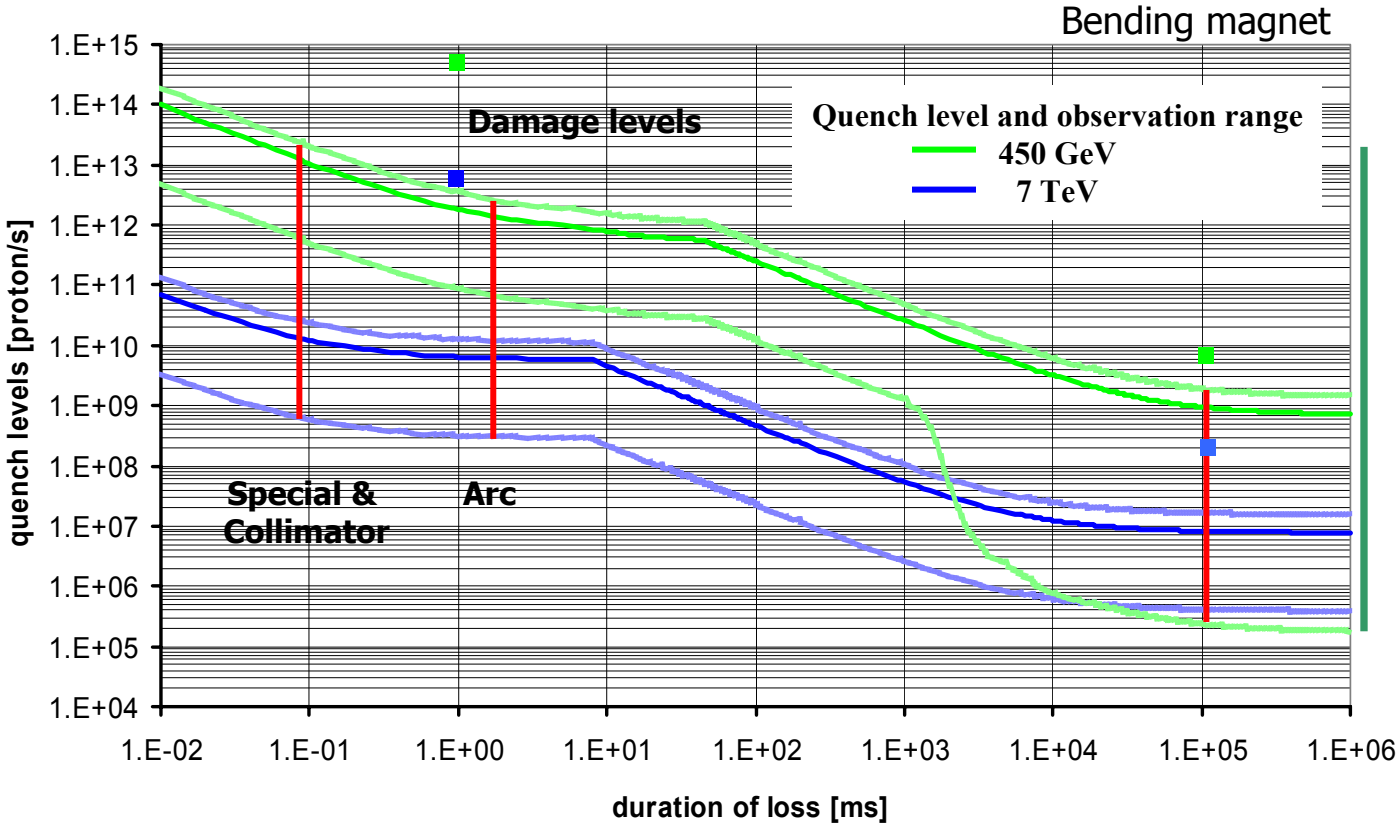
Beam Loss Monitors for the LHC

- Damage and quench protection
- Beam loss shower distribution
- Location of detectors
- Electrical signal treatment
- Reliability
- Collimation area loss monitoring

Quench and damage levels

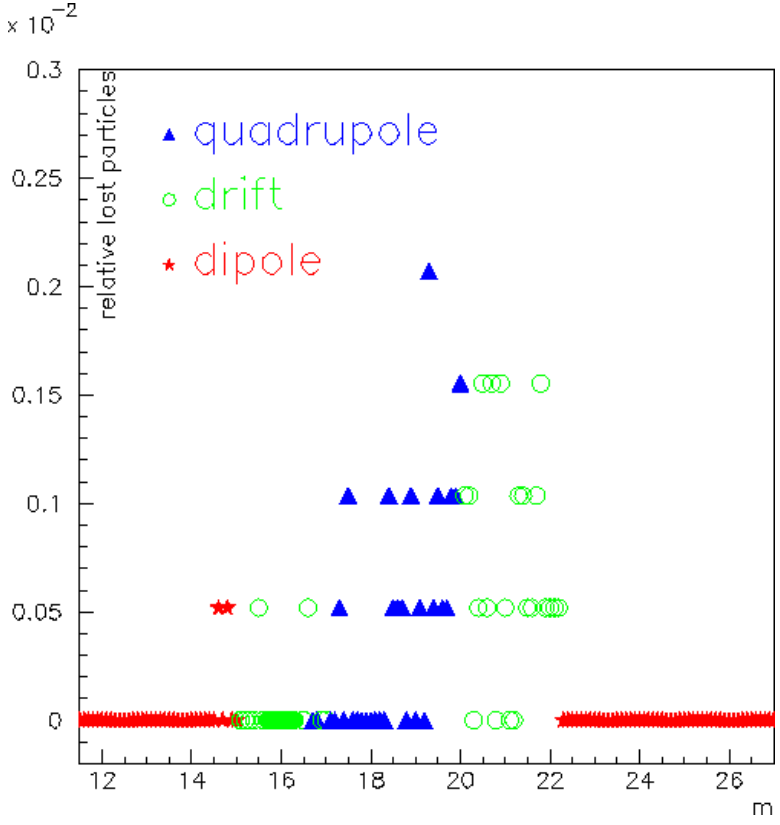
Detection of shower particles outside the cryostat or near the collimators to determine the coil temperature increase due to particle losses

