Dose profile in NPS crystals
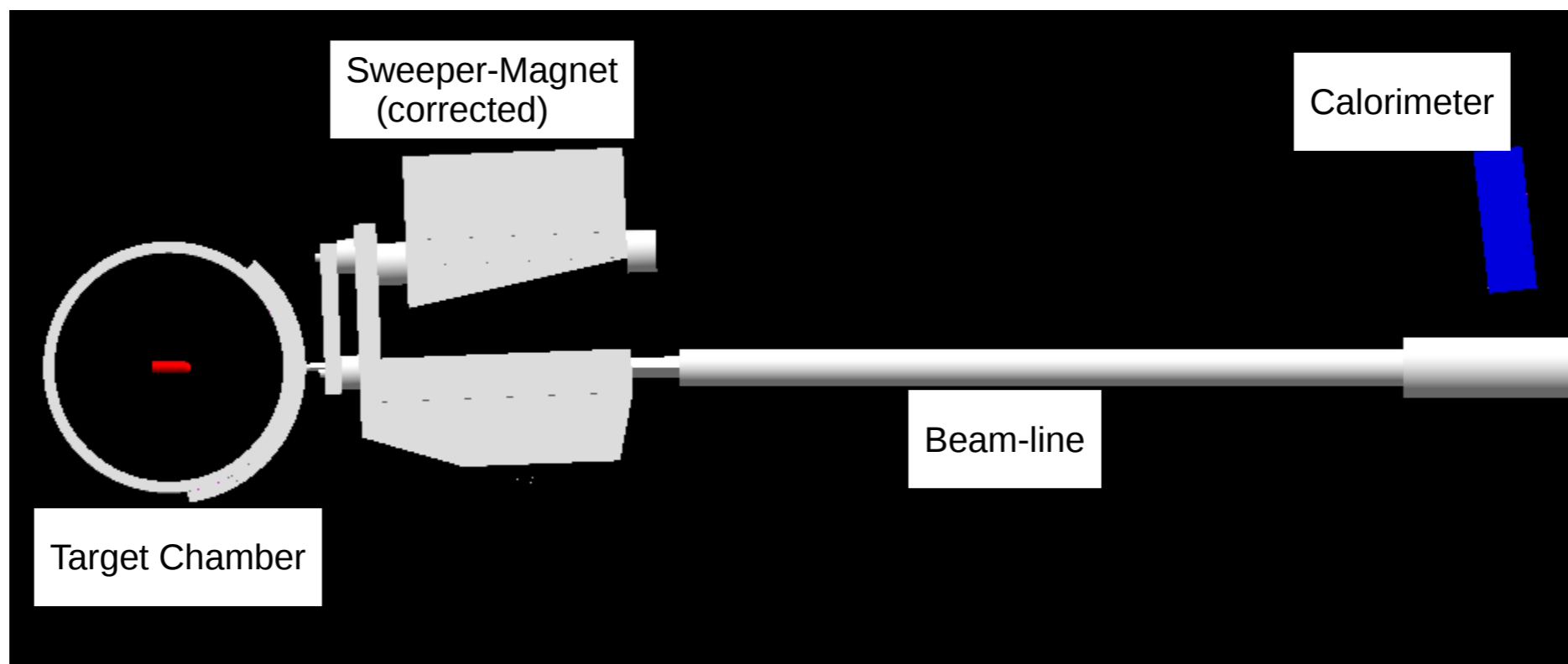## with shielding and lower magnetic field strength

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Outline

- Energy distribution and dose distribution of background in NPS

- Review of dose profile in NPS crystals with energy cuts (shielding)

- Dose profile in NPS crystals with reduced magnetic field strength : 0.6 T*m → 0.3 T*m

