Background Studies for the LDC TPC

Neutrons and Other Junk

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Background at the ILC

e^+e^- pairs are the main source of background

- created through beam-beam interaction
- smash into forward calorimeters and quadrupoles
- create neutrons, photons, and charged particles

Secondary particles produce detector hits

- charged tracks
- neutron-proton collisions in the TPC gas
- nuclear interactions $\longrightarrow$ more photons
- Compton scattering, photon conversion

Neutrons flood the detector, decay after 15 minutes

Simulation Tools

Guinea Pig

- simulates beam-beam interaction
- generates (among others) e^+e^- pair particles

Brahms

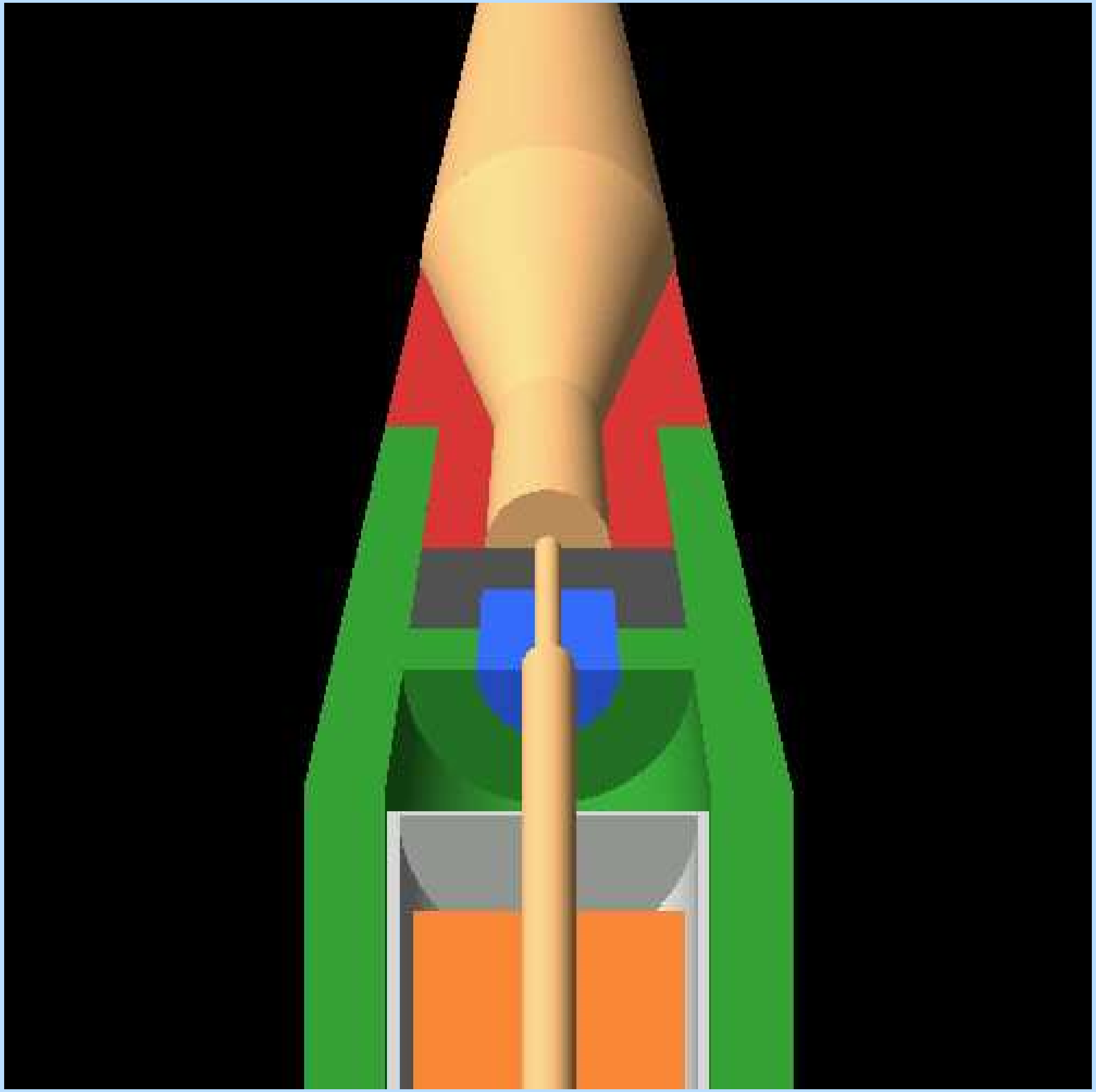
- simulates interaction of particles with the detector
- based on old Geant 3, Fortran

Mokka

- successor of Brahms, under continuous development
- based on state-of-the-art Geant 4, C++

