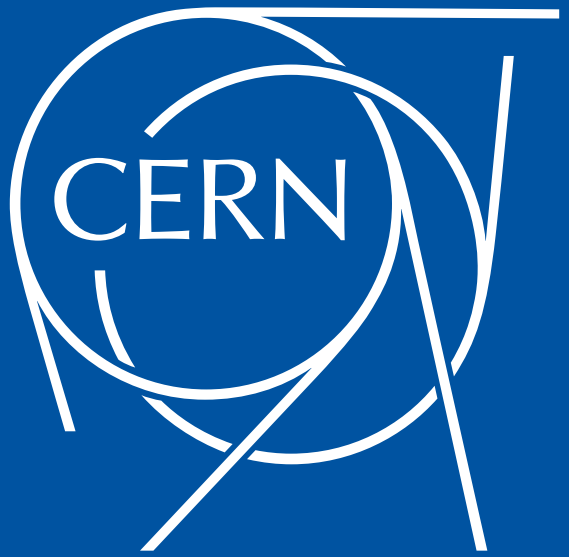
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Tracking studies for secondary ion beams in the FCC-hh

FCC collimation design meeting #24

J. Molson et al

Ion beams

- The FCC-hh will collide both protons and heavy ion beams
- When operating in heavy ion mode, at each colliding IP, secondary beams will be produced from the interactions of the colliding beams.
- These beams can each have quite a high power!
- Safe removal of this power is essential to operation of the machine.

Secondary beams produced

- Bound Free Pair production (BFPP)
- BFPP1: $^{208}\mathrm{Pb}^{82+} +^{208} \mathrm{Pb}^{82+} \longrightarrow^{208} \mathrm{Pb}^{82+} +^{208} \mathrm{Pb}^{81+} + e^{+}$
- BFPP2: $^{208}\mathrm{Pb}^{82+} +^{208} \mathrm{Pb}^{82+} \longrightarrow^{208} \mathrm{Pb}^{82+} +^{208} \mathrm{Pb}^{80+} + 2e^{+}$
- etc...
- Electromagnetic dissociation (EMD)
- EMD1: $^{208}\mathrm{Pb}^{82+} +^{208} \mathrm{Pb}^{82+} \longrightarrow^{208} \mathrm{Pb}^{82+} +^{207} \mathrm{Pb}^{82+} + n$
- EMD2: $^{208}\mathrm{Pb}^{82+} +^{208} \mathrm{Pb}^{82+} \longrightarrow^{208} \mathrm{Pb}^{82+} +^{206} \mathrm{Pb}^{82+} + 2n$
- etc...

"Ultimate" CDR beam parameters

Paramater	**Value**
Energy (TeV)	4100
Bunches	5400
Bunch intensity	2×10^8
β^* (m)	0.3
Peak luminosity $\left(cm^{-2}s^{-1}\right)$	2.5×10^{29}
σ BFPP1 (b)	354
σ EMD1 (b)	200
σ EMD2 (b)	35

