Collimation cleaning performance with the latest materials

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Thanks to R. Bruce, S. Redaelli

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Introduction

- Previous studies assumed 18 out of 22 IR7 TCS in Mo-coated MoGr and IR1 / IR5 TCTs in CuCD
  - 8 TCS in MoGr installed in LS2
- Recent decisions:
  - Remaining TCS to be Cu-coated Gr
  - All TCTs in Inermet180

- Graphite lower density than MoGr (1.83 vs 2.54 g/cm^3)
  - → more leakage!
- Inermet180 higher density than CuCD (18.0 vs 5.4 g/cm^3)
  - → more energy deposition!

- Collimation performance must be reevaluated:
  - IR7 leakage
  - TCT losses and power deposition
  - Experiment background

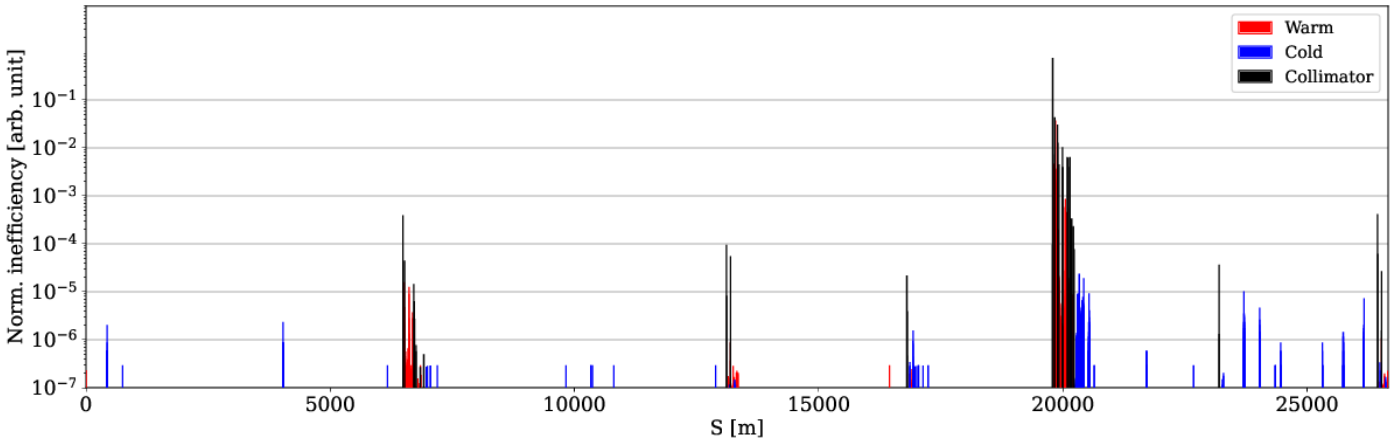
Collimator Settings ($\epsilon_n = 2.5\mu m \cdot rad$)