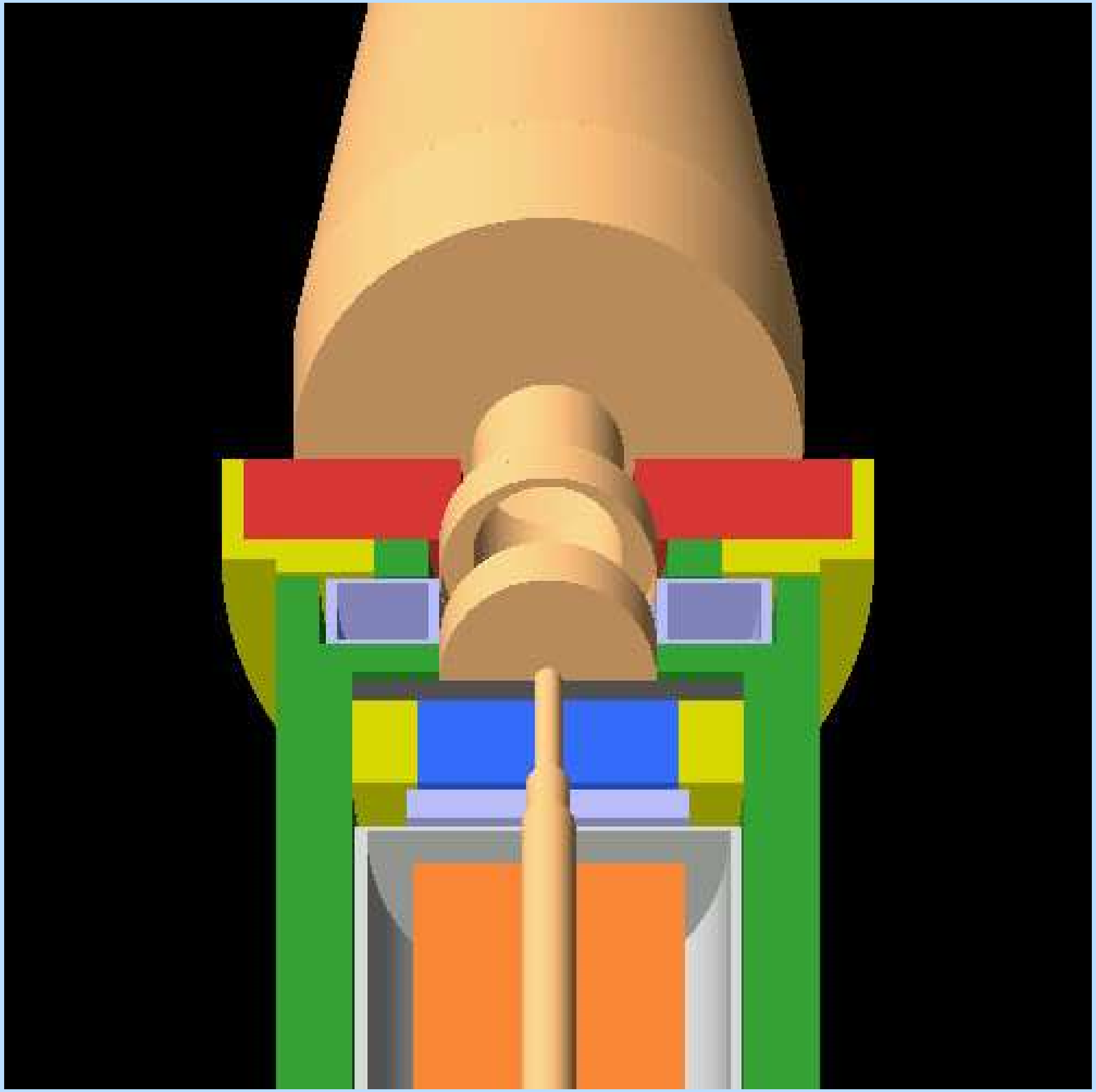
Detector Geometries – TESLA TDR

- Head-on
- LAT (red)
- Low-Z absorber
  Ø = 24 mm
- LCAL (blue)
- Quadrupoles
  L^* = 3.00 m



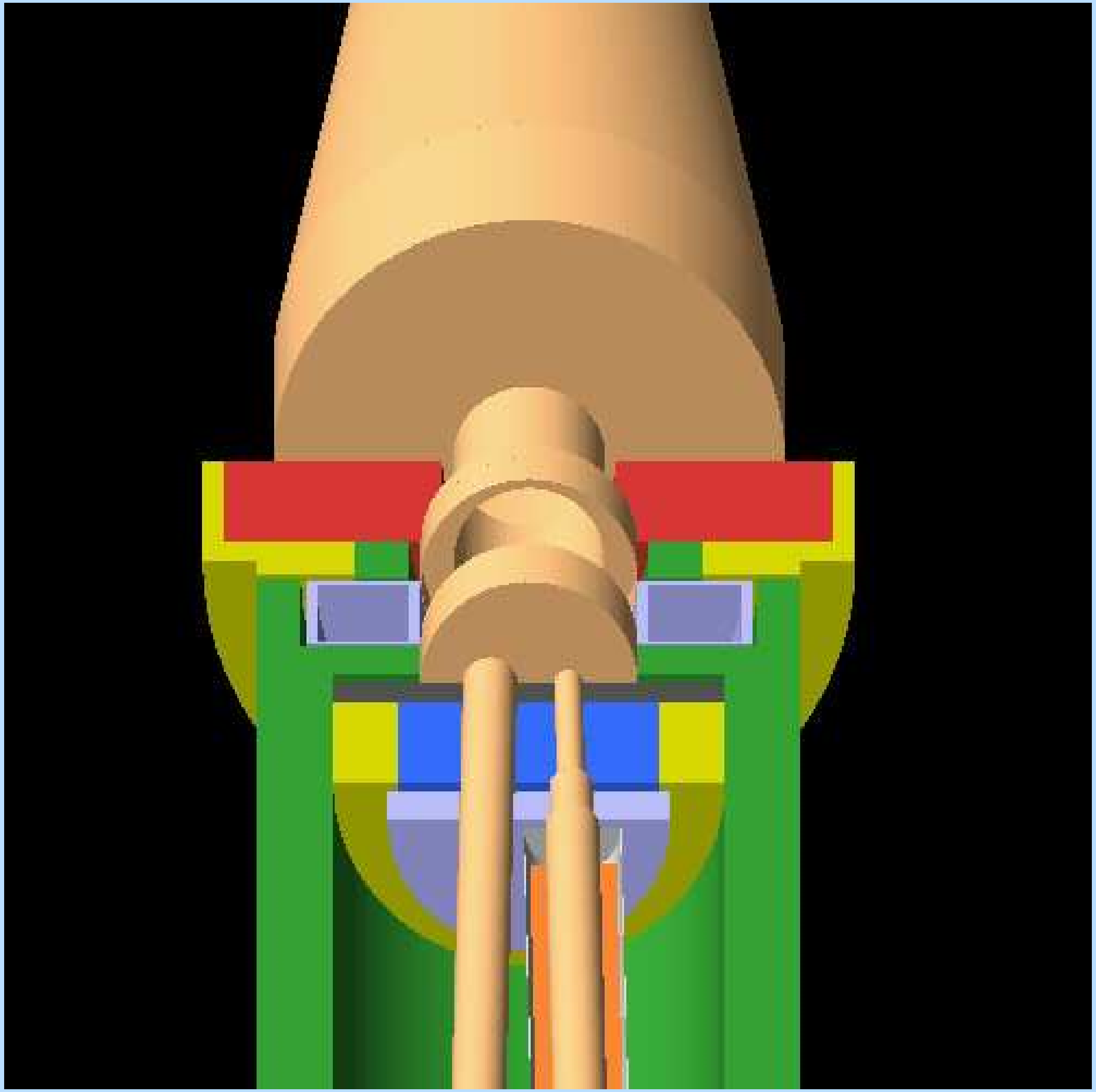
Detector Geometries – Stahl Layout

- Head-on
  or 2 mrad
- LumiCal (red)
- Low-Z absorber
  Ø = 26 mm
- BeamCal (blue)
- Quadrupoles
  L^* = 4.05 m

