FCC ion collimation

A. Abramov, R. Bruce, N. Fuster-Martinez, A. Mereghetti, J. Molson

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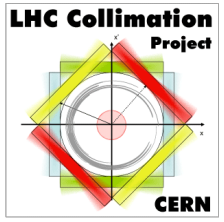


Overview

- Studied the FCC betaron collimation inefficiency for ions using the SixTrack-Fluka coupling for heavy ions.
  - Originally developed by Pascal Hermes in collaboration with the Fluka team.
  - Many recent developments by Alessio Mereghetti, James Molson et. al.
  - Multiple improvements since last studies – fixes to online aperture check, inclusion of protons etc.
- Performed an impact parameter scan to determine worst cleaning inefficiency.
  - Developed new tool for precise beam halo generation.
- Used the detailed model by James Molson for comprehensive simulations.
  - Includes a dump collimator (TCDQ), more tertiary collimators (TCT), metalic secondary collimators (MoGr TCSG), octagon beamscreen.
- Simulated Beam 1 horizontal and vertical, with and without dispersion suppressor collimators (TCLD)

Used parameters – best available model

Parameter	Value
Optics Version	fcc_hh_0300_cross
β^*	30 cm
Crossing angle	ON
Particle	Pb-82-208
ϵ_N	0.875 μm
Equiv. ϵ_{Np}	2.2 μm
E	4.1 PeV
E/Z	50 TeV
E/N	19.71 TeV
TCP jaw length	30 cm
TCP opening	7.57 σ
Beam distr.	pencil
N primaries	1×10^6
N turns	700