Background simulation geometry
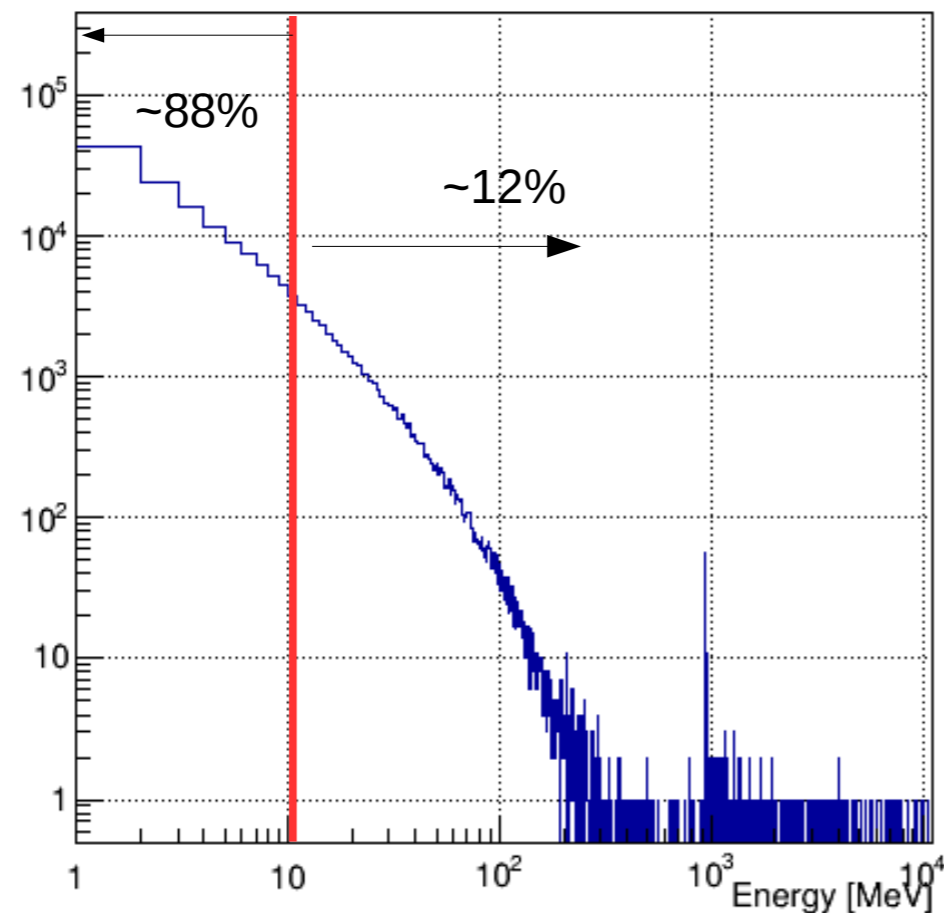

Setting #16 (low-xB) : xB = 0.2, Q^2 = 3.0 GeV^2. Beam-time : 1 day with 11uA

Calorimeter : 6m from the target, 6.3 deg from the beam-line axis
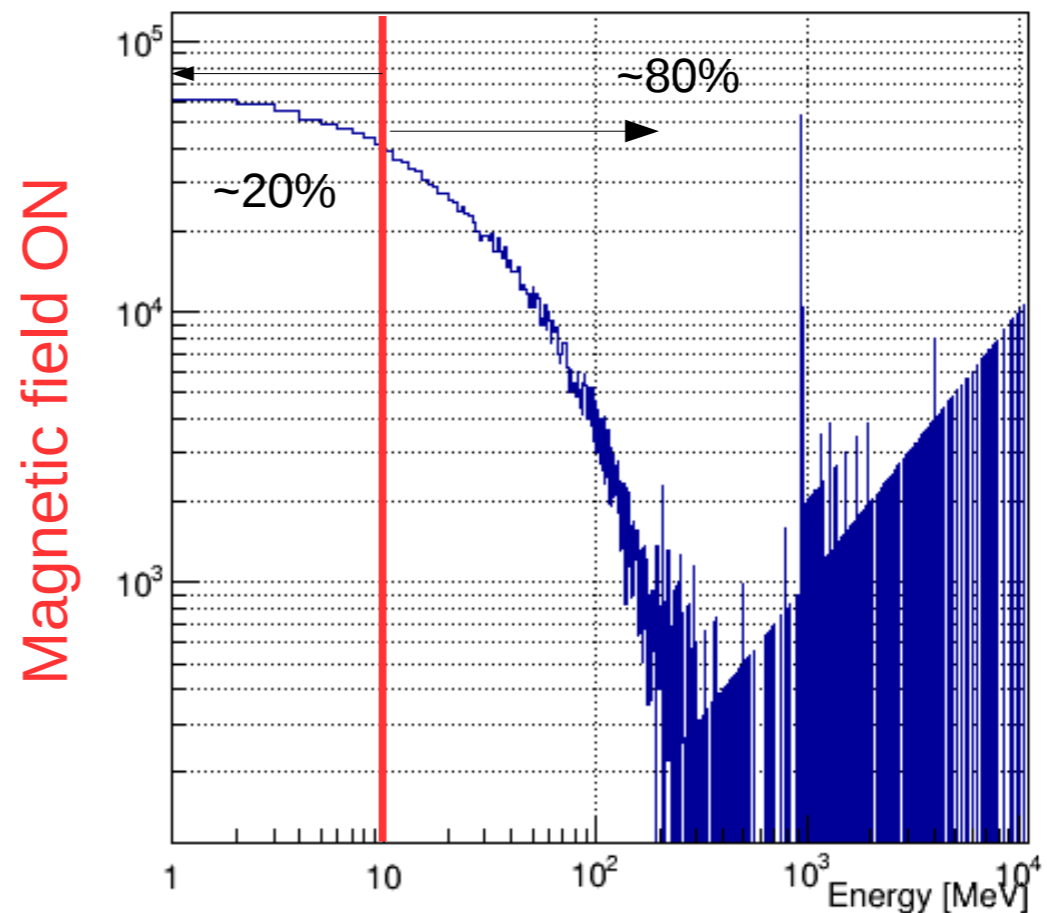
Sweeper-Magnet Center : 1.6m (for E12-13-010), 2.3 deg from the beam-line axis(6.3 - 4 deg)

Energy and dose distribution of background in NPS

Energy distribution of background in NPS.

Dose distribution

Right plot was obtained by weighting each particle by its energy.