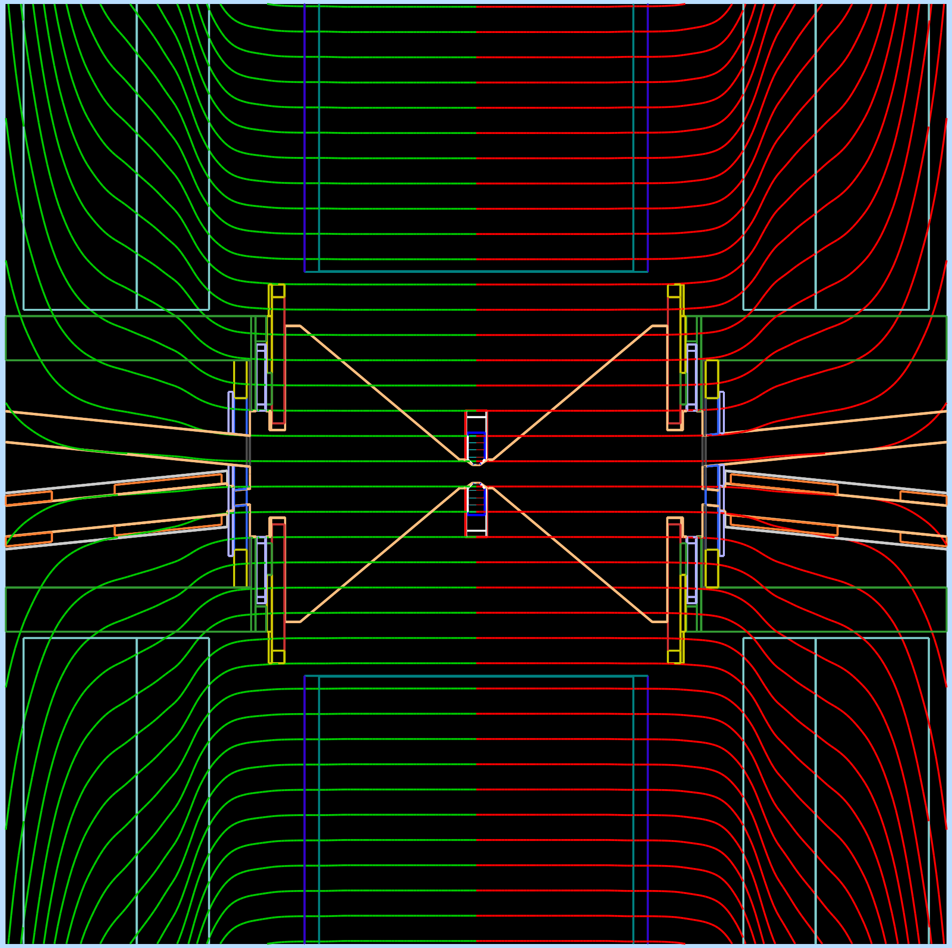


Detector Geometries – Crossing Angle

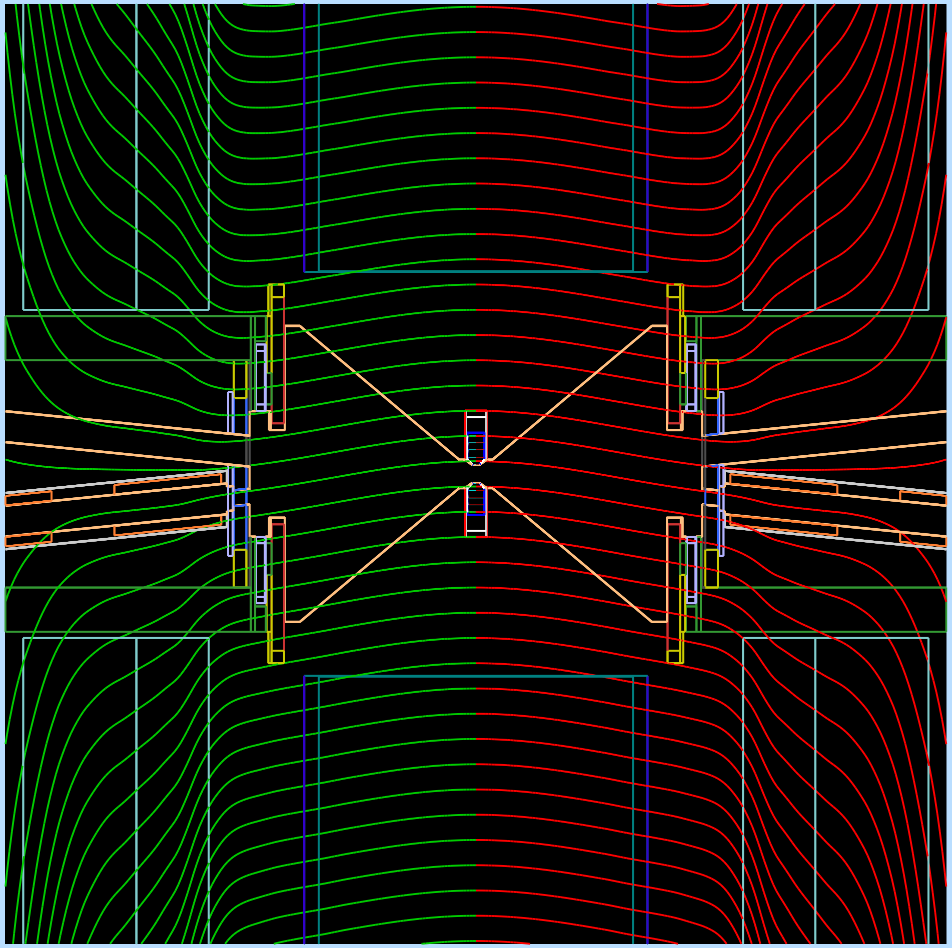
- 20 mrad
- LumiCal (red)
- Low-Z absorber
  $Ø_1$ = 26 mm
  $Ø_2$ = 50 mm
- BeamCal (blue)
- Quadrupoles
  L^* = 4.05 m
- with or without additional DID



Magnetic Field Maps



Plain solenoid



Solenoid with DID

Realistic field maps (plus simplified quadrupoles)

Running Mokka

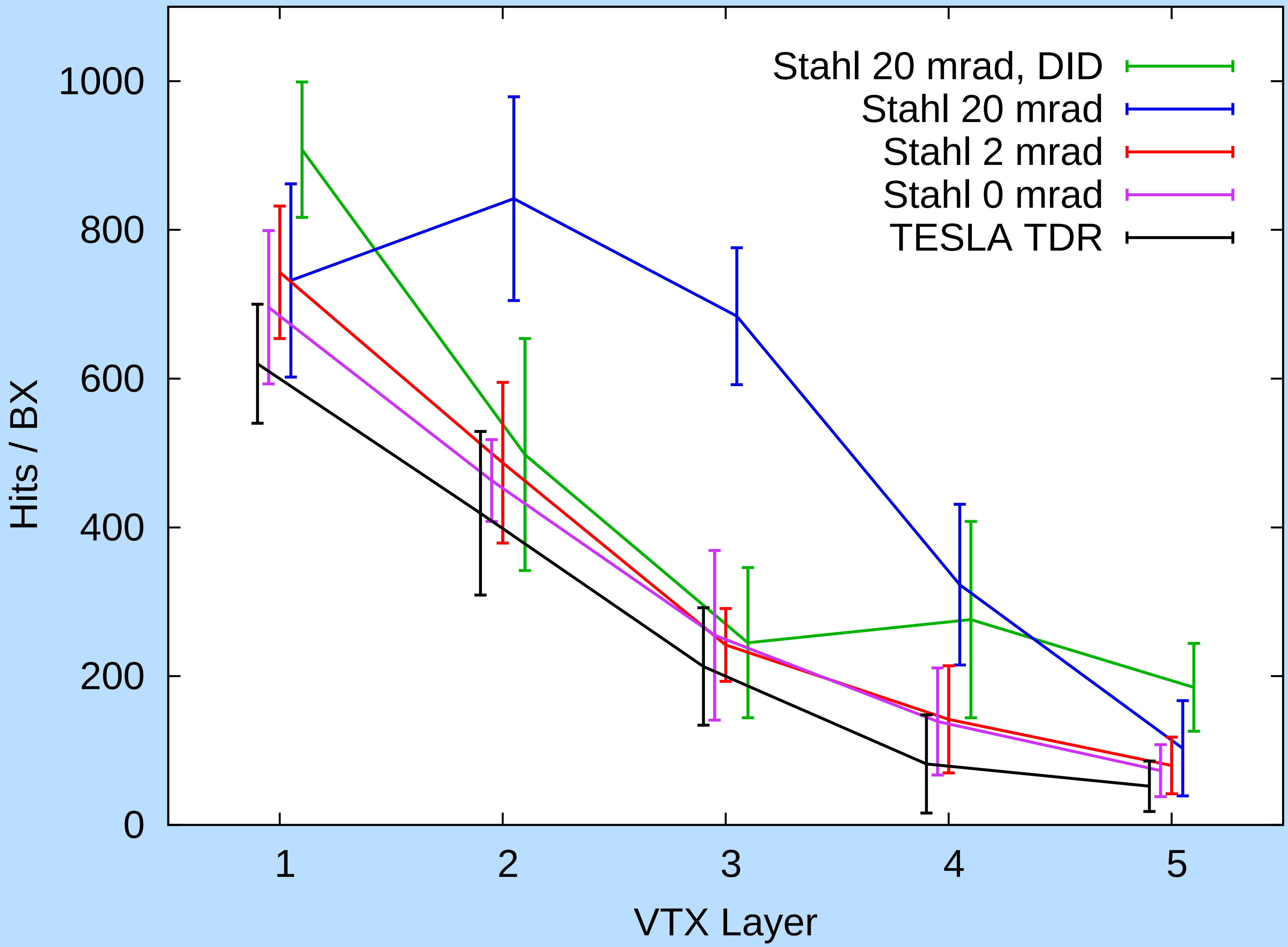
Input

- TESLA TDR beam parameters
- Guinea Pig pairs from 5 simulated BX
- different geometries and magnetic fields
- neutron production enabled in Geant 4
- standard range cuts

