

# **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  $\rightarrow$  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

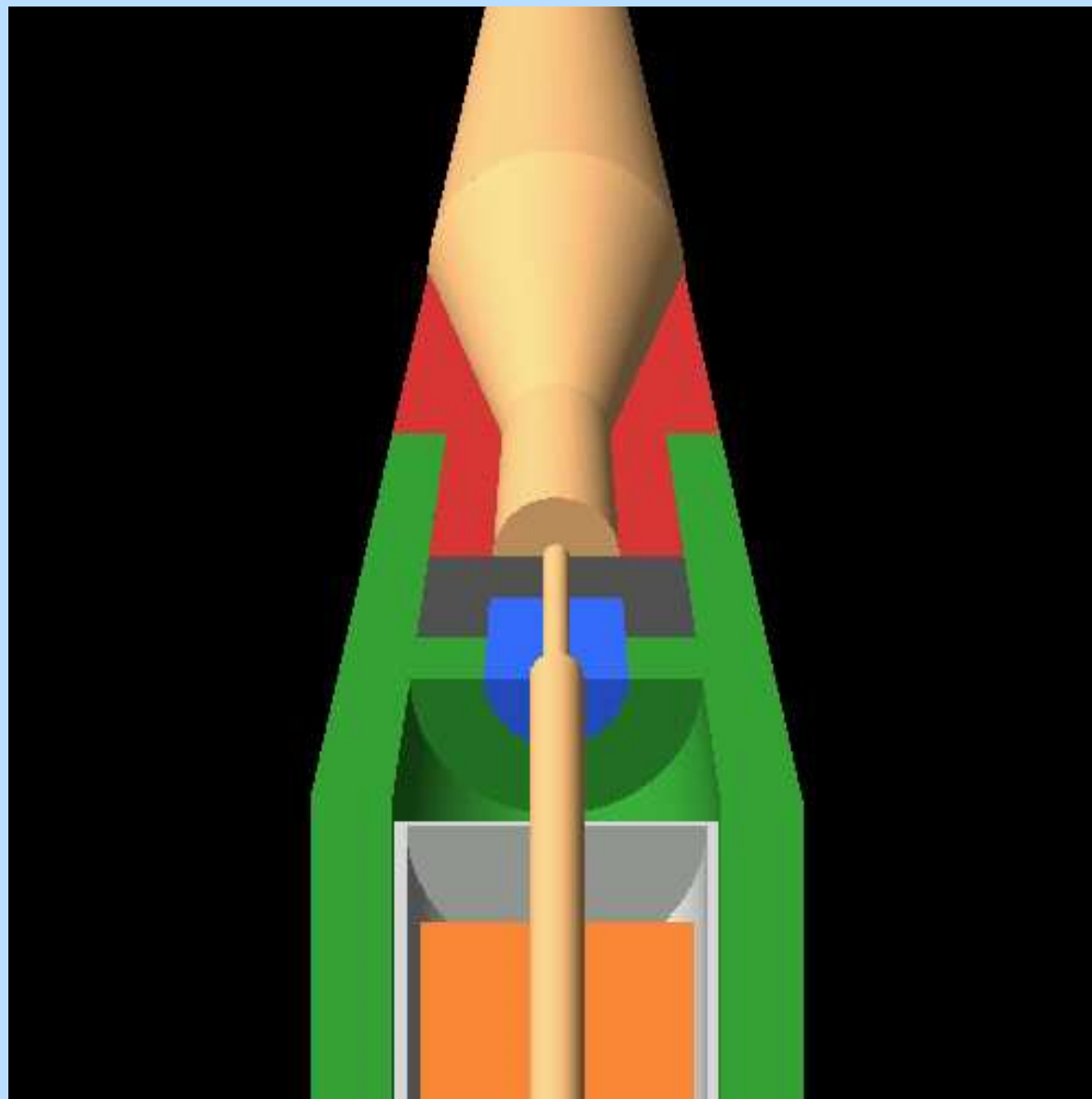
- simulates interaction of particles with the detector
- based on old Geant 3, Fortran

