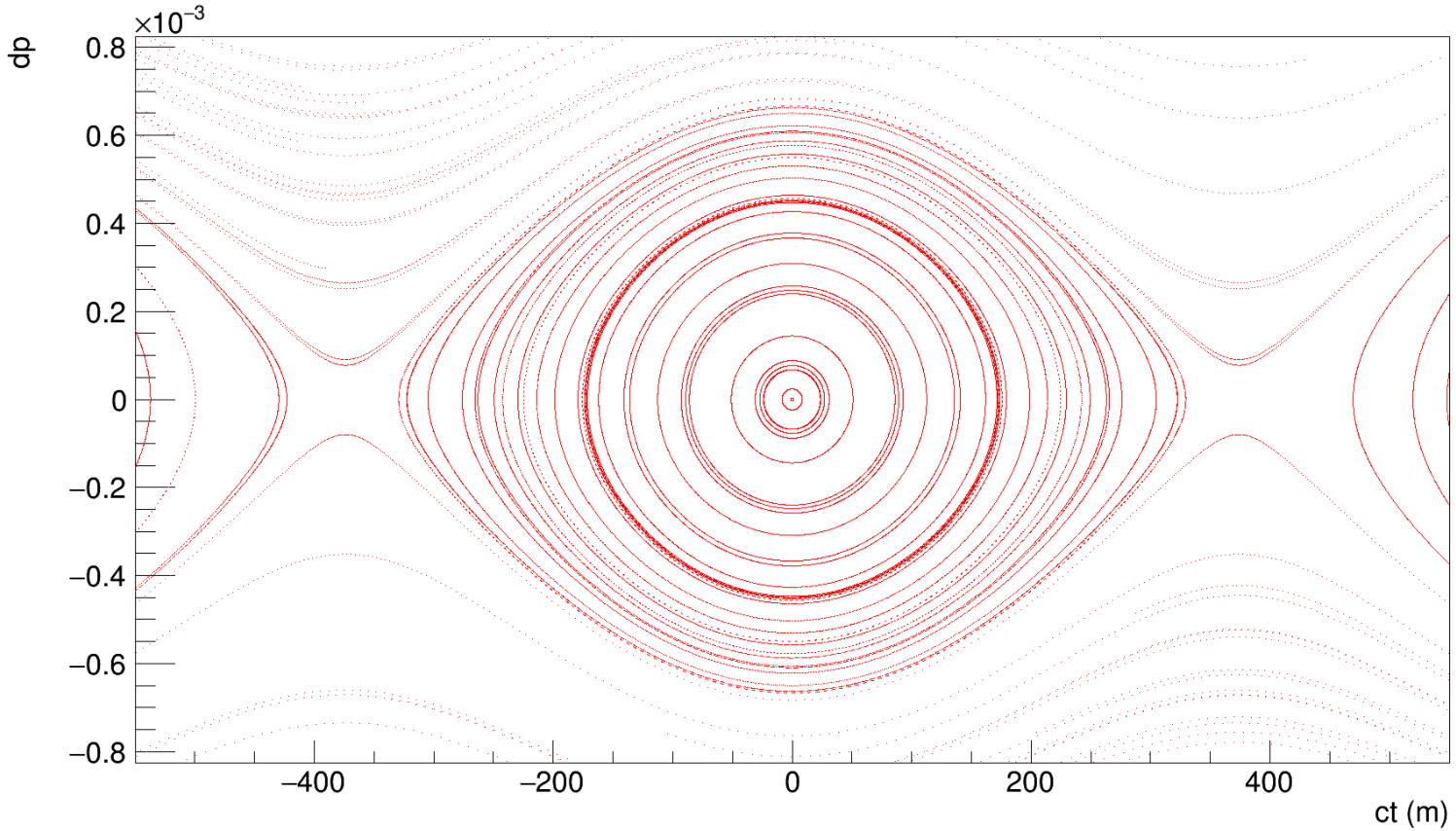
RF system

- Check RF system capture spread with sixtrack.
- Track a line of particles inside and outside the bucket and see what survives at injection.
- Vary the RF voltage, 16MV, and 32MV.
- Important to cut at this bucket edge so we do not dump out all uncaptured beam at the start of the ramp.