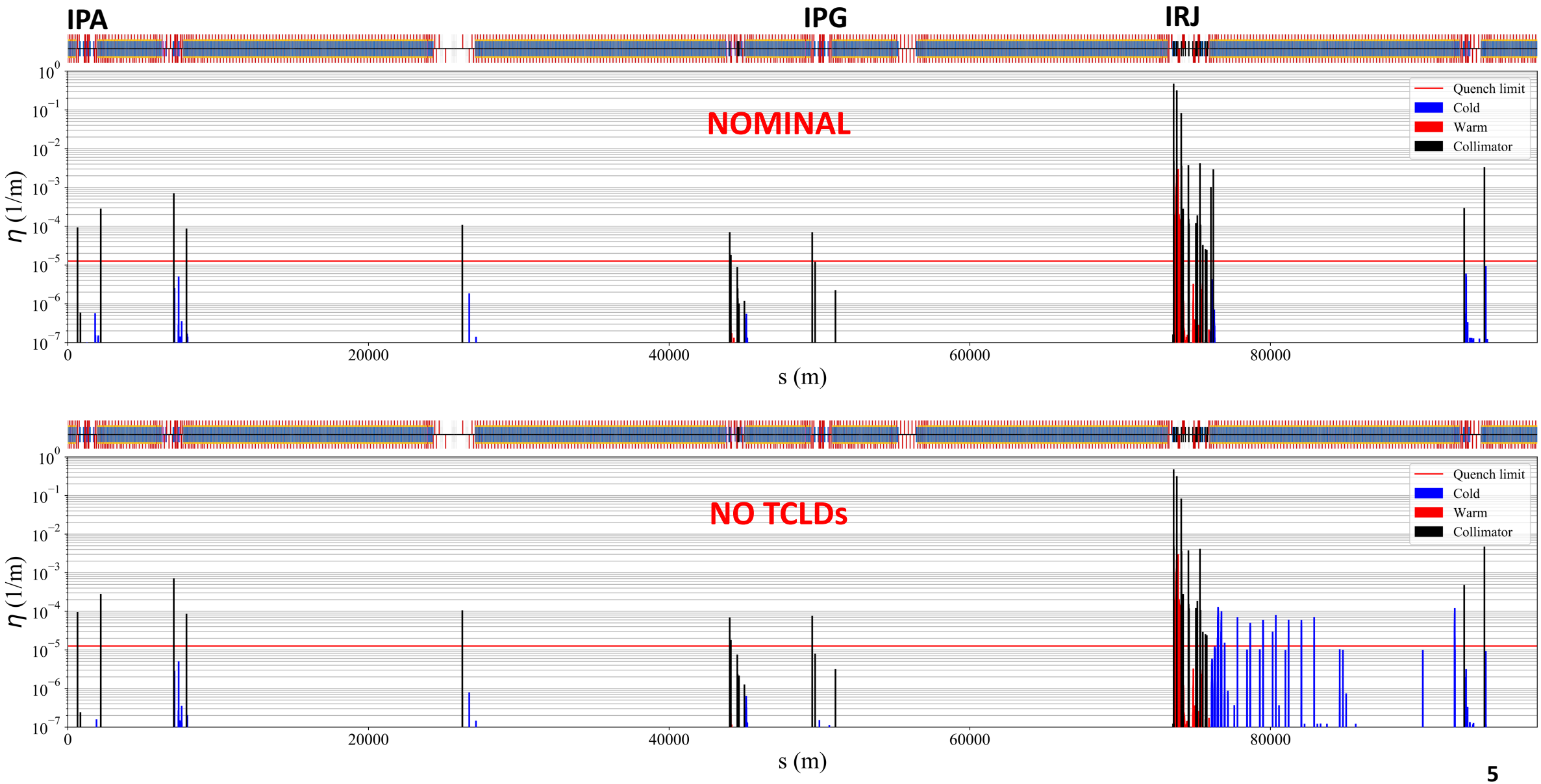
Quench limit for ions

- Use quench limit for protons quoted by Daniel Schulte
  https://indico.cern.ch/event/438866/contributions/1085167/
- Ion beam parameters by Michaela Schaumann

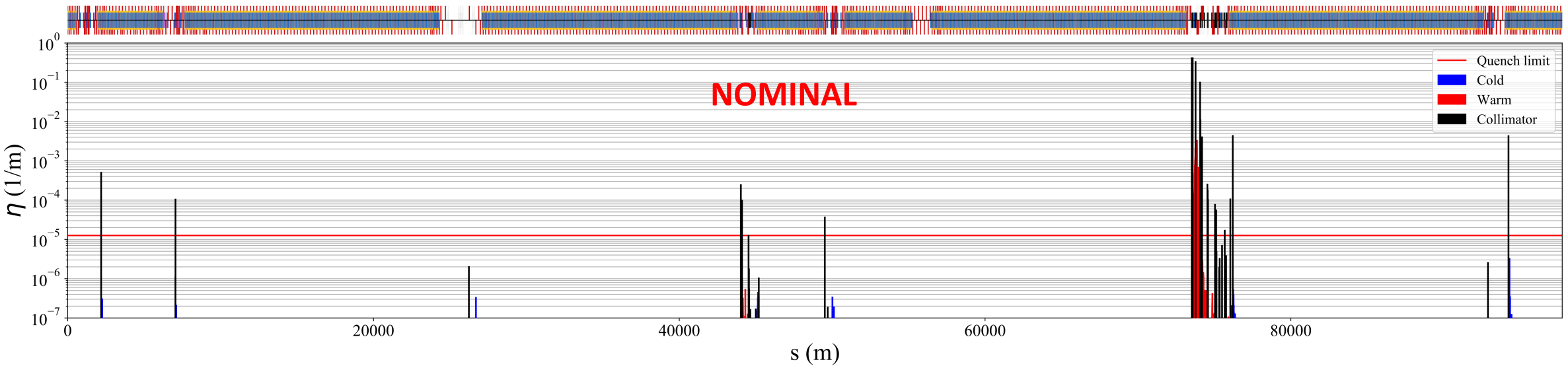
Parameter	Value
Number of bunches	2760
Ions per bunch	$2 * 10^8$
Nominal ion energy	4.1 PeV
Proton energy	50 TeV
Beam lifetime	12 min
Quench limit	$0.5 * 10^6$ protons/s/m
Quench limit	$1.26 * 10^{-5}$ 1/m

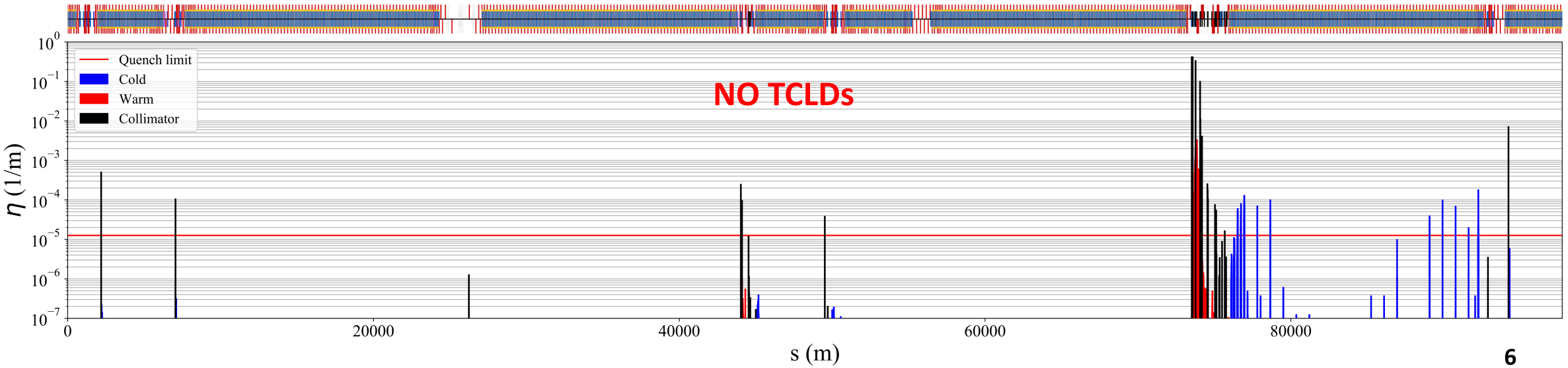
N.B. The loss maps are now all normalised to total energy loss instead of peak energy loss in the collimation system!

