



Consequences of asynchronous beam dump on TCTs 4 & 6 of IR5

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Outline

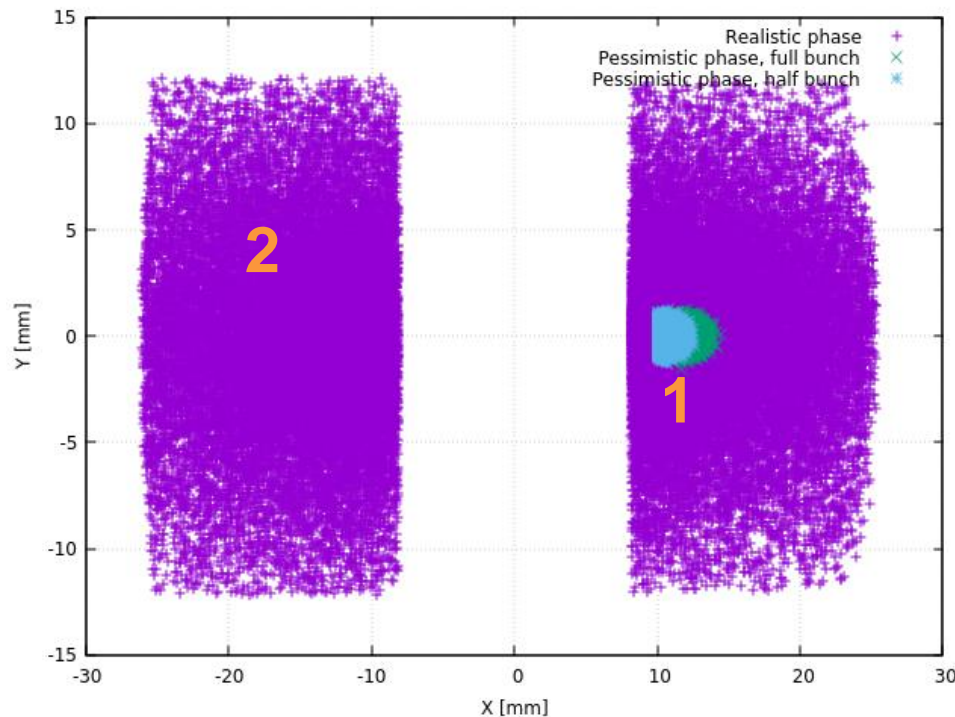
- Introduction
- Impact on TCTH4 *
- Impact on TCTH6 **
- Leakage to the experiment
- Summary

* **6th HiLumi Annual Meeting (Paris)**
<https://indico.cern.ch/event/549979/contributions/2295233/>

** **CoIUSM #89**
<https://indico.cern.ch/event/646799/>

Introduction

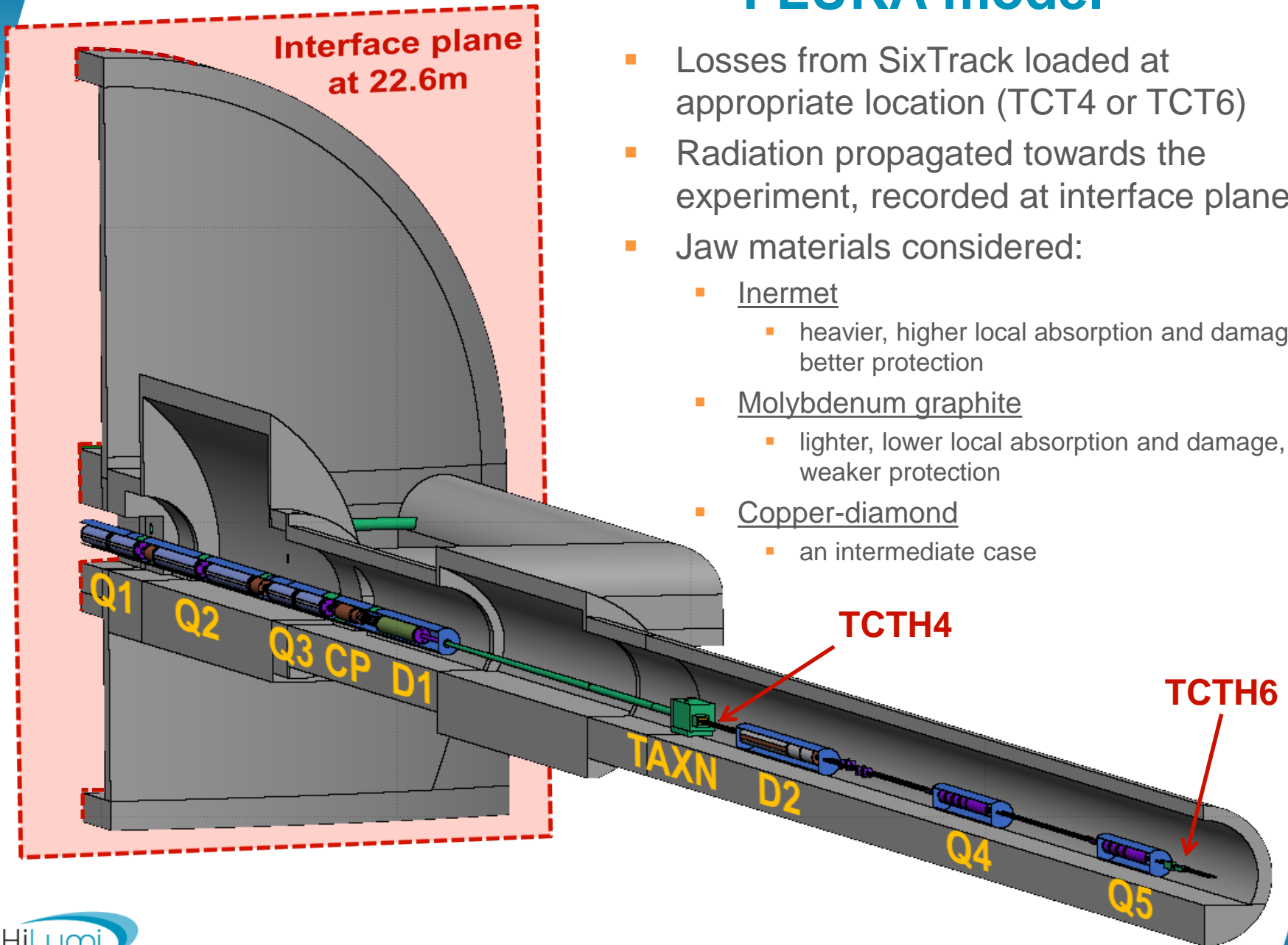
- Goal: evaluation of impact from asynchronous beam dump on TCTH4 or TCTH6 (IR5) on:
 - The triplet and matching section magnets and beam screen
 - The experiment
- Different scenarios studied (*as shown in previous talk by R. Bruce*)
 1. “Pessimistic” case: single (half or full) bunch impact on one jaw
 2. “Realistic” case: fractions of several bunches impact on both jaws *