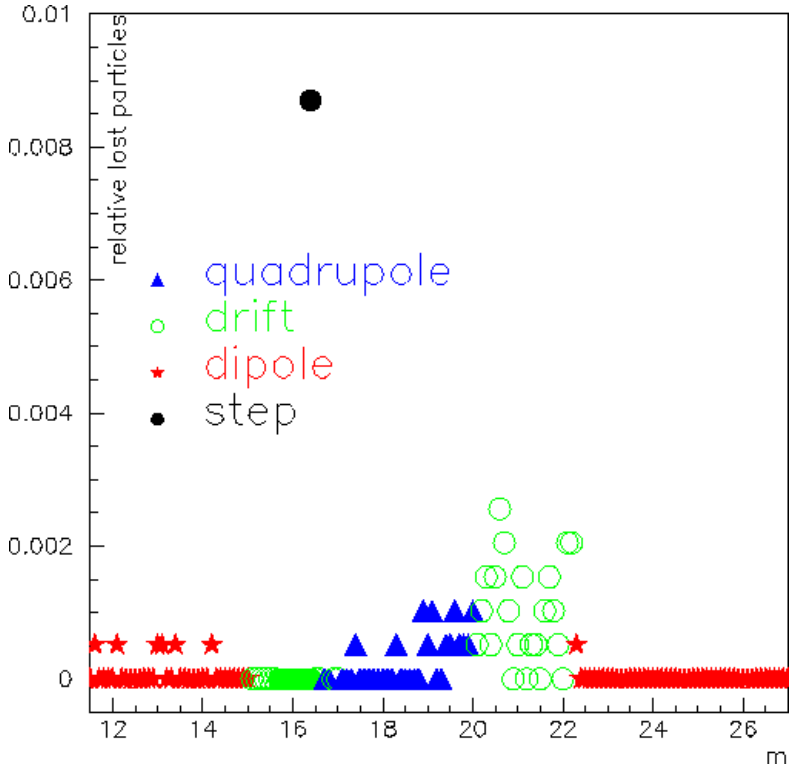


Dynamic 10^8

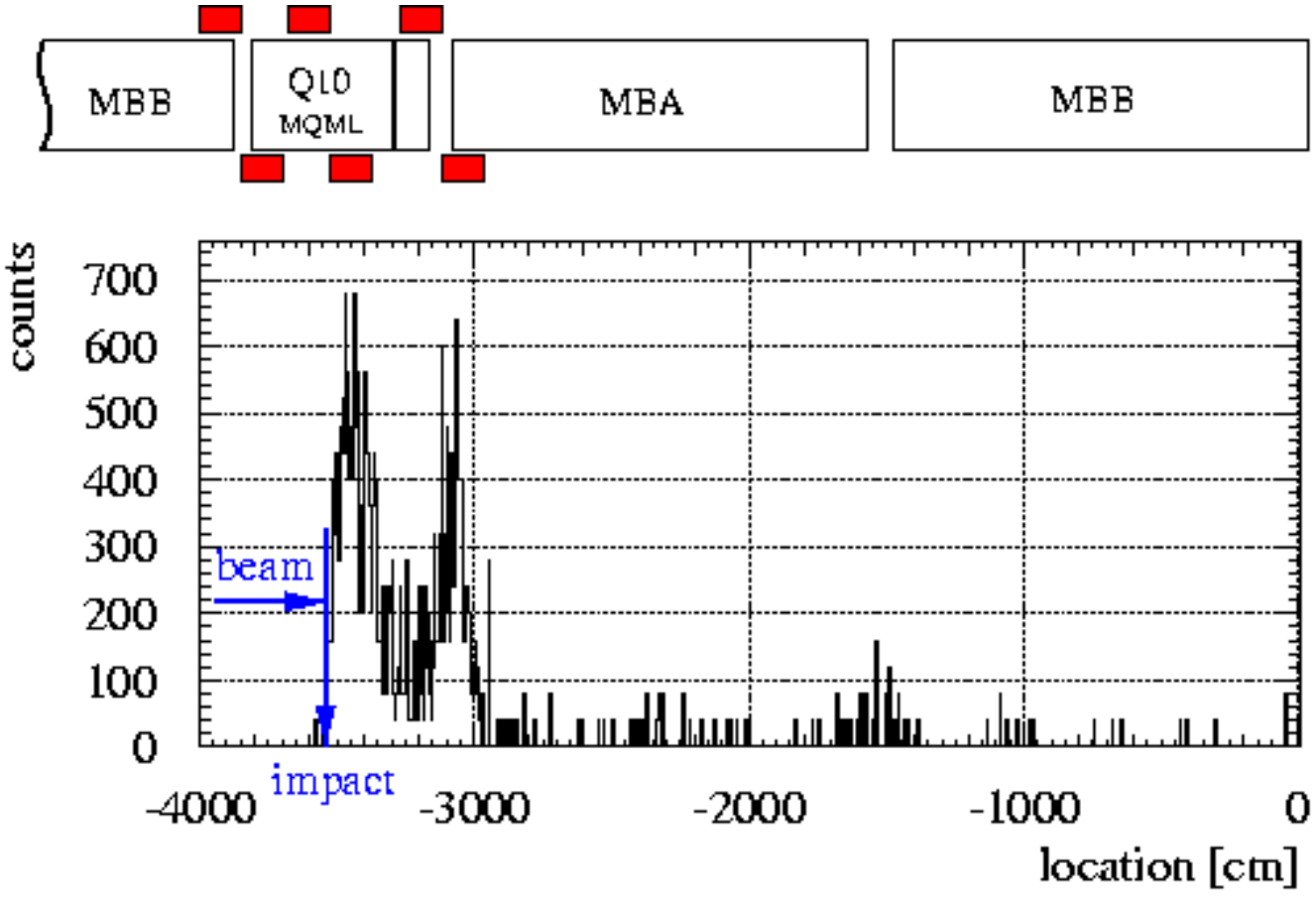
Loss distribution along the magnets

- Shower simulation; aims:
  - Determination of best monitor location
  - Determination of best shower integration (length of chamber)