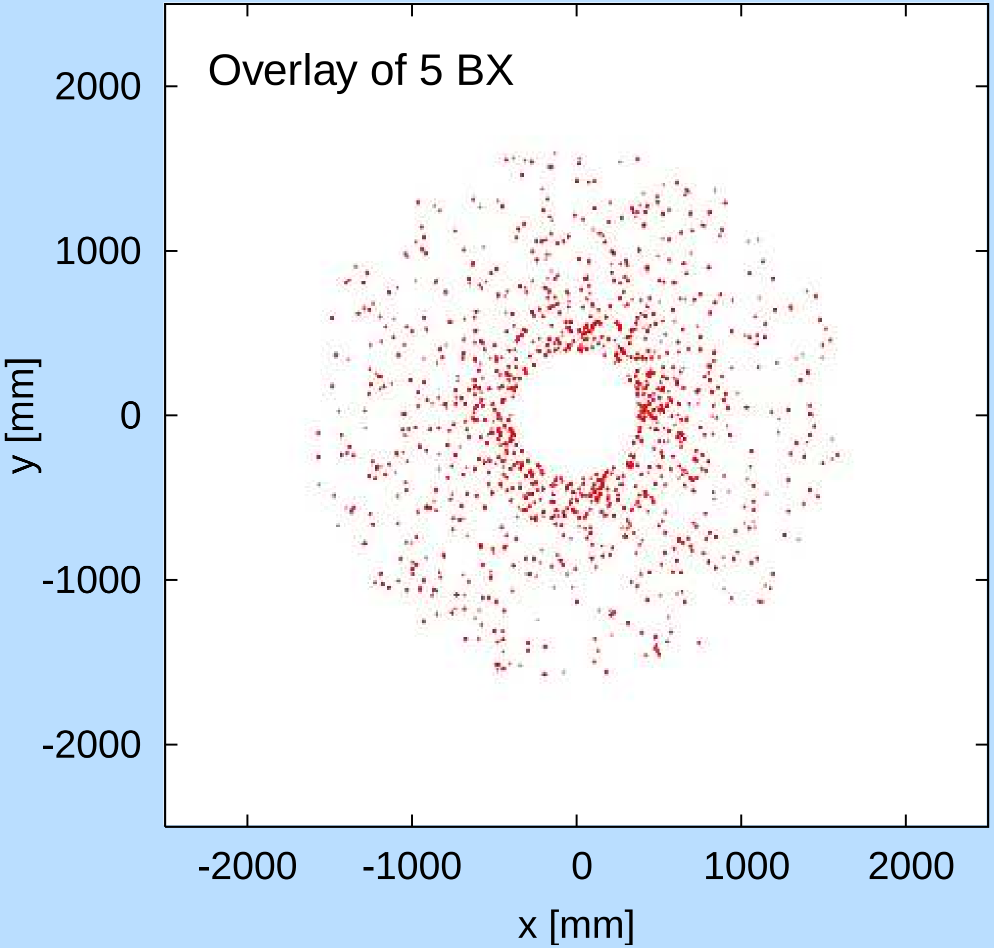
Output

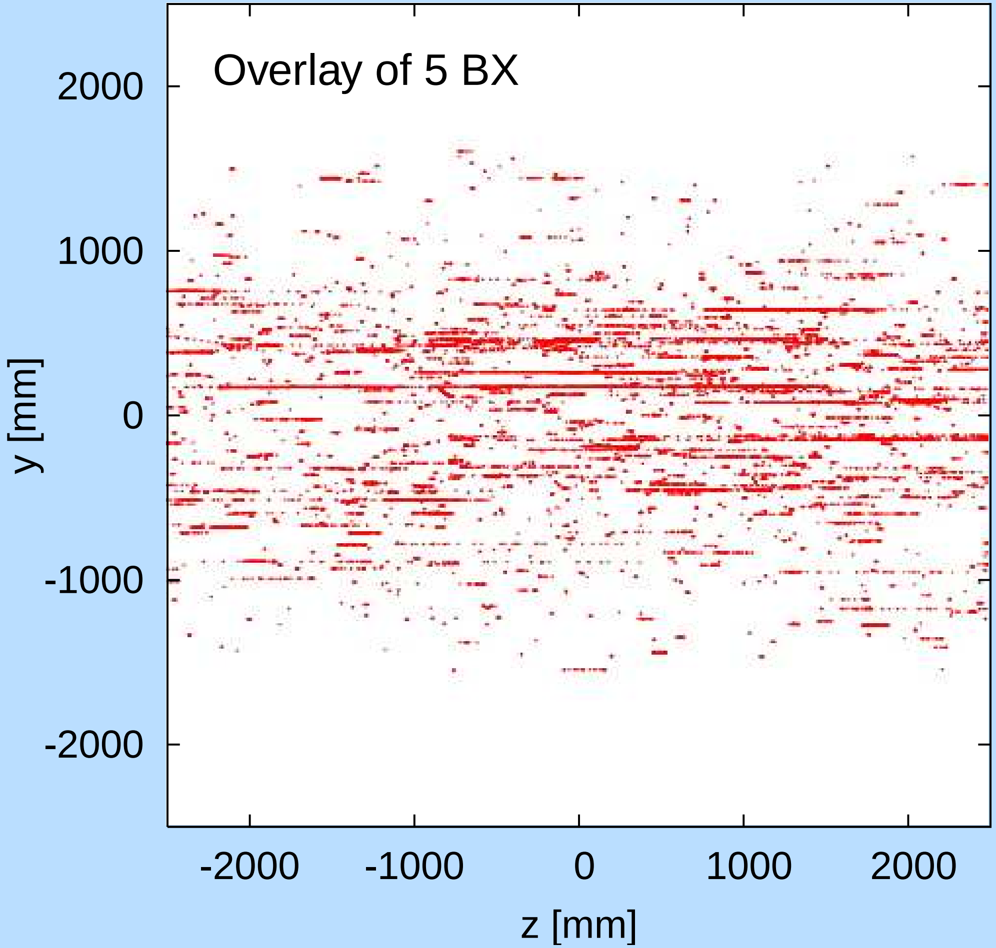
- write out hits on all detectors to LCIO files
- monitor all particles entering the TPC
  (for a future dedicated, detailed simulation)