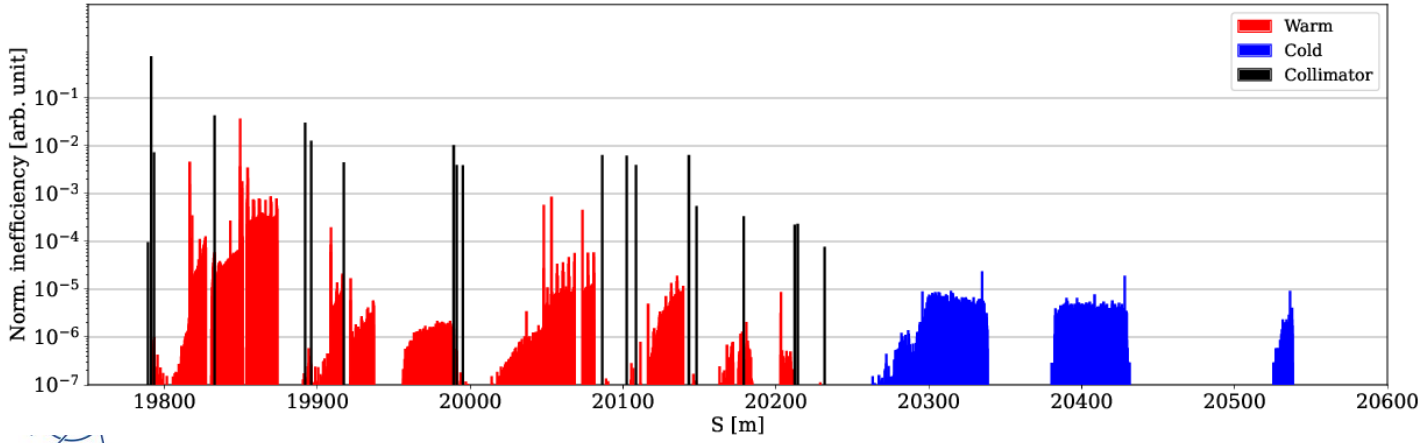
	TDR Baseline (tight settings)		Low impedance (Relaxed Settings)		
	15 cm β*	20 cm β*	15 cm β*	20 cm β*	100 cm β*
TCP IR7	**6.7**	**6.7**	**8.5**	8.5	8.5
TCS IR7	**9.1**	**9.1**	**10.1**	10.1	10.1
TCLA IR7	**12.7**	**12.7**	**14.0**	**13.7**	**13.7**
TCLD IR7	**16.6**	**16.6**	**n/a****	n/a**	n/a**
TCP IR3	17.7	17.7	17.7	17.7	17.7
TCS IR3	21.3	21.3	21.3	21.3	21.3
TCLA IR3	23.7	23.7	23.7	23.7	23.7
TCS IR6	**10.1**	**10.1**	**11.1**	11.1	11.1
TCDQ IR6	**10.1**	**10.1**	**11.1**	11.1	11.1
TCL IR1/5*	14.2	16.4	14.2	16.4	38 – 44
TCT IR1/5*	**10.4**	**12.0**	**11.4**	**13.2**	**23 – 35**
Prot. Aperture IR1/5	**11.8**	**13.4**	**12.8**	**14.6**	**>24.4**
TCT IR2	43.8	43.8	43.8	43.8	43.8
TCT IR8	17.7	17.7	17.7	17.7	17.7
TDIS	park	park	park	park	park
TCLD IR2	park	park	park	park	park

* gap in mm is set to final (15 cm) value and kept constant throughout squeeze
** n/a for runIV, status for runV to be confirmed

Simulations

- HLLHCV1.5 optics (15, 20, 64, 100 cm β* // tight and relaxed settings)
- Sixtrack-FLUKA
- Betatron loss maps (B1/B2, H/V)
- Asynchronous beam dumps (Single-module prefire – worst case)