* Only 10^{10} protons impacting in total

FLUKA model

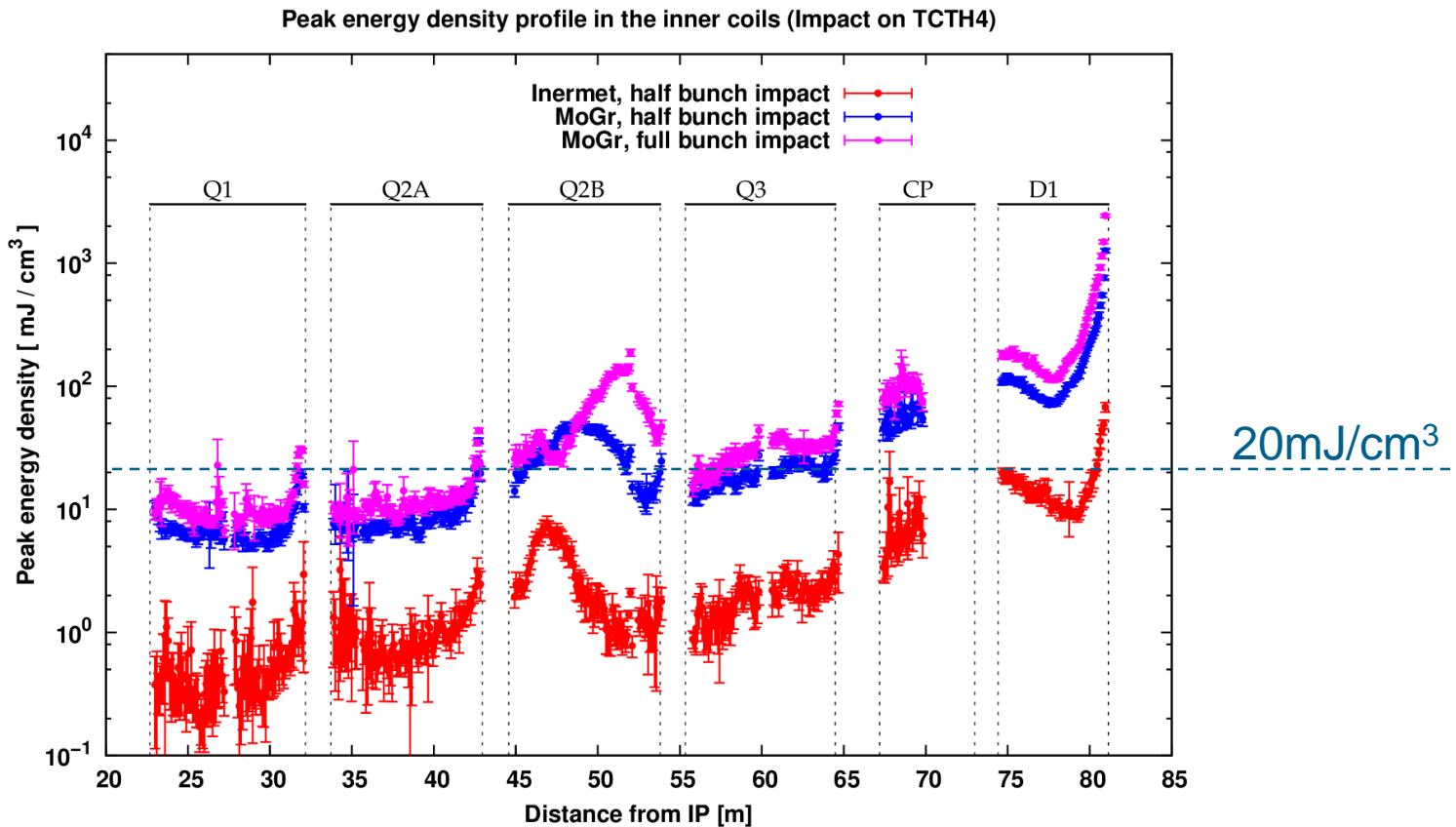
- Losses from SixTrack loaded at appropriate location (TCT4 or TCT6)
- Radiation propagated towards the experiment, recorded at interface plane
- Jaw materials considered:
 - Inermet
 - heavier, higher local absorption and damage, better protection
 - Molybdenum graphite
 - lighter, lower local absorption and damage, weaker protection
 - Copper-diamond
 - an intermediate case





