Micro-BEAST-TPC MC simulation studies

Igal Jaegle

University of Hawai'i at Mānoa

for the Belle2 Collaboration

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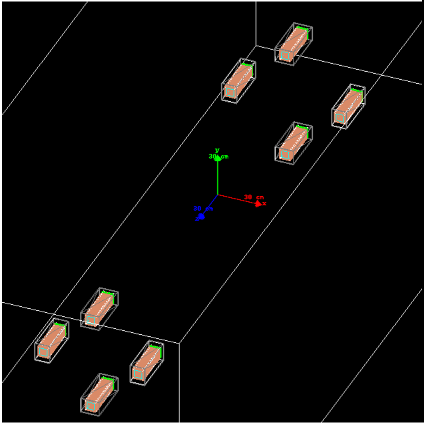
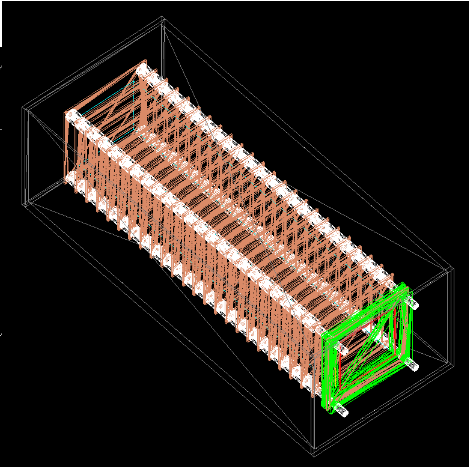
Geometry updated

- 8 TPC chambers 10.12 x 12.7 x 30 cm^3 (surface 4 x 5 $inch^2$)
- active volume $5 \times 5 \times 25$ cm^3
- surface from 0.72 x 0.8 to 4 x 3.36 cm^2 can be instrumented (1 FE-I3 to 4 FE-I4)
- E || B (0.3 to 0.9 kV/cm [depending of the chip and gas] || 1.5 T)



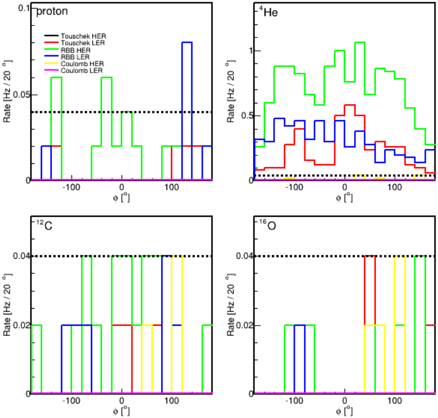


Angular rate expected of recoils measured at phase 2

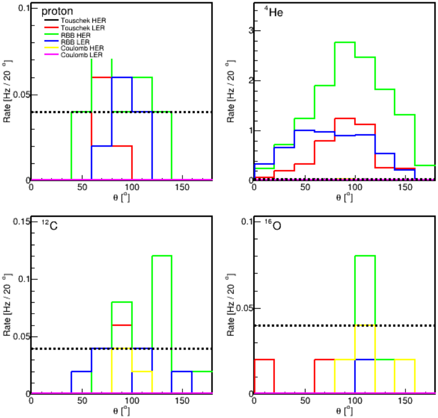
gas mixture He:CO_2:70:30 at 1 atm

- 4 chips, directional and edge cuts
- rates for different recoils
- compared to irreductible internal detector background (dashed black line)

- azimuthal rates



- polar rates

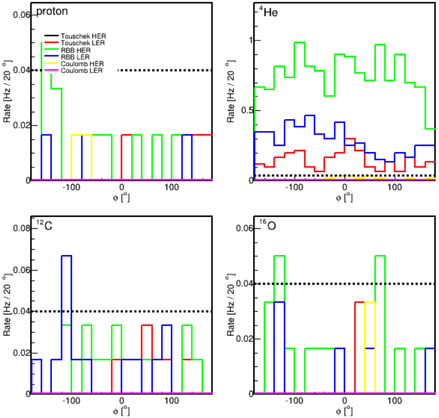


Angular rate expected of recoils measured at phase 2

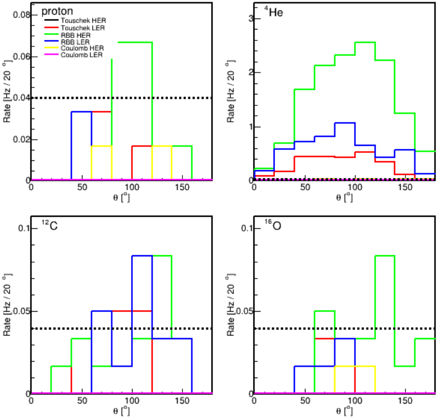
gas mixture He:CO_2:70:30 at 1 atm with previous geometry