The numbers (~88%, ~20%, etc.) were calculated by integrating the ranges of interests ([0 MeV, 10 MeV] or [10 MeV, 11 GeV]) of the plots above.

~88% of background is from particles with E < 10 MeV.
However, the total energy from particles with E < 10 MeV is ~20% of the total energy deposited in the detector

Background dose with energy cut (shielding) (review)

Dose rate on the middle row of the calo. low-x_B, Calo : 6m, 6.3°.
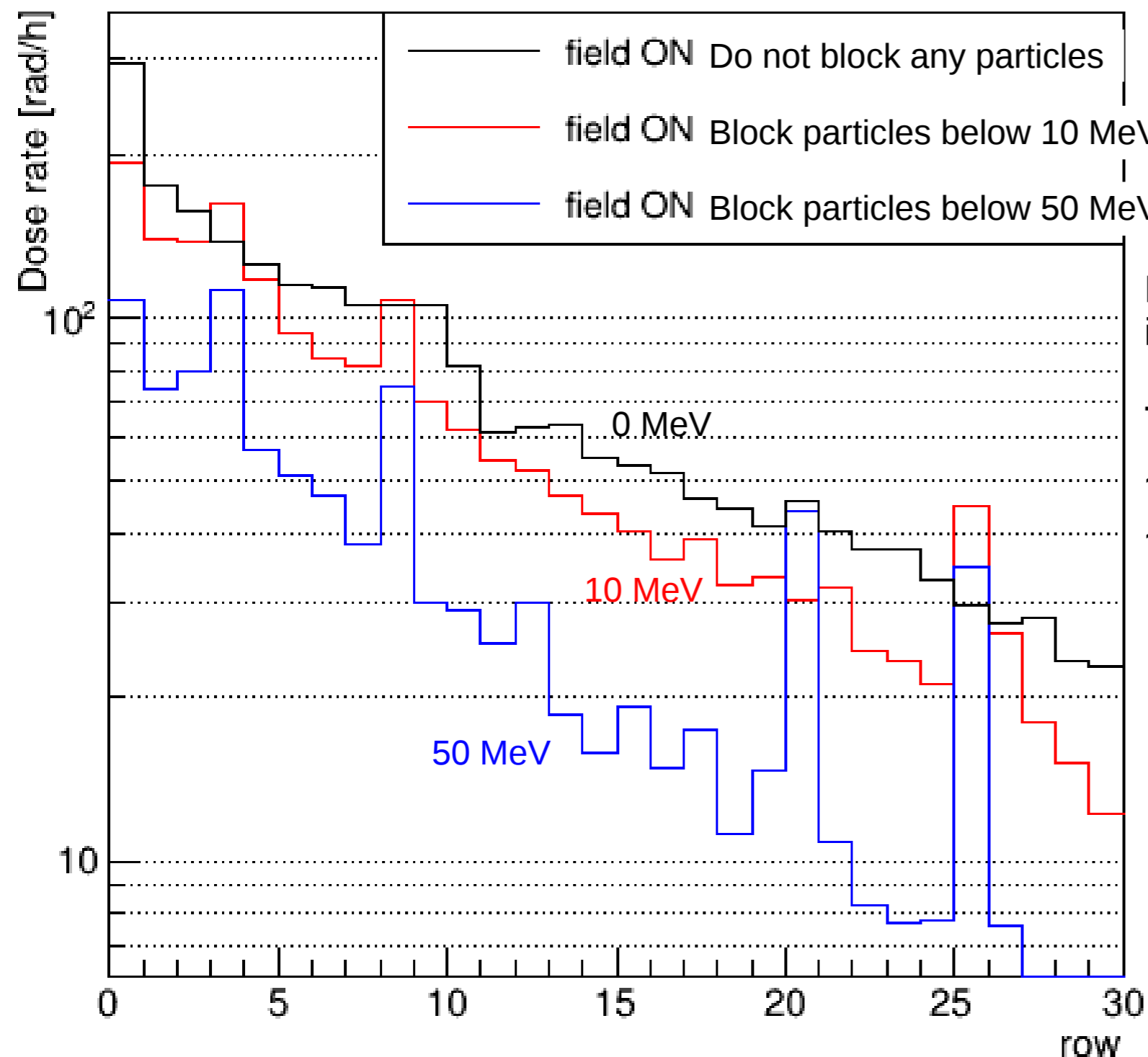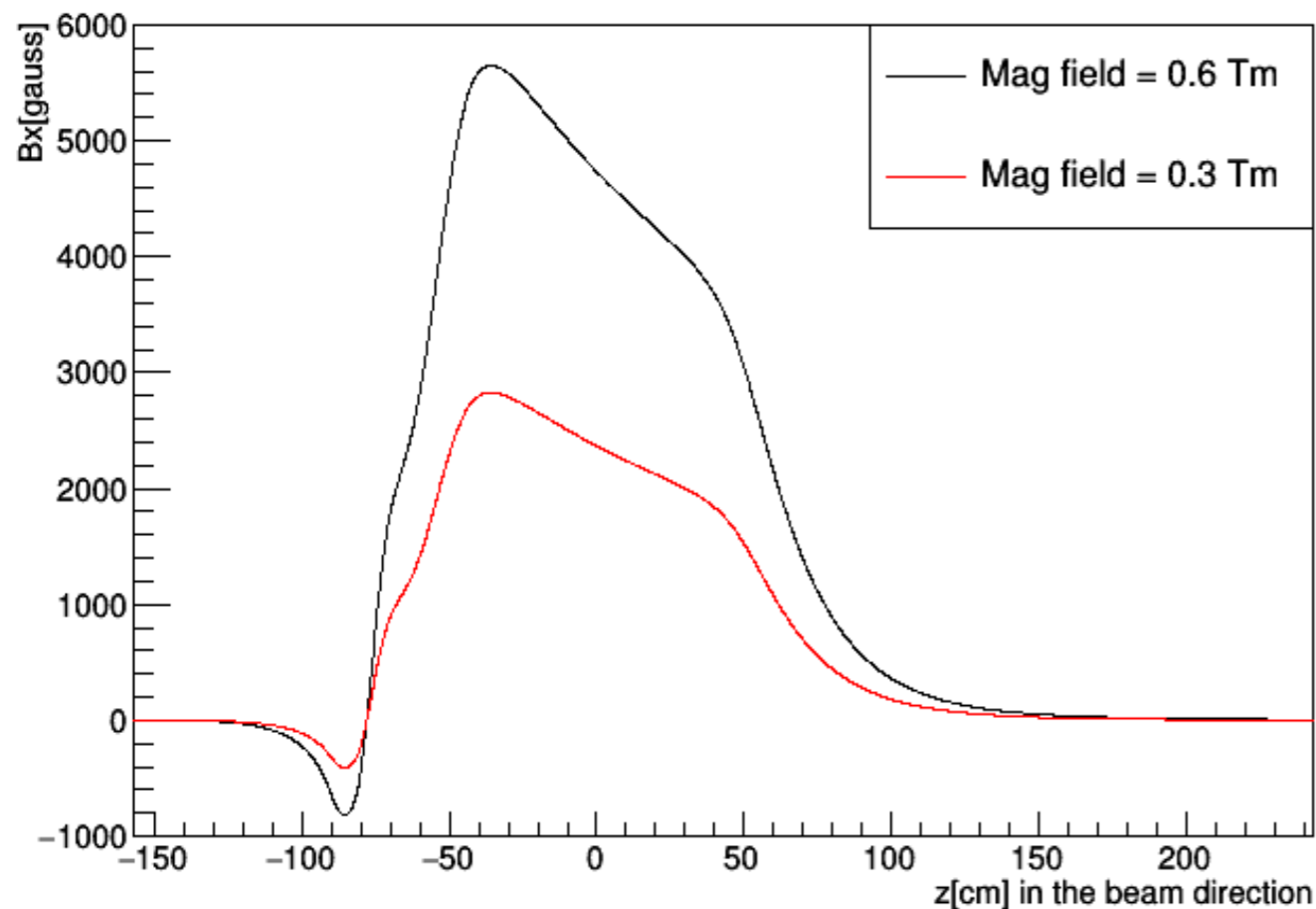