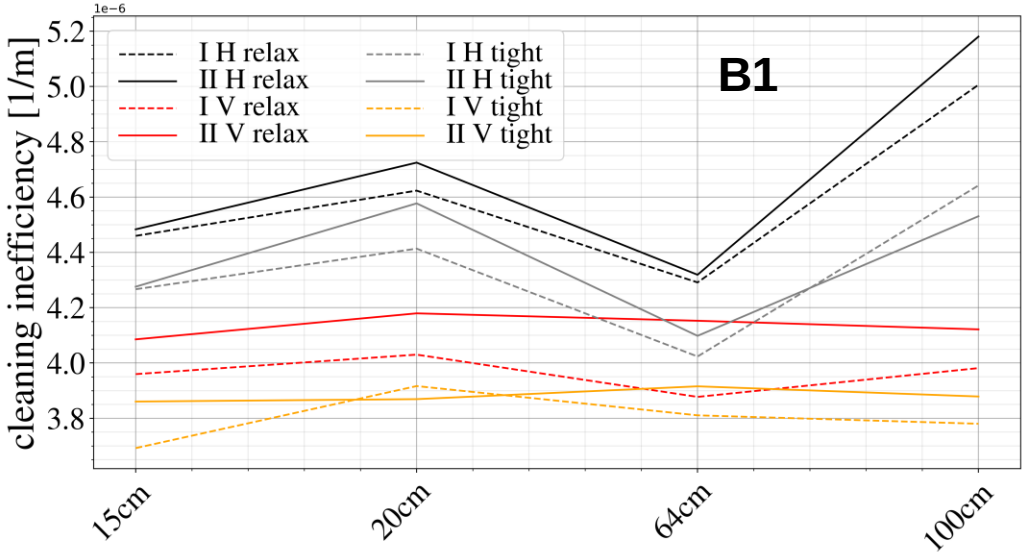


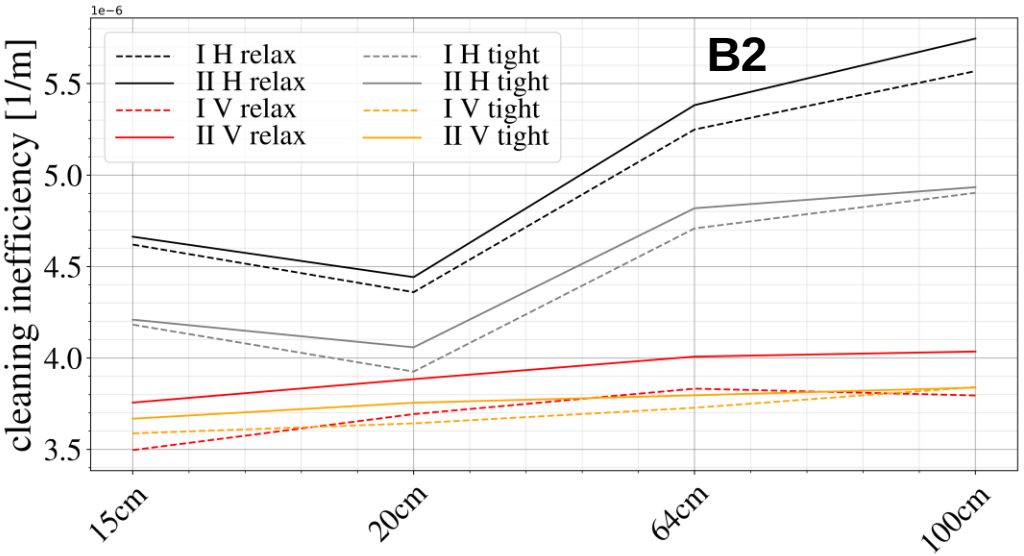


DS losses (first cluster avg.)

- New material leads to more leakage (up to ~7 %)
- Worsening due to relaxed settings similar
- DS losses generally worse at larger β* due larger TCT gaps
- 64 and 20 cm β* have different optics, notably in IR6, affecting multi-turn cleaning

- V. Rodin* is currently simulating power deposition for new materials, tight / relaxed settings