Cleaning inefficiency – B1H, 0.1 µm impact parameter

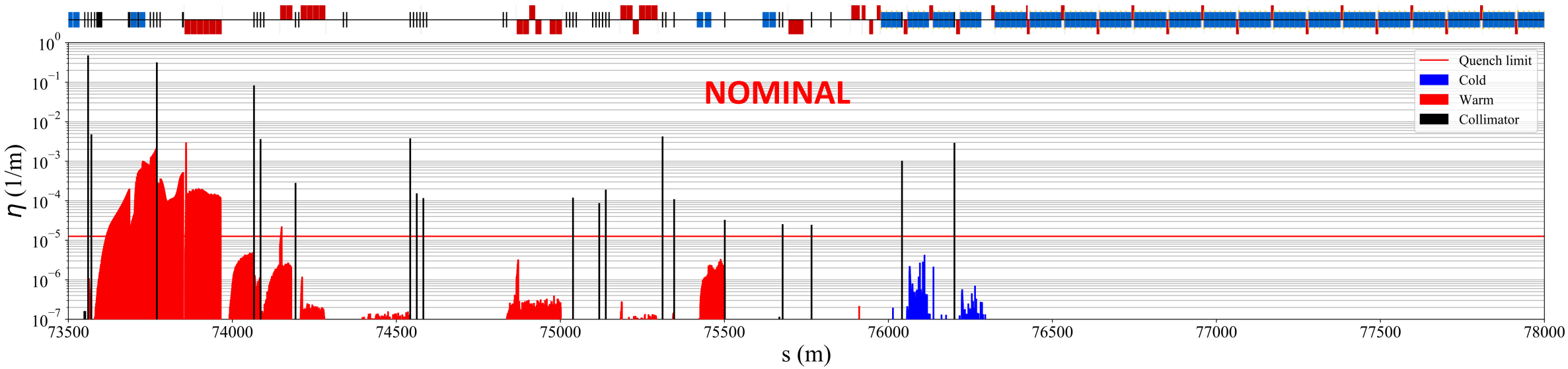


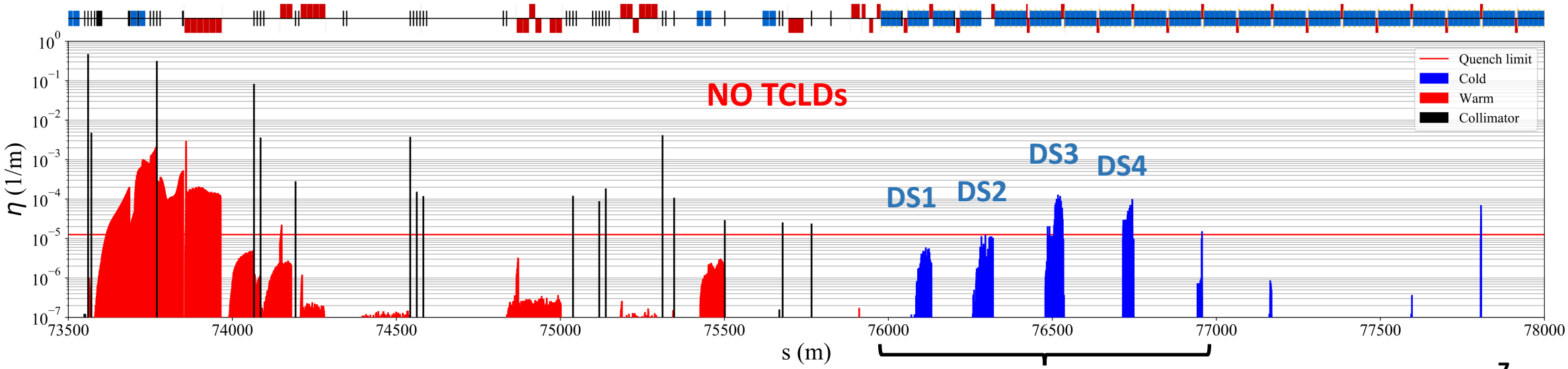
Cleaning inefficiency – B1V, 0.1 µm impact parameter