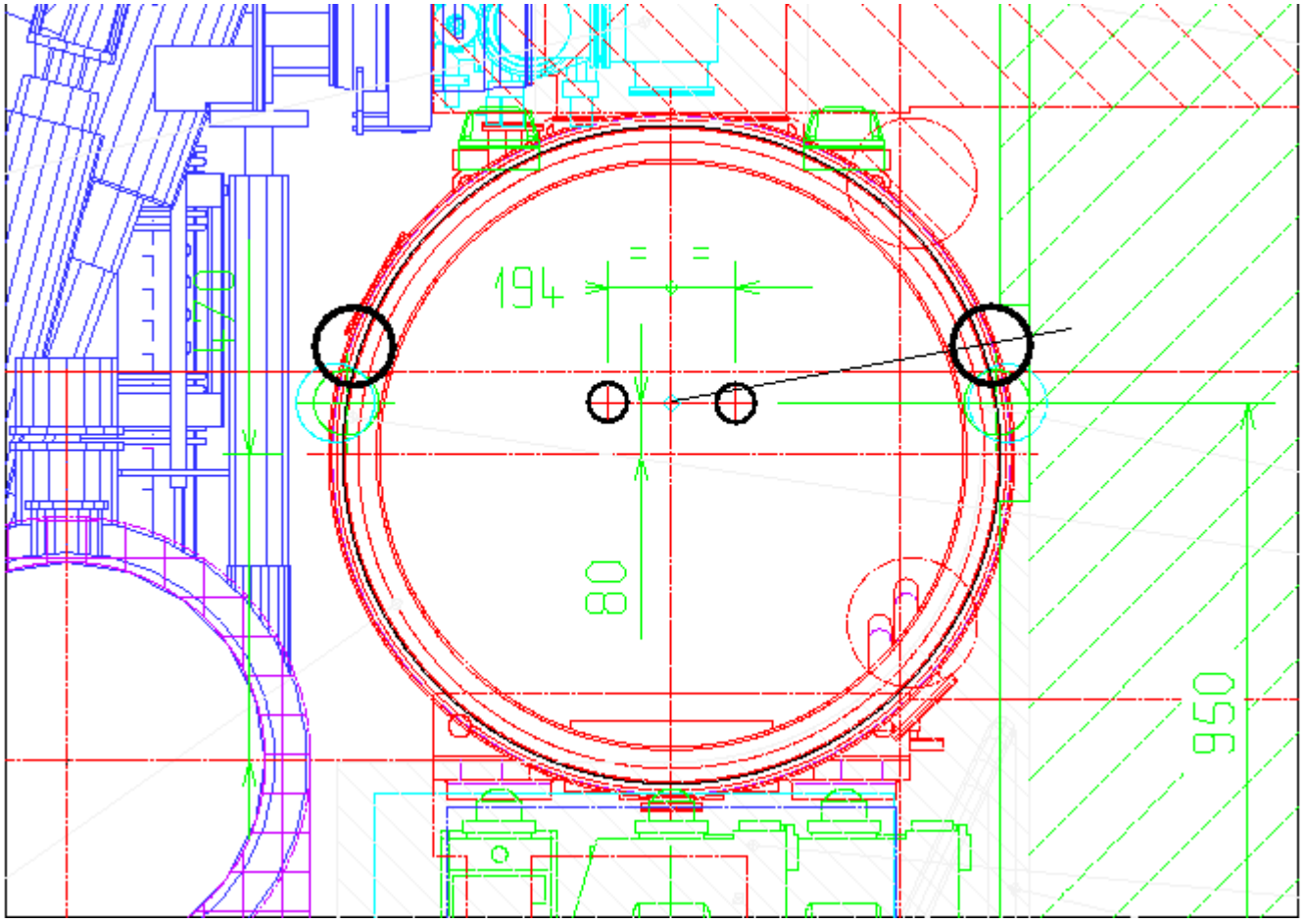




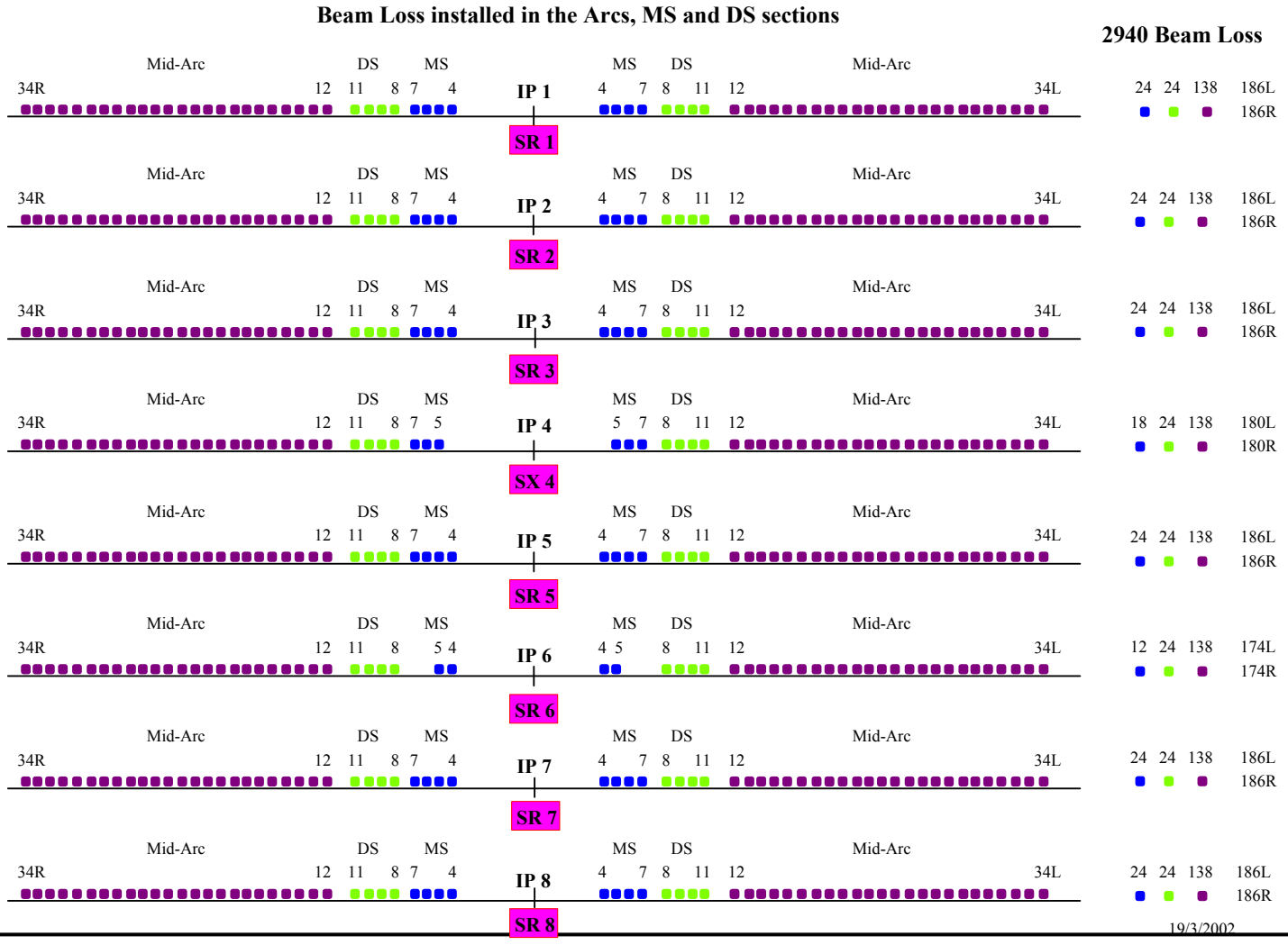
Detector locations and shower distribution