## Mokka

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

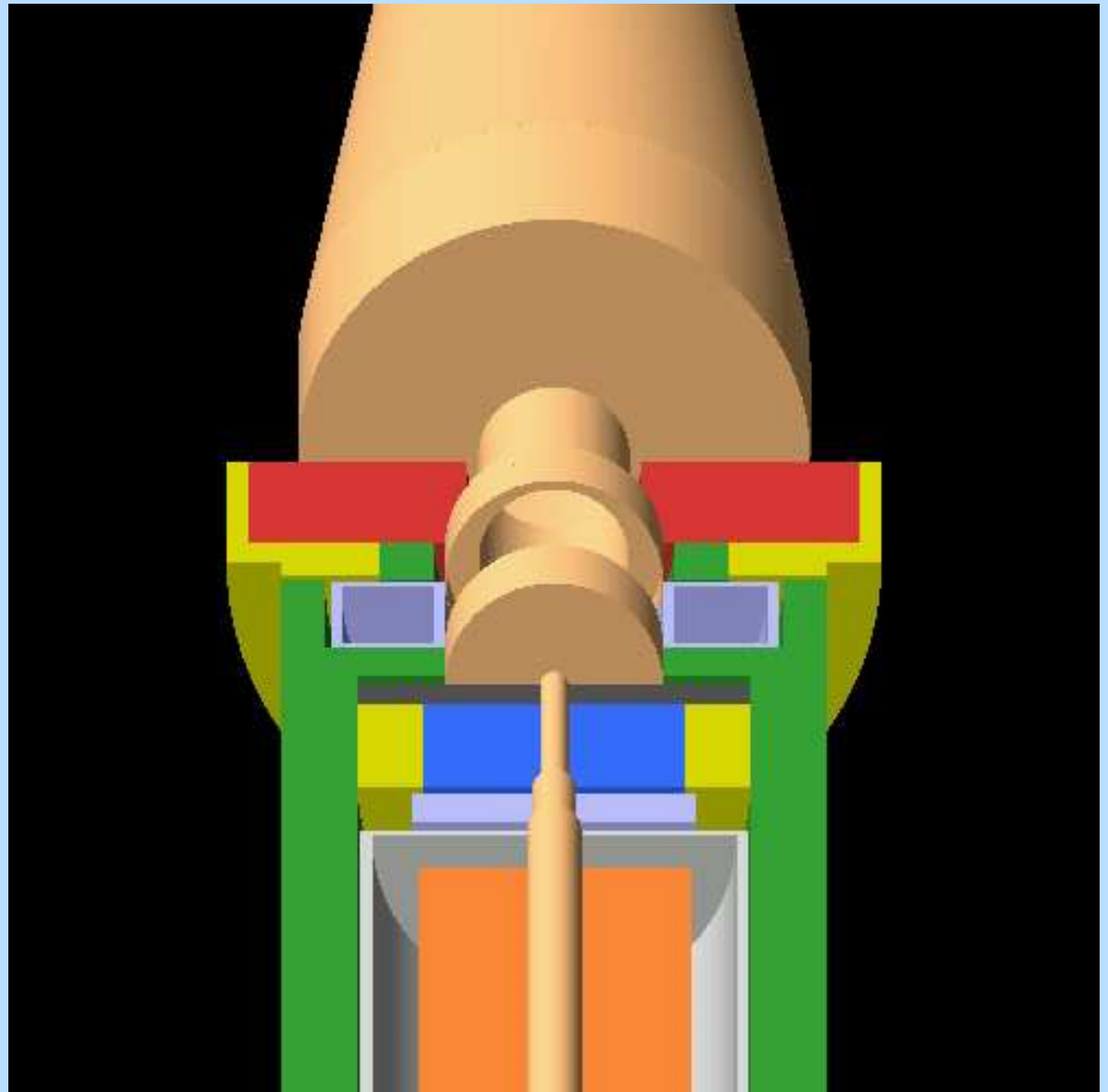
# Detector Geometries – TESLA TDR

- Head-on
- LAT (red)
- Low-Z absorber  
 $\varnothing = 24 \text{ mm}$
- LCAL (blue)
- Quadrupoles  
 $L^* = 3.00 \text{ m}$