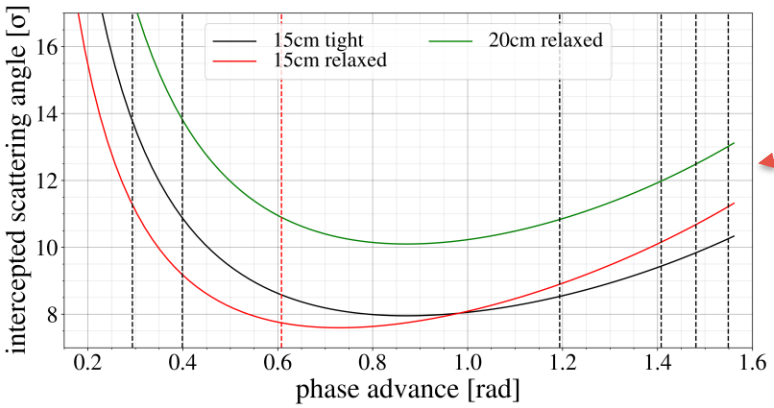


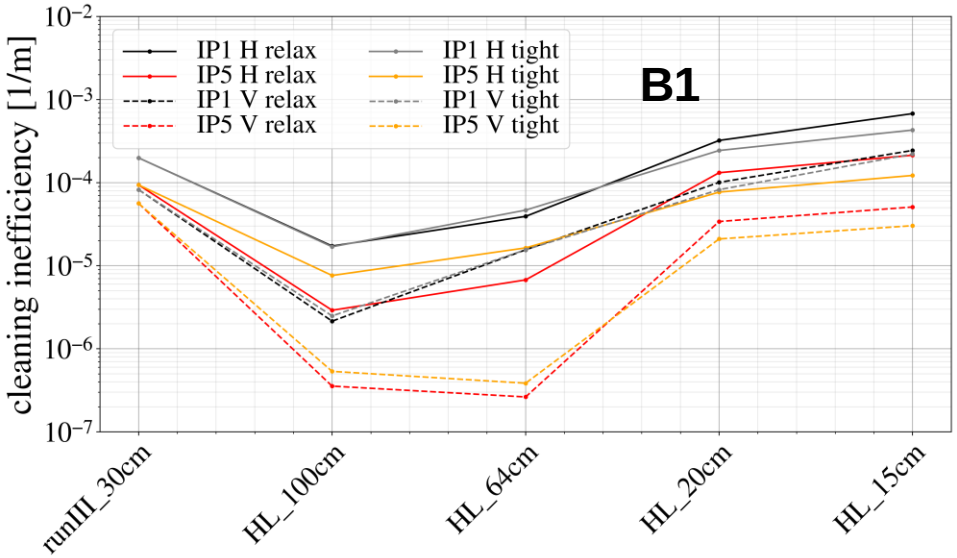


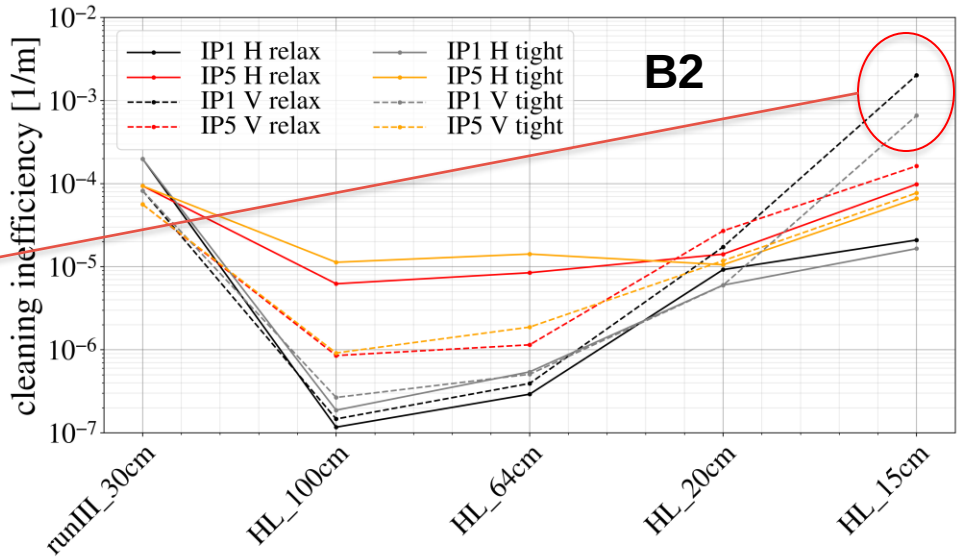
*see also: V. Rodin – Power deposition studies for betatron halo losses in HL-LHC, IPAC23

TCT losses

- Up to 75 % (B1) and 200 % (B2) worse with relaxed settings
  - B2V IP1 particularly bad due to phase advance(!)
- Up to 55 % worse with new materials
  - nb in B2V IP1, increase is ~15 %