Field ON : from no blocking to <10MeV blocking
i.e. Black → Red

The dose rate decreases
~19% in total in the middle row.
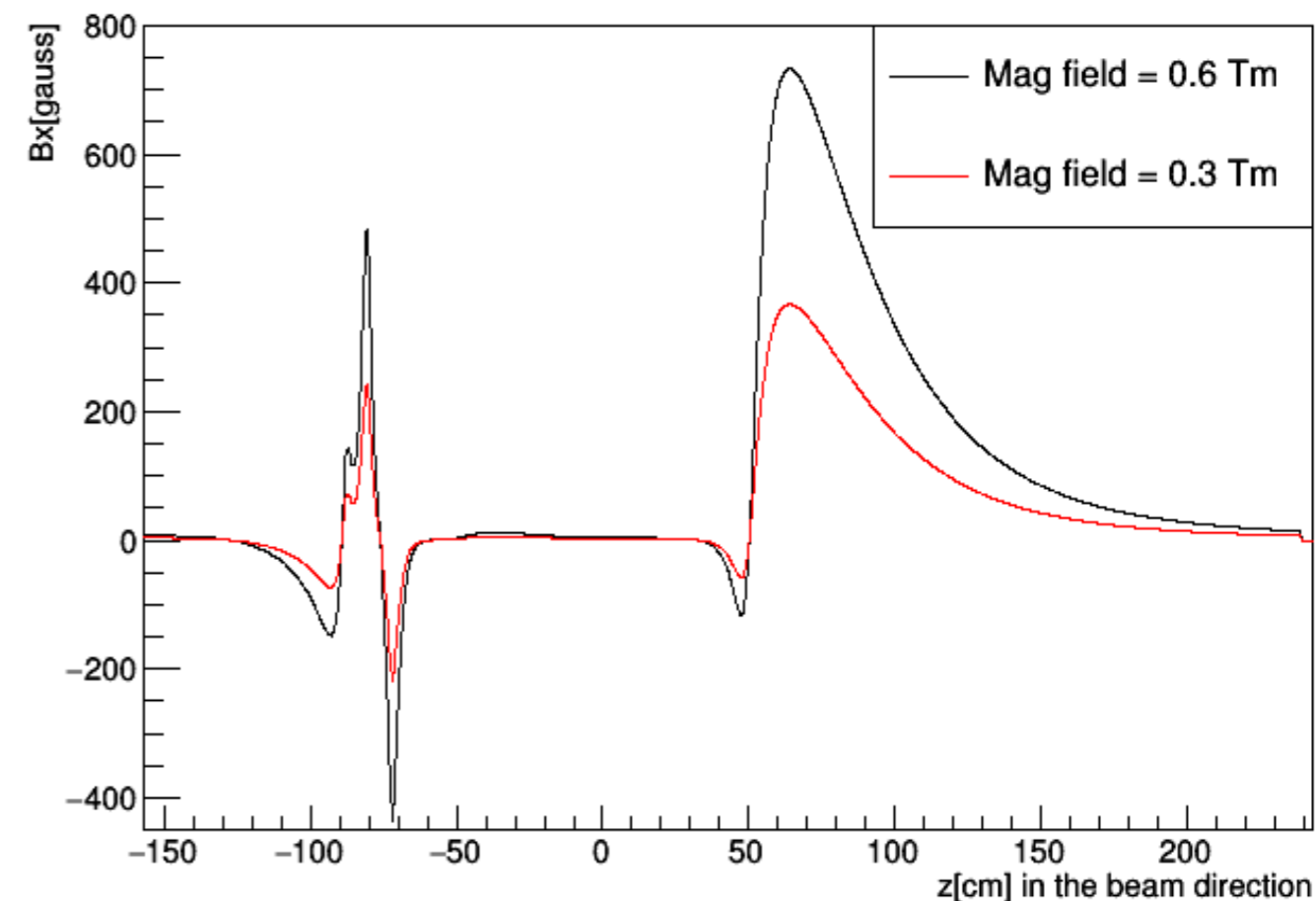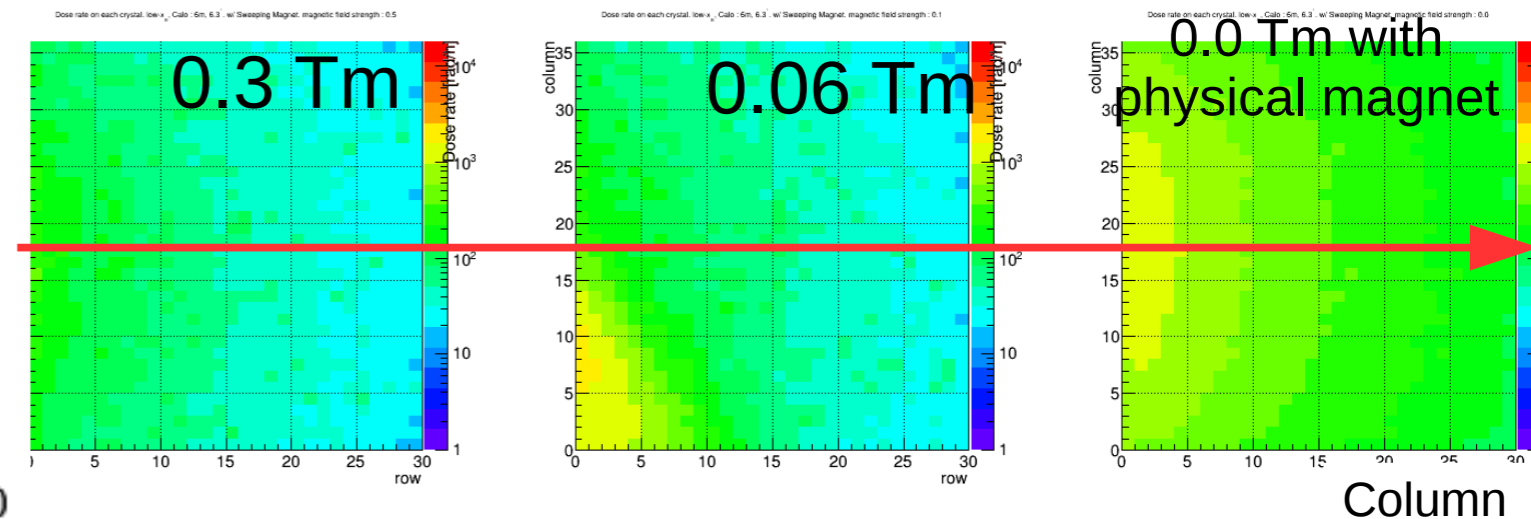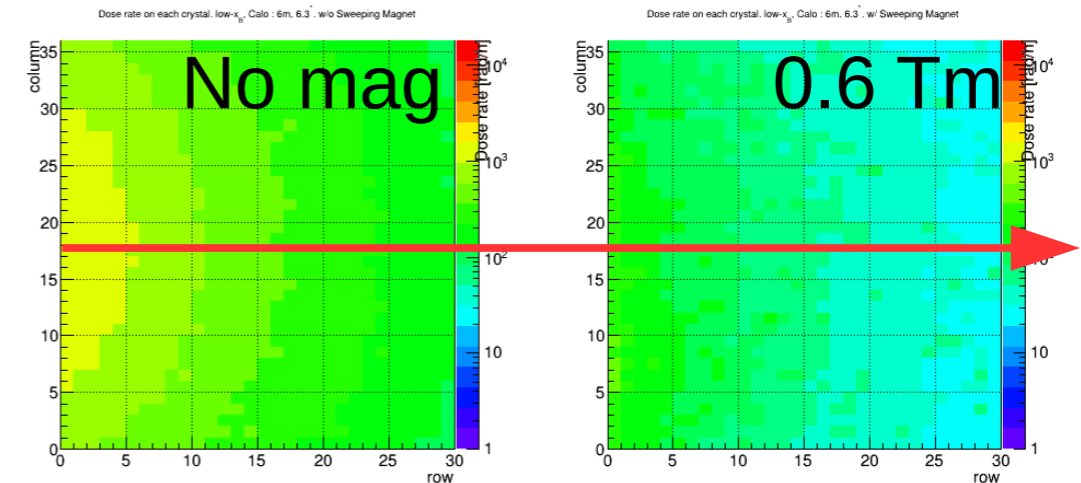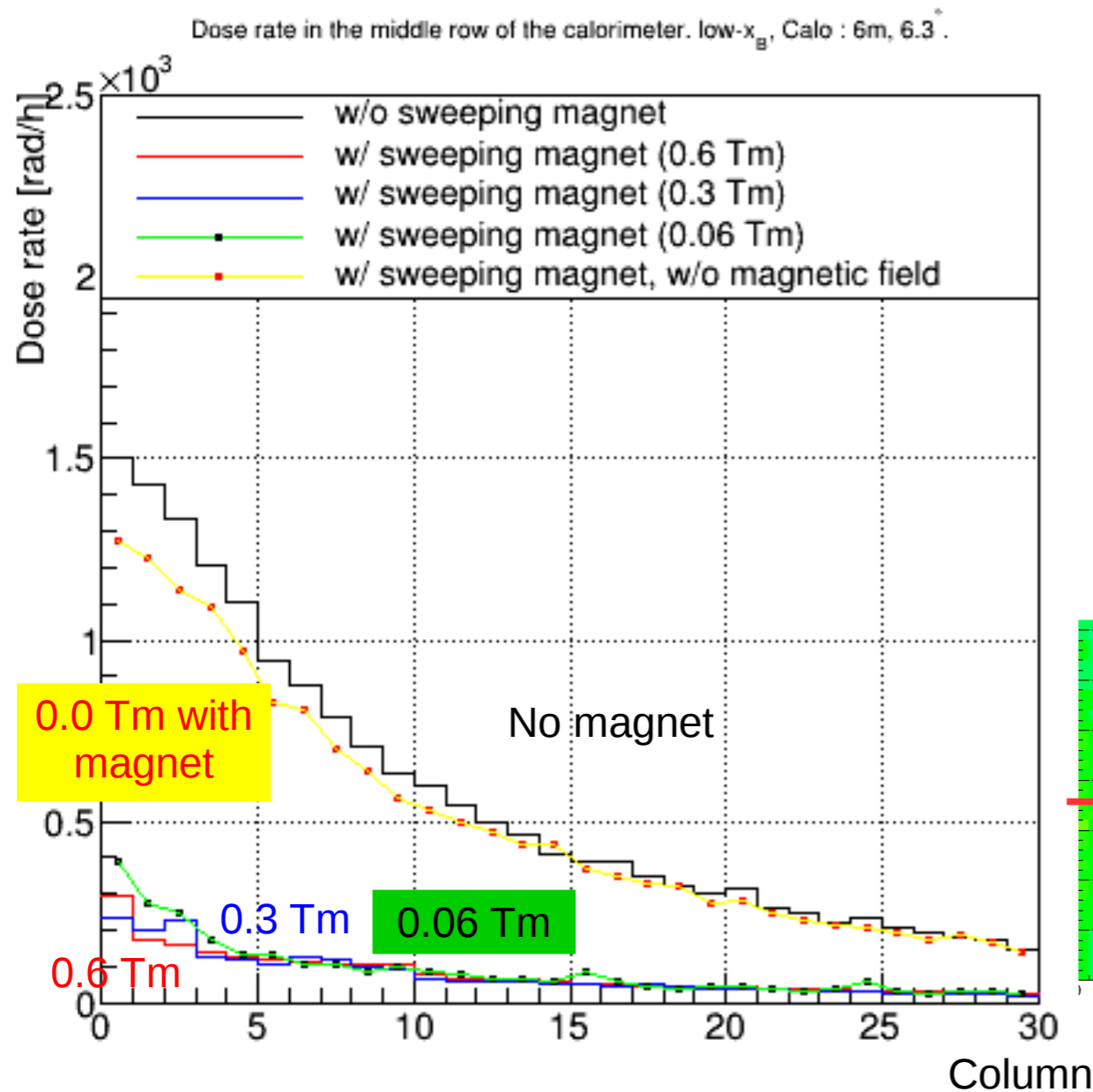~20% in total across the calorimeter.

→ consistent result with
dose distribution

Reduced magnetic field strength

Reduced magnetic field strength to its originally proposed (0.3 Tm) and other values to check the background dose.

## No magnetic field shielding on the beam-pipe, yet.

Background dose with reduce magnetic field

Dose rate in the middle row of the calorimeter. low-x_B, Calo : 6m, 6.3°.