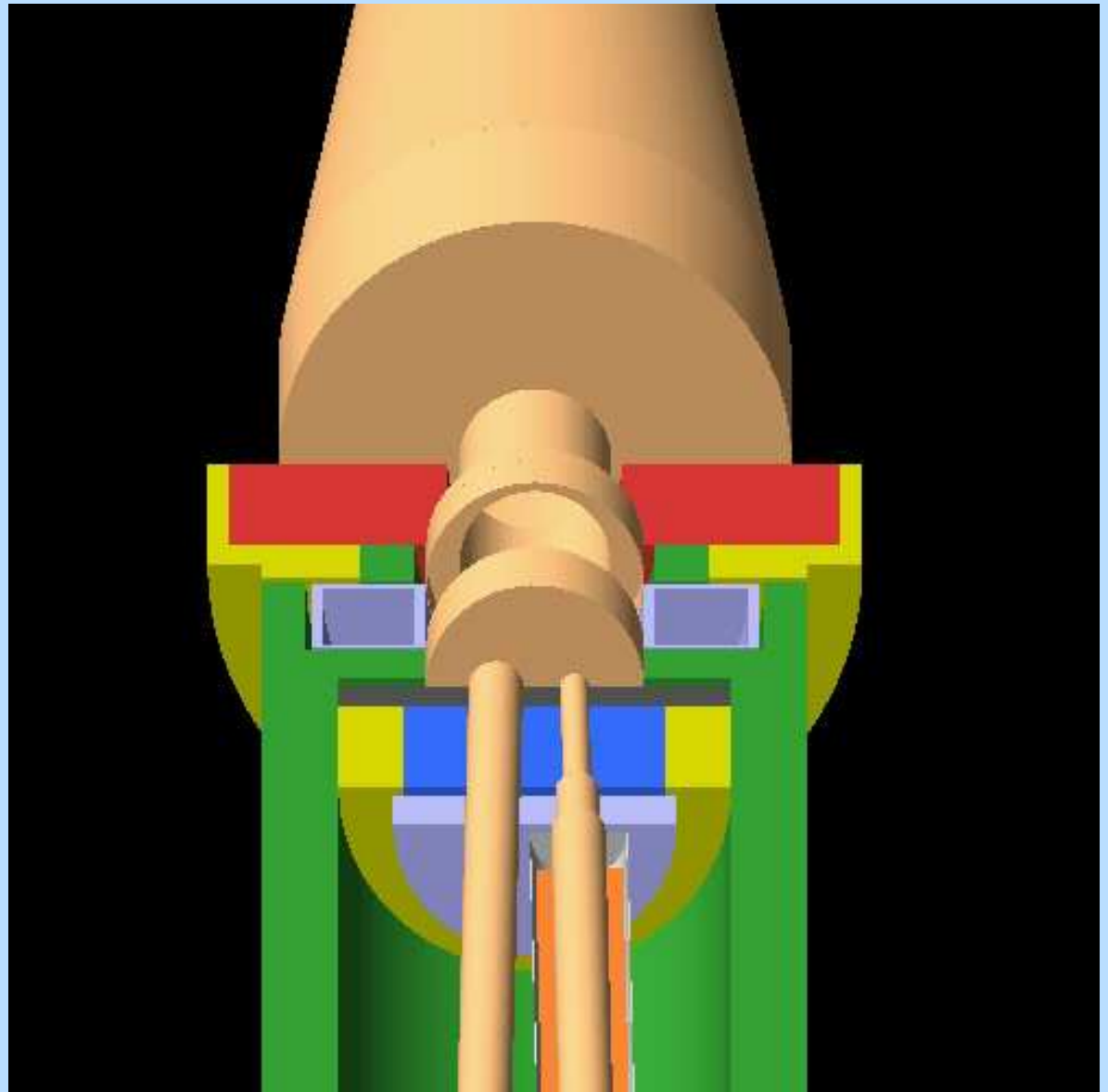
# Detector Geometries – Stahl Layout

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

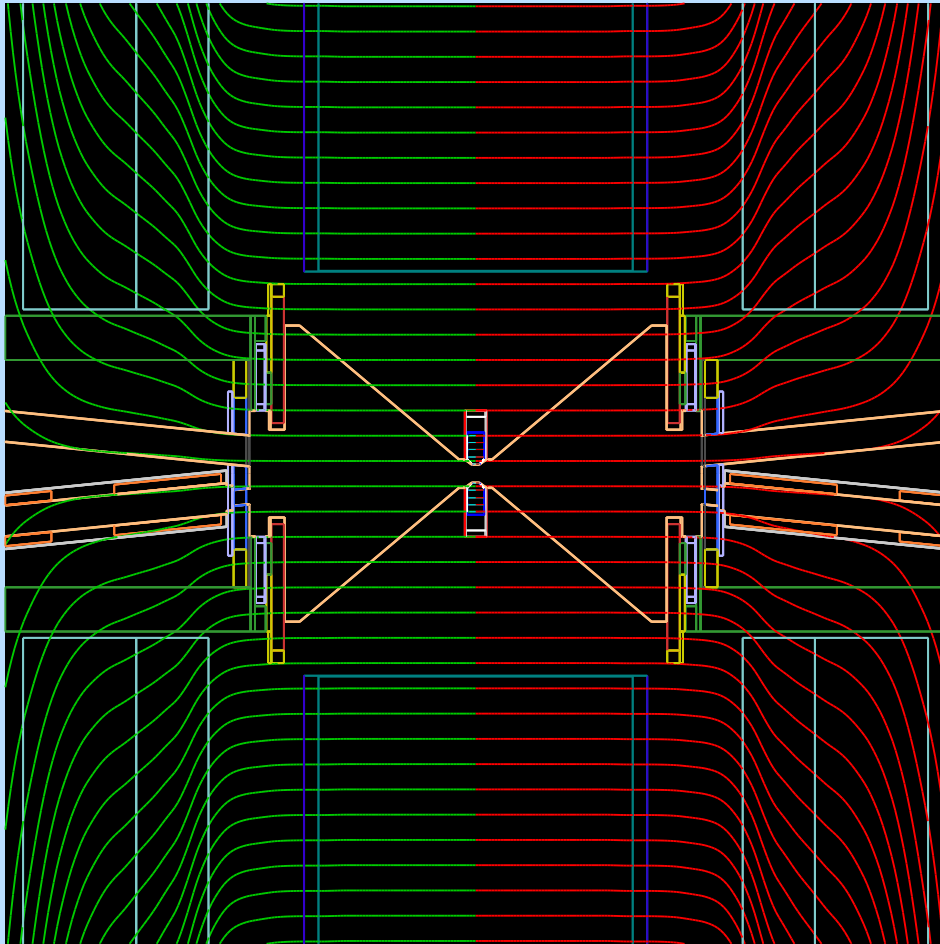


# Detector Geometries – Crossing Angle

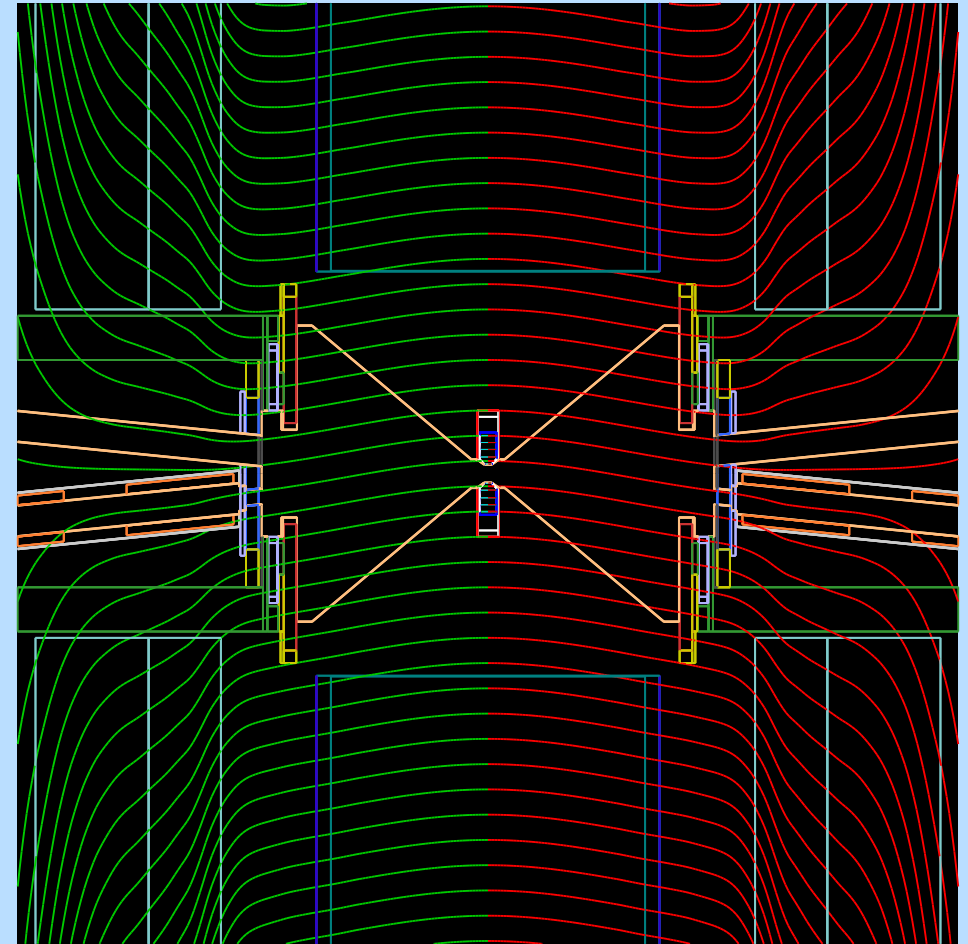
- 20 mrad
- LumiCal (red)
- Low-Z absorber  
 $\varnothing_1 = 26 \text{ mm}$   
 $\varnothing_2 = 50 \text{ mm}$
- BeamCal (blue)
- Quadrupoles  
 $L^* = 4.05 \text{ m}$
- with or without additional DID



