Update on ion collimation studies for FCC-hh

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

J. Molson, L. Nevay, S. Redaelli

CERN, 17.06.2019

Overview

- Performed a new set of studies of the FCC-hh collimation cleaning performance for ion beams using the SixTrack-FLUKA coupling.
- Used the lattice and collimation configuration by James:
  - The new stable lattice release includes changes accumulated over a long period of time.
  - Additional collimators introduced in locations with larger losses.
- Fixed several bugs found in previous results:
  - Previously missing ion physics process included.
  - Collimators losses in loss maps correctly normalised to the active length of the collimator.
- The results presented are included in the FCC-hh CDR.

Used parameters

Parameter	Value
β^*	$30\,\mathrm{cm}$
Crossing angle	200
Particle	$^{208}\mathrm{Pb}^{82+}$
ϵ_N	$0.875\,\mu\mathrm{m}$
Equiv. ϵ_Np	$2.2\,\mu\mathrm{m}$
E	$4.1\,\mathrm{PeV}$
E/Z	$50\,\mathrm{TeV}$
E/N	$19.71\,\mathrm{TeV}$
TCP jaw length	$30\,\mathrm{cm}$
TCP opening	$7.57\,\sigma$
Impact parameter	$1\,\mu\mathrm{m}$
N primaries	1×10^6
N turns	700
Tracking cut E	1 TeV / nucleon