Results – Hits on the Vertex Detector



Results – TPC Hits





Stahl layout, TDR gas: 5500 $\pm$ 900 Mokka hits / BX

Stahl layout, P 10 gas: 5000 $\pm$ 600 Mokka hits / BX

Results – Particles in the TPC

- Particles entering the TPC per BX

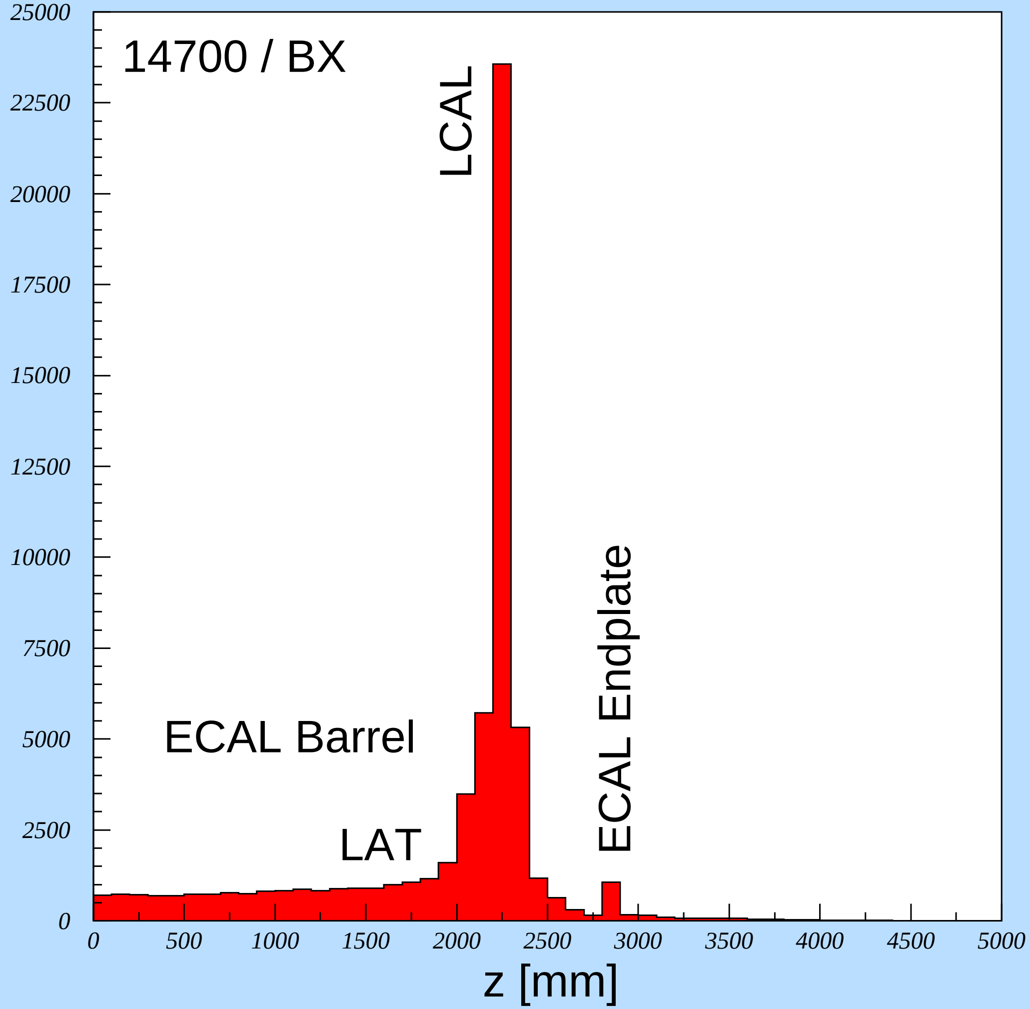
	TDR layout	Stahl layout
Neutrons	14700 ± 400	720 ± 70
Photons	9400 ± 200	5500 ± 100
Electrons	70 ± 60	40 ± 40

- Particles created inside the TPC per BX

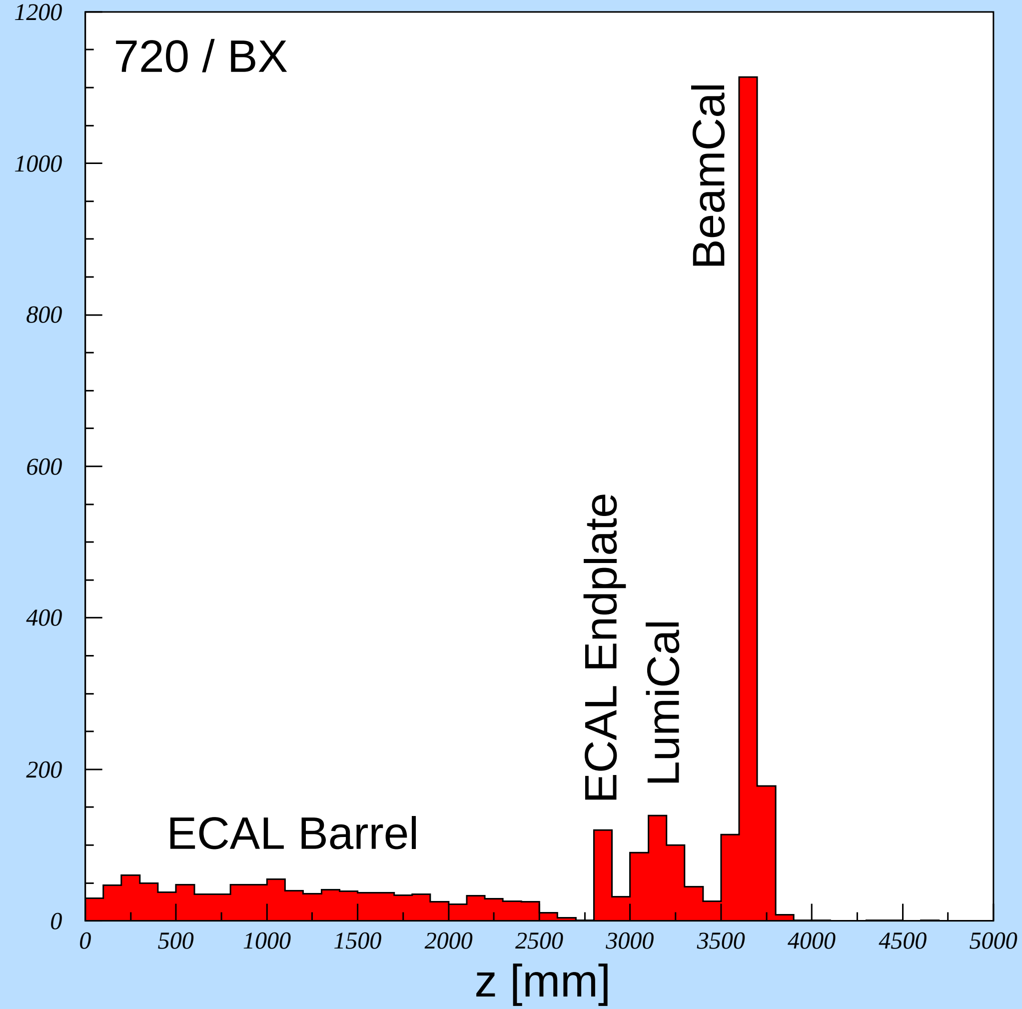
	TDR layout	Stahl layout
Electrons	3700 ± 400	2550 ± 350
Protons	150 ± 10	12 ± 2