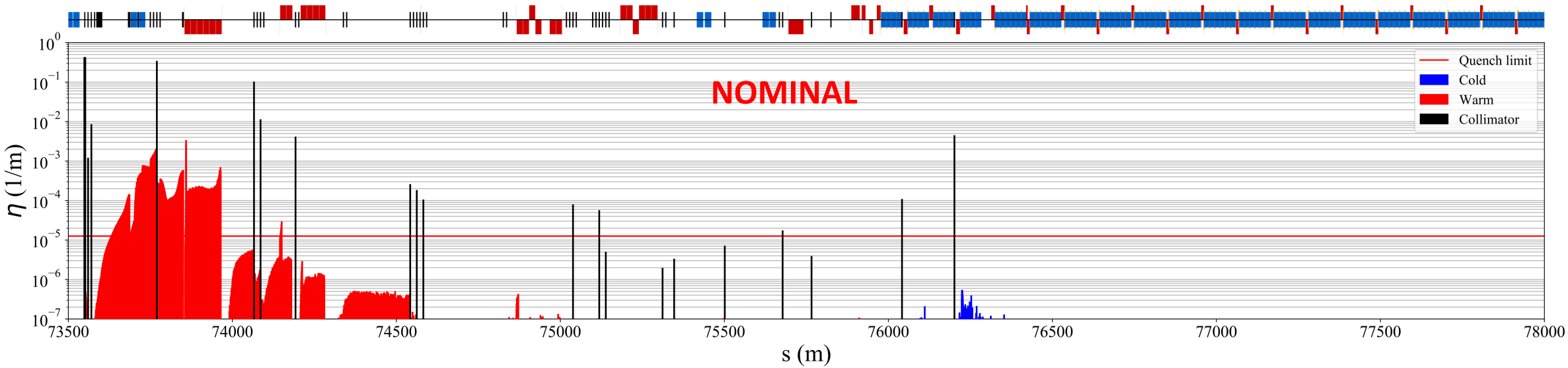


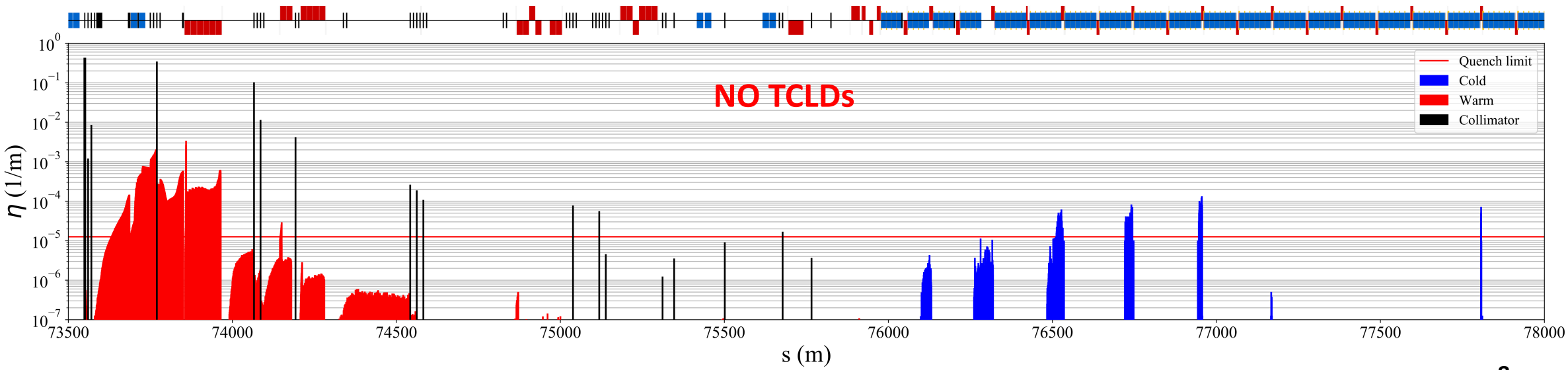
Cleaning inefficiency – B1H IRJ, 0.1 µm impact parameter