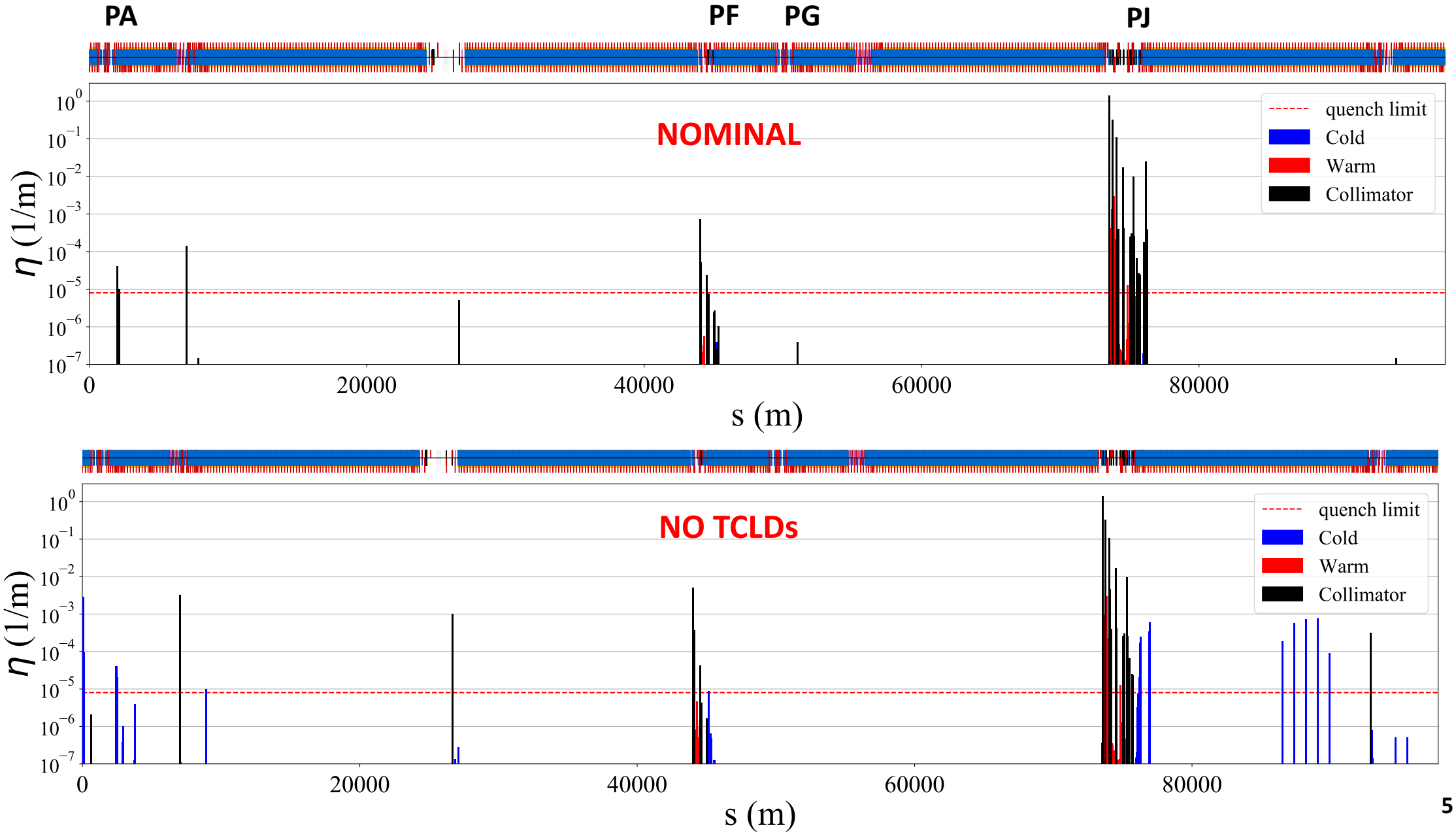
Quench limit for ions - recap

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

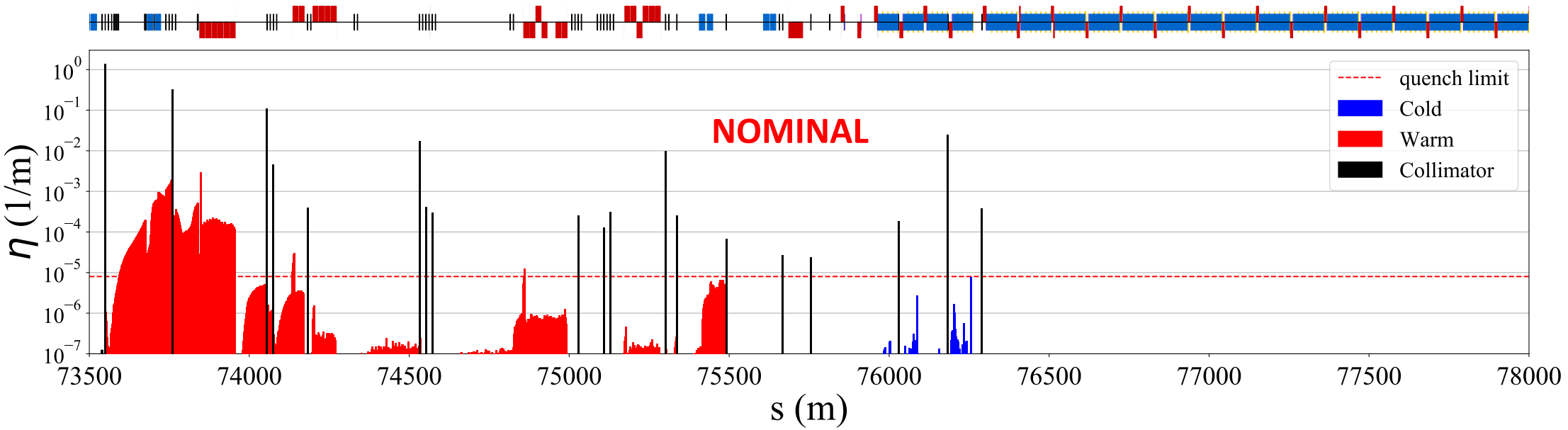
Parameter	Value
Number of bunches	2760
Ions per bunch	$2 * 10^8$
Nominal ion energy	4.1 PeV
Proton energy	50 TeV
Beam lifetime	12 min
Quench limit	$0.5 * 10^6$ protons/s/m
Quench limit	$8 * 10^{-6}$ 1/m

