

# Constraints to Handling of Collimators, Shielding and Vacuum Installations



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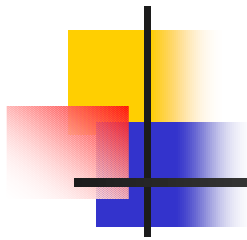
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CERN/TIS-RP



# Reminder

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- Legal limit:
  - The dose received during any consecutive 12-month period must not exceed **20mSv**.
- CERN reference limit:
  - With the aim of keeping exposures at CERN at the ALARA level, an annual reference dose of **15mSv** has been introduced.
- Design limit:
  - It is unreasonable in the present design phase to “allowed” values of 15mSv in one year. It is therefore reasonable to plan maintenance operations with a design limit for the annual dose of **5mSv**.
- **100μSv/h – 2mSv/h:**
  - Work has to be planned
- **2 mSv/h – 20 mSv/h:**
  - Remote Handling should be envisaged; intervention time has to be limited and supervised by RP
- **> 20 mSv/h:**
  - Remote Handling is obligatory!



# Examples

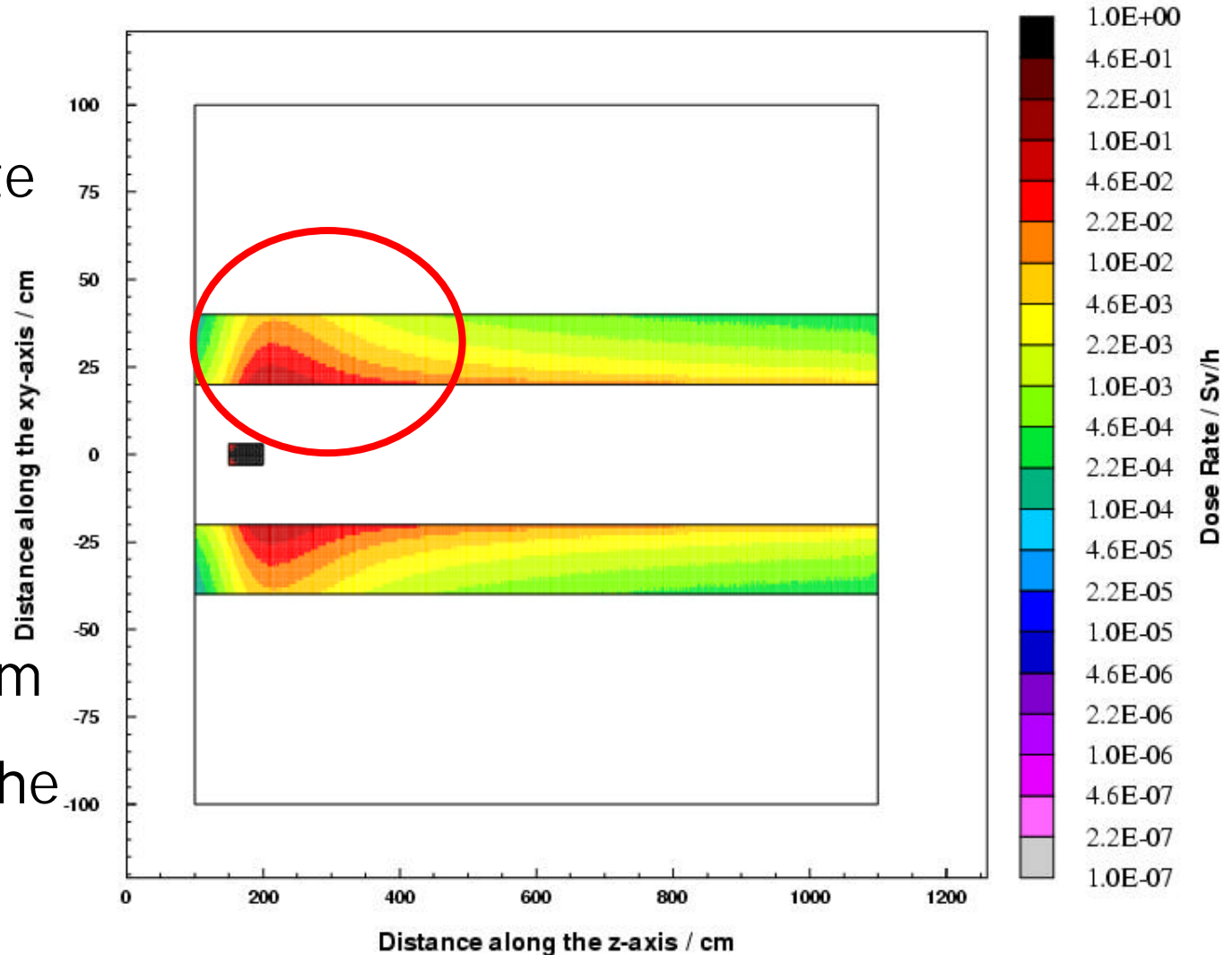
## Copper

Remanent Dose Rate according to:

$10^9$  part/s  
accumulated over  
one year of LHC  
operation

Length of jaw: 50 cm

$\omega$ -factors used for the  
estimate



# Examples

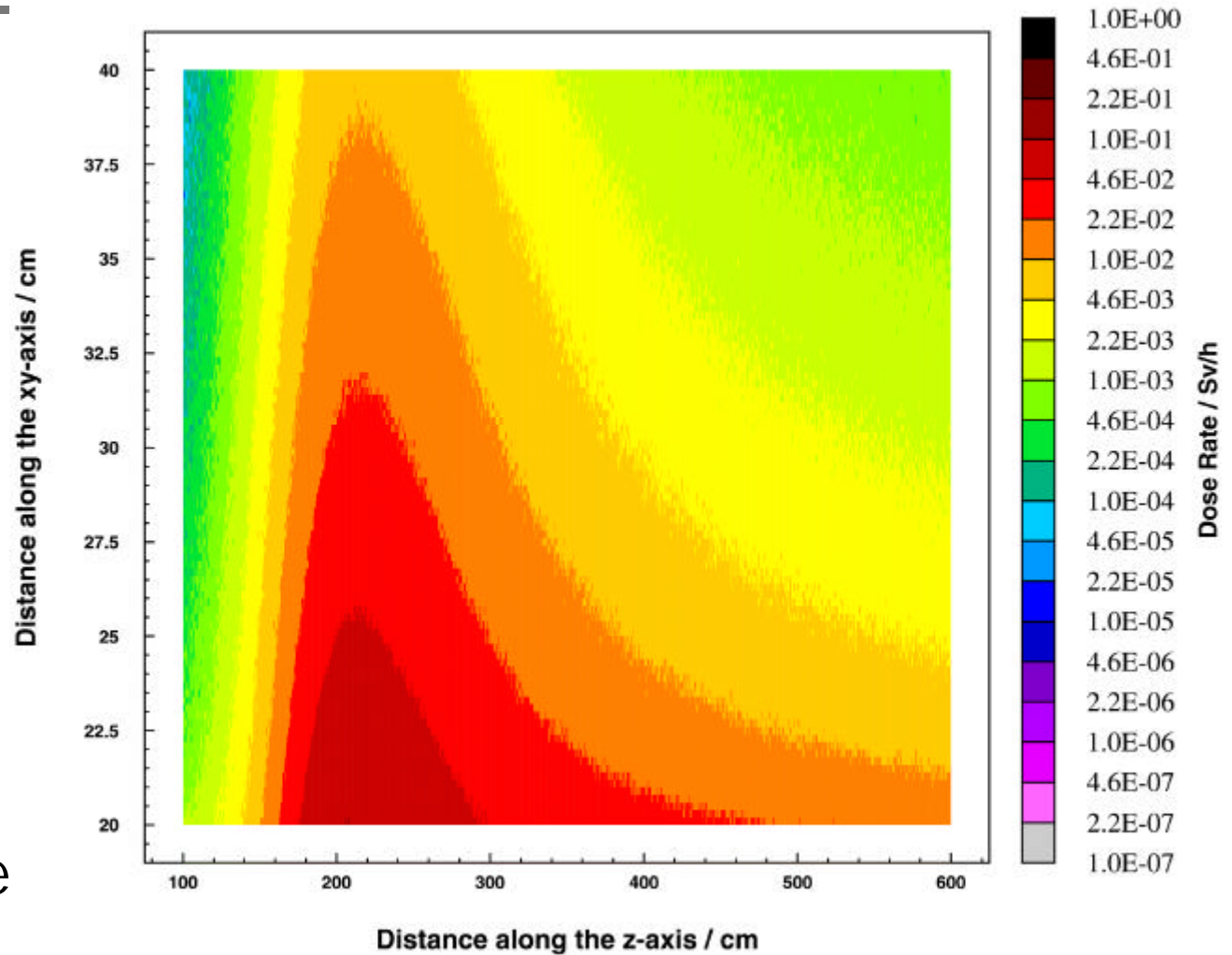
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# Examples

