Expected Dose Rates around the Collimators

What to Prepare for the upcoming LTC Meeting?

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To Clarify

- What would you like to present at the LTC
  - Locations, Plots, Values, etc…
  - Materials, Comparison?
  - Detailed Geometries
- Time Constraints
  - Stefan and Markus will not be around in June, hence everything has to be prepared until the end of this month (Stefan already leaves in one week!)
- Studies already performed
- New studies necessary?
- Anything Else? Suggestions?

Dose Rates (simplified case)

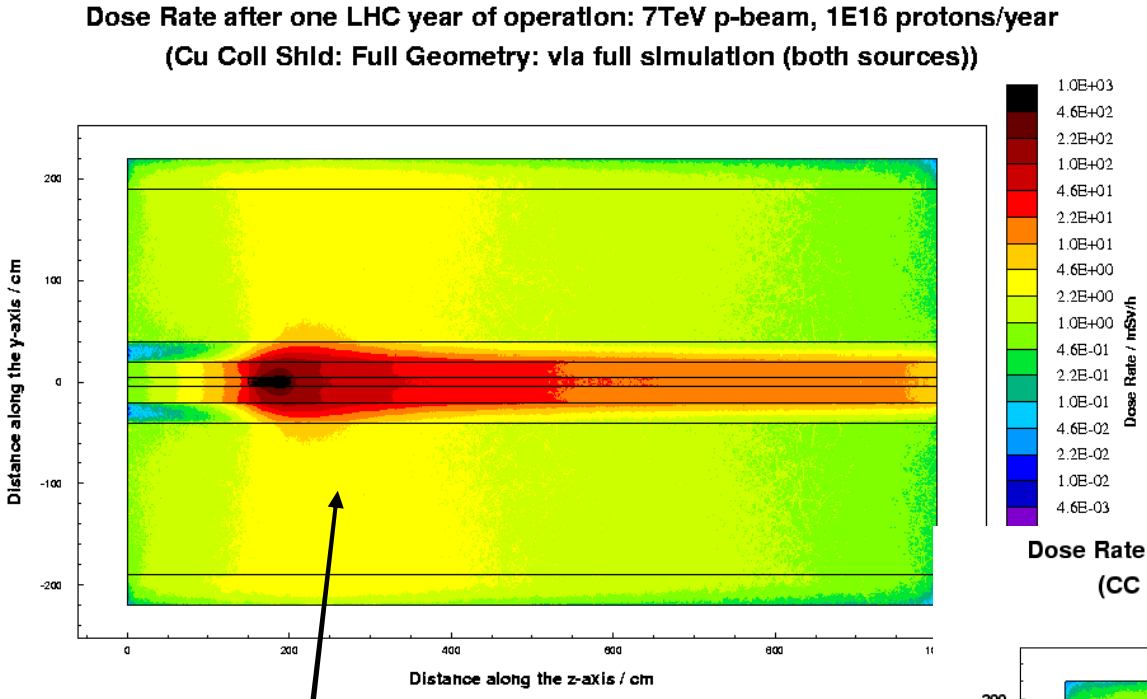
- Geometry: 10m long tunnel section including (cylindrical approximation)
  - collimator (cylinder) with 7TeV pencil proton beam hitting the center of the front face
  - beam pipe downstream of collimator, copper, 2mm thick,
  - 80 mm inner diameter
  - iron shield, cylindrical shell, 20cm thick (optional)
  - tunnel wall/floor/ceiling, cylindrical shell, 30cm thick
- collimator material length (cm) diameter (cm)

CC	126	6
Be	135	6
Cu	50	6

- Loss assumption: 10^{16} protons/year, 180 days of continuous operation
- 1 hour, 1 day, 1 week, 1 month, 1 year of cooling
- Results: ambient dose equivalent rates anywhere within the 10m long tunnel section for each collimator material and two scenarios: with iron shield, w/o iron shield