Neutron Production – Distances

Origins of neutrons reaching the TPC



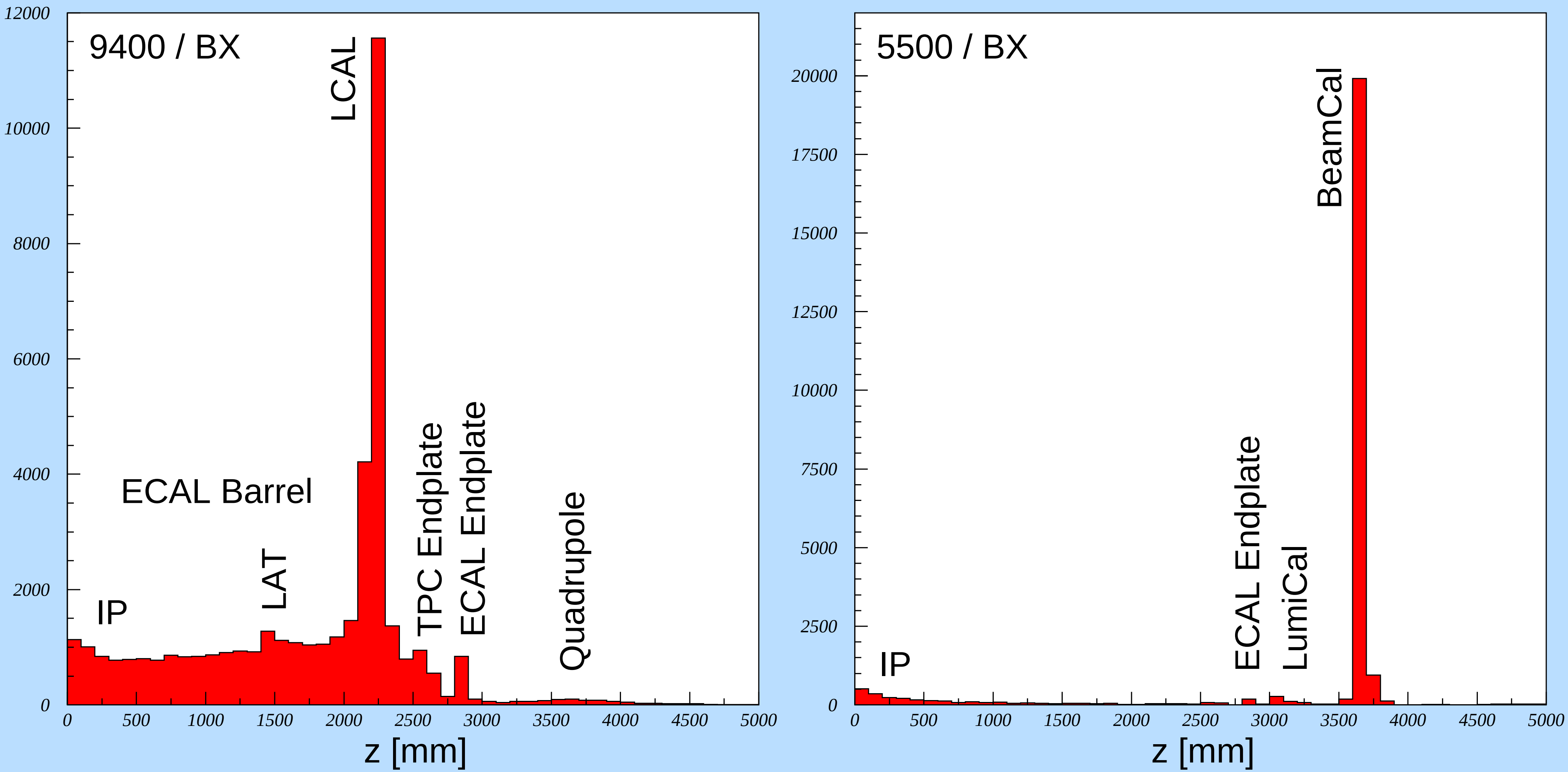
TDR layout



Stahl layout

Photon Production – Distances

Origins of photons reaching the TPC

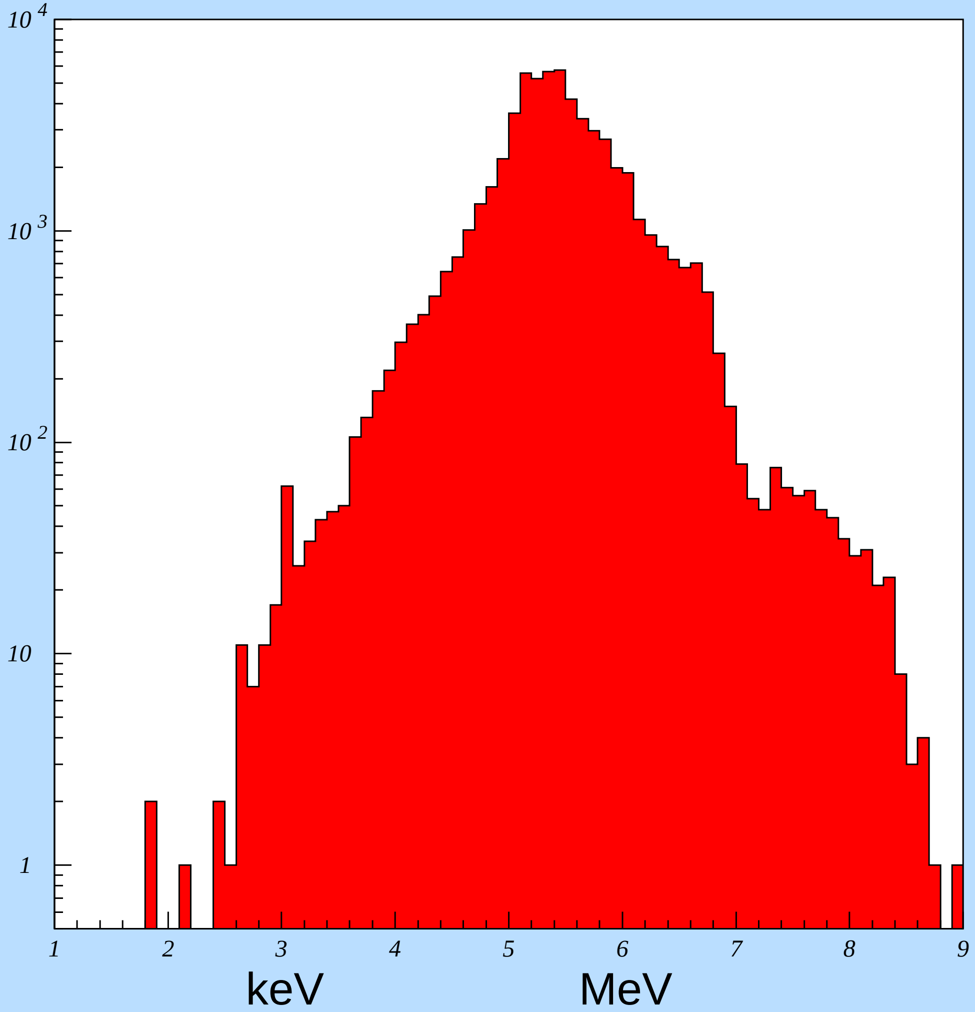