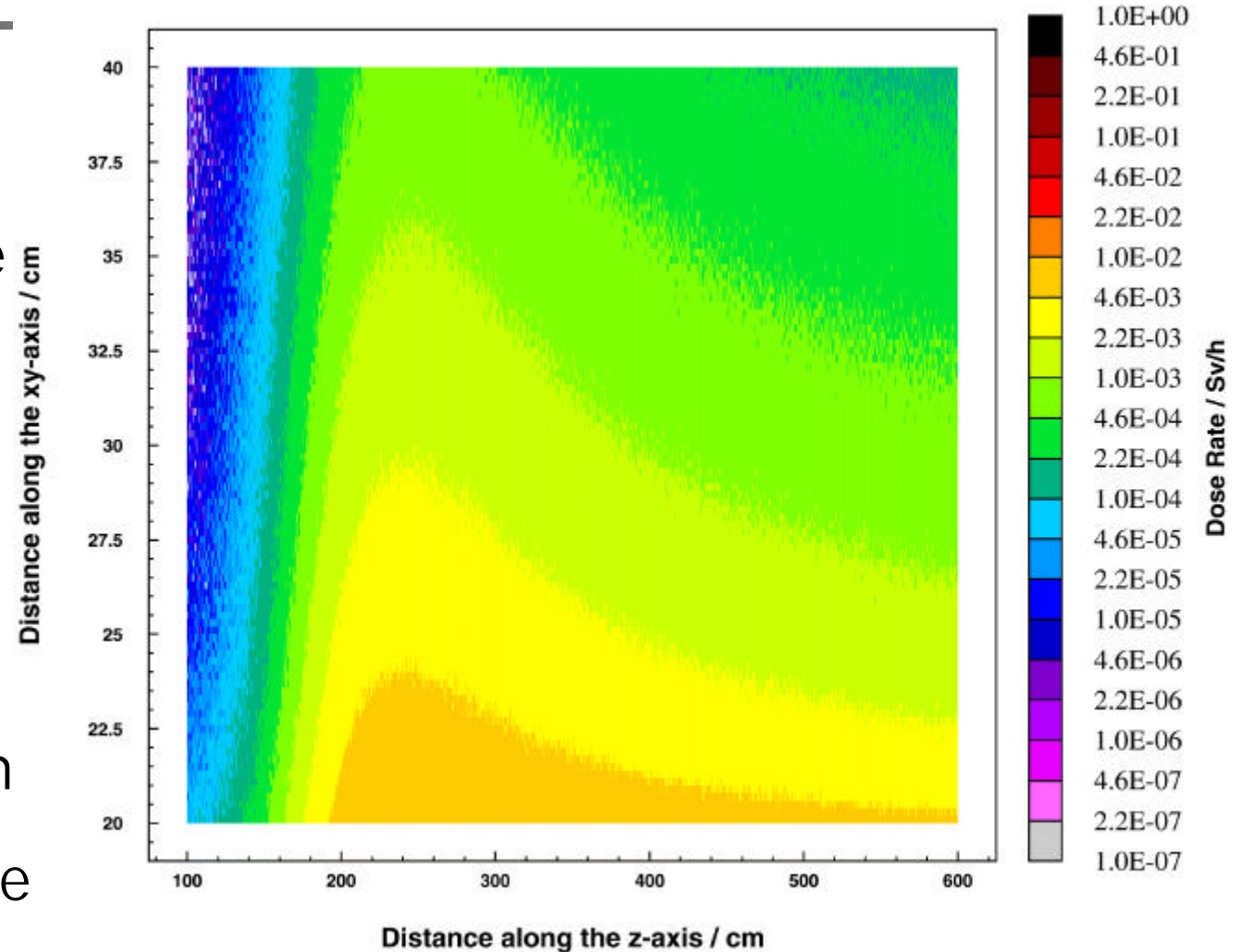
## Boron Nitride:

Remanent Dose Rate according to:

$10^9$  part/s  
accumulated over  
one year of LHC  
operation

Length of jaw: 50 cm

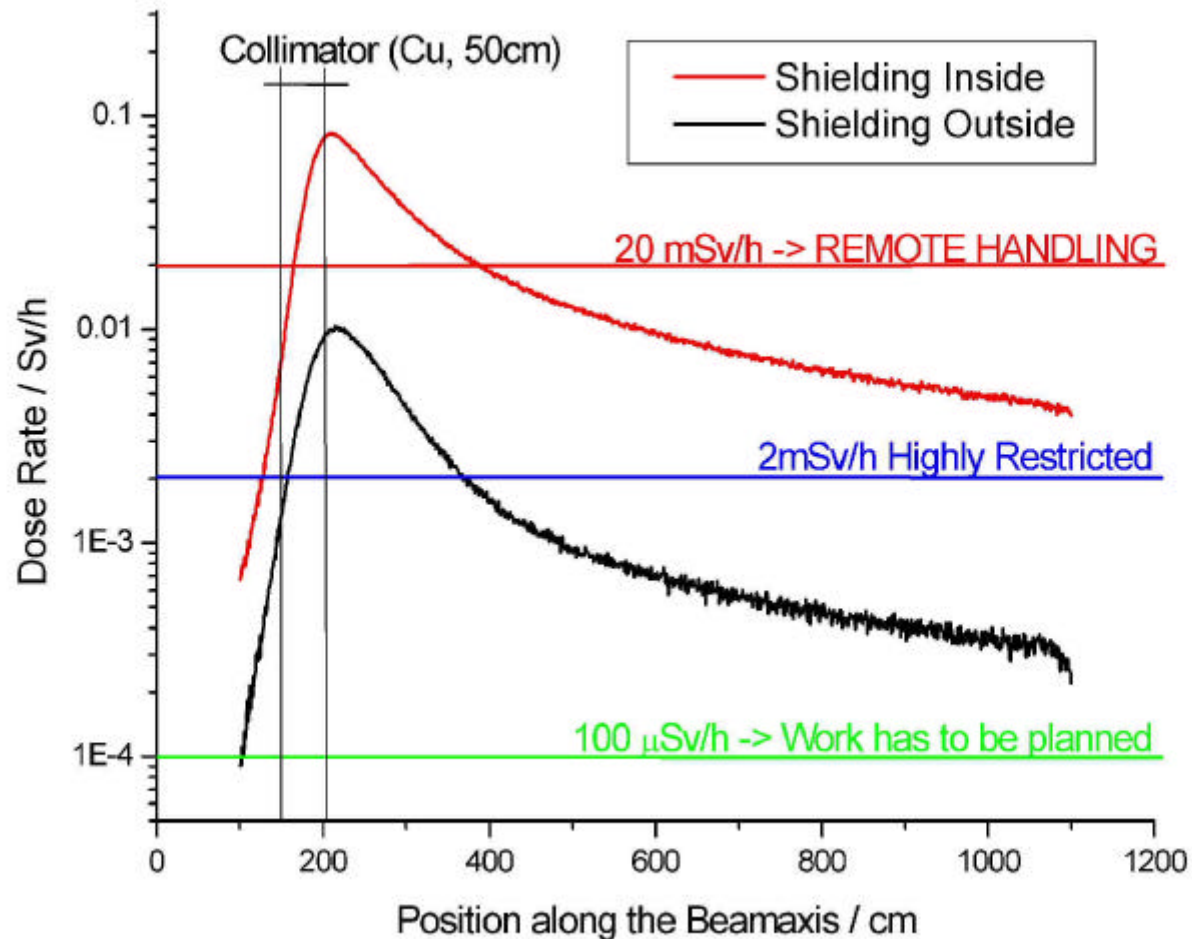
$\omega$ -factors used for the  
estimate



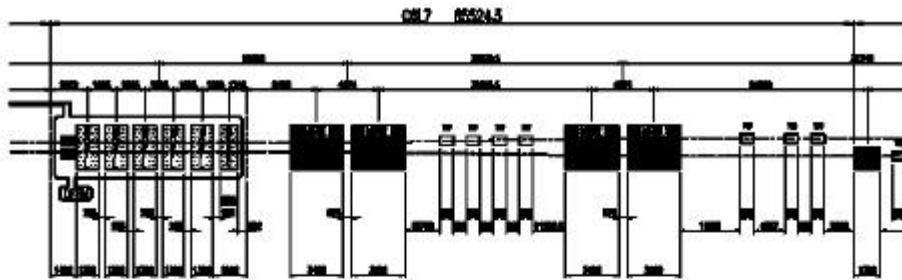
# Remanent Dose Rate (Max!)