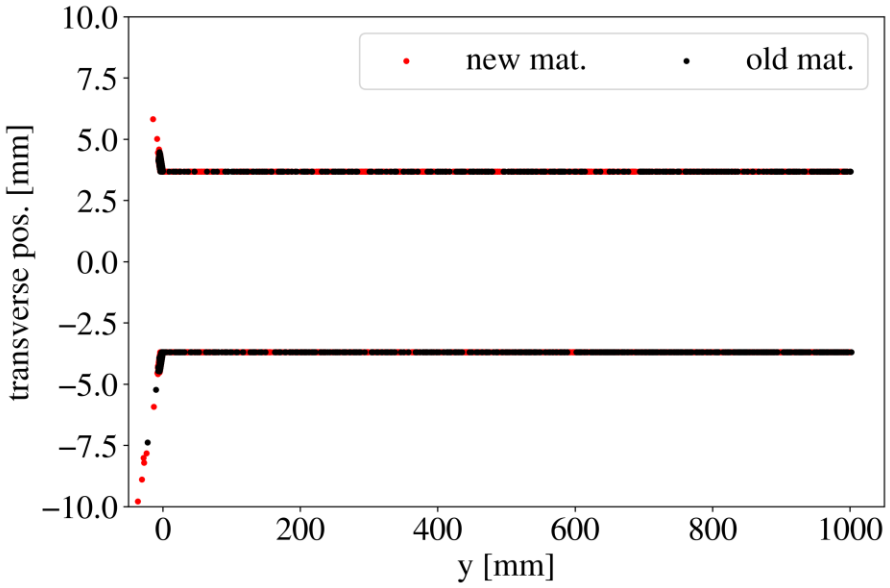


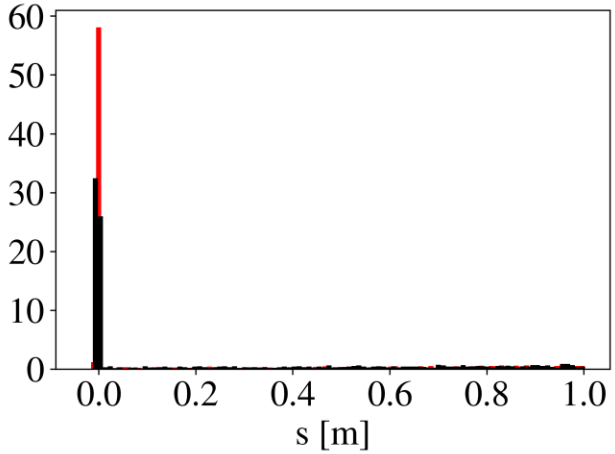


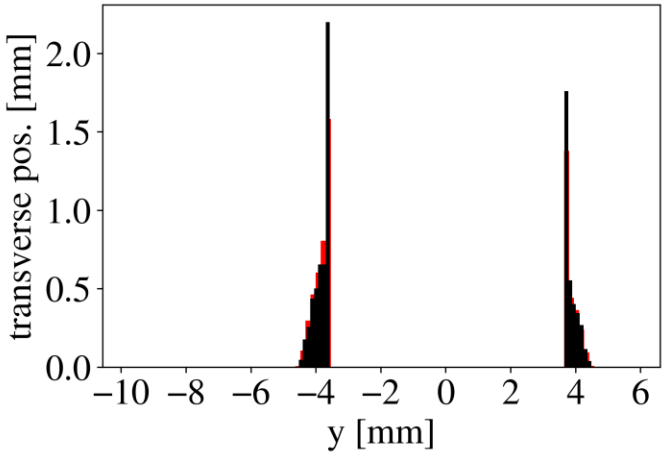


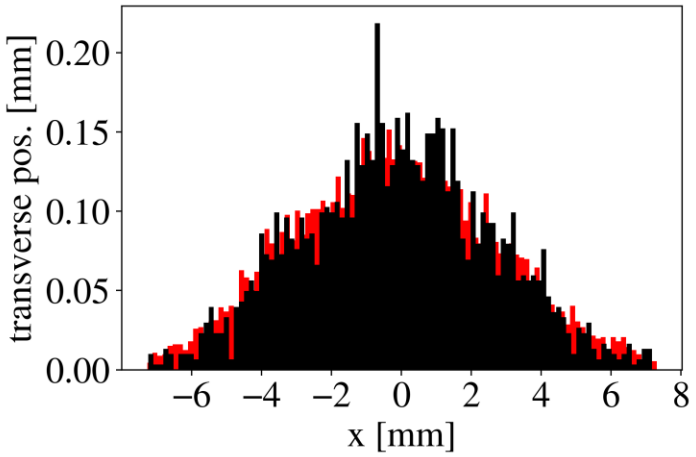
Impact distribution on TCT

- Energy deposition factor ~2 more on Inermet180 than CuCD (1.05 vs 0.45 W) – *assuming MoGr TCS**
- Cu-coated Gr TCS gives more leakage to TCT, but distribution of impacts similar
- Power deposition can be scaled up by total number of impacts
  – no need to redo FLUKA(?)