TDR layout

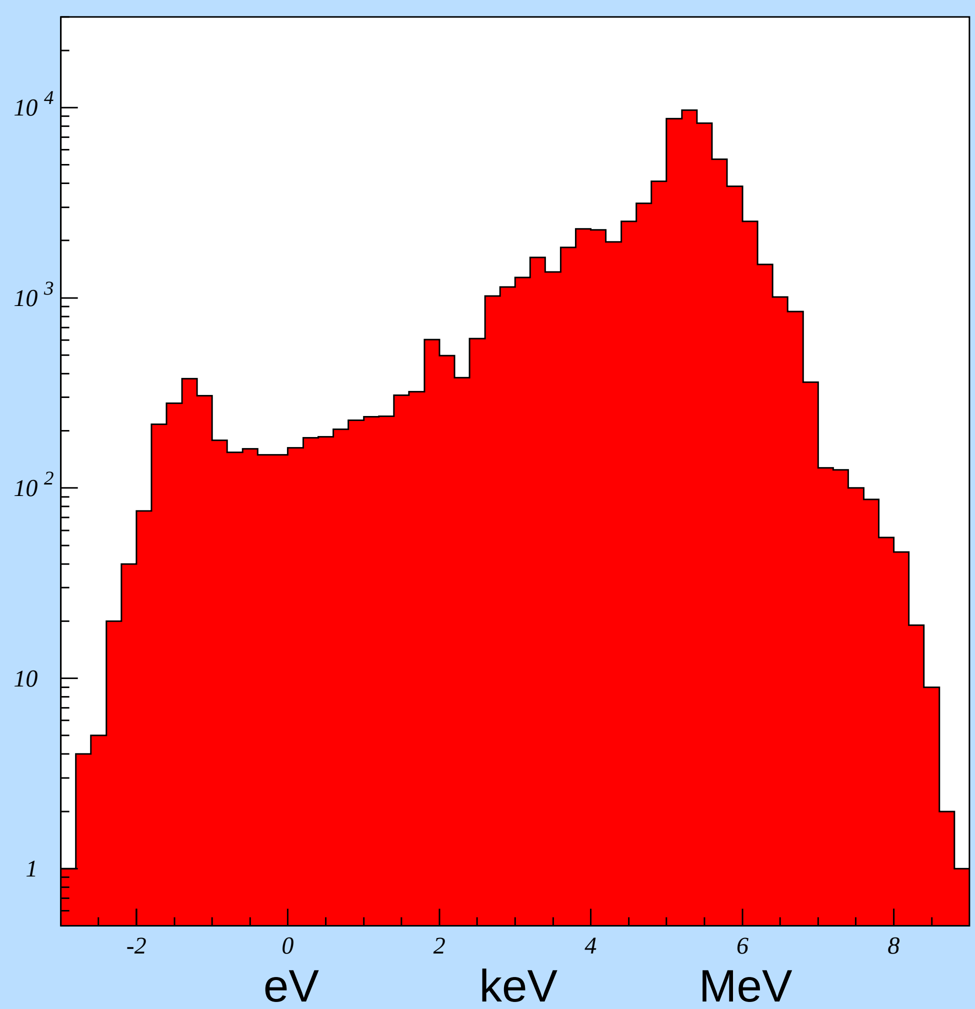
Stahl layout

Neutron Production – Energies

Spectra for 5 BX with TDR layout (Stahl is similar)



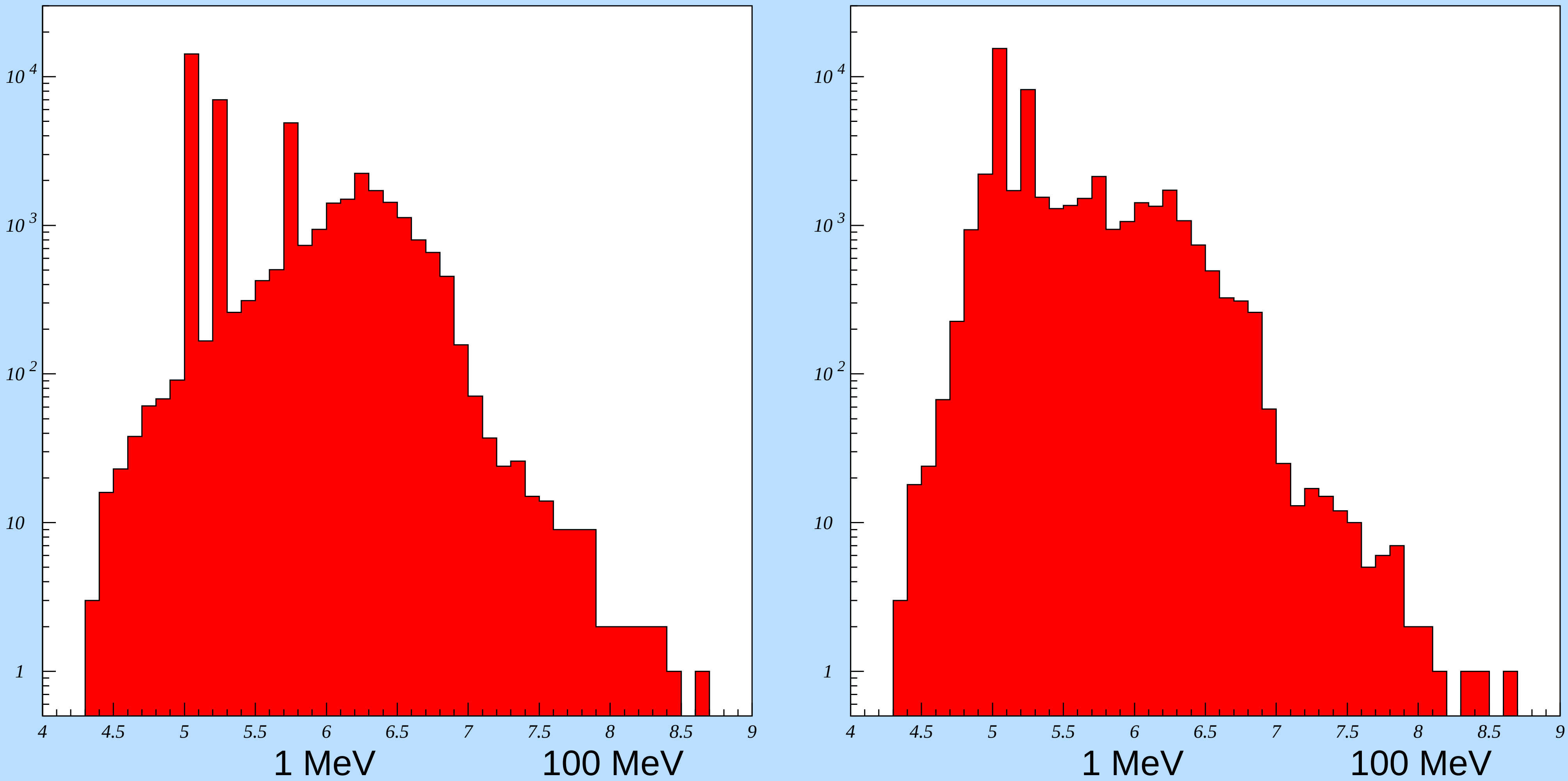
Energies of neutrons. . .