- Collimator                      Shielding (ins)                      Shielding (out)
  - Al:                      5mSv/h                      1mSv/h                      0.1mSv/h
    - Dominated by  $^7\text{Be}$  (53d) ,  $^{24}\text{Na}$  (15h) ,  $^{44}\text{Sc}$  (3.9h),  $^{56}\text{Mn}$  (2.6h)
  - C:                      ???                      5mSv/h                      0.5mSv/h
    - Dominated by  $^7\text{Be}$  (53d),  $^{11}\text{C}$  (20.5min)
  - Cu:                      >1Sv/h                      50mSv/h                      5mSv/h
    - Dominated by  $^{42}\text{K}$  (12.4h),  $^{44}\text{Sc}$  (4h),  $^{56}\text{Mn}$  (2.6h),  $^{61}\text{Cu}$  (3.3h),  $^{61}\text{Cu}$  (12.7h)
  - BN:                      ???                      5mSv/h                      0.5mSv/h
    - Dominated by  $^7\text{Be}$  (53d) and  $^{11}\text{C}$  (20.5min)
  - W:                      >1Sv/h                      100mSv/h                      10mSv/h
- Beam pipe:
  - Cu:                      ~ 1 – 10 mSv/h up to ~ 12 meters downstream
    - Dominated by  $^{42}\text{K}$  (12.4h),  $^{44}\text{Sc}$  (4h),  $^{56}\text{Mn}$  (2.6h),  $^{61}\text{Cu}$  (3.3h),  $^{61}\text{Cu}$  (12.7h)

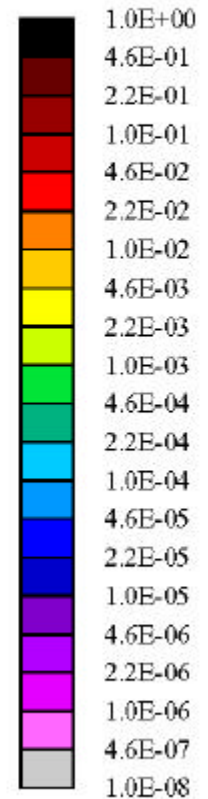
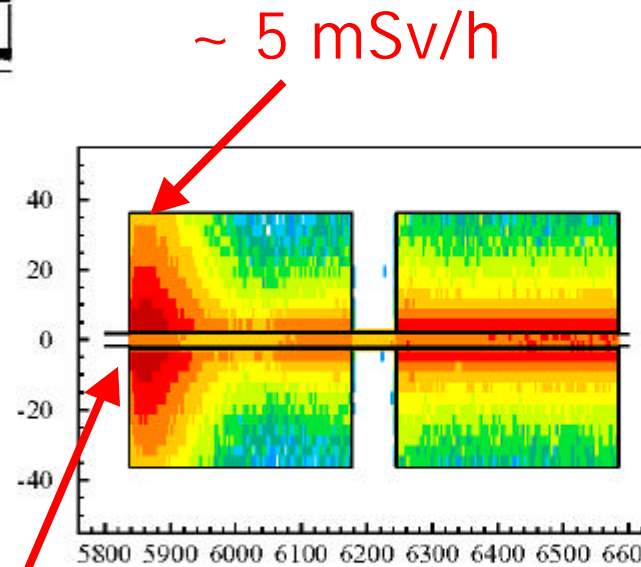
# Remanent Dose Rates