16 MV



32 MV



Current energy collimation system

- Assuming injection from the LHC:
- Interpolate LHC injection/collision values to 3.3TeV.

E (GeV)	**Energy spread** ($\times 10^{-4}$)
450	3.06
7000	1.129
3300	2.087

- The beam will be captured by the RF system.
- Good!

Problems

- This looks good so far, but.....
- The peak dispersion in the arc is just before the beam injection.

Parameter	TCP	Arc
$\beta_x(m)$	301.38	402.074
$\sigma_x(m)$	0.0004342	0.0005015
Physical aperture half gap (m)	0.0078414	0.013825
$D_x(m)$	1.86	3.25
$D_x/\sqrt{\beta_x}$	0.1073	0.1618
dp cut	0.0042088	0.0042599
E cut (GeV)	13.889	14.057

- A difference of $\approx 168 MeV$.
- The system has a cut with $dp \approx 0.0042$.
- See the RF bucket at $dp \approx 0.0005$.
- We are not even close to the edge of the bucket.

Options

- Close the momentum collimation system aperture (limited by the aperture of the betatron system).
- Increase the normalised dispersion at the TCP - increase the dispersion or reduce the beta function.
- Increase the RF bucket size with more RF voltage - maybe a lower harmonic capture system like what was proposed for the LHC?
- All of the above.

Collimator settings

- Lets close the collimation jaws as much as we can.
- Set the energy TCP to the same gap size as the TCTs.
- Scale all other energy related collimators by the same factor.

Collimator	**Old**	**New**
TCP	18.06	10.80
TCSG	21.67	12.96
TCLA	24.08	14.40
TCLD	35.14	21.00