Impact on TCT4

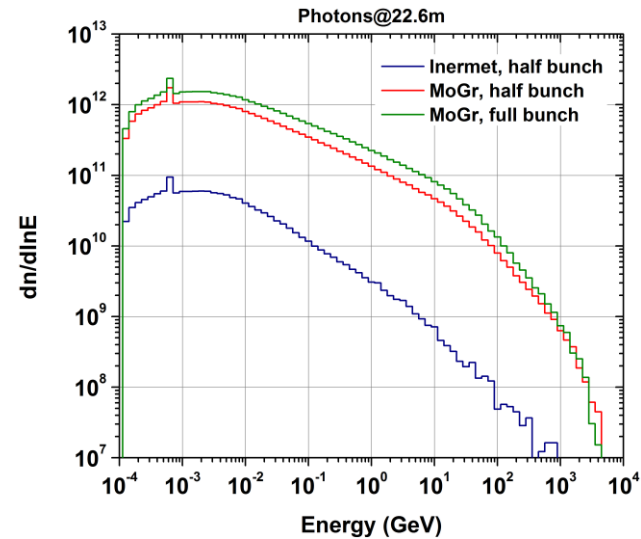
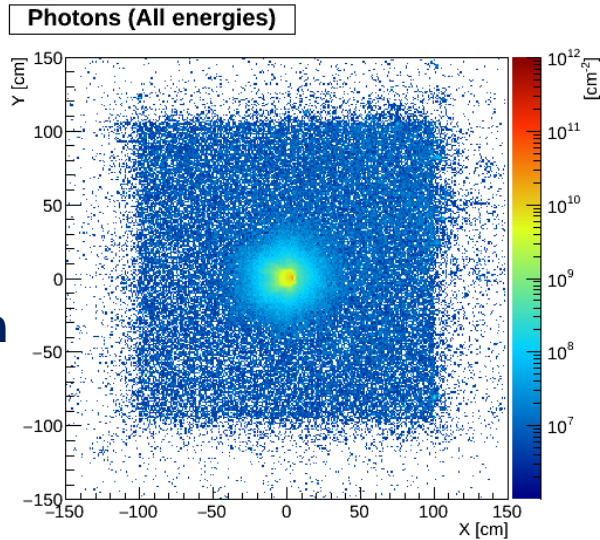
Triplet - D1 exposure (“pessimistic” case)



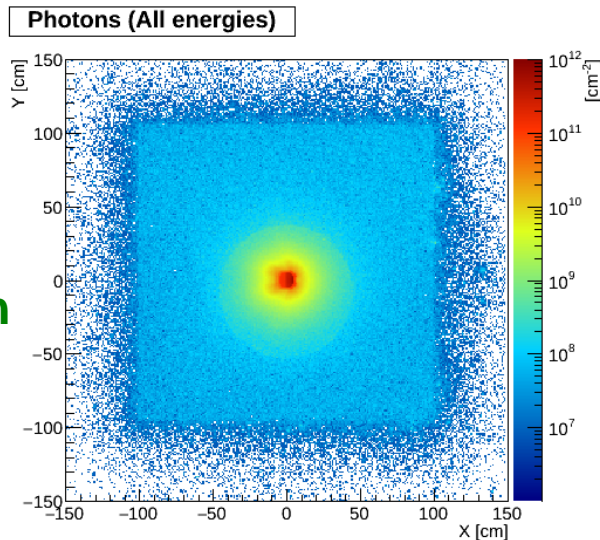
- All values well below **damage limit (>1 kJ/cm³)** (D. Wollman talk on Tue PM)
- Values higher by at least a factor of 10 with MoGr TCT4
- (Only D1 would quench with Inermet TCT4)

Leakage to experiment: Photons (transport threshold = 100keV)