# Magnetic Field Maps



Plain solenoid



Solenoid with DID

Realistic field maps (plus simplified quadrupoles)

# Running Mokka

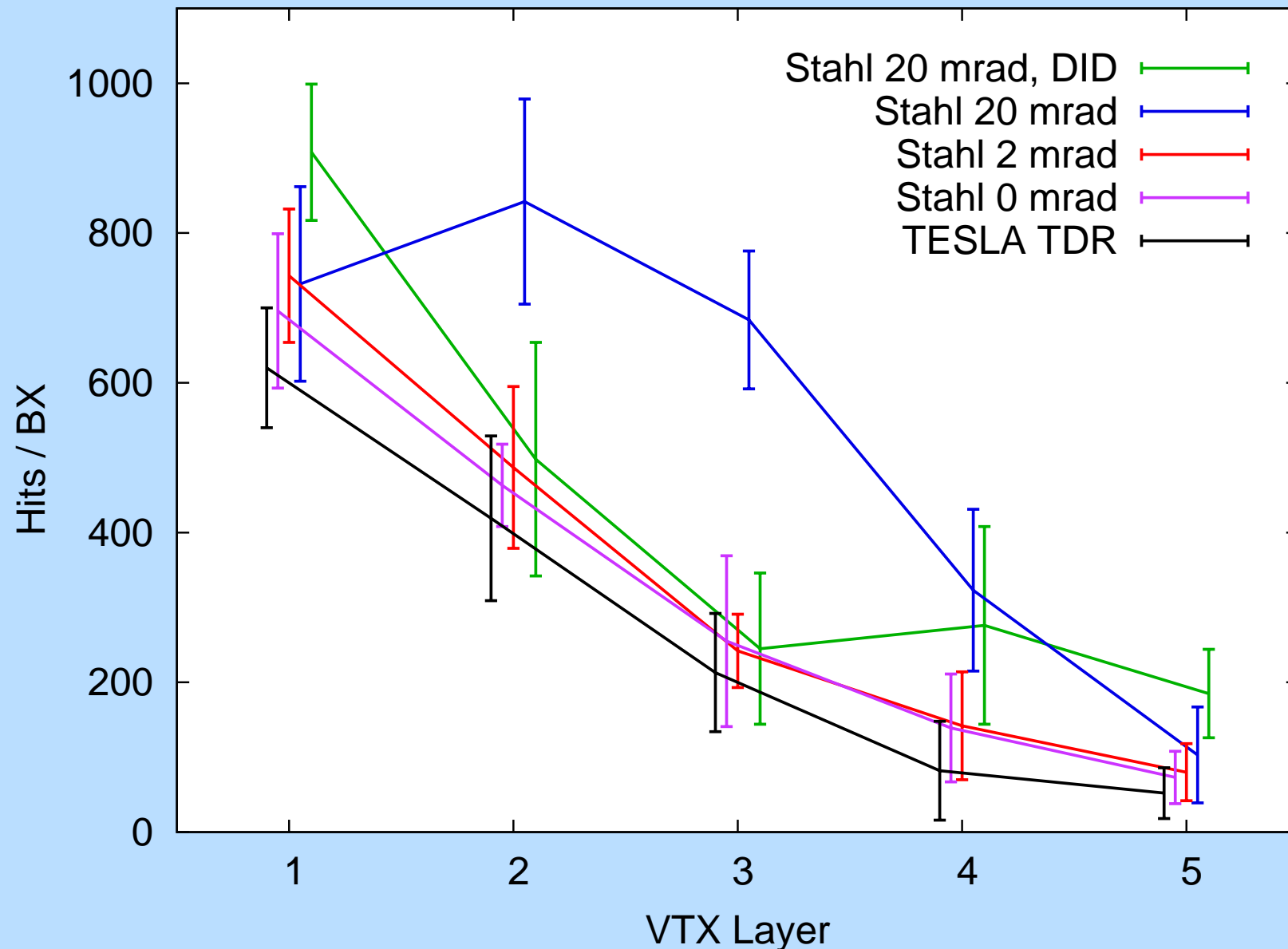
