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Topical discussion session material

Spent beam extraction - magnets and target

IMCC Annual meeting, DESY, Hamburg 13th May 2025

Material from past presentations (D. Calzolari, J. Manczak, C. Rogers) and from today's slides by J. Manczak

What does the 'spent beam' consist of?

- With a 1.8λ target, e^{-1.8}=16.5% of the protons do not interact (<u>D. Calzolari, 2023 IMCC</u>). For a 4MW proton beam, this alone is 640 kW!
- But the collision secondaries are also there...
- We can break down the particles entering the chicane into 3 groups:
 - Low-energy (below ~2 GeV)
 - Intermediate energy (2-8 GeV)
 - High energy (> 8 GeV)
- These particles behave differently under the solenoidal field in the tapering and chicane

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Momentum distribution of particles arriving at the end of the 24M taper



In total, ~1.16 MW of power (for a 4 MW beam) enters the chicane after a 24m tapering (J. Manczak)

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Chicane options after the tapering (J. Manczak)





Bending	Opening
radius	Angle
22.917 m	12.5



Bending	Opening
radius	Angle
22 m	15

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Chicane options after the tapering (J. Manczak) - 1



Increased aperture and shielding, with shift

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Bending
radiusOpening
Angle21 m18

Shielding idea (J. Manczak)



The cylindrical shielding of the tapering continues into the chicane, where it splits into two:

One continues straight towards the aperture

The second follows the curvature of the chicane

Allows the high-energy particles to exit without depositing their power in the chicane

Protects the coils from lower-energy particles, minimizing the impact on the yield

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Yield and radiation load comparison

J. Manczak

Configuration	µ⁺/proton	µ⁻/proton	π+/proton	π ⁻ /proton	Max abs dose [MGy/year]	Peak DPA/year
END TAPERING / REFERECE	0.22	0.19	0.053	0.045		
MAP Chicane	0.22	0.19	0.026	0.021	-	
Small extraction, small shielding, no shift	0.21	0.18	0.022	0.019	~1000	
IncApt, no shift SHIELDED	0.20	0.17	0.018	0.016	~100	0.0035
IncApt, no shift NOT SHIELDED	0.21	0.18	0.019	0.016	~4000	0.025
IncApt, x shift SHIELDED	0.17	0.14	0.013	0.011	~80	
IncApt, x shift NOT SHIELDED	0.17	0.14	0.013	0.011	-	

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Alternative idea: extracting the spent beam 'early'





Recently revisited by <u>C. Rogers</u>, finding an ideal tilt of around 10 degrees





Also examined in the past by D. Calzolari (2023 IMCC)

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