. . . when entering the TPC

Photon Production – Energies

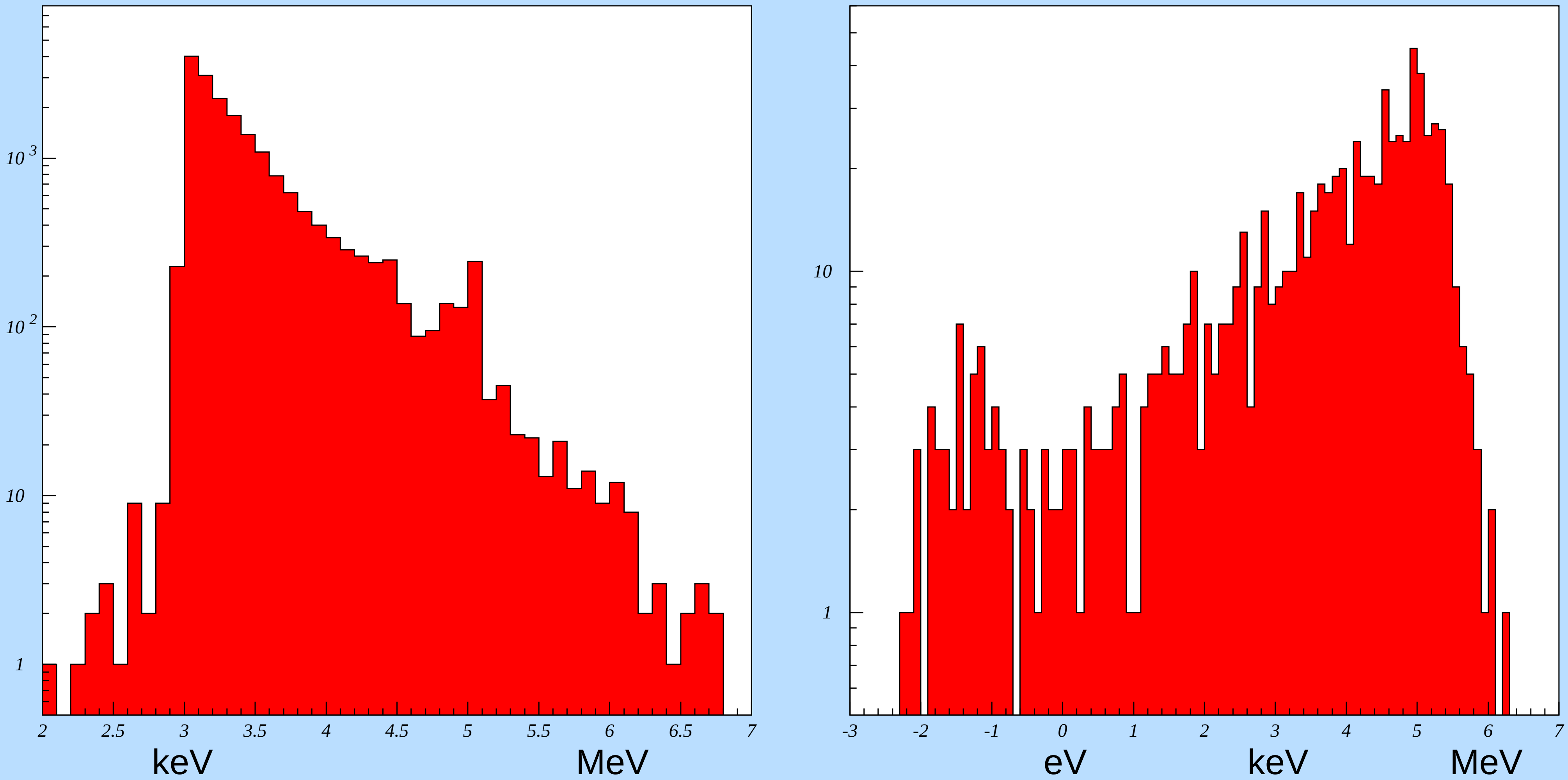
Spectra for 5 BX with TDR layout (Stahl is similar)



Energies of photons. . .   . . . when entering the TPC

Charged Particle Production – Energies

Energies of charged particles created inside the TPC



Electrons (mostly delta) Protons (mostly recoil)

Next Steps

Further work still needs to be done:

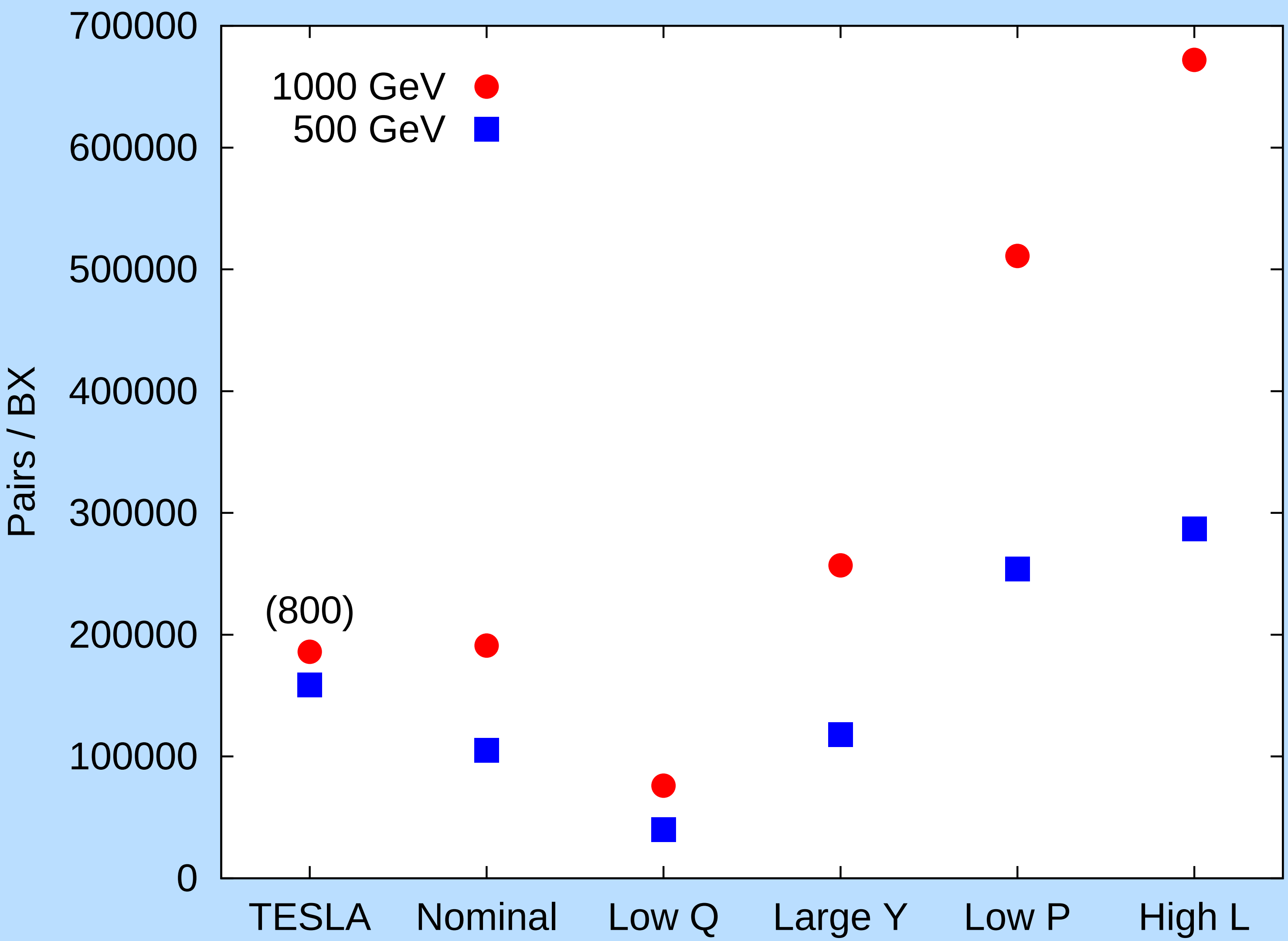
- use a dedicated, detailed TPC simulation (A. Münnich)
- get a better understanding and handling of neutrons (low-energy behaviour, diffusion, decay) – use Fluka?
- get more statistics (unleash the power of the Grid!)

Final goal of the TPC simulations:

- create a “background library” with ready-to-use events
- estimate all background tracks and the occupancy at a given time (with superposition of 160 BX)

How much background will the detector be able to handle?

Beware – Things Might Get Worse . . .



S. Gronenborn (EUROTeV-Memo-2005-003-1)