Dose rate [rad/h]

- w/o sweeping magnet
- w/ sweeping magnet (0.6 Tm)
- w/ sweeping magnet (0.3 Tm)
- w/ sweeping magnet (0.06 Tm)
- w/ sweeping magnet, w/o magnetic field

0.0 Tm with magnet

No magnet

0.3 Tm

0.06 Tm

0.6 Tm

Column

No mag

0.6 Tm

0.3 Tm

0.06 Tm

0.0 Tm with physical magnet

Column

Dose rate in the middle row of the calorimeter (arrow)

Background dose with reduce magnetic field
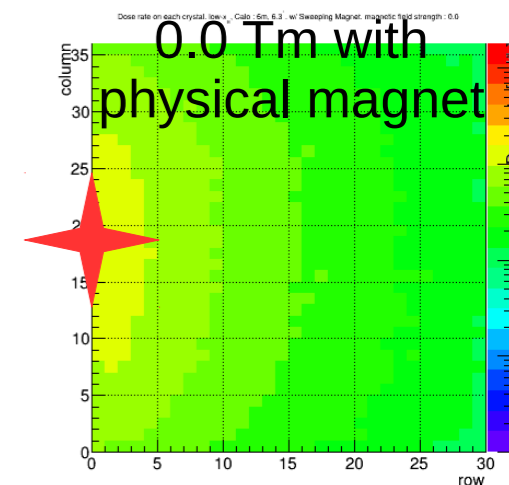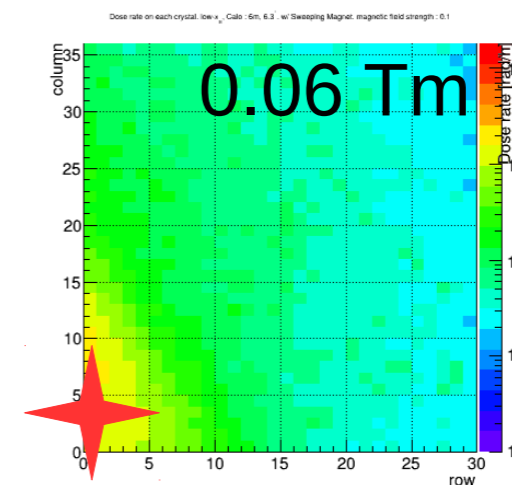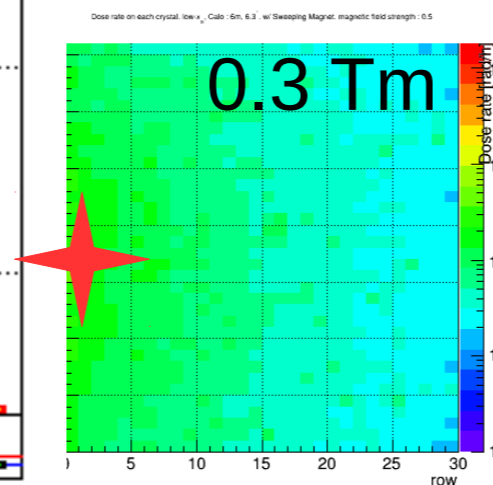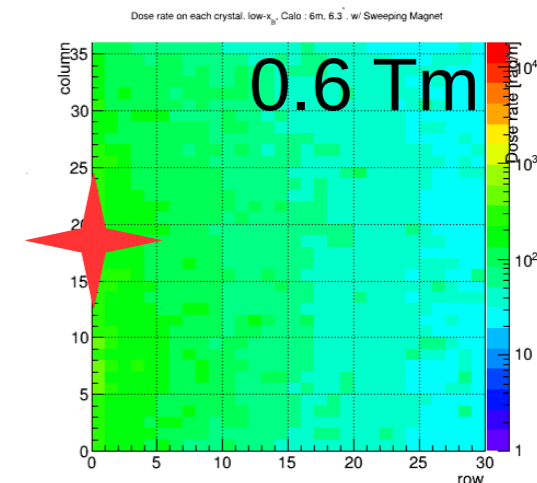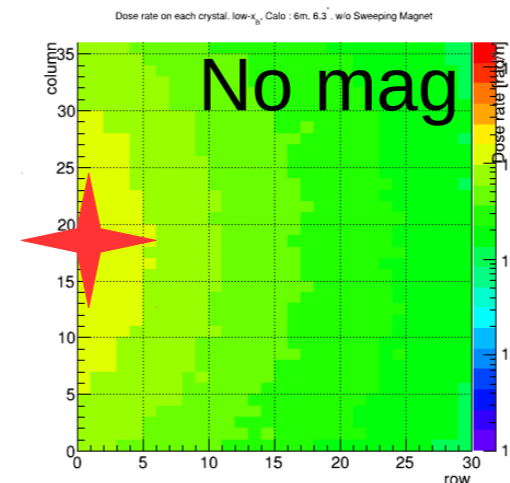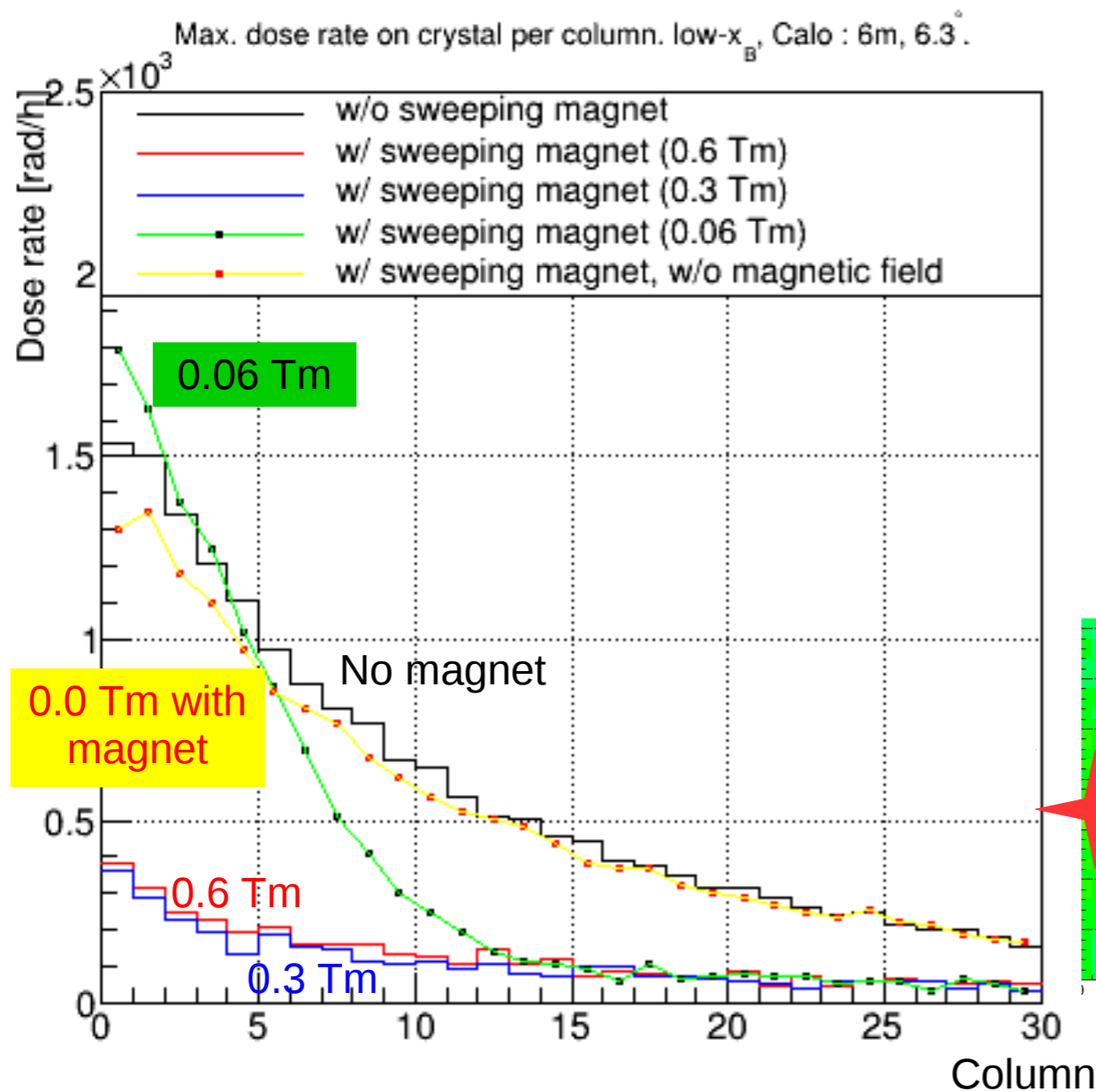
Maximum dose in each column of crystals.
Not necessarily comparing the same crystals.(stars)

Summary

- With magnetic field, the total energy of the particles with E < 10 MeV is ~20% of the total energy deposited in the detector

- Reduced magnetic field strength, 0.6 T*m → 0.3 T*m, does not significantly affect the background dose on the calorimeter

  Keep in mind that the magnetic field have not considered the beam-pipe shielding, yet.