**Inermet,
half bunch**



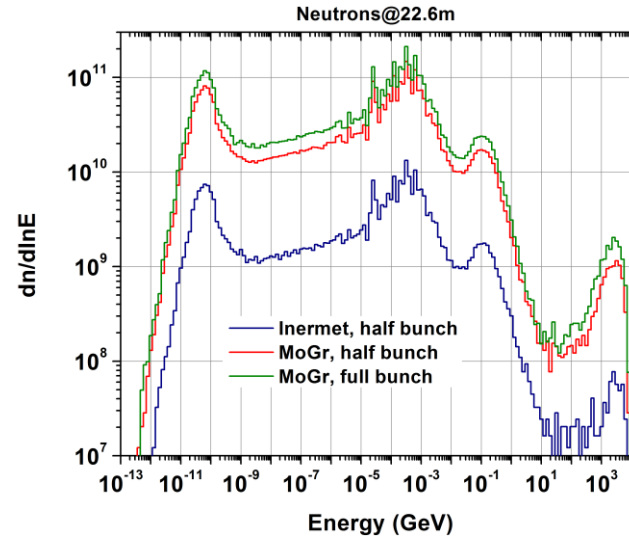
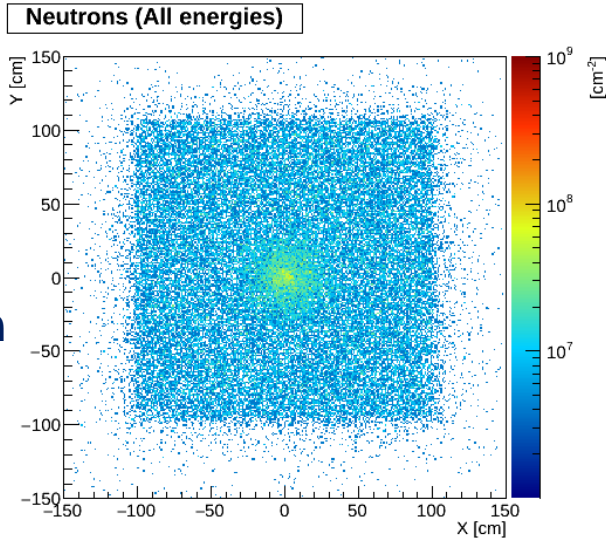
**MoGr,
full bunch**



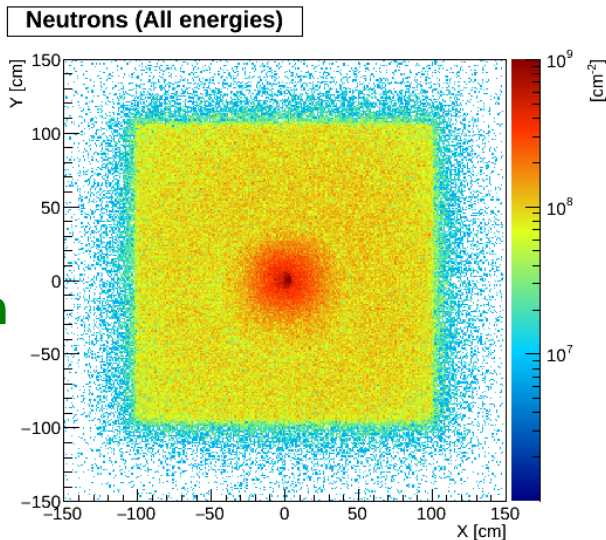
- One order of magnitude increase with MoGr with respect to Inermet

Leakage to experiment: Neutrons

**Inermet,
half bunch**



**MoGr,
full bunch**



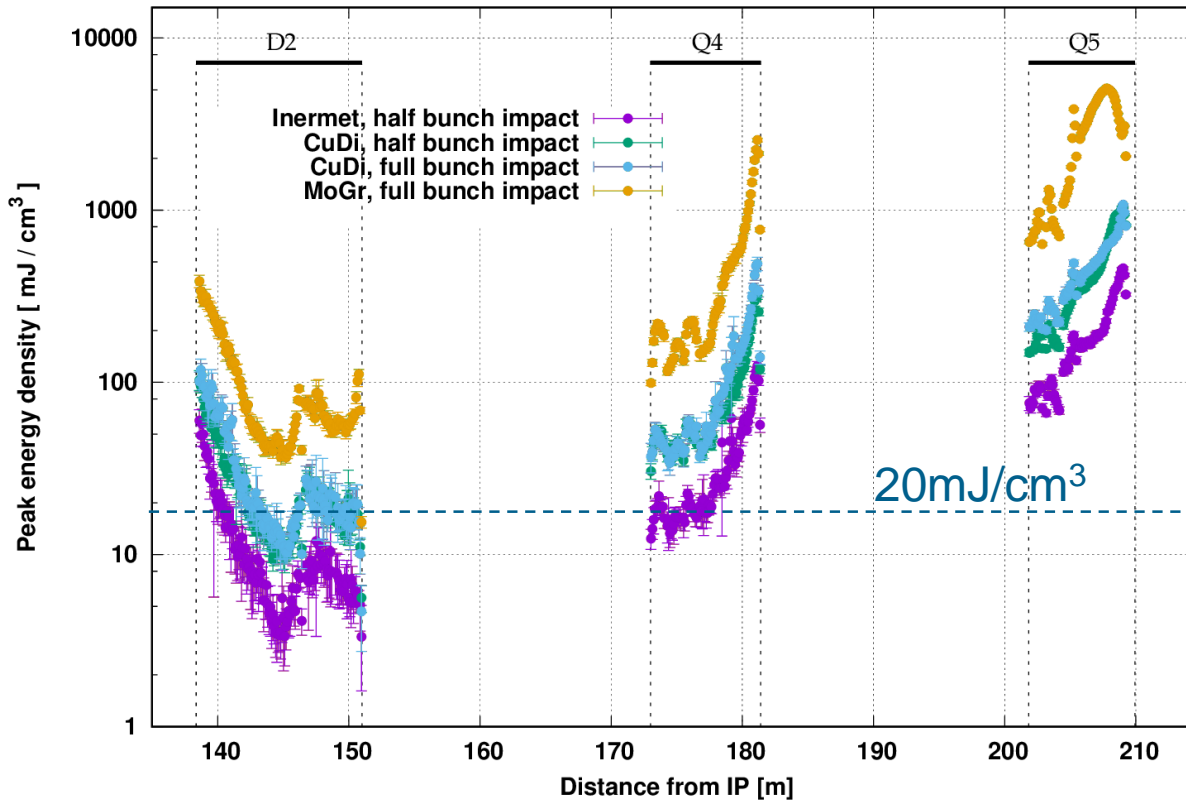
- One order of magnitude increase with MoGr with respect to Inermet