# Remanent Dose Rates High Losses

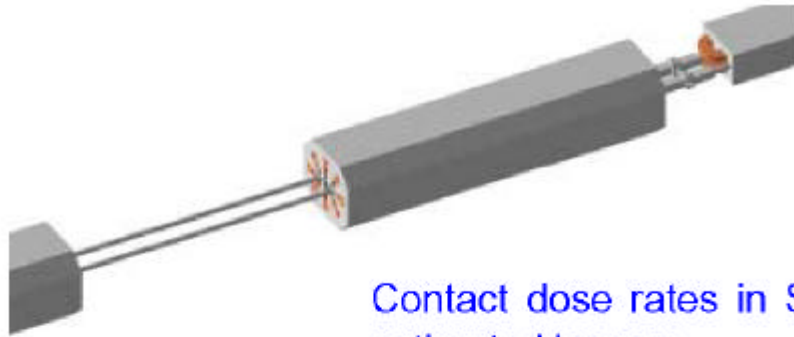


The contact dose rates in Sv/h for the D3 dipoles downstream of the primary collimators in which all the  $1.6 \times 10^{16}$  protons per year are assumed to interact is given:

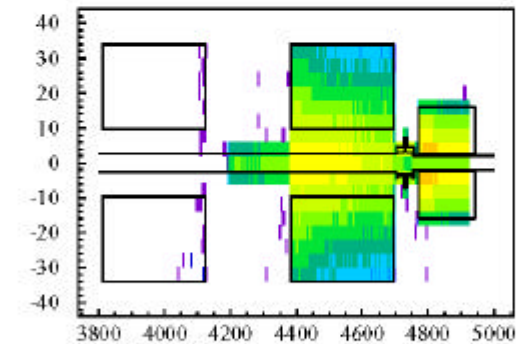




# Remanent Dose Rates Low Losses

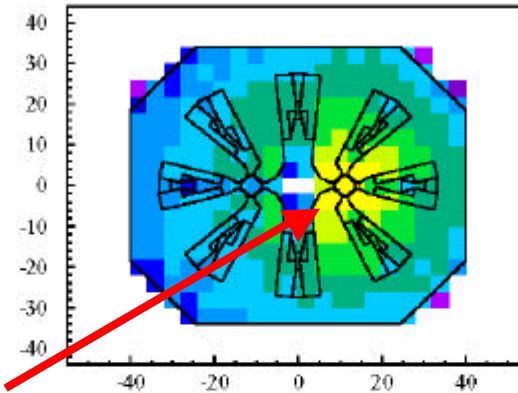


Contact dose rates in Sv/h from estimated losses:



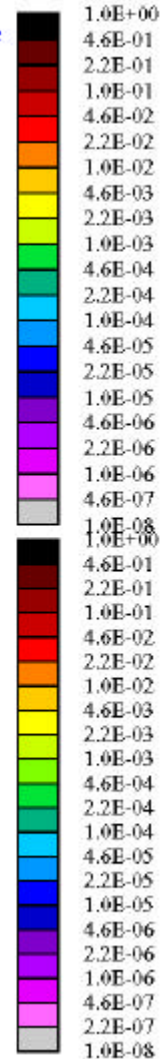
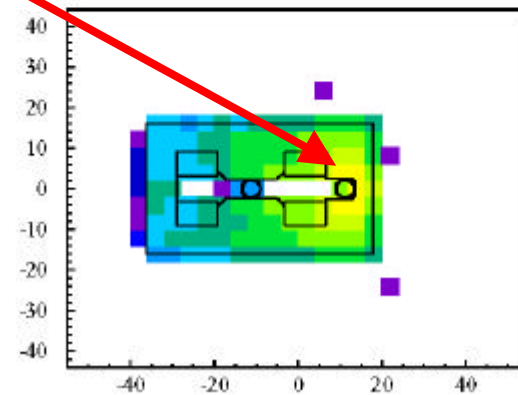
Vertical cut along beam-pipe.