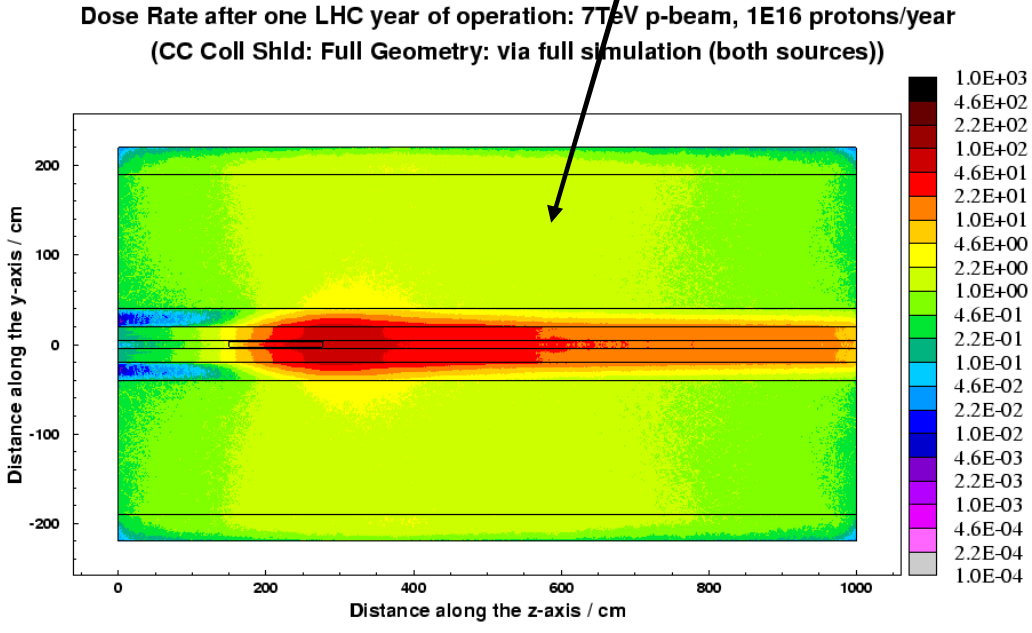
e.g. Copper - Carbon

10^{16} protons/year,
180 days irradiation
1 day of cooling

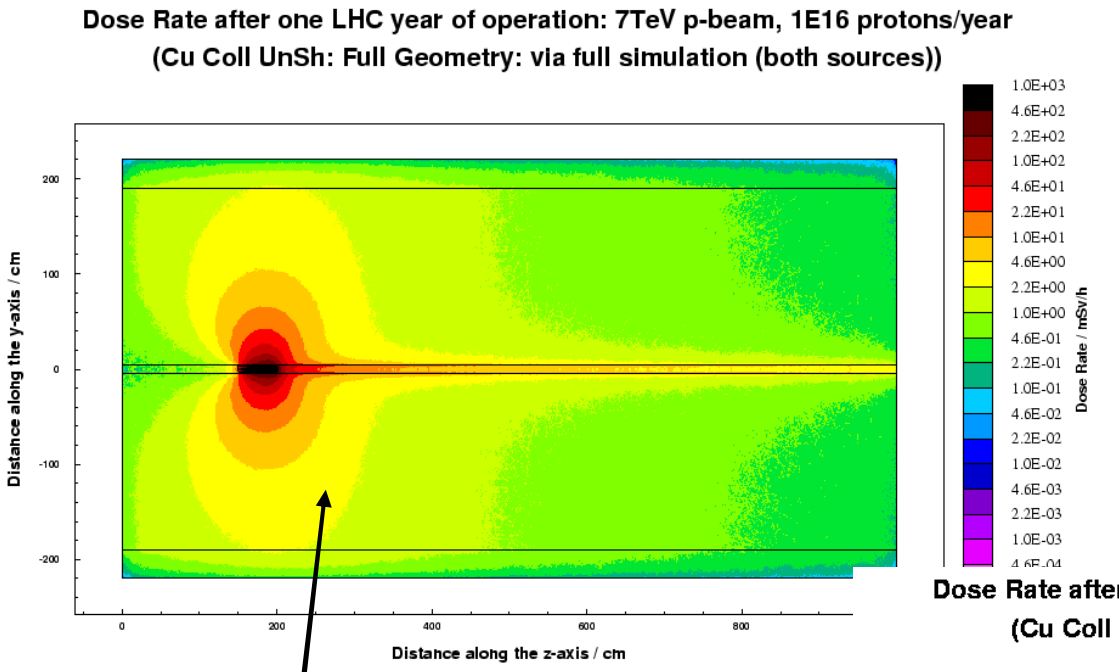


Aisle: 2.2 – 4.5 mSv/h