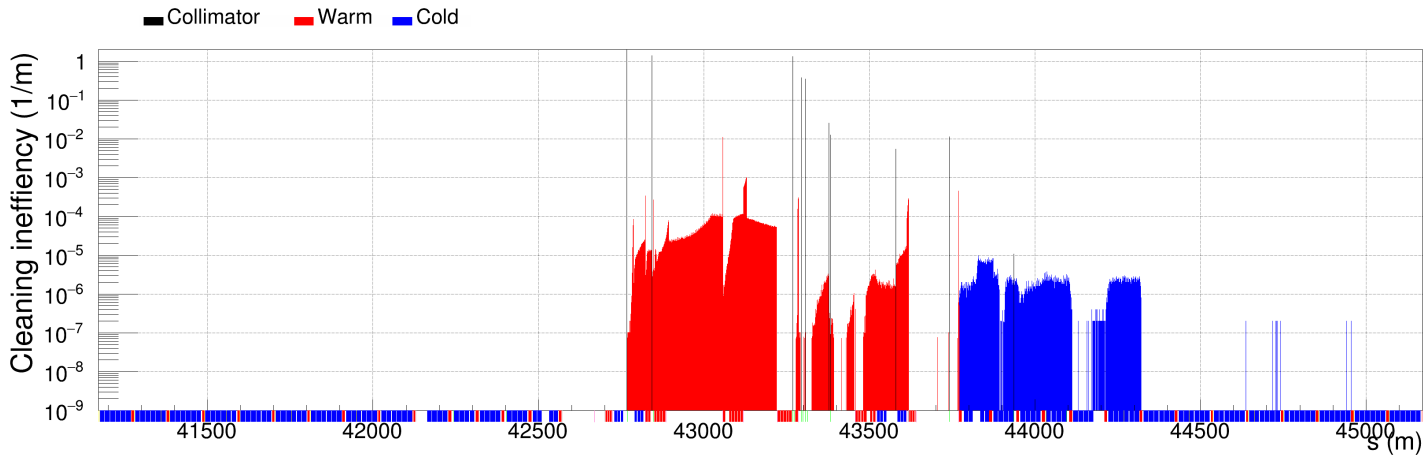
Lossmaps

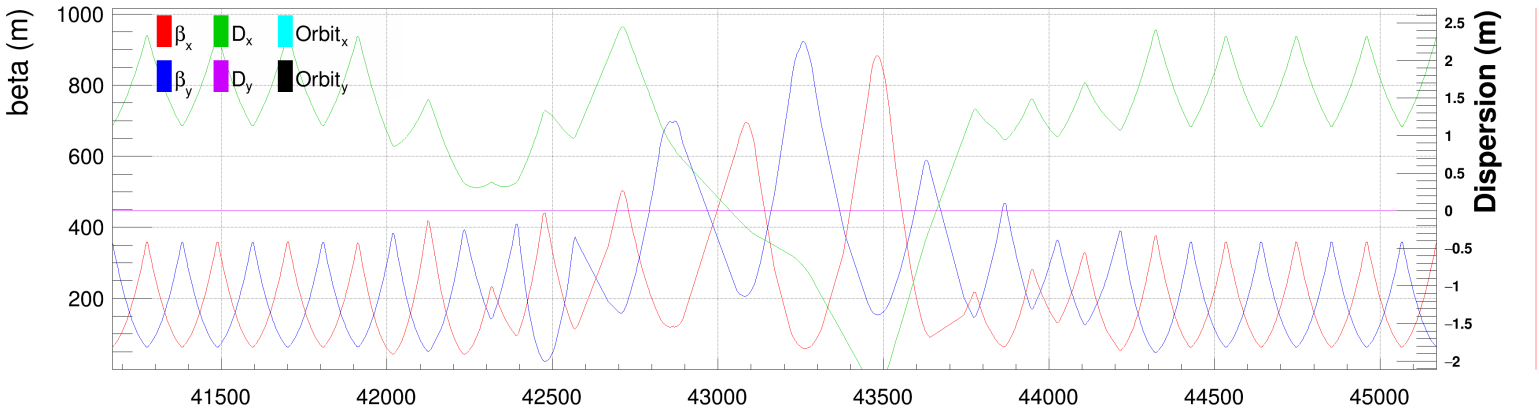
- Run at injection with a fixed $dp = \pm 8.4 GeV$ - previously $13.9 GeV$.
- Use new collimation settings, 2MV/RF cavity (the simulation is so short this does not matter).
- Use 100m protons with the FLUKA coupling.
- Same old injection and collimation optics
- Start tracking at IPA

+dp


Collimator
Warm
Cold
Cleaning ineffiency (1/m)
s (m)
beta (m)
Dispersion (m)
β_x
D_x
$Orbit_x$
β_y
D_y
$Orbit_y$