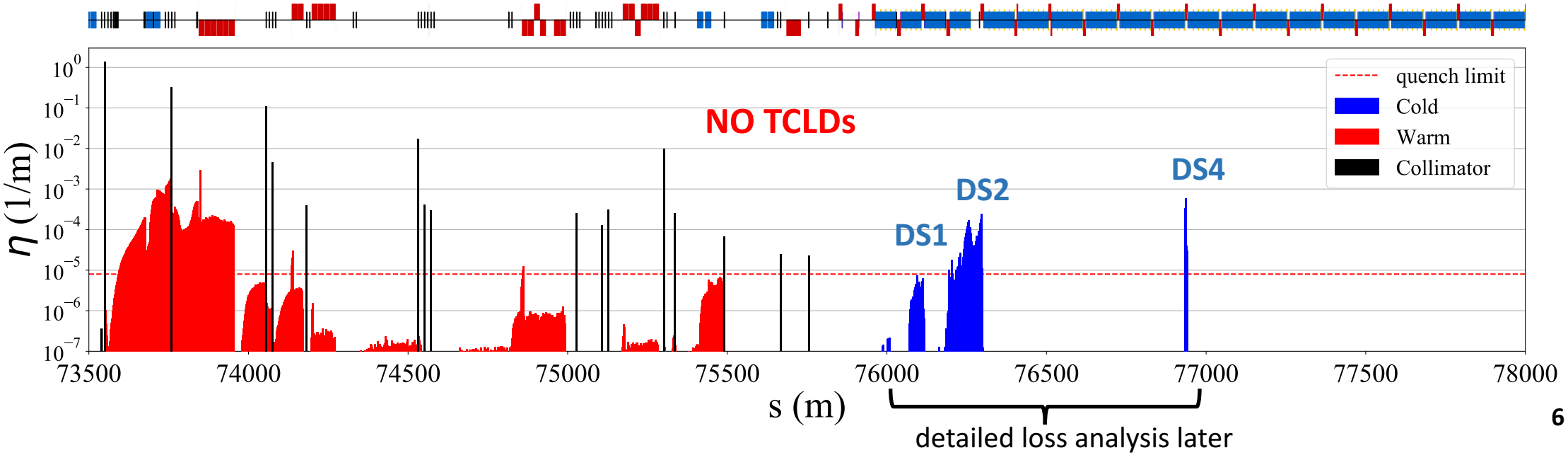
N.B. The loss maps are normalised to total energy loss instead of peak energy loss in the collimation system!