Shield Outside Peak: ~20 mSv/h
Shield Inside Peak: ~200 mSv/h
Collimator Peak: > 460 mSv/h

Aisle: 1.0 – 2.2 mSv/h
Shield Outside Peak: ~5 mSv/h
Shield Inside Peak: ~50 mSv/h
Collimator Peak: ~ 100 mSv/h



Copper: Shielded - Unshielded



10^{16} protons/year,
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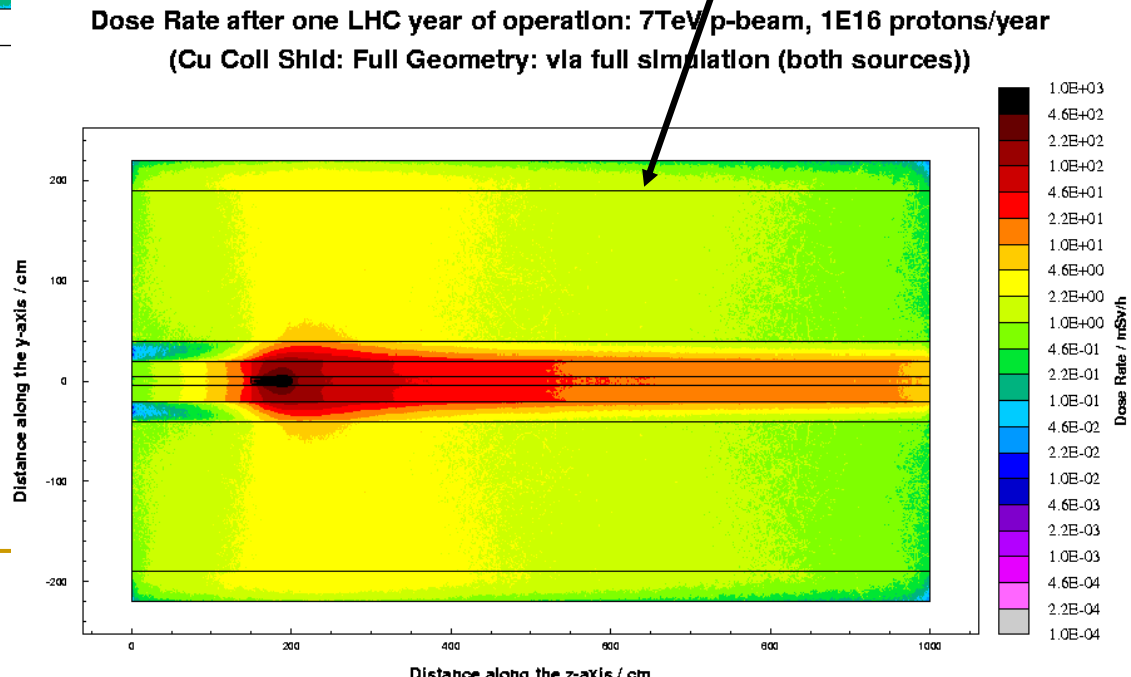
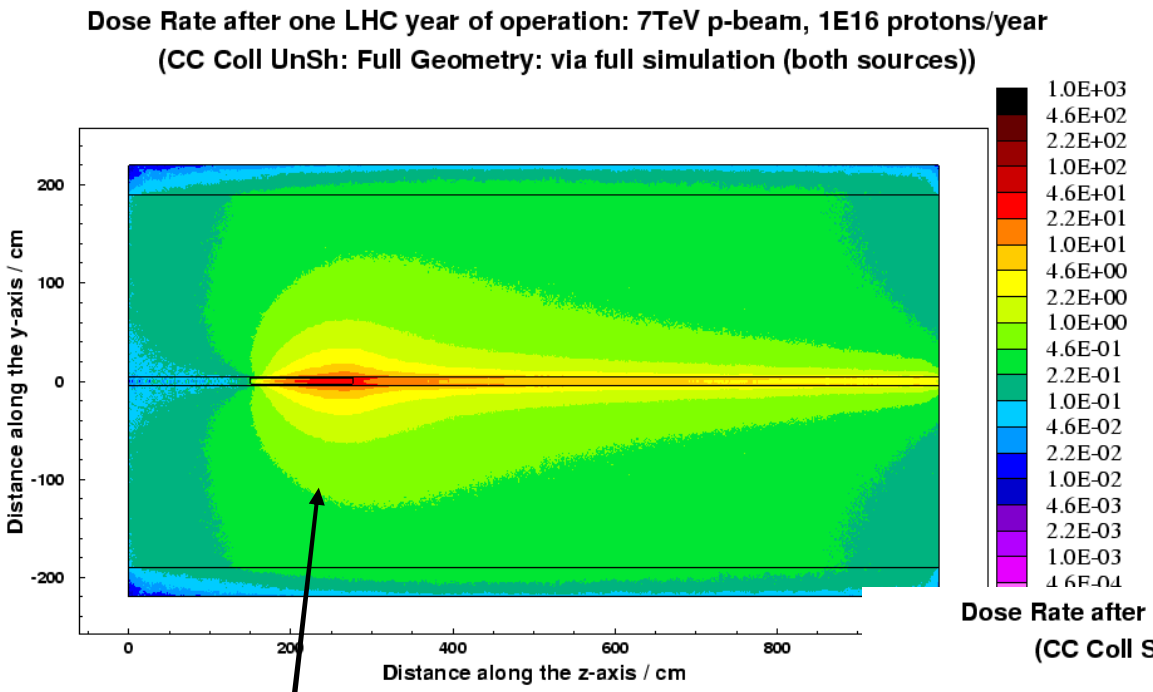
1 day of cooling