Backups

Geant4 cuts

- Geant4 version using : 10.03.p03

- Has only one cut value called "range cut (in length unit) (default : 0.1 mm)"

  → convert into threshold energies for each material and for each particle type for the secondary particle production.

- Do not have tracking cuts.

  → All particles produced and accepted are tracked up to zero range.

  ==> Each process has its intrinsic limit(s) to produce secondary particles. And all particles produced (and accepted) will be tracked up to zero range.

- Document :

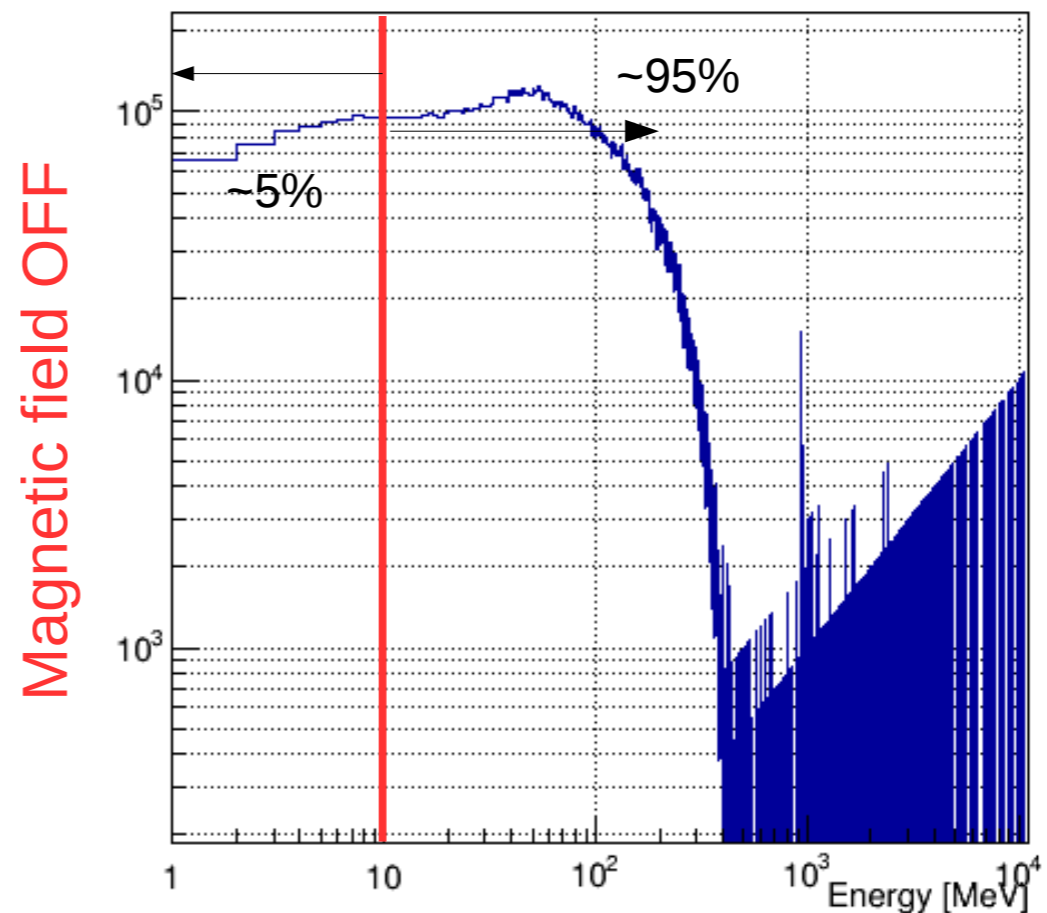 http://cern.ch/geant4-userdoc/UsersGuides/ForApplicationDeveloper/BackupVersions/V10.3/fo/BookForAppliDev.pdf

  see : ch.2.4.2 (p.12), ch.5.4 (p.220)

Energy and dose distribution of background in NPS

Energy distribution of background in NPS.
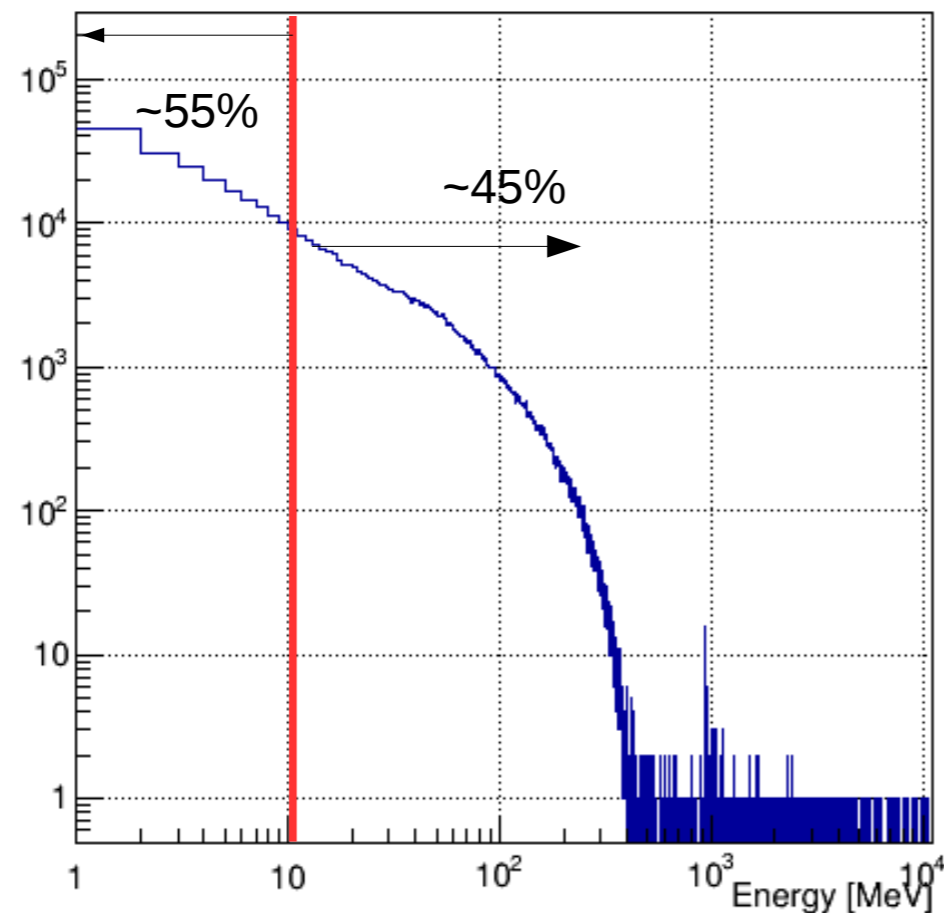
Dose distribution