Cleaning inefficiency – B1V IRJ, 0.1 µm impact parameter

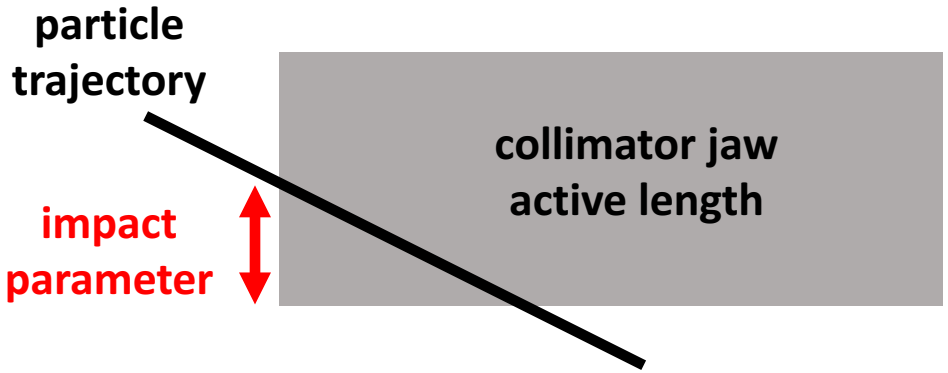




Impact parameter scan – worst cleaning

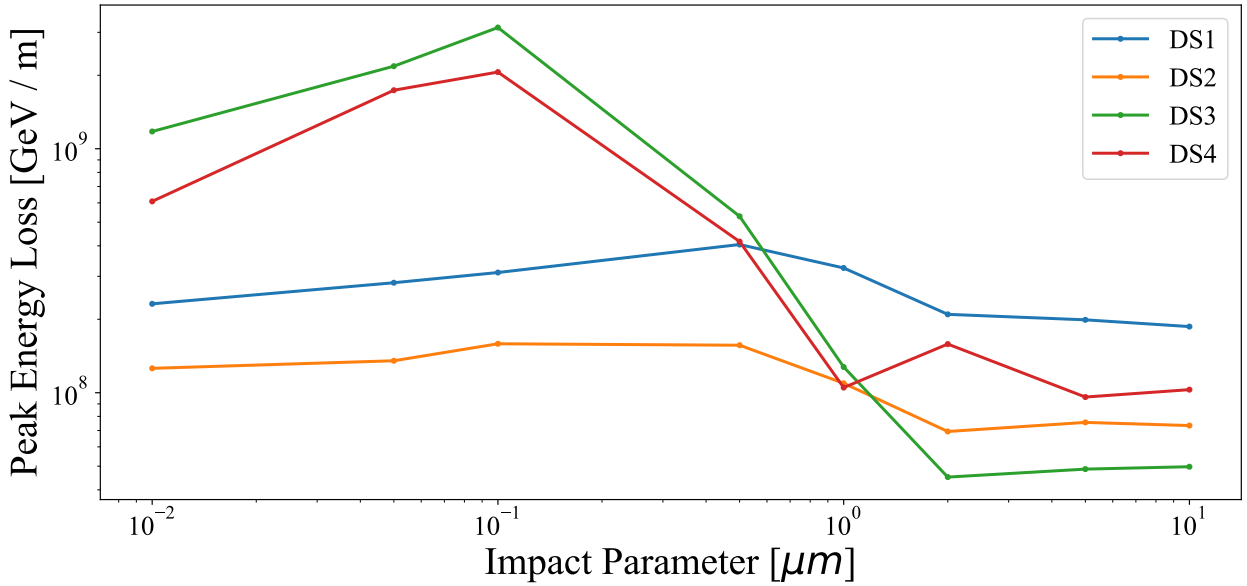
- Impact parameter is the depth into the jaw at which beam particles hit – it is a proxy for the distance travelled in the collimator by the particle.
- Perform a scan of 8 cases of B1H with 1 million primaries different impact parameter.
- Different, less detailed version of the lattice.
- The TCLD are removed.
- Determine efficiency by looking at dispersion suppressor (DS) loss in different loss clusters (1-4).
- Protons excluded from this simulation.

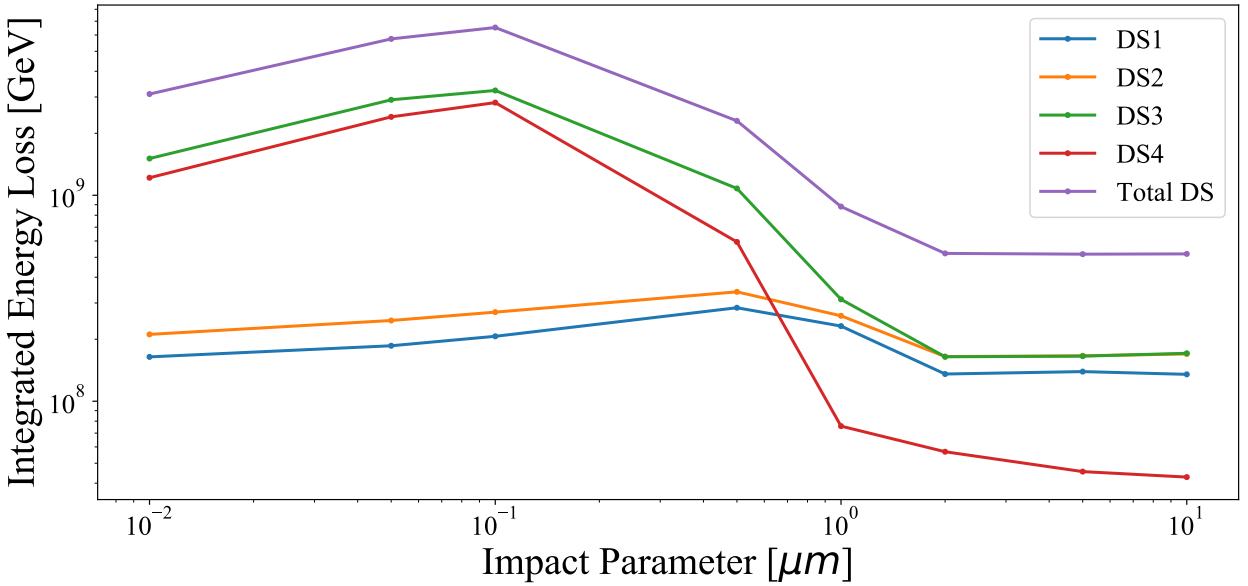
Parameter	Value
Optics Version	fcc_hh_0150
β^*	15 cm
Crossing angle	OFF