## Input

- 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

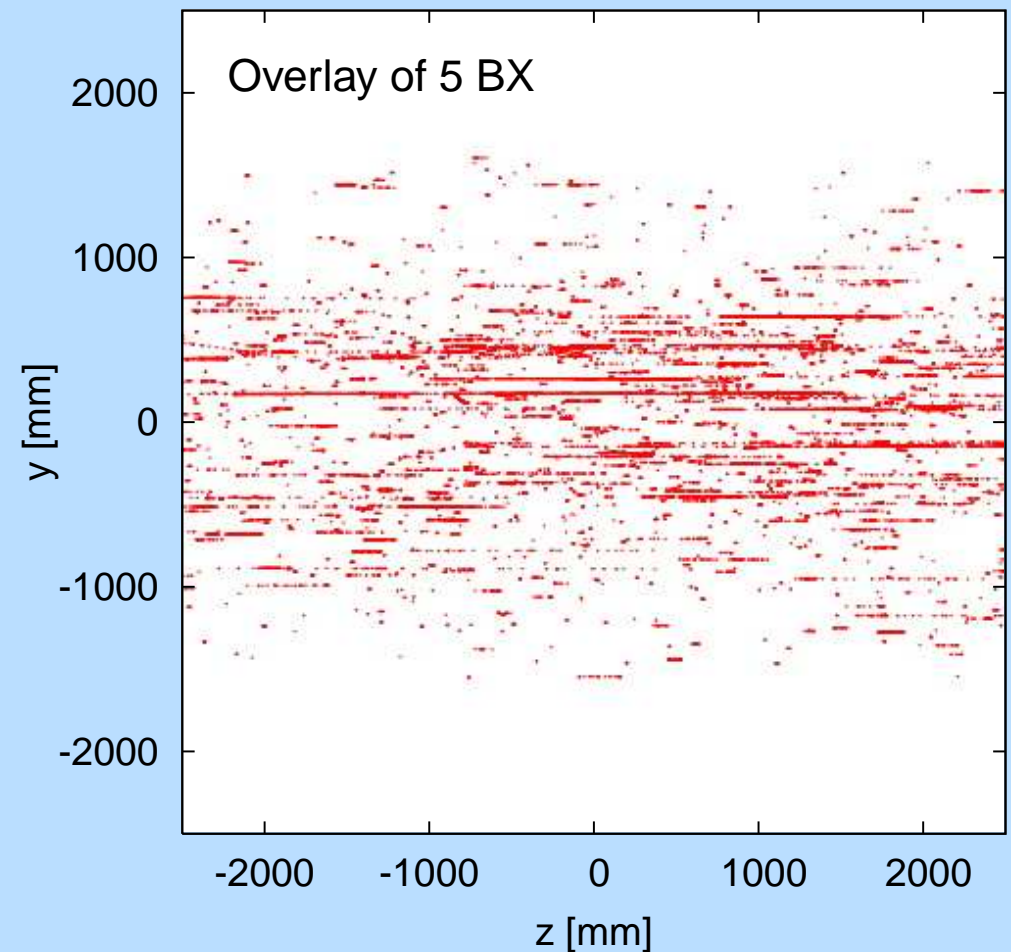
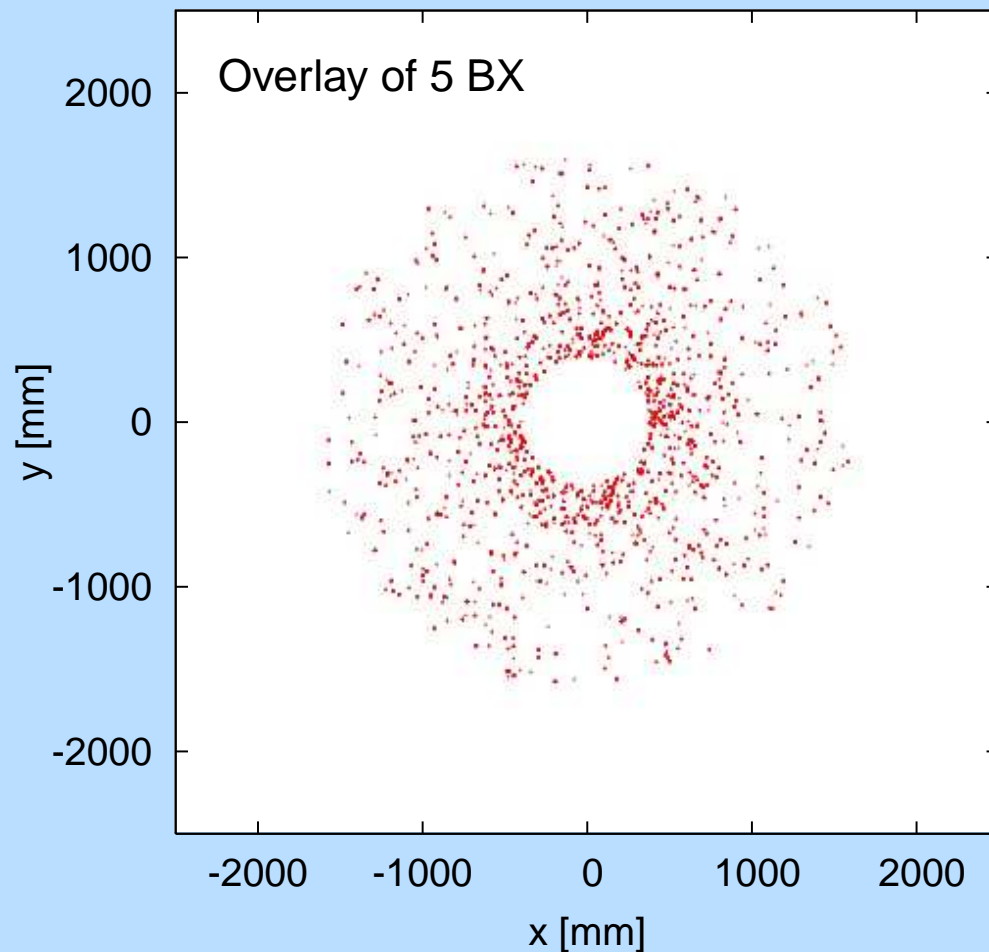
## Output