Right plot was obtained by weighting each particle by its energy.
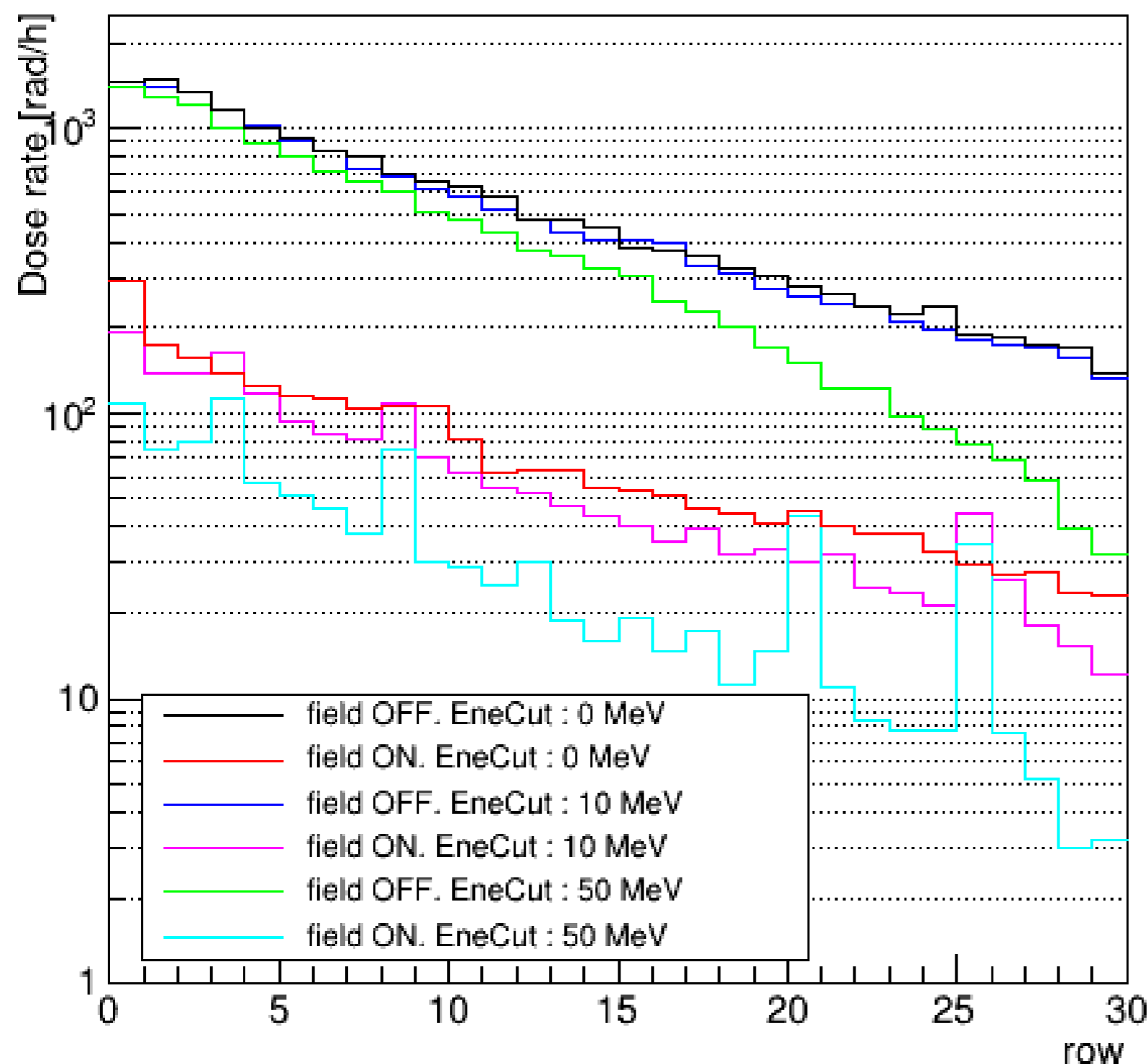
The numbers (~55%, ~5%, etc.) were calculated by integrating the ranges of interests ([0 MeV, 10 MeV] or [10 MeV, 11 GeV]) of the plots above.

~55% of background is from particles with E < 10 MeV.
However, the total energy from particles with E < 10 MeV is ~5% of the total energy deposited in the detector

Dose rate review

Dose rate on the middle row of the calo. low-x_B, Calo : 6m, 6.3°.

Field ON : from no cut to 10MeV cut
i.e. red → magenta

The dose rate decrease
~19% in total in the middle row.
~20% in total across the calorimeter.

Field OFF : from no cut to 10MeV cut
i.e. black → blue

The dose rate decreases
~3.3% in total in the middle row.
~4.4% in total across the calorimeter.

Legend:
- field OFF. EneCut : 0 MeV
- field ON. EneCut : 0 MeV
- field OFF. EneCut : 10 MeV
- field ON. EneCut : 10 MeV
- field OFF. EneCut : 50 MeV
- field ON. EneCut : 50 MeV

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Background dose with reduce magnetic field

Maximum dose in each column of crystals.