Impact parameter scan – worst cleaning

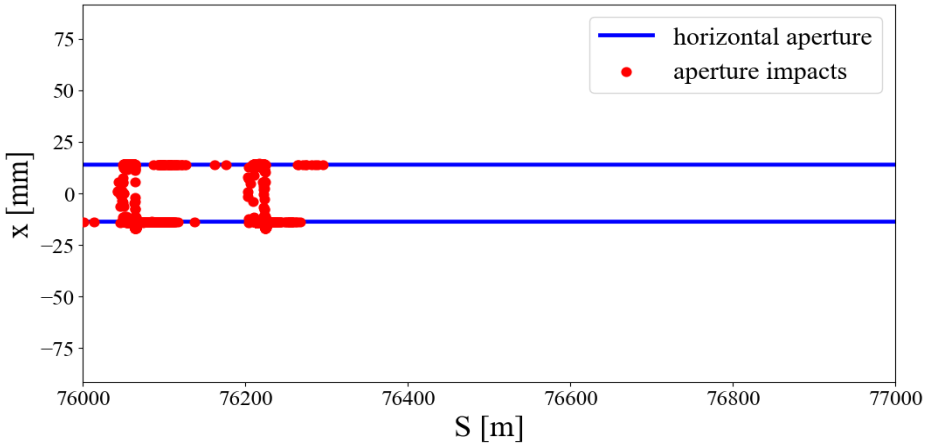
- Worst case determined to be 0.1 µm.
- Need to perform the same in the vertical plane in the future.

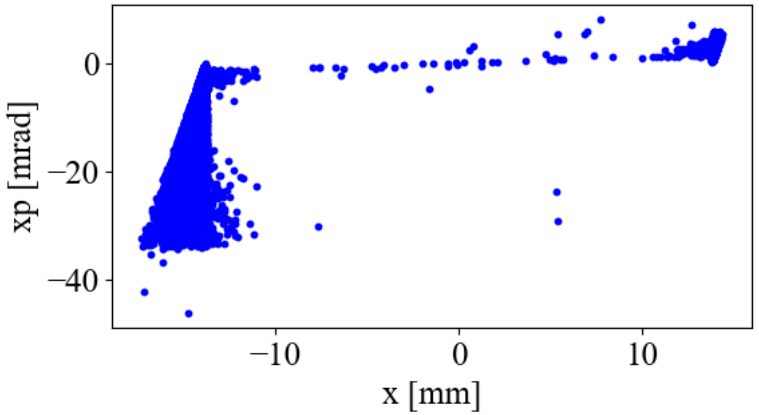


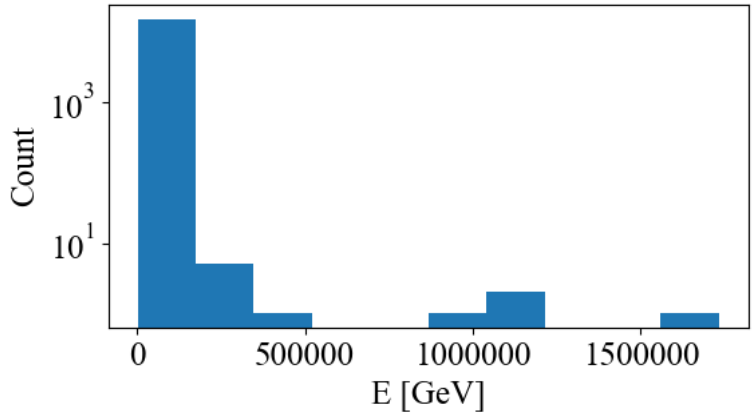


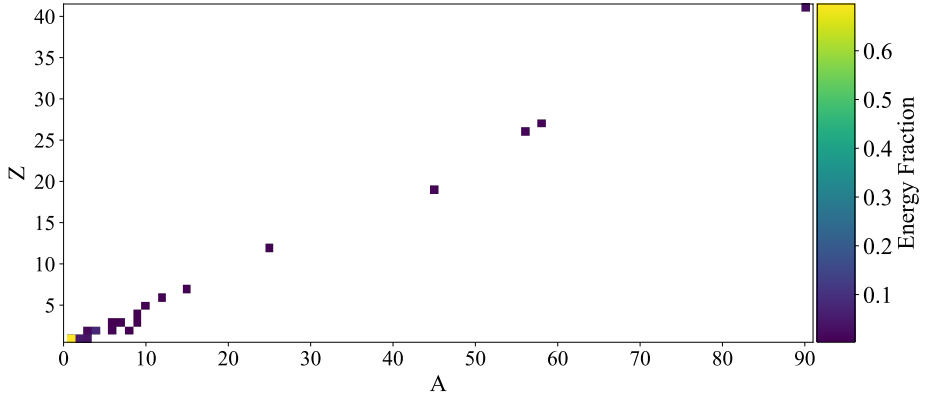
DS losses analysis – B1H, 76000 – 77000 m