Betatron cleaning at collision – B1H

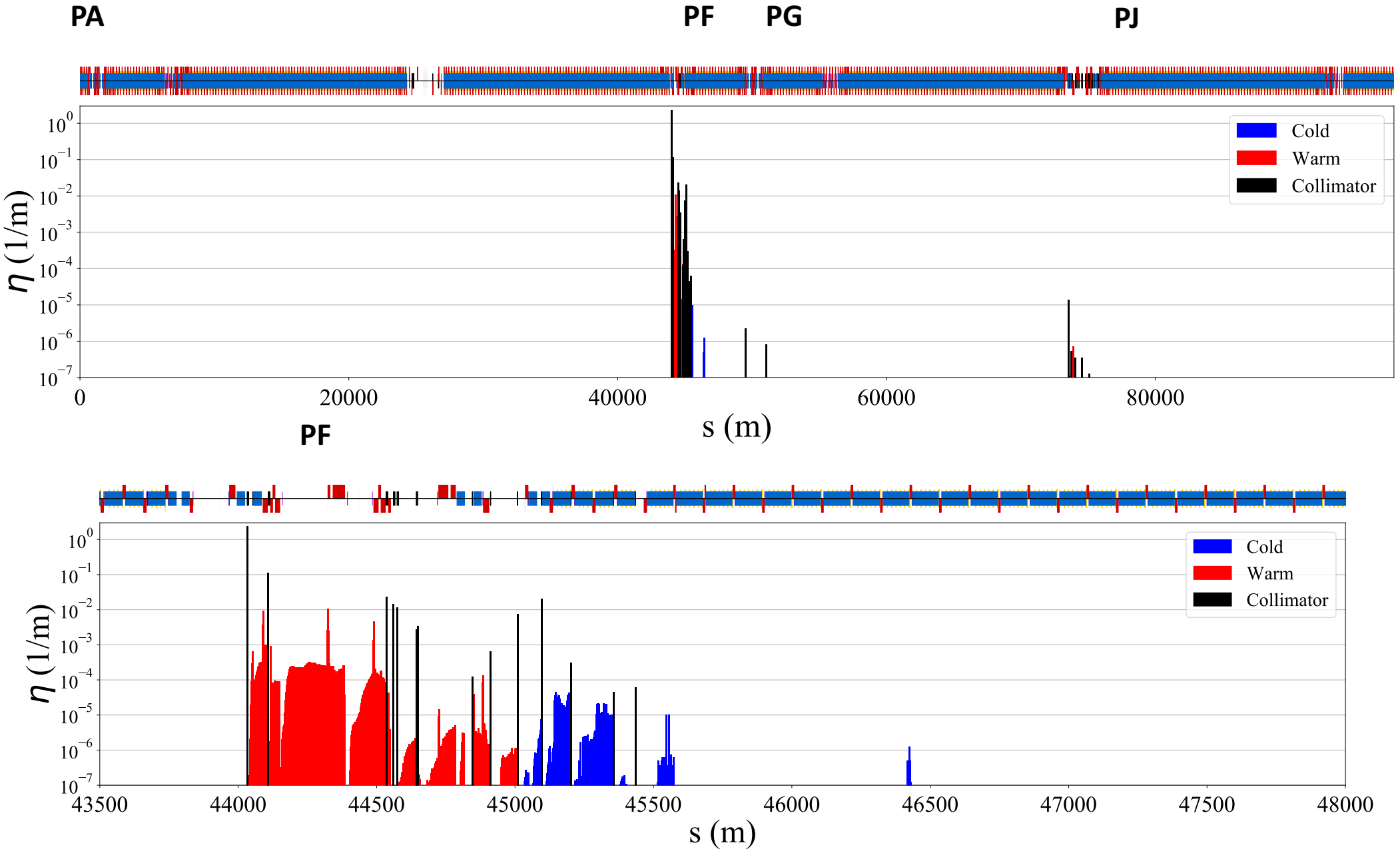


Betatron cleaning at collision – B1H IRJ



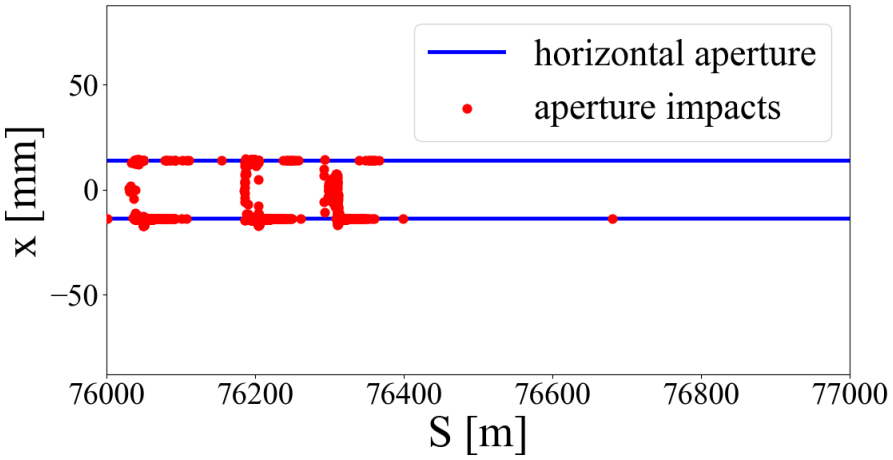