- 4 chips, directional and edge cuts
- rates for different recoils
- compared to irreductible internal detector background (dashed black line)

▶ azimuthal rates



▶ polar rates



Material budget and dose definition

- material budget used in GEANT4 for the geometry updated
- dose = energy deposited / mass over a year

▸ material budget

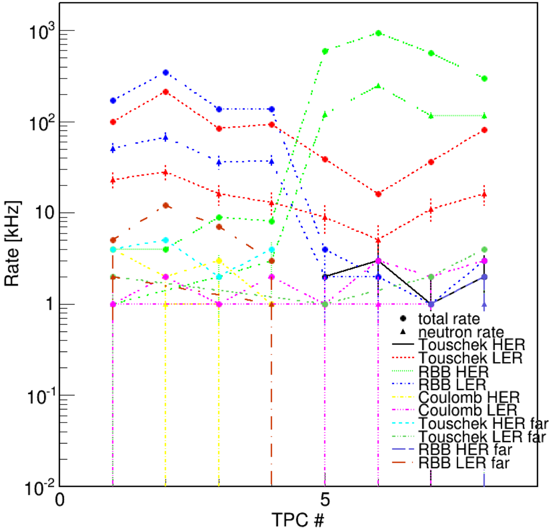
part	mass [kg]
gas	0.00245961
vessel	1.68071
endcap	0.315451
pixel board	0.0367019
pixel chip	0.00258
one ring	0.0282191
copper plate	0.0259732
one GEM	0.03344

▸ conversion table

1 rad (or rem) = 0.01 J/kg
1 gray (or sievert) = 1 J/kg
1 rad = 6.24e7 MeV/g
1 rad = 100 ergs/g

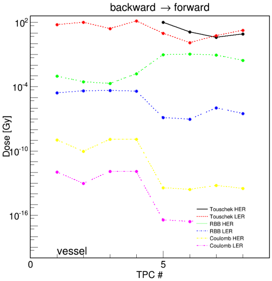
- TPC mass $\sim$ 2.5 kg

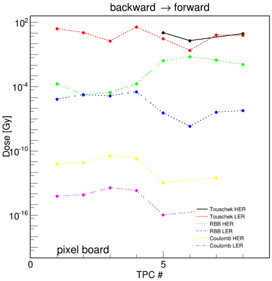
Expected rates in dock-spaces at phase 2

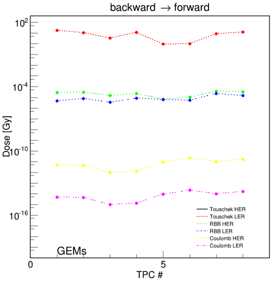


Estimated doses

Estimated doses for a year exposure at phase 2 luminosity derived from 5th compaign MC simulation at designed luminosity





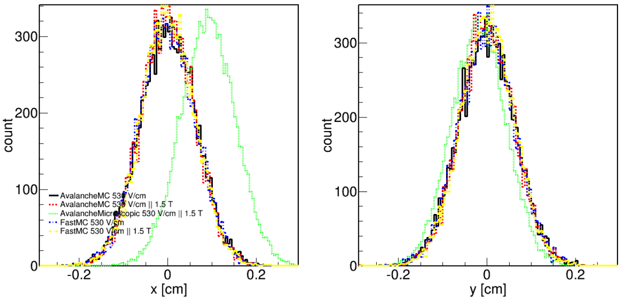


- doses range between 10's and 100's Gy or 1's to 10's krad for a year exposure
- GEM and board can operate up to few Mrad
- Touschek radiation dominating due mostly to EM particles
- RBB radiation relatively low

Magnetic field effect

Magnetic field effect on a drifting charge over long distances (25 cm) for the case where E || B in:

- FastMC: MC integration based on the macroscopic drift velocity and diffusion coefficients as functions of the electric and magnetic field
- GARFIELD++/AvalancheMC: MC integration based on the macroscopic drift velocity and diffusion coefficients as functions of the electric and magnetic field
- GARFIELD++/AvalancheMicroscopic: MC simulation based on the microscopic scattering rates as functions of the electron energy ("microscopic tracking")



- FastMC and GARFIELD++/AvalancheMC are in good agreement
- bug in GARFIELD++/AvalancheMicroscopic ?
- or MAGBOLTZ coefficients alone cannot properly describe the motion of a drifting charge ?