Impact on TCT6

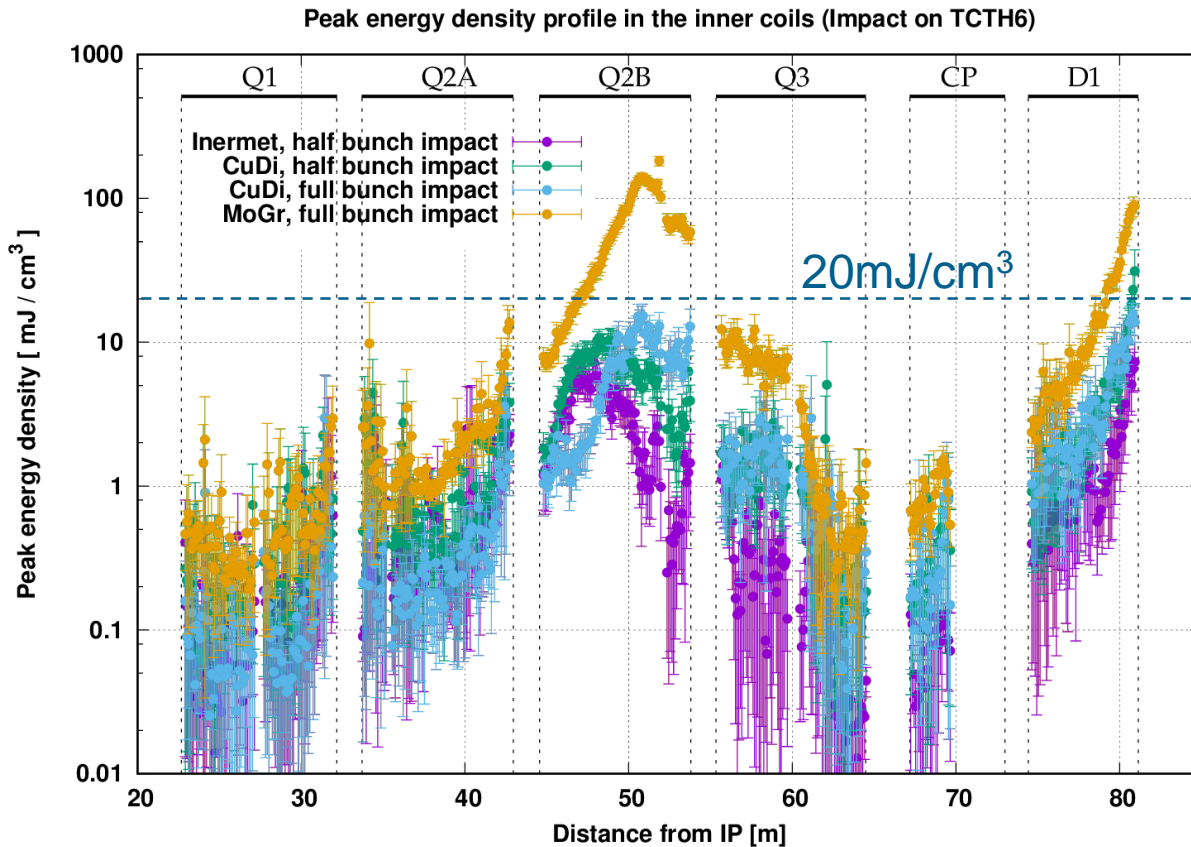
D2 - Q5 exposure (“pessimistic” case)

Peak energy density profile in the inner coils (Impact on TCTH6)