Front face of downstream quadrupole

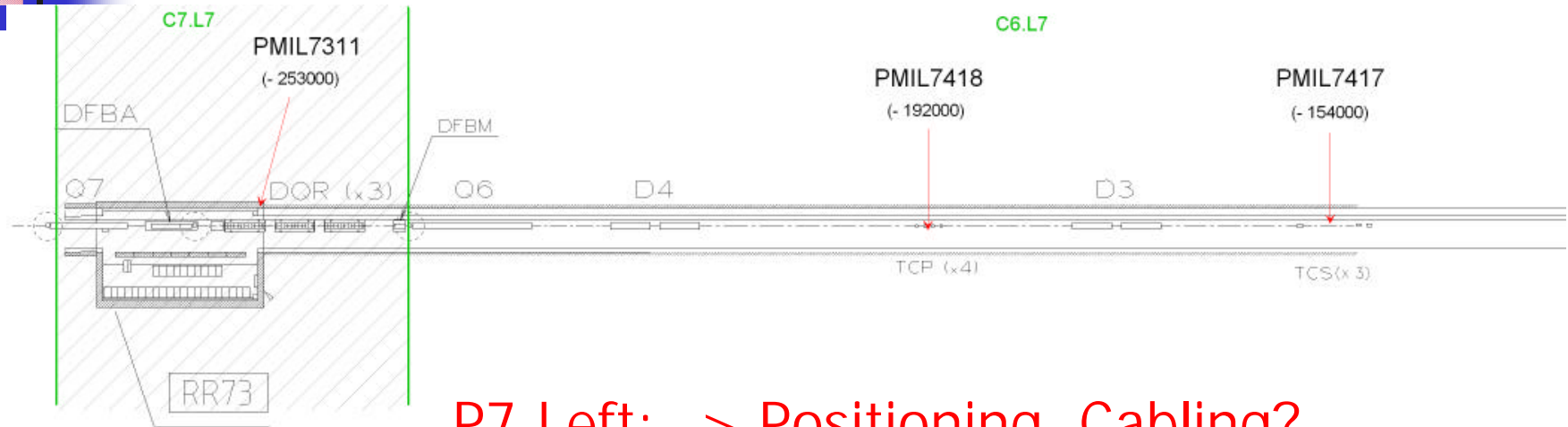


~ 3 mSv/h

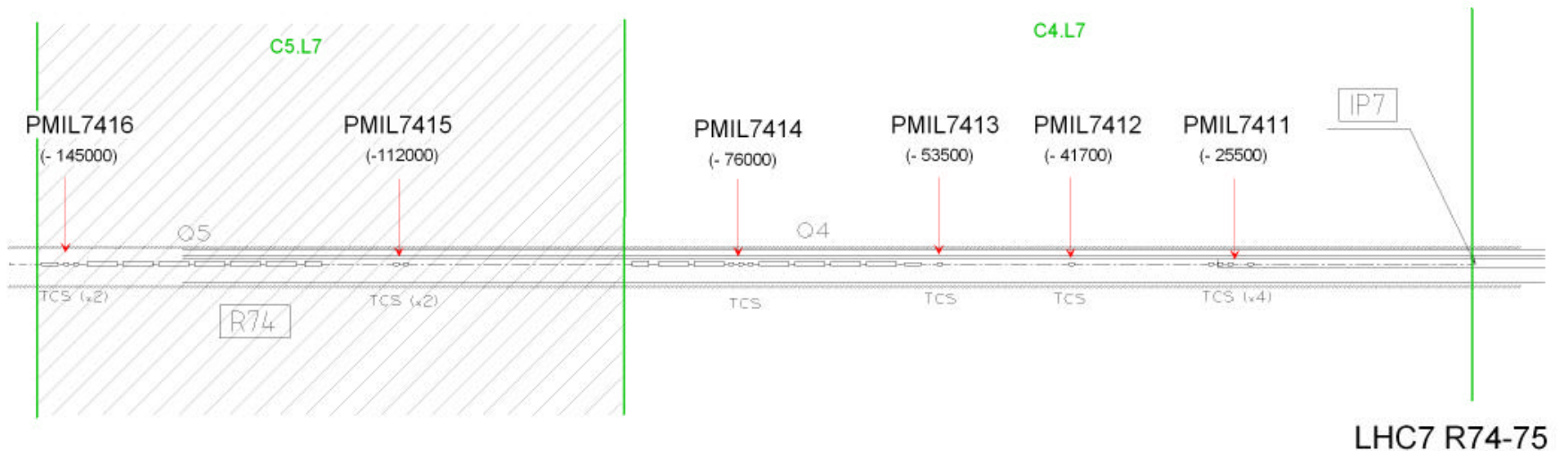
Front face of correction dipole



# Induced Activity Monitors I

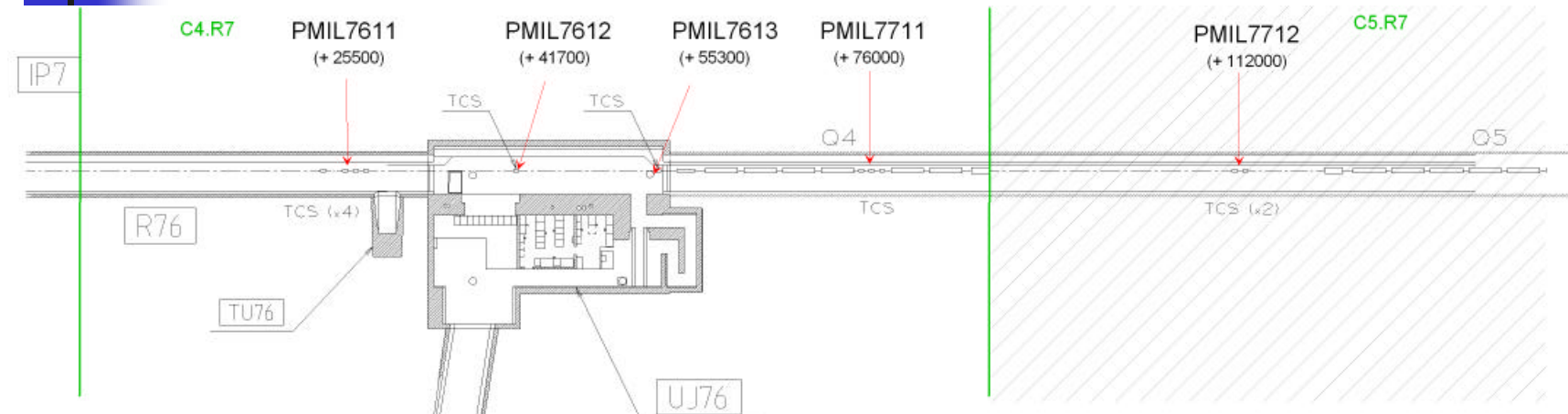


P7 Left: -> Positioning, Cabling?