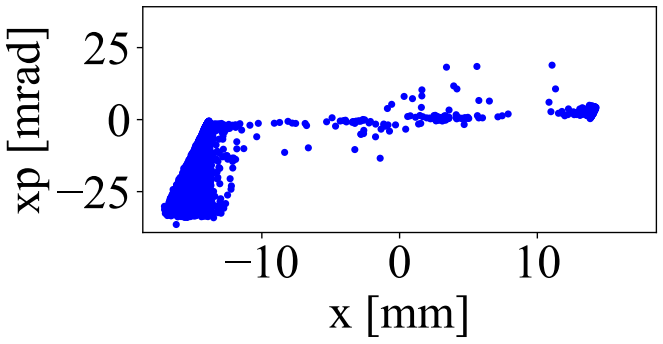
Momentum cleaning at injection – B1H

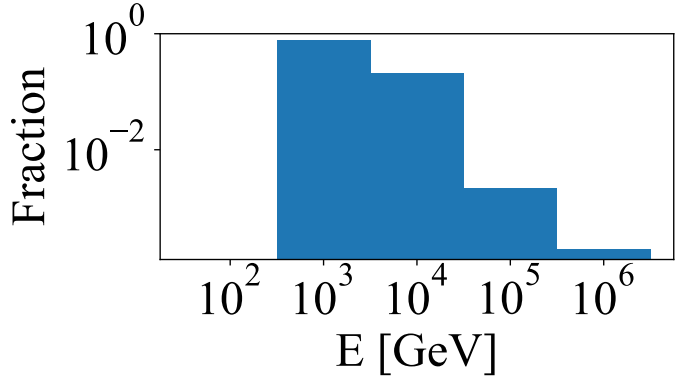


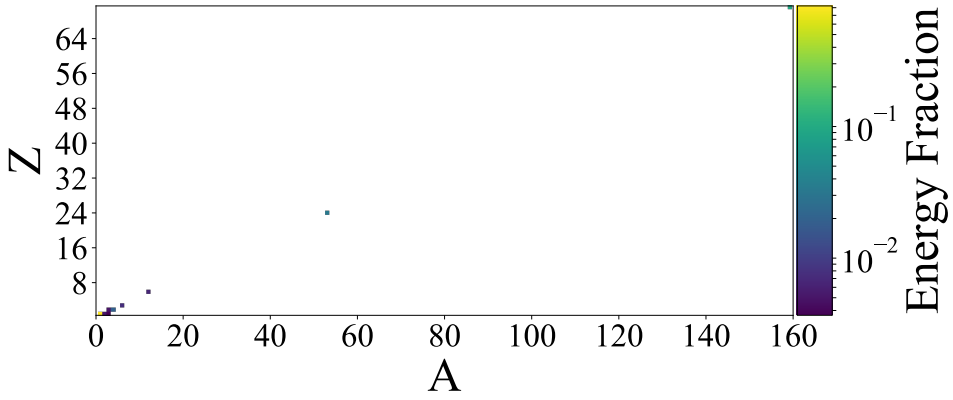
DS losses analysis – B1H, 76000 – 77000 m