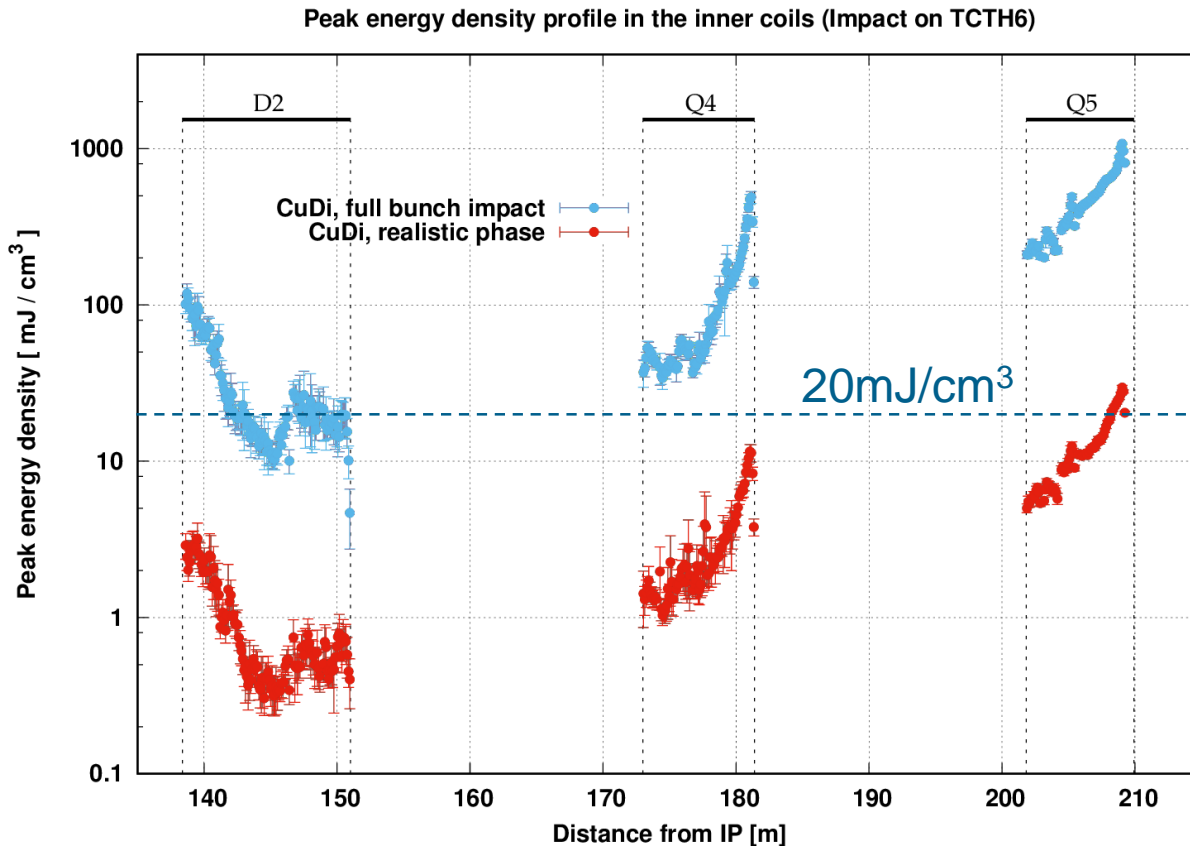
- Max value approaching 10 J/cm³ (MoGr), still far from expected damage limit
- Strong dependence on jaw material choice
- <20 J/cm³ in Q5 beam screen (for MoGr full bunch – worst case)
- The damage limit cannot be approached even with the envisaged Q5 aperture reduction to 56mm

Triplet - D1 exposure (“pessimistic” case)