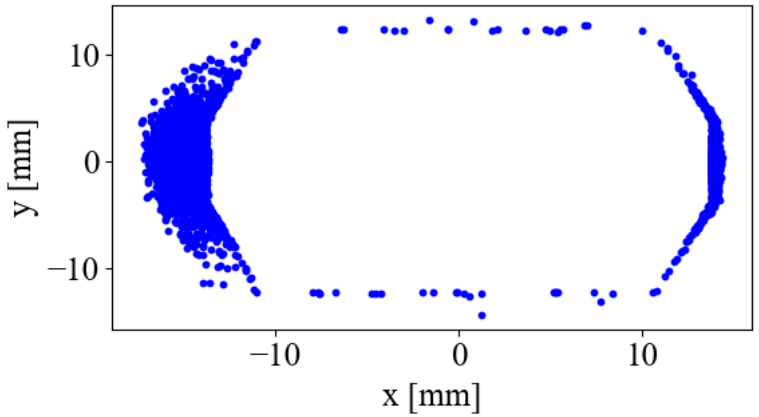
NOMINAL

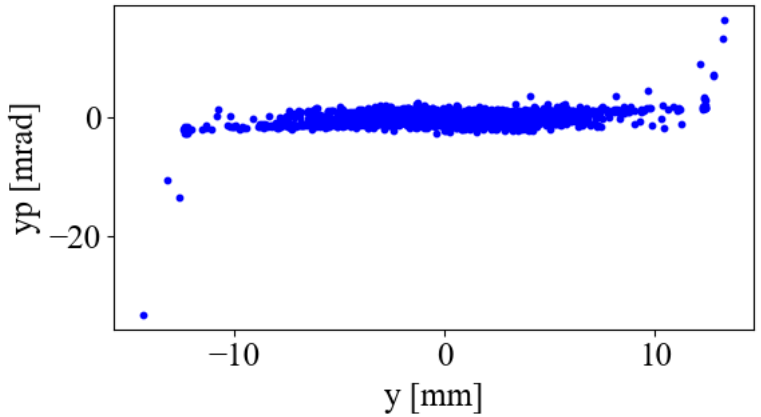






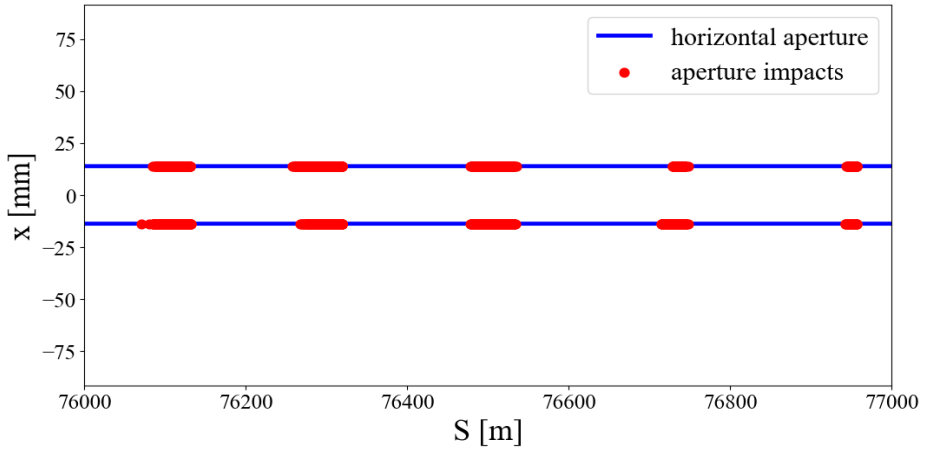


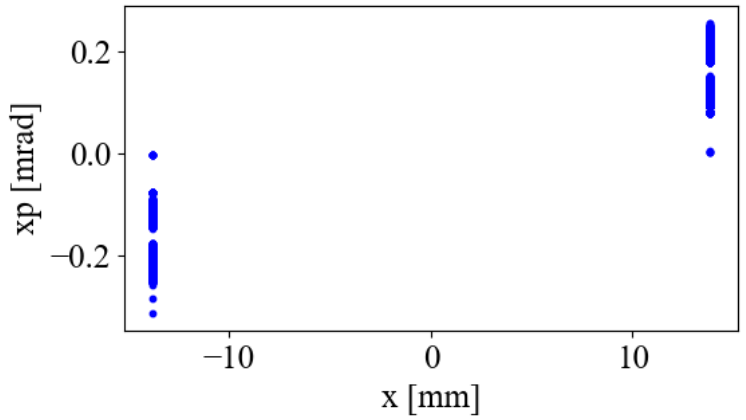


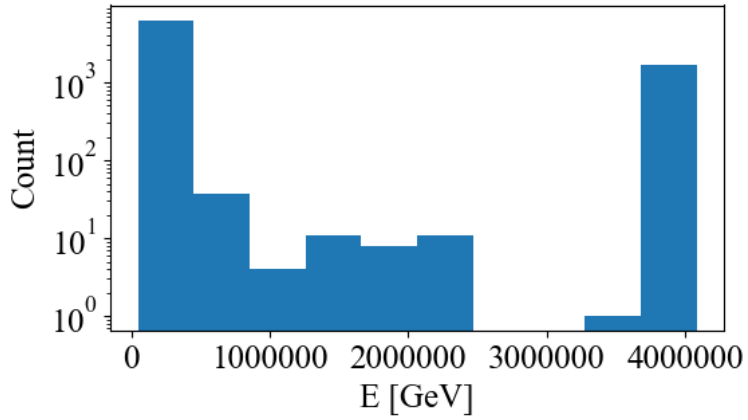


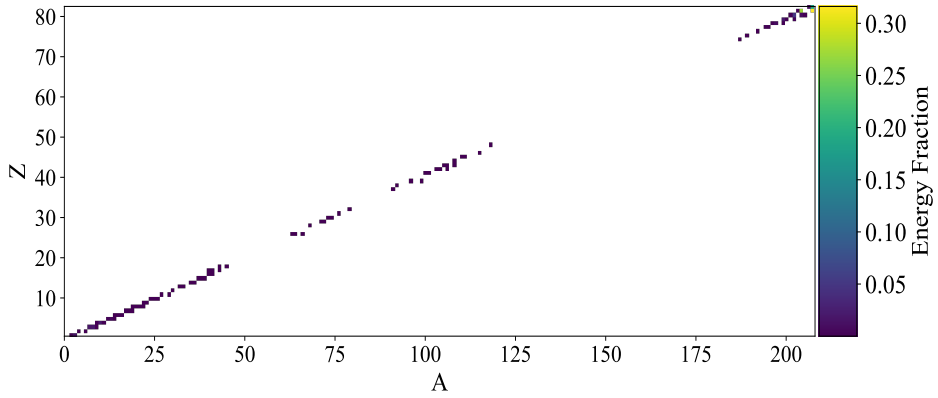
DS losses analysis – B1H, 76000 – 77000 m

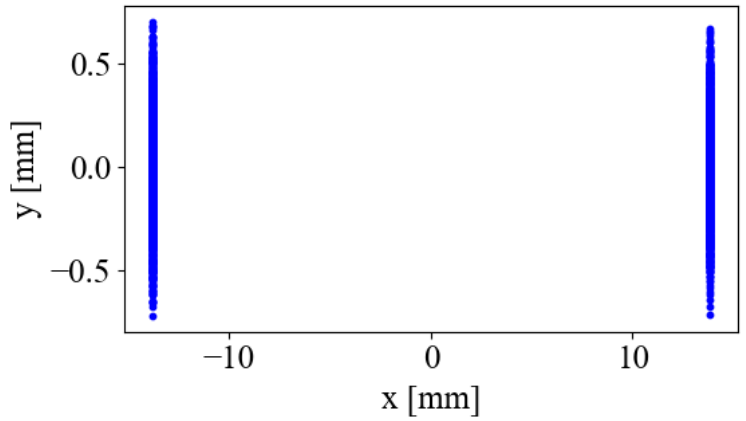
NO TCLD

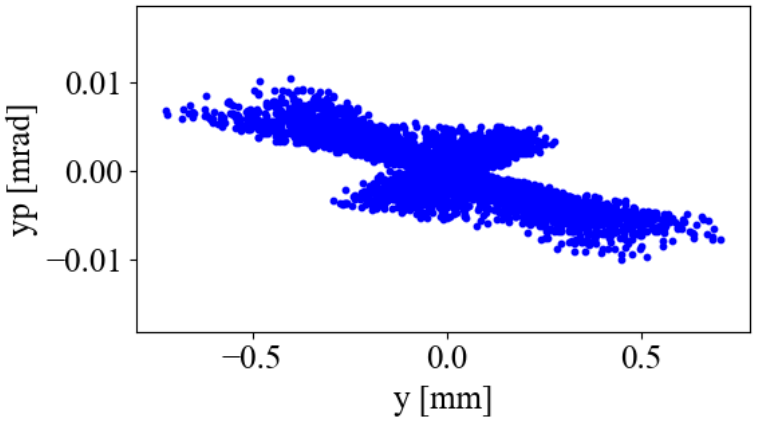












Conclusions

- Performed a study of cleaning efficiency for FCC with heavy ions.
- Used an impact parameter scan to determine the worst cleaning inefficiency.
- The worst impact parameter was found to be 0.1 µm.
- Results show that the TCLDs reduce DS losses for ions by about 2-3 orders of magnitude.
- Tentatively the losses seem to be under the quench limit in all cold regions.
- In future studies need to consider the effect of orbit sagitta in straight dipoles.