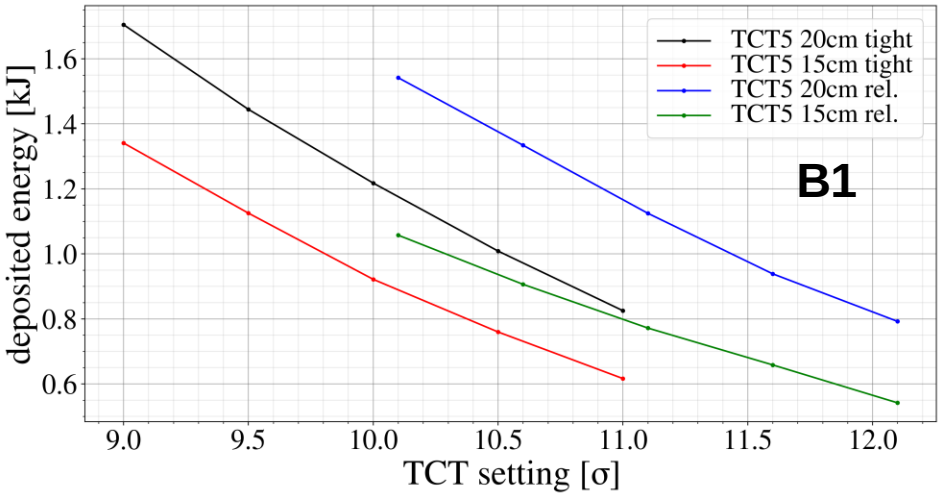


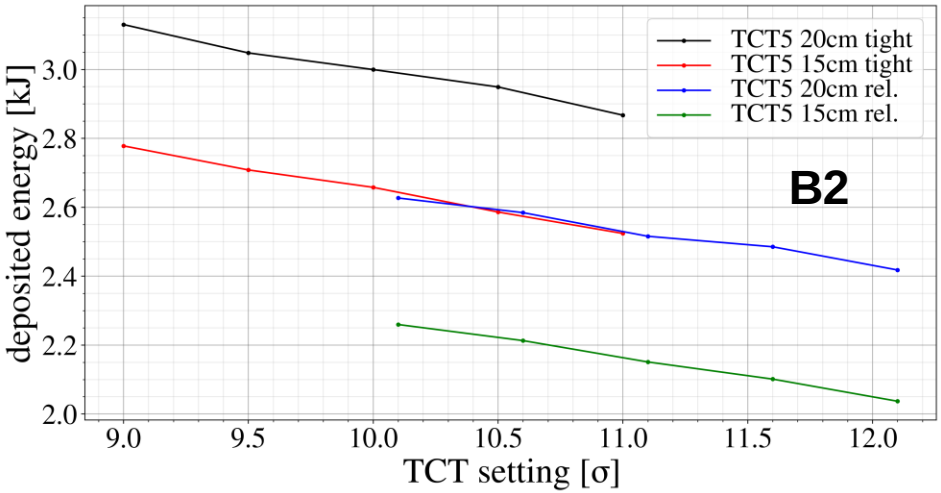


*M. Sabarte – LBS#114 https://indico.cern.ch/event/1195003

Asynchronous beam dump

- B1 factor ~2 better than B2 (B1 passes IR7)
- 20 cm worse than 15 cm
  - 20cm uses ”tcdq4” optics with 8 % larger MKD beta functions
  - Indicates that optimizations can be done w.r.t. TCT losses
- New material gives less than 6 % increase of TCT losses
- Plastic deformation limit ~7.8 kJ
  - Not breached even for tighter than intended TCT settings





Conclusions and Outlook

- Relaxed settings:
  - Up to 75 % / 200 % worse TCT losses (B1 / B2)
  - Up to 7 % worse DS losses
- Cu-Gr + Inermet180 vs MoGr + CuCD:
  - Up to 55 % worse TCT losses
  - Up to 7 % worse DS losses
  - Up to 6 % worse TCT losses in asynch dumps

- Increased DS losses likely not a concern:
  - IR7 power deposition simulations with new materials ongoing
- TCT impact distributions with new materials similar – no FLUKA needed?
- B2V TCT losses need to be mitigated (phase advance)