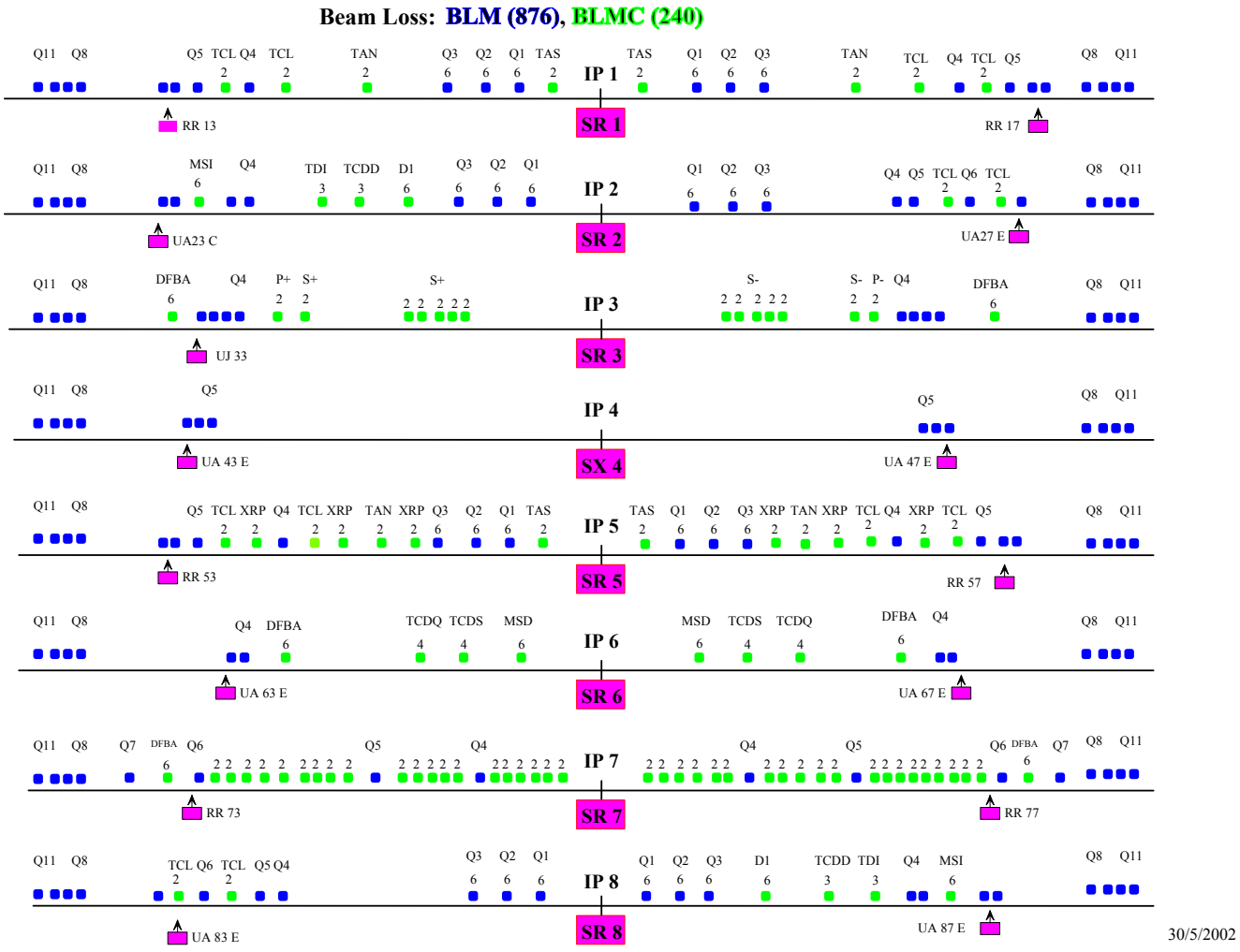
Cryostat Cross-section and Ionisation Chamber