+dp

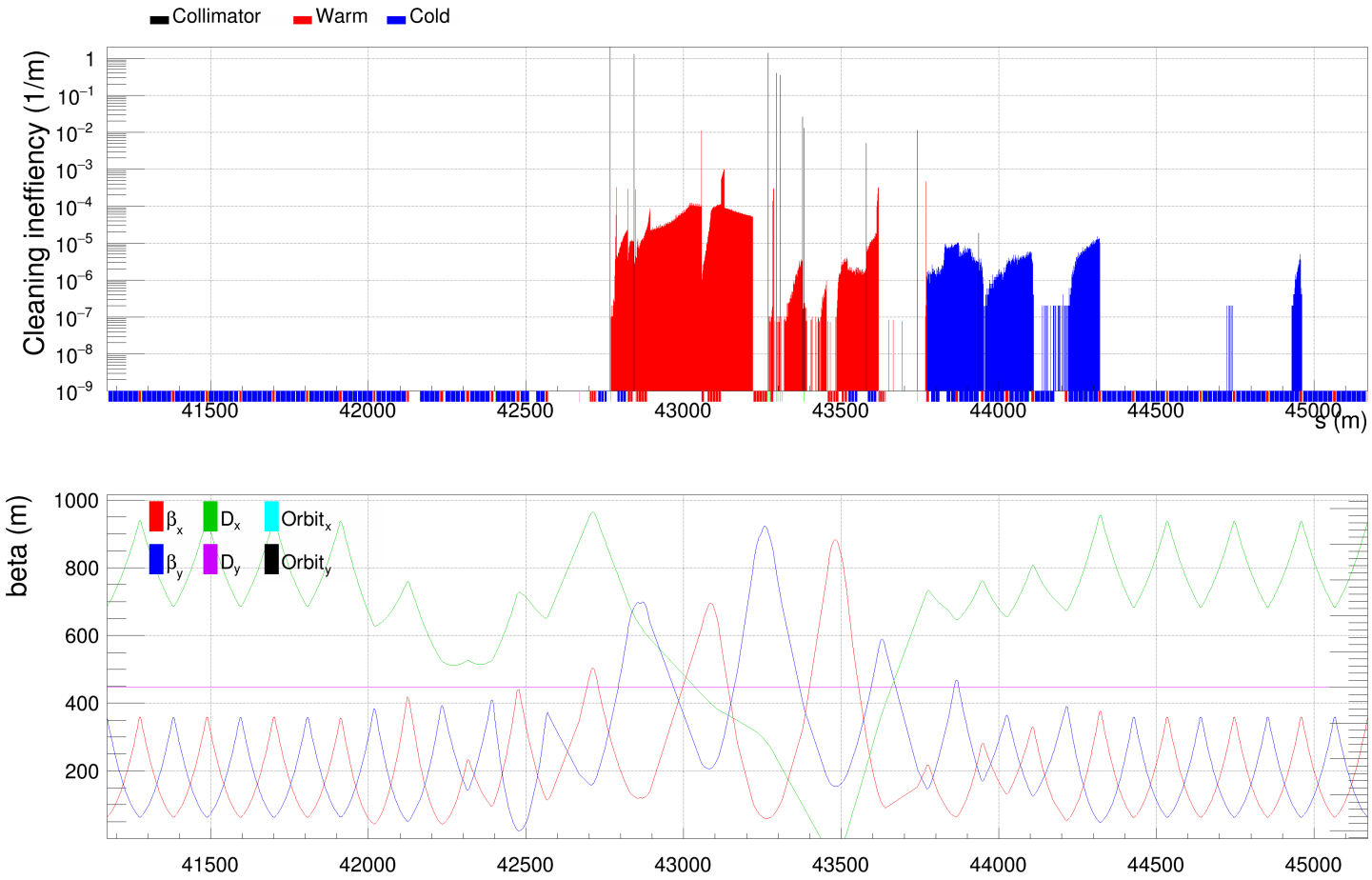

Collimator
Warm
Cold
Cleaning ineffiency (1/m)
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
41500
42000
42500
43000
43500
44000
44500
45000
s (m)


beta (m)
1000
800
600
400
200
β_x
D_x
$Orbit_x$
β_y
D_y
$Orbit_y$
Dispersion (m)
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
41500
42000
42500
43000
43500
44000
44500
45000