Aisle: 2.2 – 4.5 mSv/h
Shield Outside Peak: ~20 mSv/h
Shield Inside Peak: ~200 mSv/h
Collimator Peak: > 460 mSv/h

Aisle Peak: 2.2 – ~50 mSv/h
Collimator Peak: > 460 mSv/h



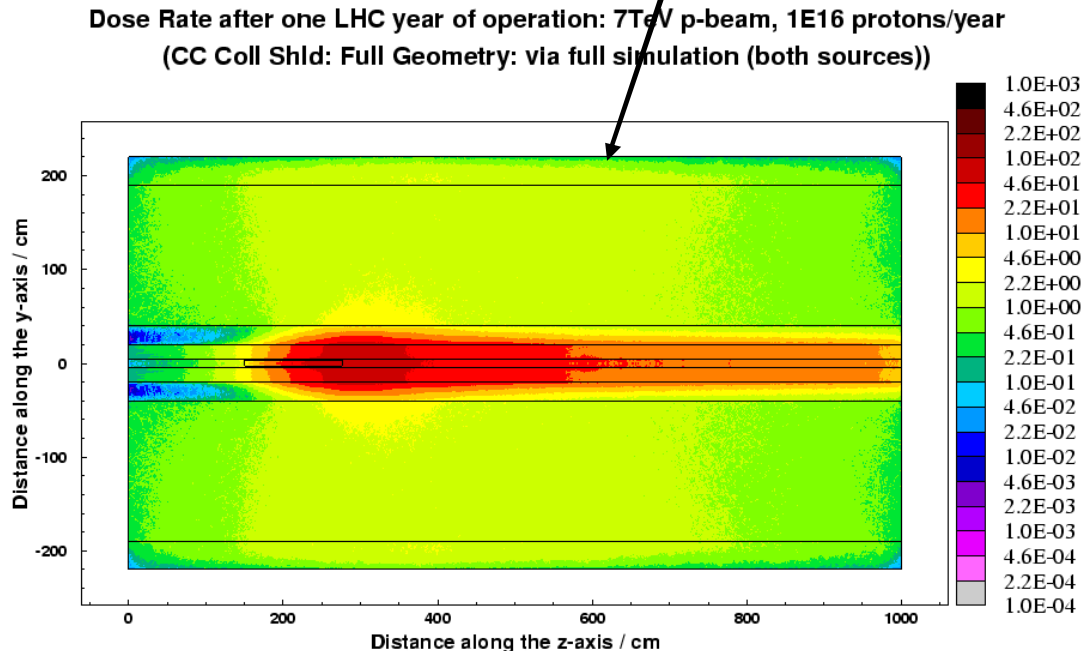
Carbon: Shielded - Unshielded



10^{16} protons/year,
180 days irradiation
1 day of cooling

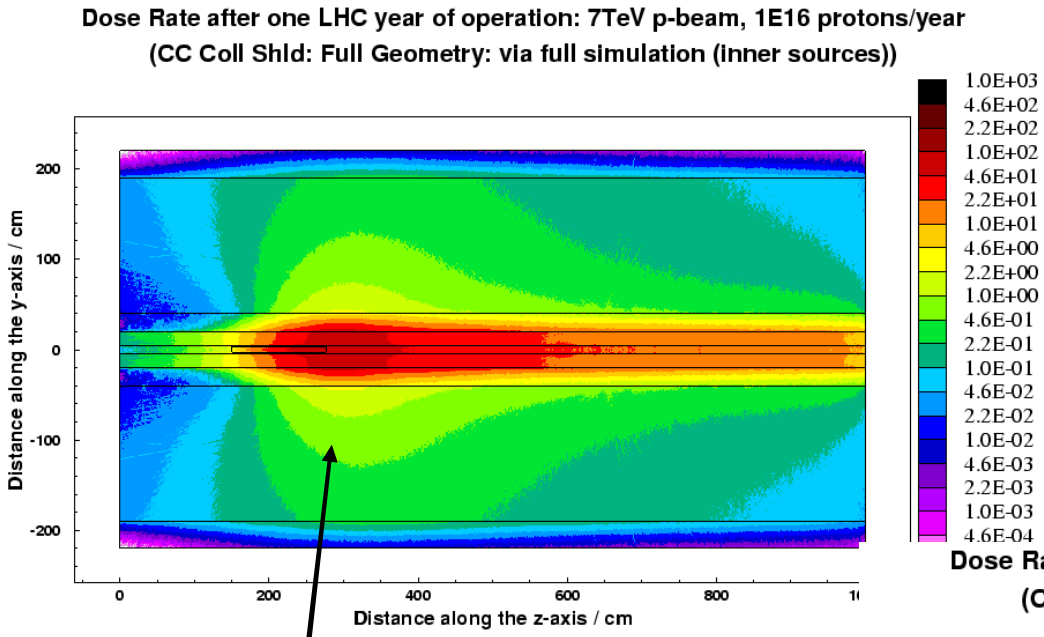
Aisle: 1.0 – 2.2 mSv/h
Shield Outside Peak: ~5 mSv/h
Shield Inside Peak: ~50 mSv/h
Collimator Peak: ~ 100 mSv/h