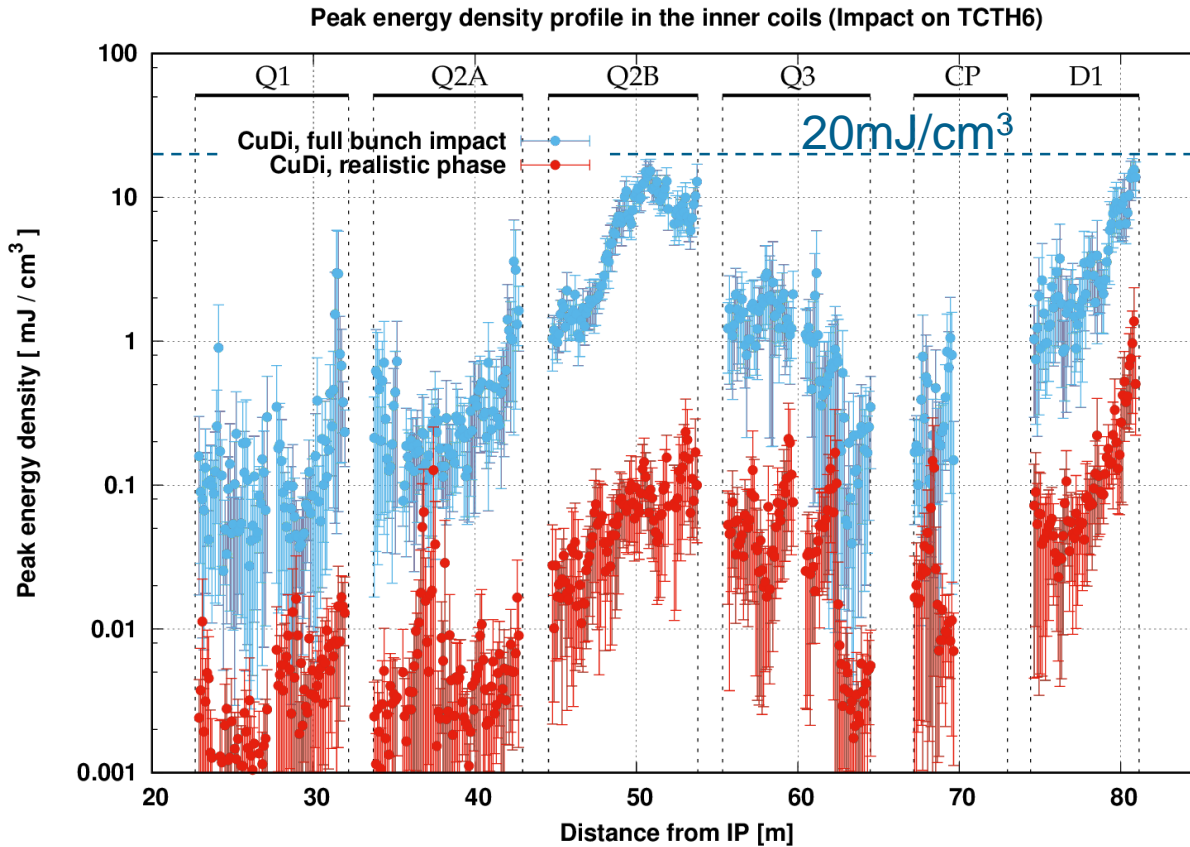
- Values drop in the triplet-D1 region, but quenches are not excluded

D2 - Q5 exposure: comparison of the two cases



- Peak energy density values are about 20-30 times lower in the realistic case compared with the pessimistic case, mainly scaling with the impacting population

Triplet - D1 exposure: comparison of the two cases



- Values below $\sim 1 \text{ mJ/cm}^3$ in the realistic case

Leakage to the experiment: particle population

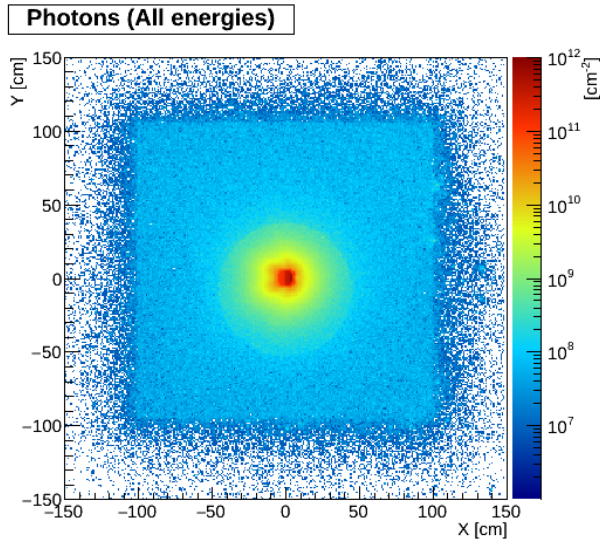
Full bunch impact on MoGr jaw

- Particles crossing the scoring plane at 22.6m
 - Impact on TCT4:
 - 85% photons
 - 10% neutrons
 - 0.1% protons
 - Impact on TCT6:
 - 92% photons
 - 2% neutrons
 - 0.1% protons
- Total population one order of magnitude lower for the TCT6 impact (4.8×10^{13} vs 3.2×10^{12})

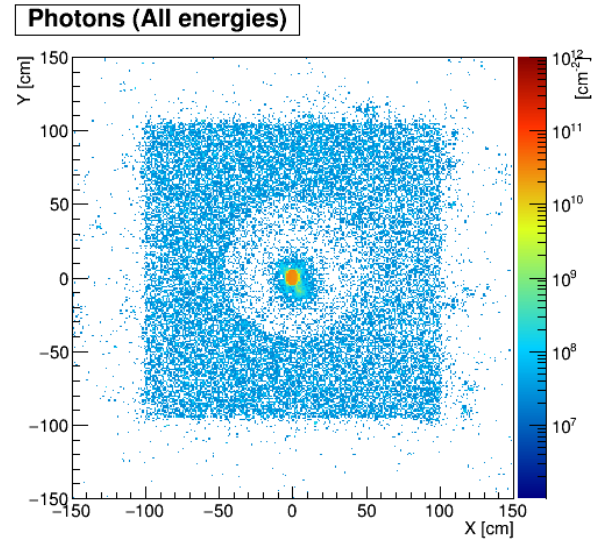
Photons

(transport threshold = 100keV)