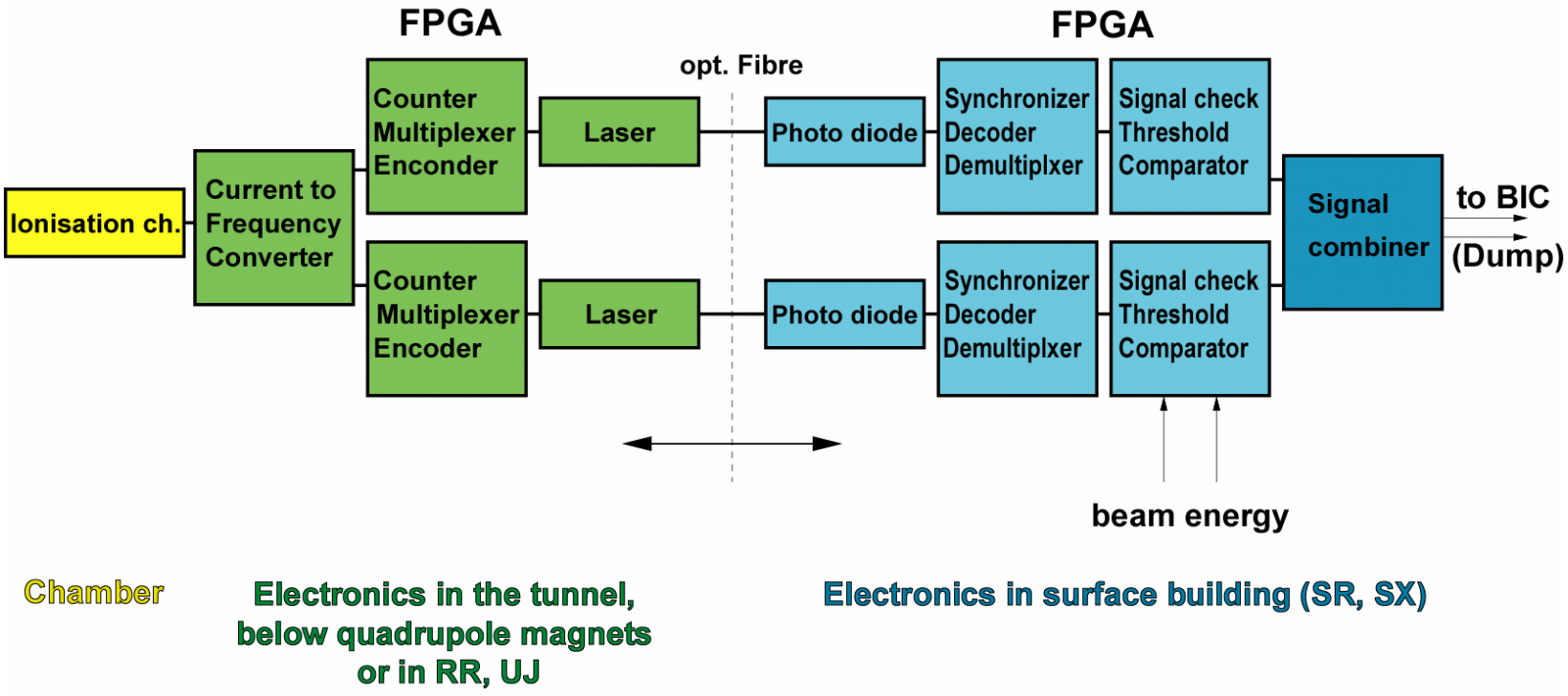
Arc Monitors



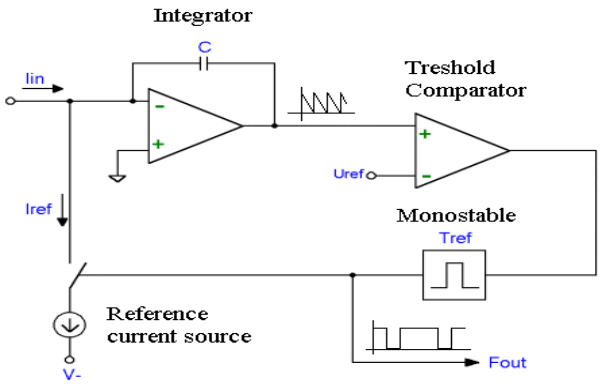
Straight Section Monitors

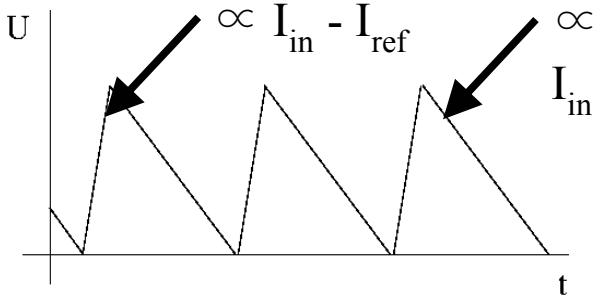


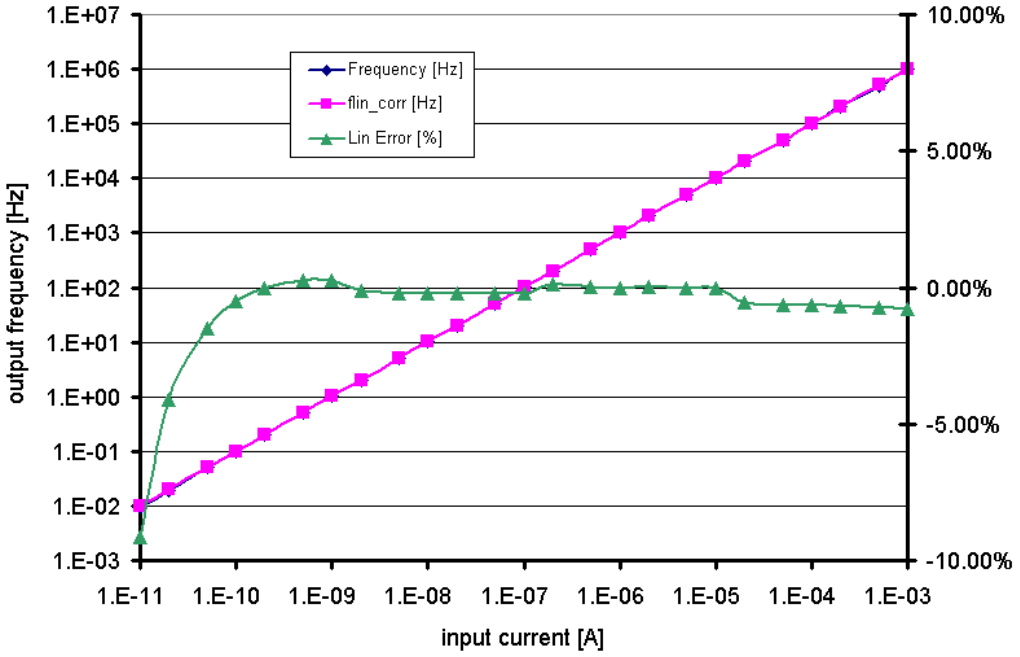
The Readout Chain



Charge Balanced Converter







- Every f_{out} period is proportional to the average input current during the period
- f_{out} independent of capacitor
- relative error $\Delta f_{out}/f_{out}$ proportional to relative error of $\Delta I_{ref}/I_{ref}$ and $\Delta T_{ref}/T_{ref}$