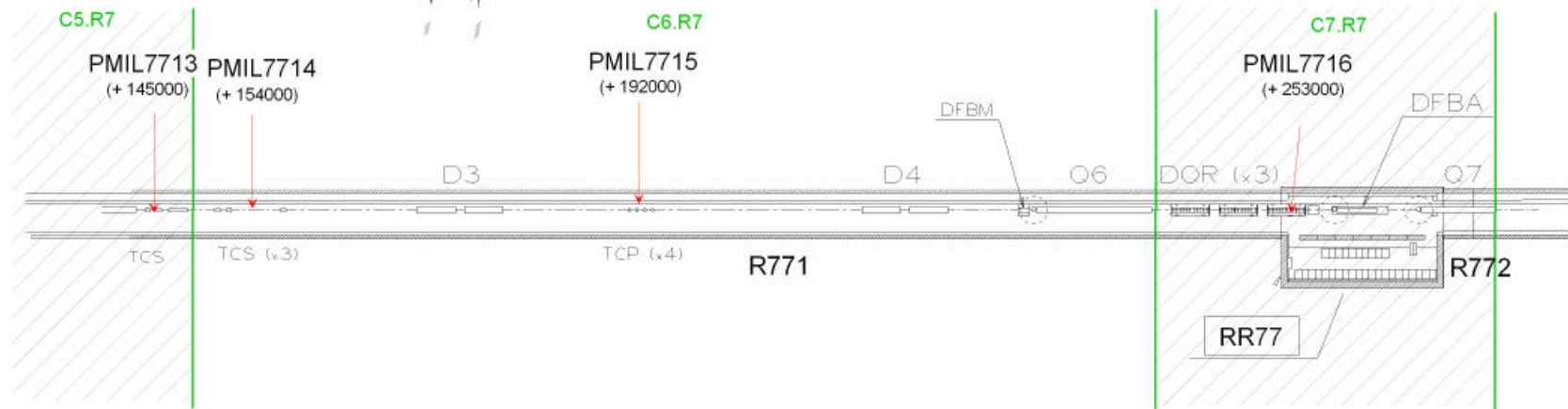


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# Induced Activity Monitors II

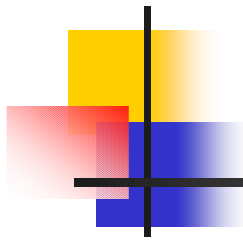


P7 Right: -> Positioning, Cabling?



LHC7 R76-77

Jpg-12/1102



# Fractions of Total Loss IP7