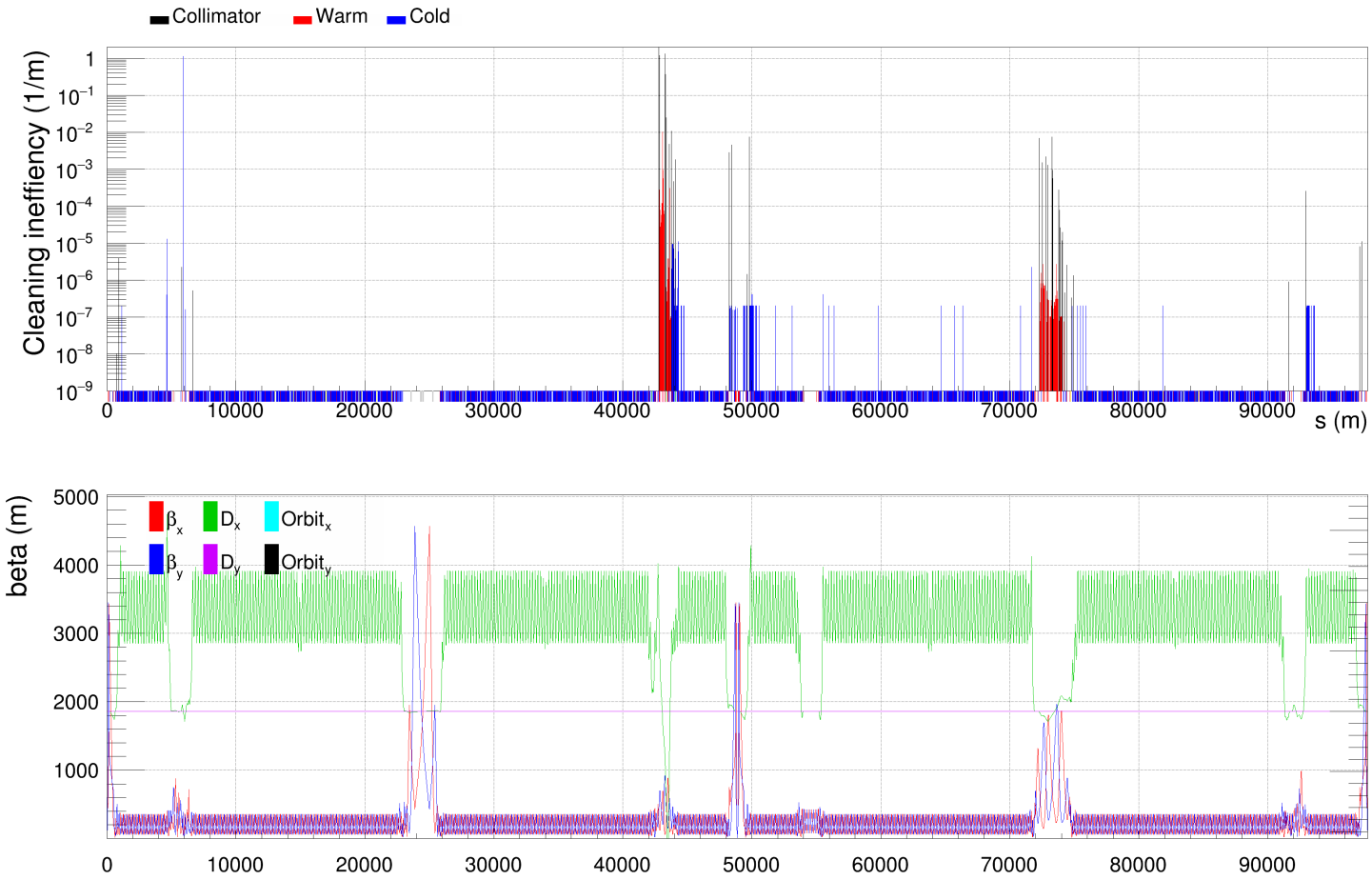
-dp


Collimator
Warm
Cold
Cleaning ineffiency (1/m)
s (m)
beta (m)
Dispersion (m)
β_x
D_x
$Orbit_x$
β_y
D_y
$Orbit_y$