Secondary beams - power

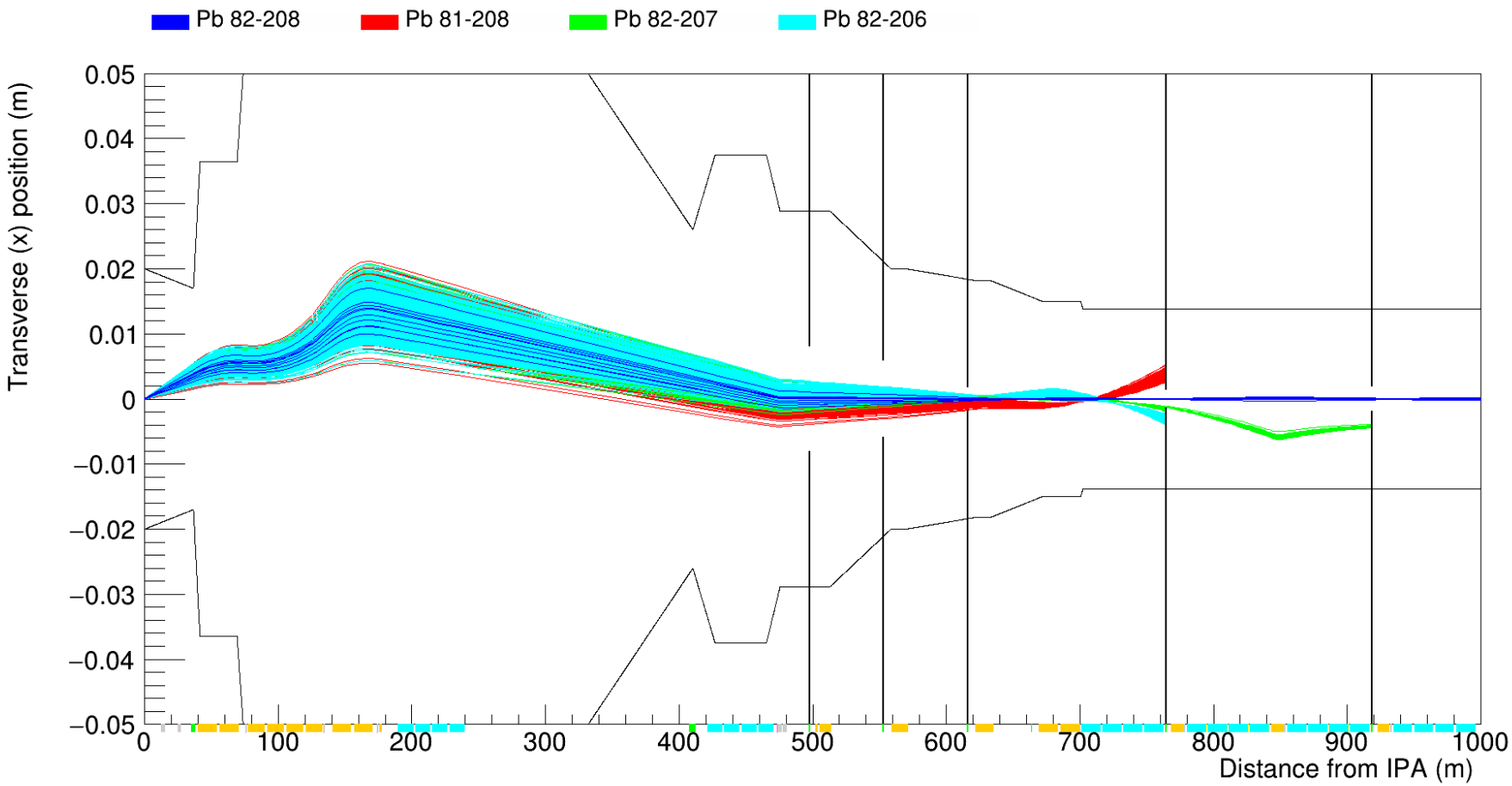
Reaction	Power (kW)
BFPP1	56.0
EMD1	39.4
EMD2	6.9

- Remember the quench limit for magnets is $\approx mW/cm^3$!
- The cross sections for each reaction are not exact, and therefore different studies can use different parameters giving different power loads.
- Other reactions exist e.g. BFPP2, EMD3, etc, but their cross sections are smaller and have not currently been considered.

Bunch configuration

Parameter	Value
Energy (TeV)	50.0 Z
Emittance ($\mu mrad$)	$2.2 \times 10^{-6}/\sqrt{2} = 1.56 \times 10^{-6}$
Transverse profile	Gaussian: $0 \longrightarrow 7.57\sigma$
Longitudinal profile	Gaussian: $0 \longrightarrow 3\sigma$

- Emittance smaller by $\sqrt{2}$ to simulate the luminous region.
- Bunch generated up to the primary collimator jaw gap as a cut.
- For BFPP, an energy offset was used to simulate the charge difference (at the time of running this was not natively supported in the coupling).
- For EMD, the energy contained in the lost neutrons were removed from the beam energy $\left(\frac{A}{208} * 50.0\right)$.