- 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

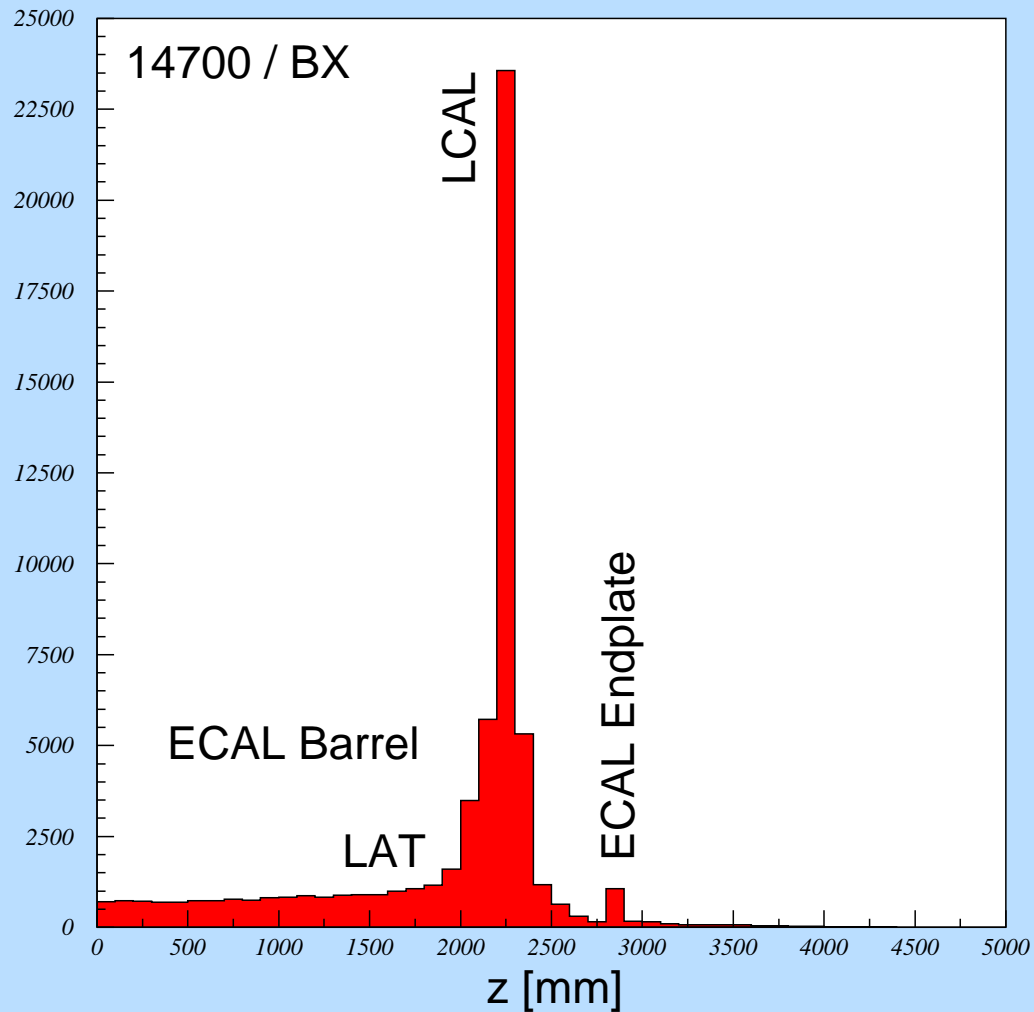
	TDR layout	Stahl layout
Neutrons	$14700 \pm 400$	$720 \pm 70$
Photons	$9400 \pm 200$	$5500 \pm 100$
Electrons	$70 \pm 60$	$40 \pm 40$

## ■ Particles created inside the TPC per BX

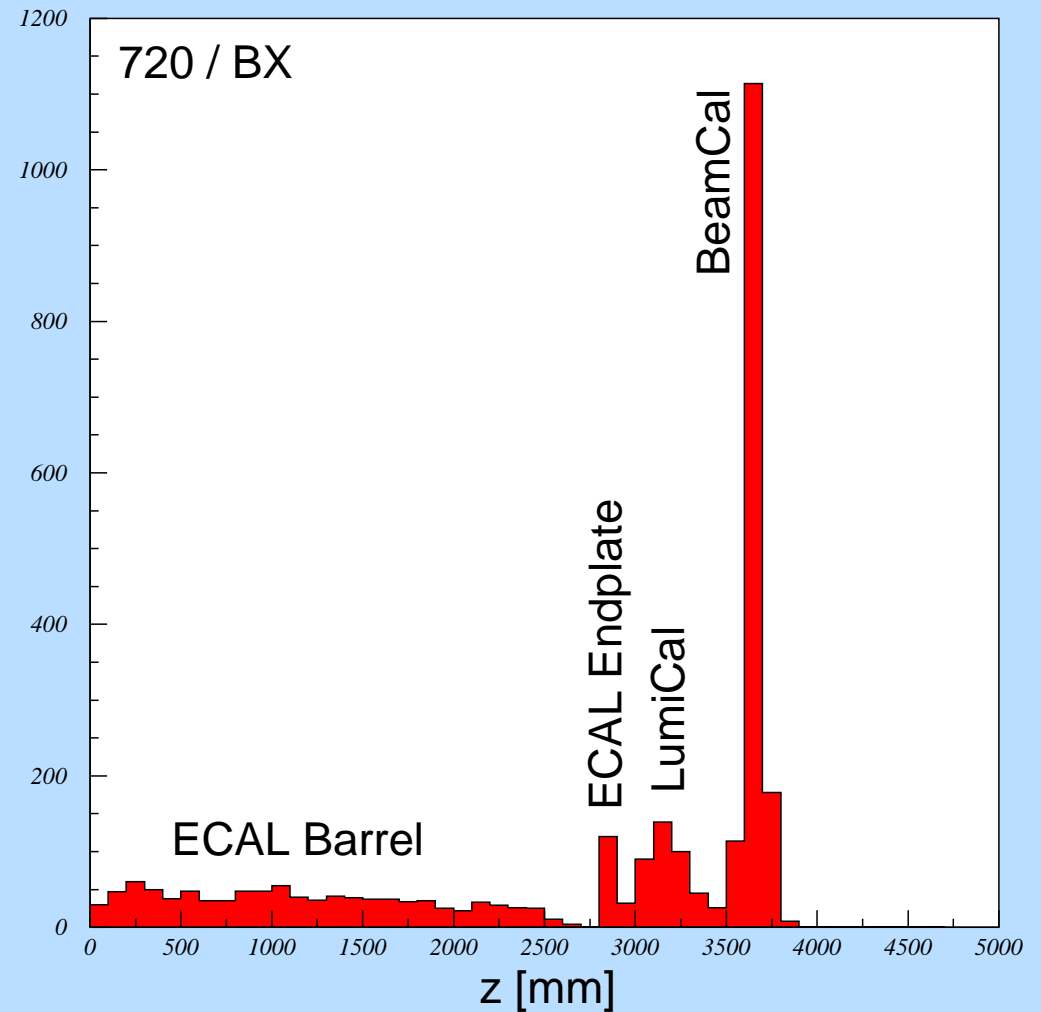
	TDR layout	Stahl layout
Electrons	$3700 \pm 400$	$2550 \pm 350$
Protons	$150 \pm 10$	$12 \pm 2$