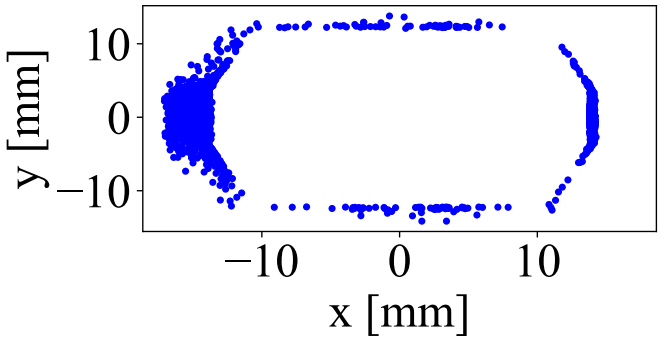
NOMINAL

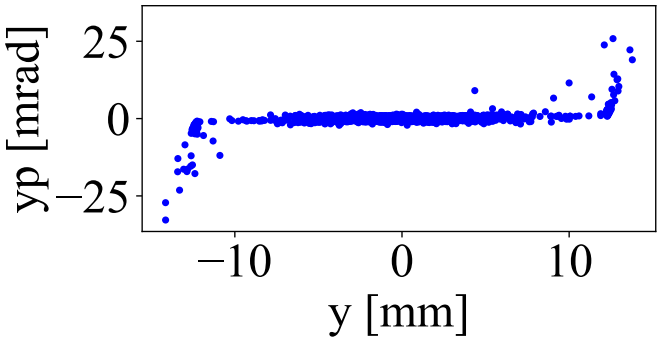






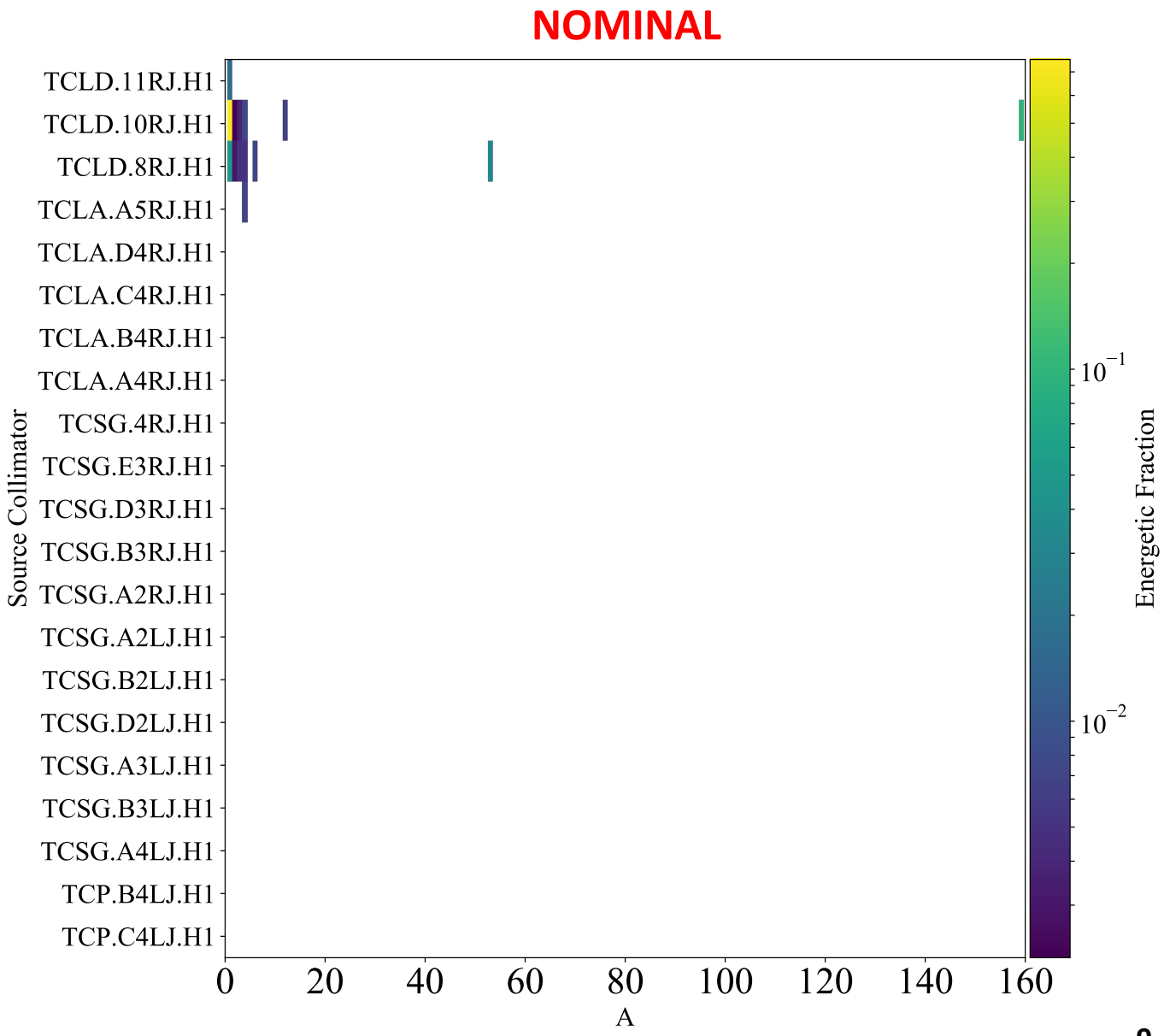






DS losses analysis – B1H, 76000 – 77000 m

- Connect the aperture losses to the collimator where they originated.
- All the fragments coming from the TCPs and TCSGs are successfully intercepted by the TCLDs.
- The dominant contribution to energy lost in the DS are light fragments leaking out from the TCLDs