Pb 82-208
Pb 81-208
Pb 82-207
Pb 82-206
Transverse (x) position (m)
0.05
0.04
0.03
0.02
0.01
0
−0.01
−0.02
−0.03
−0.04
−0.05
0
100
200
300
400
500
600
700
800
900
1000
Distance from IPA (m)

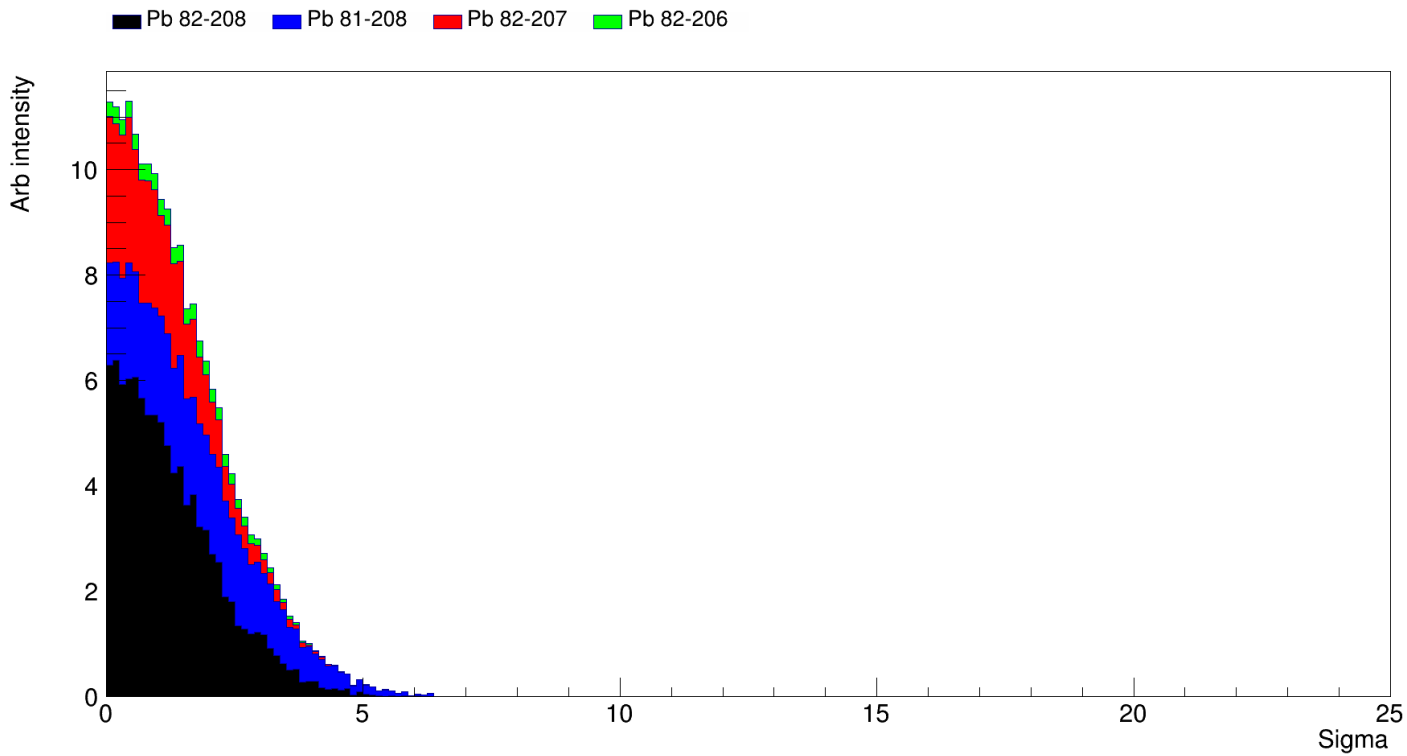
Results

- Collimator touches were dumped.
- This required some FLUKA coupling modifications.
- Output was sent to the FLUKA team.
- See next talk for energy flow.