# Neutron Production – Distances

## Origins of neutrons reaching the TPC



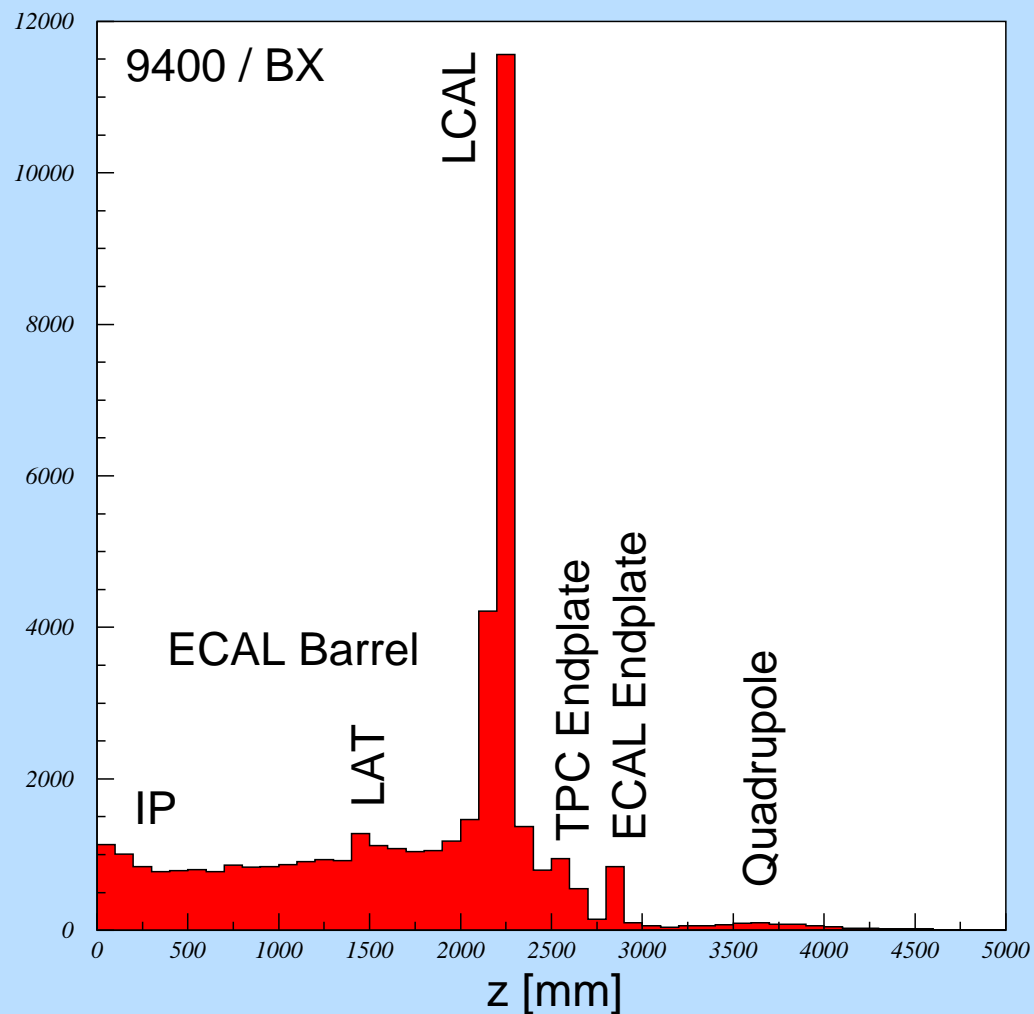
TDR layout



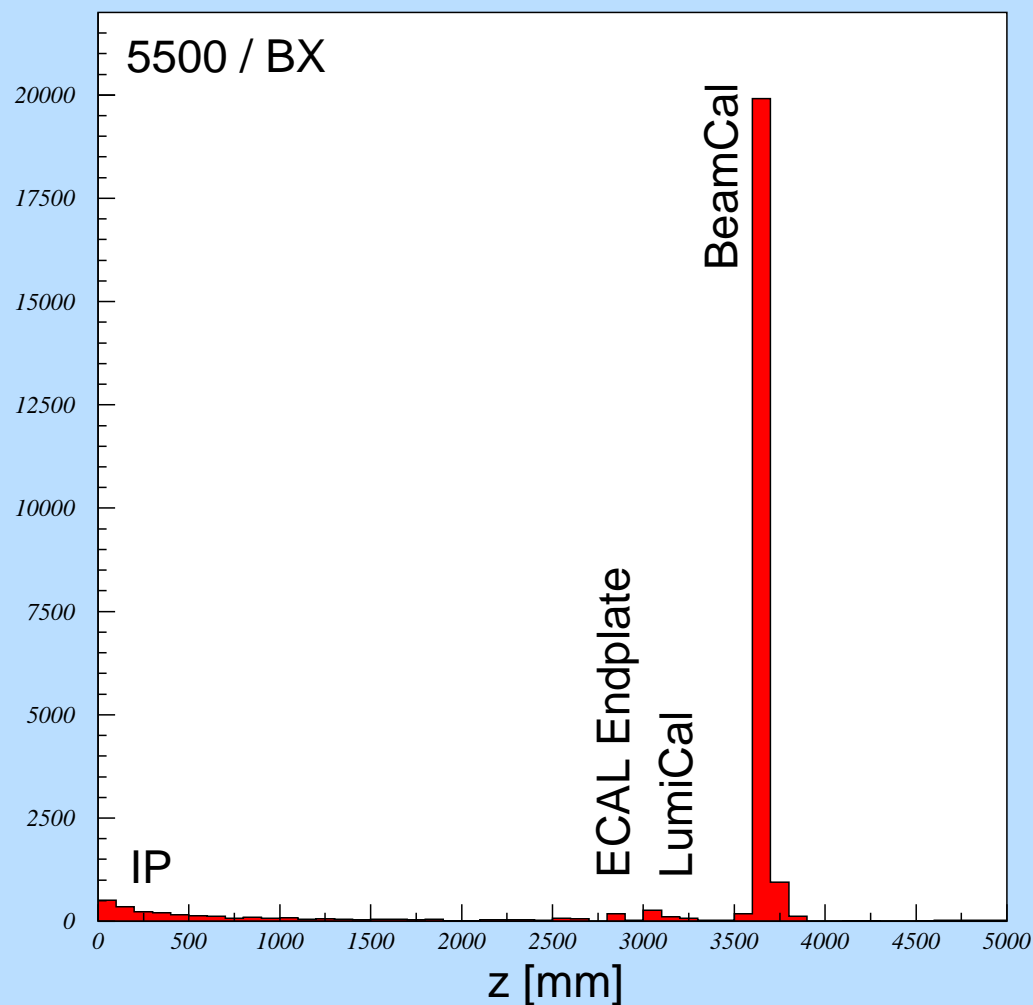