Damages and Failures per Year

- MaDa: $1.7\ 10^{-6}$/h * 4000 h/y * 100 = 0.7/y

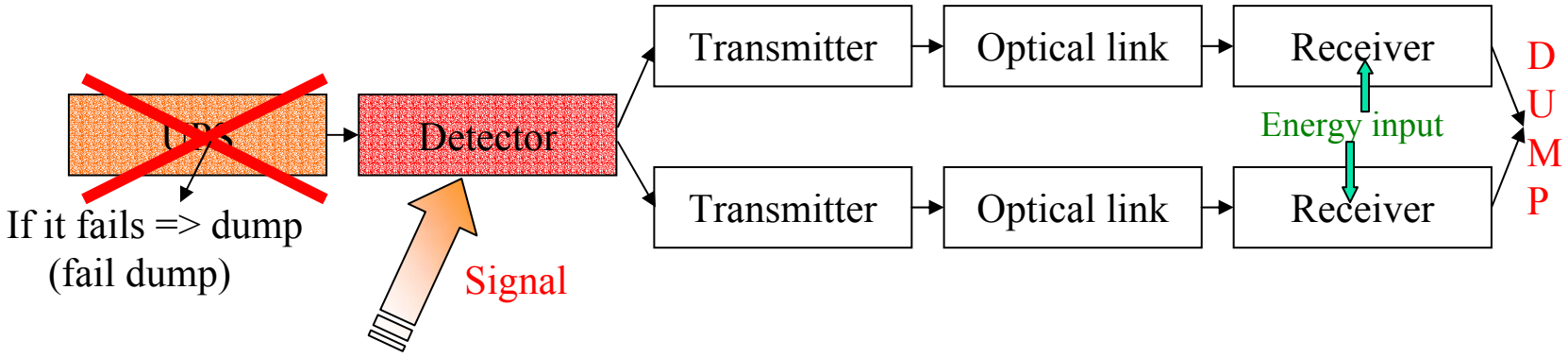
Beam hours: 200 d*20 h/d

Dangerous losses per year

- FaDu: $2.7\ 10^{-6}$/h * 4000 h/y * 3600 = 39/y

Number of channels

Magnet Damage



$$P_{MaDa} \sim P_S + Q_{BLM} + P_{en-} + Q_{DUMP}$$

P_{MaDa} — Probability to have a Magnet Damage

P_S — Probability not to detect the dangerous loss

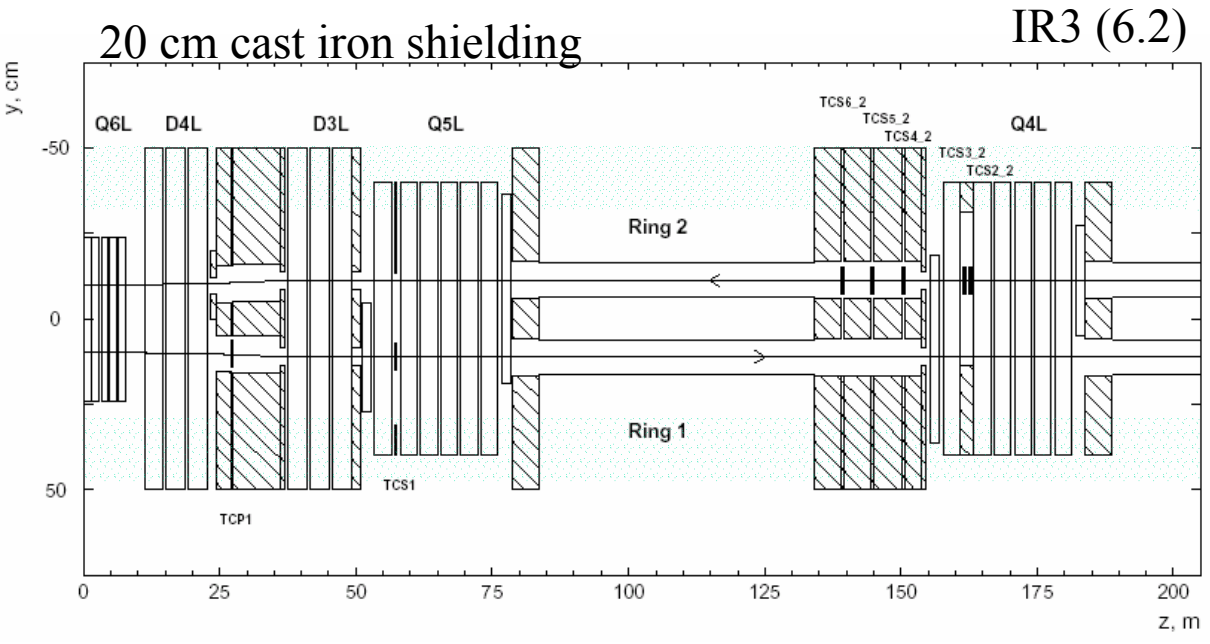
Q_{BLM} — Unavailability of the BLM system