Background dose with reduce magnetic field
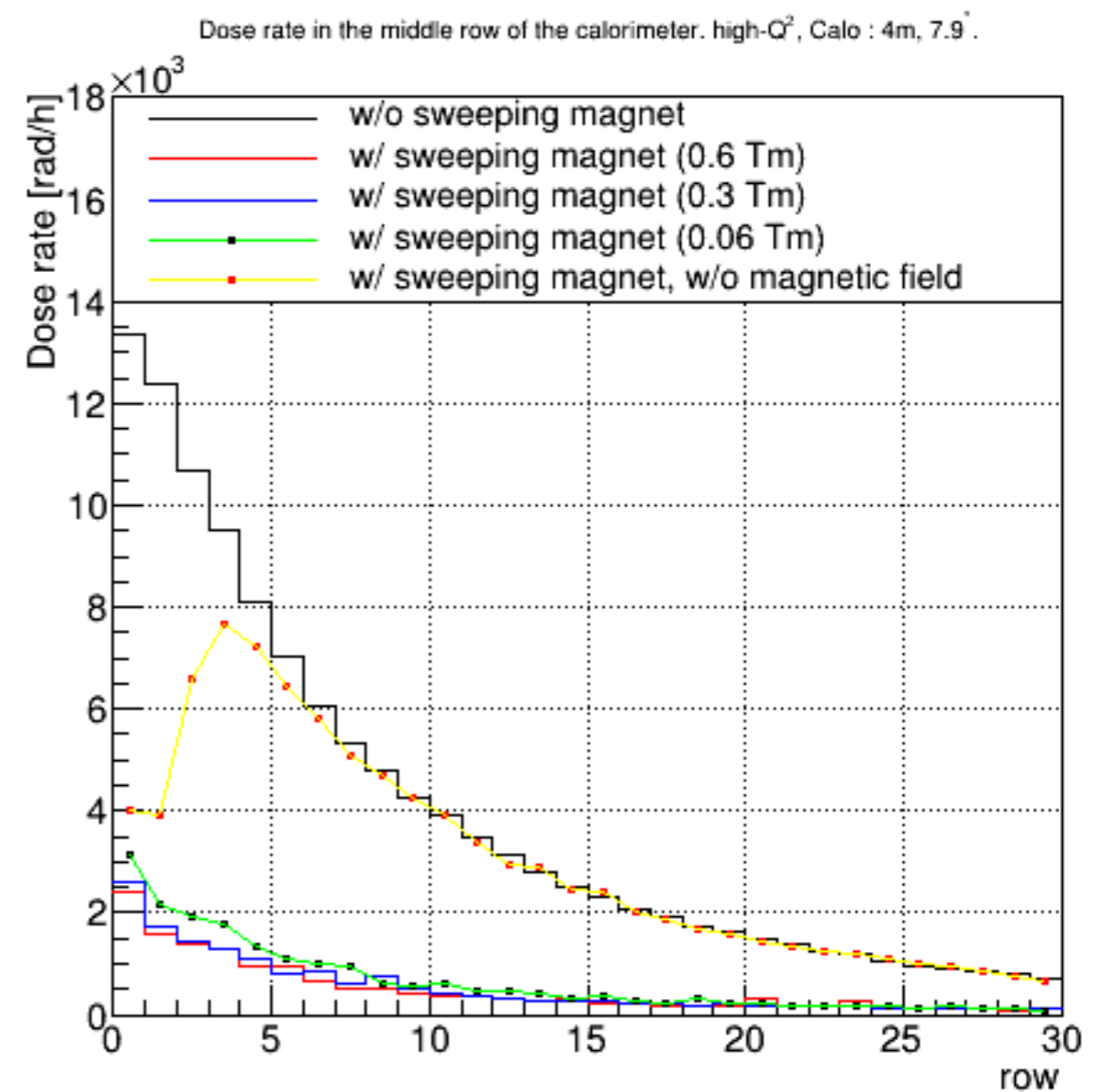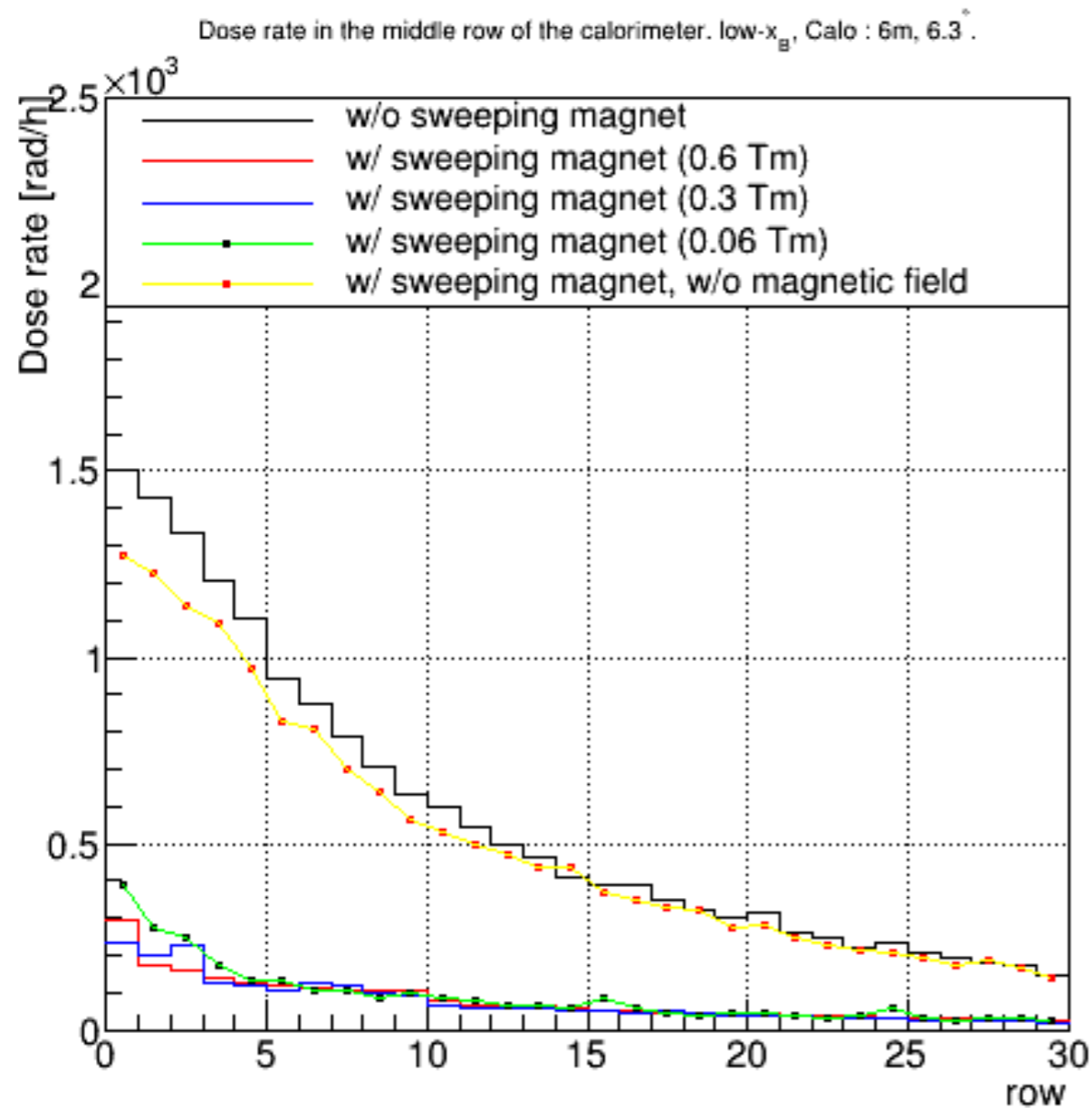
Dose rate in the middle row of the calorimeter

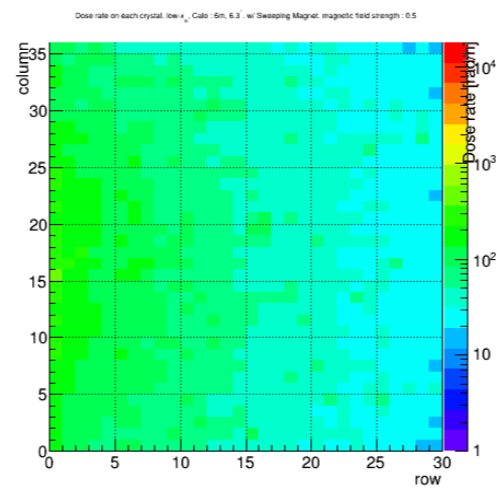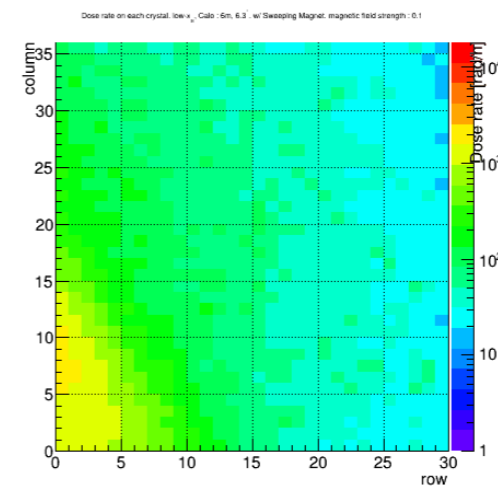# Background dose with reduce magnetic field
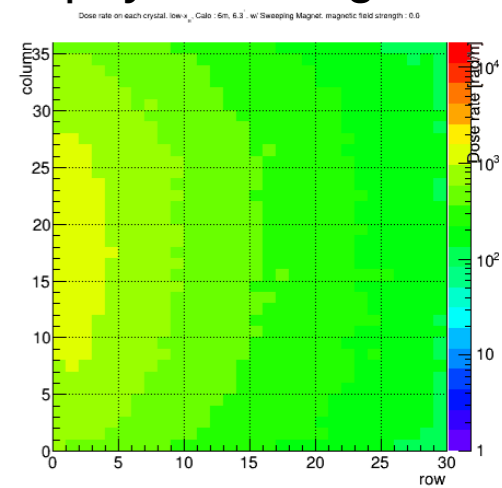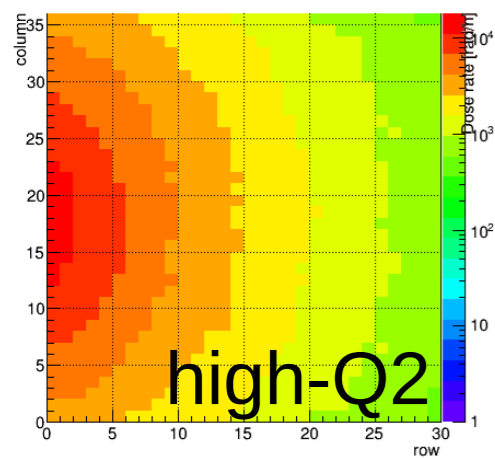
No mag	0.6 Tm	0.3 Tm	0.06 Tm	0.0 Tm with physical magnet