Aisle: 0.22 – 2.2 mSv/h
Collimator Peak: > 22 mSv/h



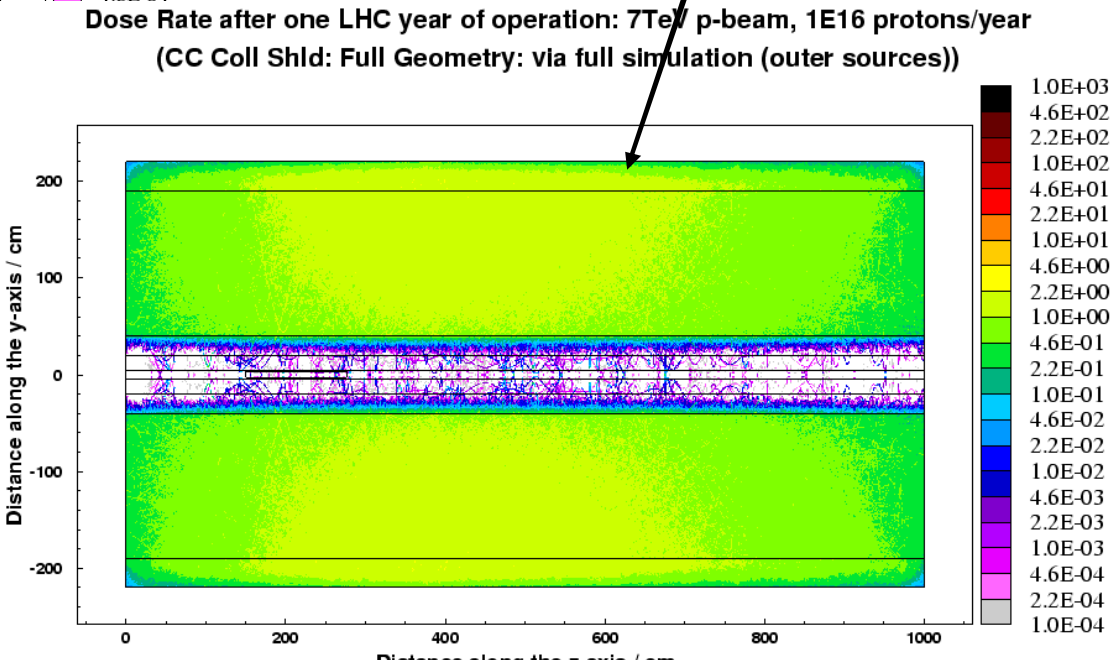
Carbon: Contribution from the Wall

10^{16} protons/year,
180 days irradiation
1 day of cooling



Inner Contribution (Shield, Pipe, Collimator)
Aisle: 0.5 – 1.0 mSv/h

Outer Contribution (Wall)
Aisle: 1.0 – 2.2 mSv/h



Remanent Dose Rate (Max!)

- Collimator Shielding (ins) Shielding (out)
  - Be: 20mSv/h 40mSv/h 3mSv/h
    - Dominated by ^{7}Be (53d) and ^{11}C (20.5min)
  - C: 20mSv/h 40mSv/h 3mSv/h
    - Dominated by ^{7}Be (53d), ^{11}C (20.5min)
  - Cu: 650mSv/h 100mSv/h 6mSv/h
    - Dominated by ^{42}K (12.4h), ^{44}Sc (4h), ^{56}Mn (2.6h), ^{61}Cu (3.3h), ^{61}Cu (12.7h)
  - W: >1Sv/h 100mSv/h 10mSv/h

- Beam pipe (Copper):
  - Be: Peak: 20mSv/h ~ 2 – 10 mSv/h within the first 10 m downstream
  - C: Peak: 20mSv/h ~ 2– 10 mSv/h within the first 10 m downstream
  - Cu: Peak: 300mSv/h ~ 2 – 10 mSv/h within the first 10 m downstream
    - Dominated by ^{42}K (12.4h), ^{44}Sc (4h), ^{56}Mn (2.6h), ^{61}Cu (3.3h), ^{61}Cu (12.7h)

Dose rates (more realistic case)

- Geometry: 30m long tunnel section including (realistic geometry)
  - CC collimator, 252 cm length (~two former Cu-Coll), design as used for Vacuum study
  - quadrupole magnet at ~3.5 m downstream of the collimator
  - copper beam pipe, 2 mm thick, ~40 mm inner diameter
  - various flanges
  - iron shield, 20cm thick (optional)
  - tunnel wall/floor/ceiling
- Loss assumption: 10^{16} protons/year, 180 days of continuous operation
- 1 hour, 1 day, 1 week, 1 month, 1 year of cooling
- Results: ambient dose equivalent rates anywhere within the 30m long tunnel section for each collimator material and two scenarios: with iron shield, w/o iron shield

More Realistic Simulation

10^{16} protons/year,
180 days irradiation
1 day of cooling