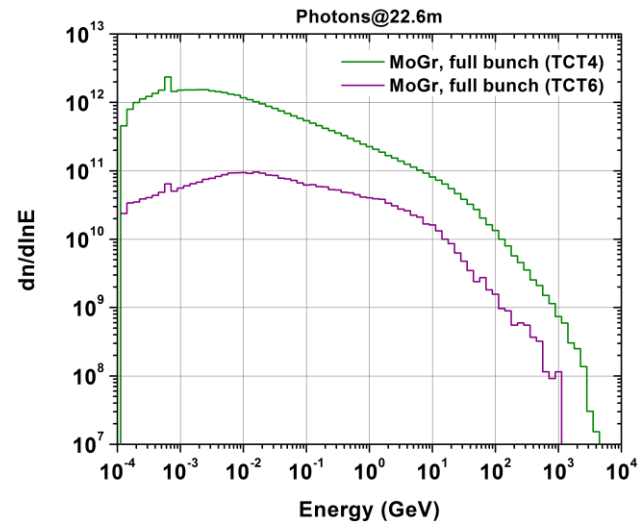
MoGr, full bunch on TCT4



MoGr, full bunch on TCT6



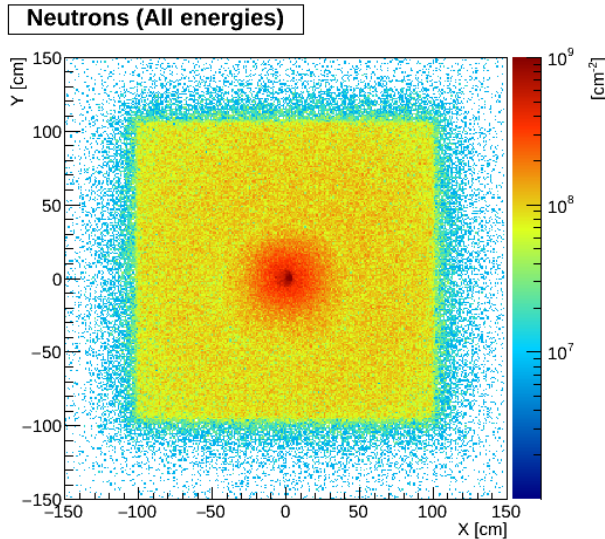
- About one order of magnitude decrease when impacting on TCT6



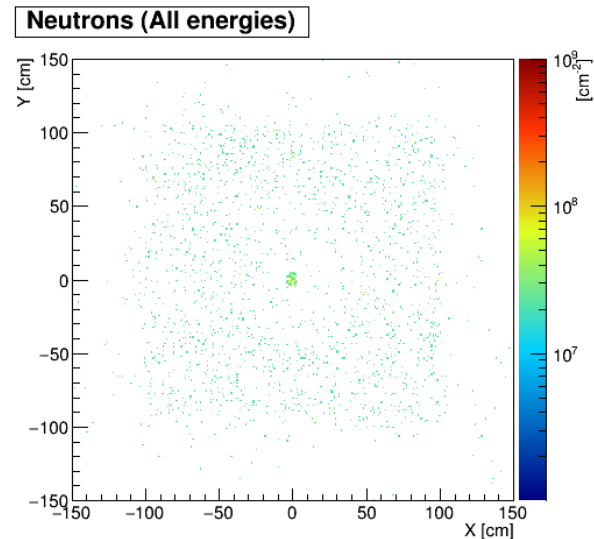
Neutrons

(no transport threshold)

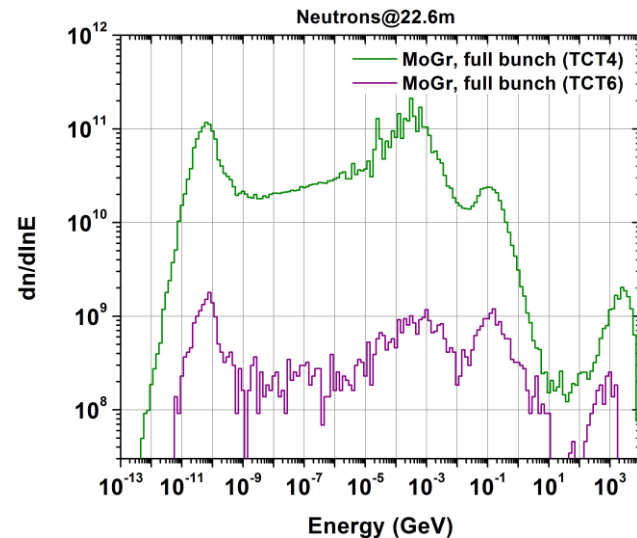
MoGr, full bunch on TCT4



MoGr, full bunch on TCT6



- Decrease up to two orders of magnitude when impacting on TCT6



Summary

- The present baseline, featuring TCT pairs both in cell 4 and 6, is shown to stay safely below the material damage threshold (over the Q1-Q5 region) in case of an asynchronous beam dump, for all TCT jaw material options.
- Still, the **choice of jaw material** naturally leads to significant variations in terms of protection effectiveness on one side and collimator robustness on the other.
- **Quench** occurrence is not considered here as a relevant criterion (TCTs are not designed to prevent quenches in case of failures).
- The **realistic scenario** (with fractions of several bunches scattered on the TCT) further improves the picture.
- The **leakage to the experiment** from an impact on TCT6 is clearly reduced by the distant origin compared with an impact on TCT4.