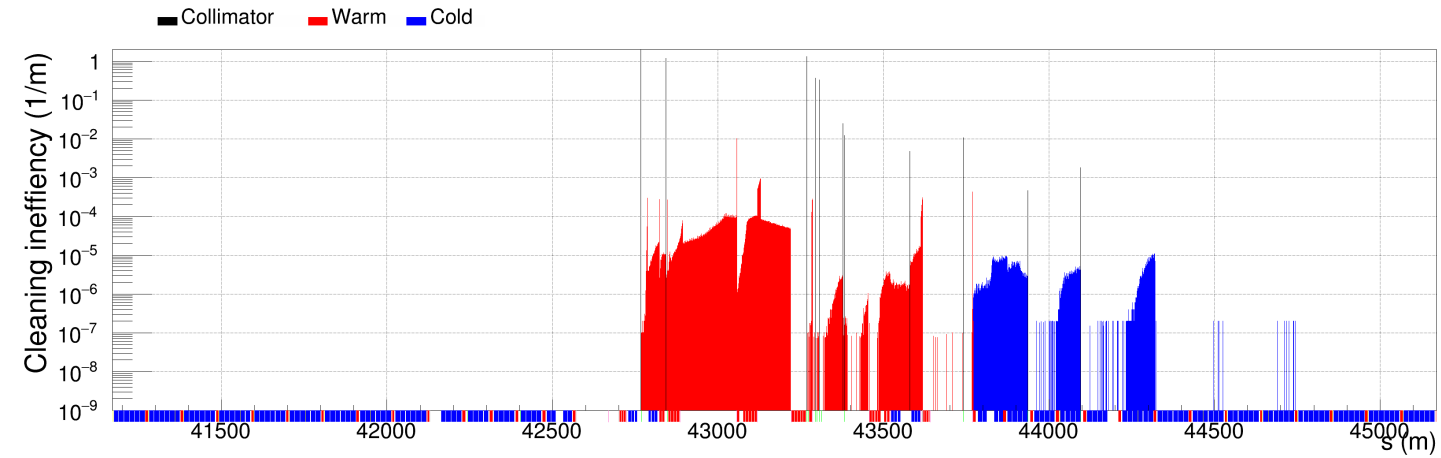
-dp

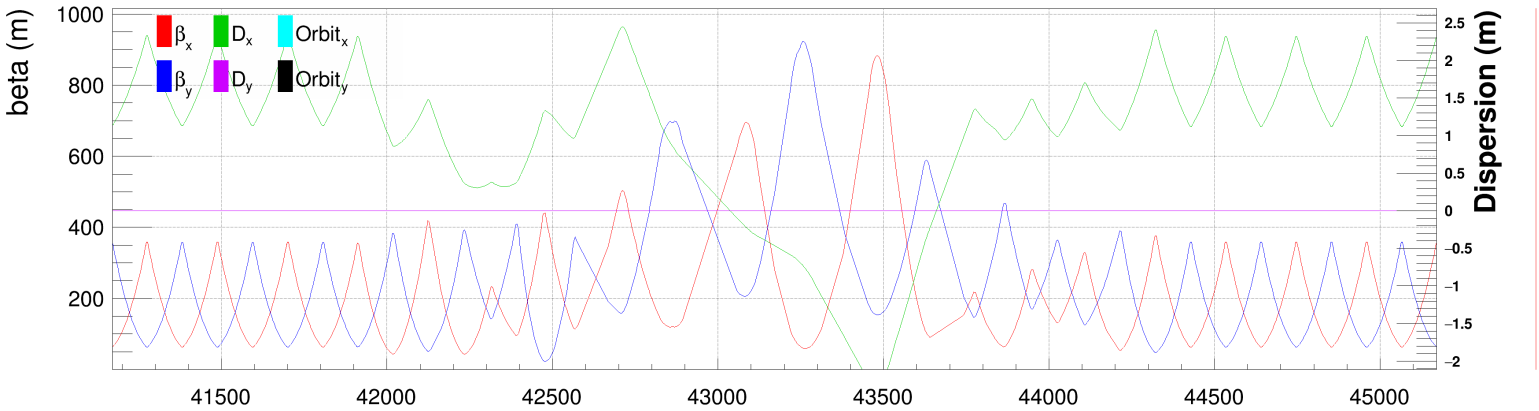

Collimator
Warm
Cold
Cleaning ineffiency (1/m)
1
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
41500
42000
42500
43000
43500
44000
44500
45000
s (m)
beta (m)
1000
800
600
400
200
β_x
D_x
$Orbit_x$
β_y
D_y
$Orbit_y$
Dispersion (m)
2.5
2
1.5
1
0.5
0
−0.5
−1
−1.5
−2
41500
42000
42500
43000
43500
44000
44500
45000

-dp + tighter TCLD



-dp + tighter TCLD





Summary

- This needs work.
- As previously requested, the dispersion peak in the DS before the injection IR needs to be removed.
- The energy collimation needs to be swapped for the version with the same normalised dispersion (or better) than the LHC.