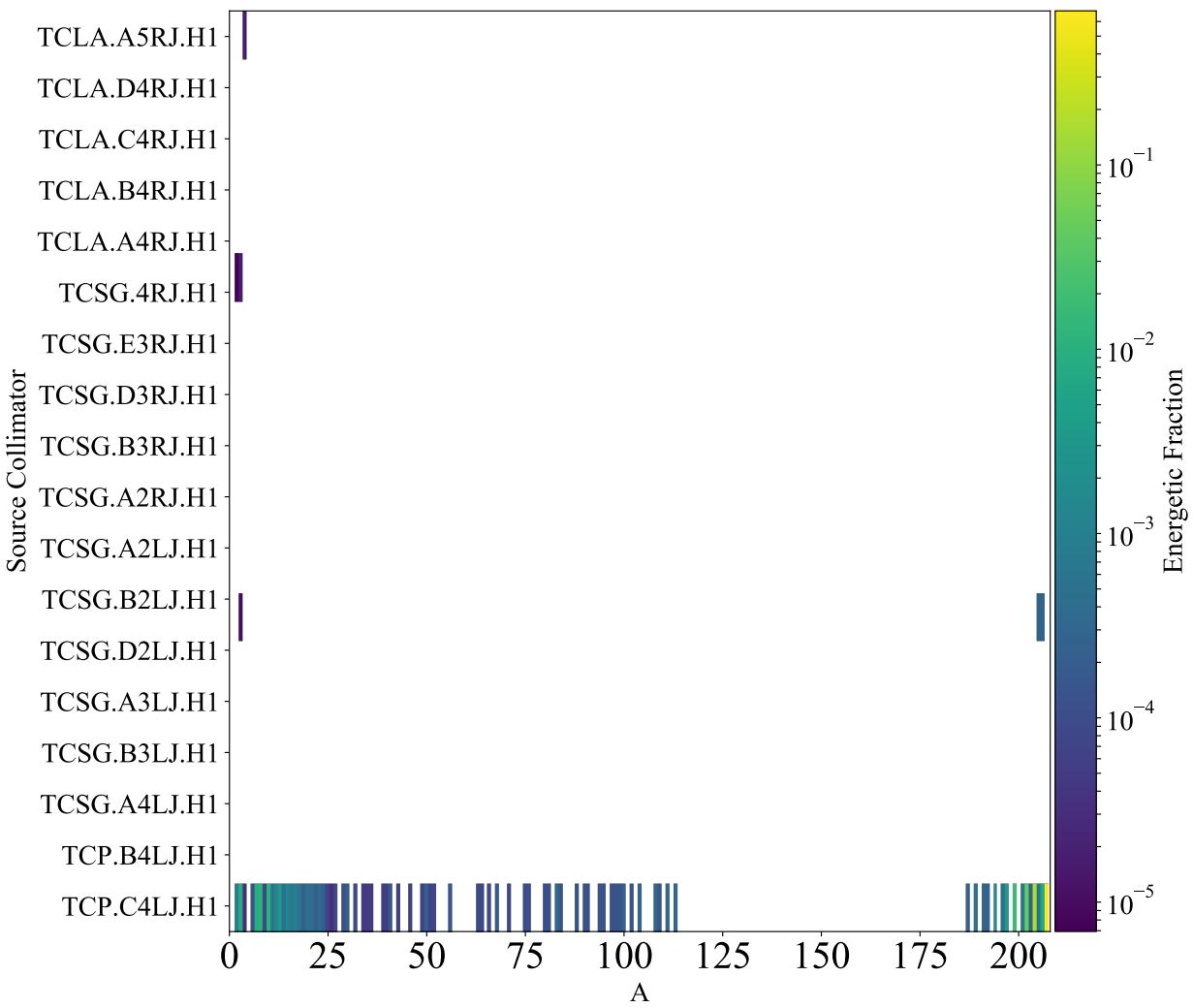


Conclusions

- The latest studies of ion collimation for FCC-hh show generally good cleaning performance.
- The TCLD collimators are shown to intercept heavy-ion fragments coming from the TCPs and the TCSGs.
- A better estimate for the quench limit must be obtained using:
  - The latest NbSn quench limit values.
  - The latest energy deposition studies.
- Local losses in the DS of the betatron cleaning insertion and the extraction region must be studied further.

DS losses analysis – B1H@collision, 76000 – 77000 m

NO TCLD



NOMINAL