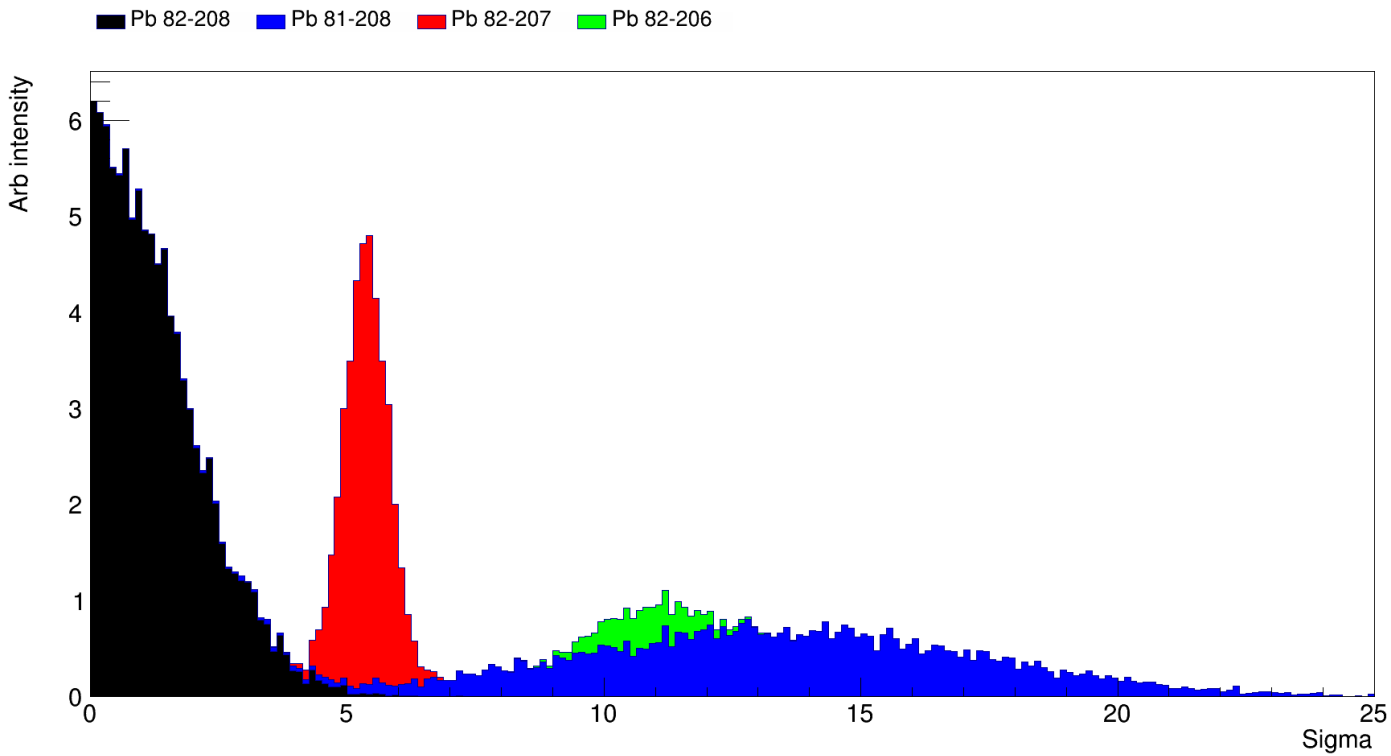
Mitigation options

- Current layout will not survive.
- Add extra collimators in the matching section - tested: neutrals scatter off the jaw face and impact the DS magnets. Gap sizes will be very small. Chose name TCI for ion collimators. Select secondary collimator gap size to start.
- Change the matching section optics to increase the beams separation.
- More exotic options?

TCI.4RA.H1 (after Q4)



TCI.6RA.H1 (after Q6)



Next steps

- Still no solution found.
- Next steps:
- Open jaw gaps
- Increase jaw lengths
- Modify optics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