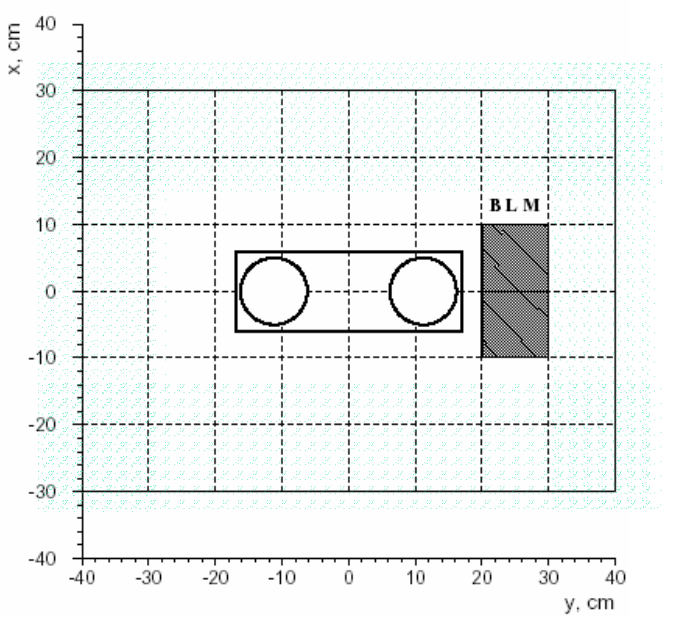
P_{en-} — Probability to underestimate the beam energy

Q_{DUMP} — Unavailability of the DUMP system

$$\Sigma < 10^{-7}\ /h \Rightarrow \text{single } 1\ 10^{-8}\ /h$$

Collimation Areas

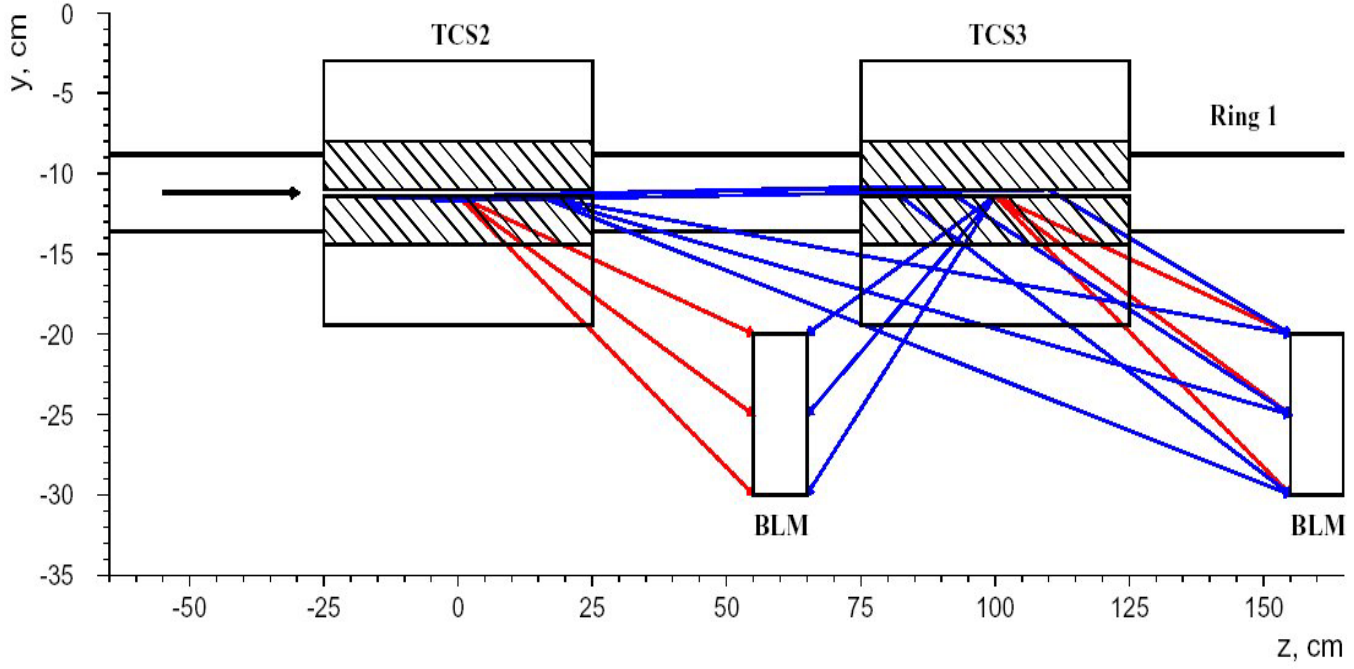




- Loss rate at the collimators 4 orders of magnitude higher as at the arc locations
- Instead of gas ionisation detection secondary electron emission detection under investigation

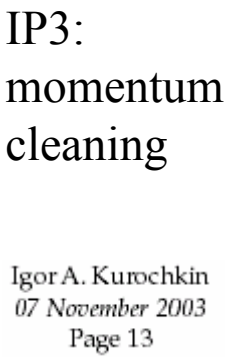
BLM Signal Simulation for the Cleaning Insertion I

- Aims:
  - Minimisation of cross talk
  - Optimisation of BLM signal
  - Definition of total loss estimator



Collimation Monitor Design Issues

- Due to high loss rate activation of materials
- Due to shielding activated material near to the monitors
- Due to background and cross talk monitor position near to the vacuum chamber



top energy

- BLM1 – "good" spatial resolution (100%)
- BLM3 (close to TCS2) – only 57.4%
- "Good" signal
  - BLM2 – 4%
  - BLM4 – 9%
  - BLM5 – 5%
  - BLM6 – 4%
  - BLM7 – 1%
- TCP1 - major contributor to background
  - BLM2 – 96%
  - BLM7 – 20%