Stahl layout

# Photon Production – Distances

## Origins of photons reaching the TPC



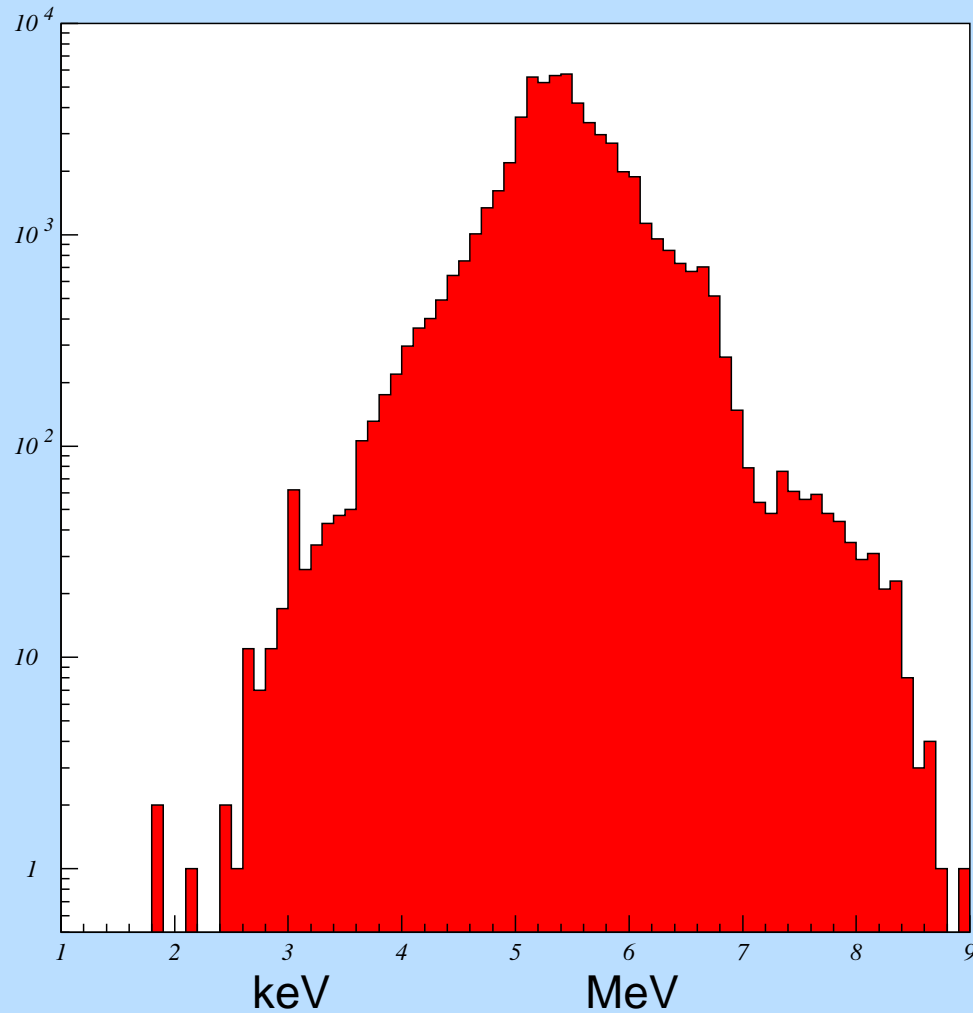
TDR layout



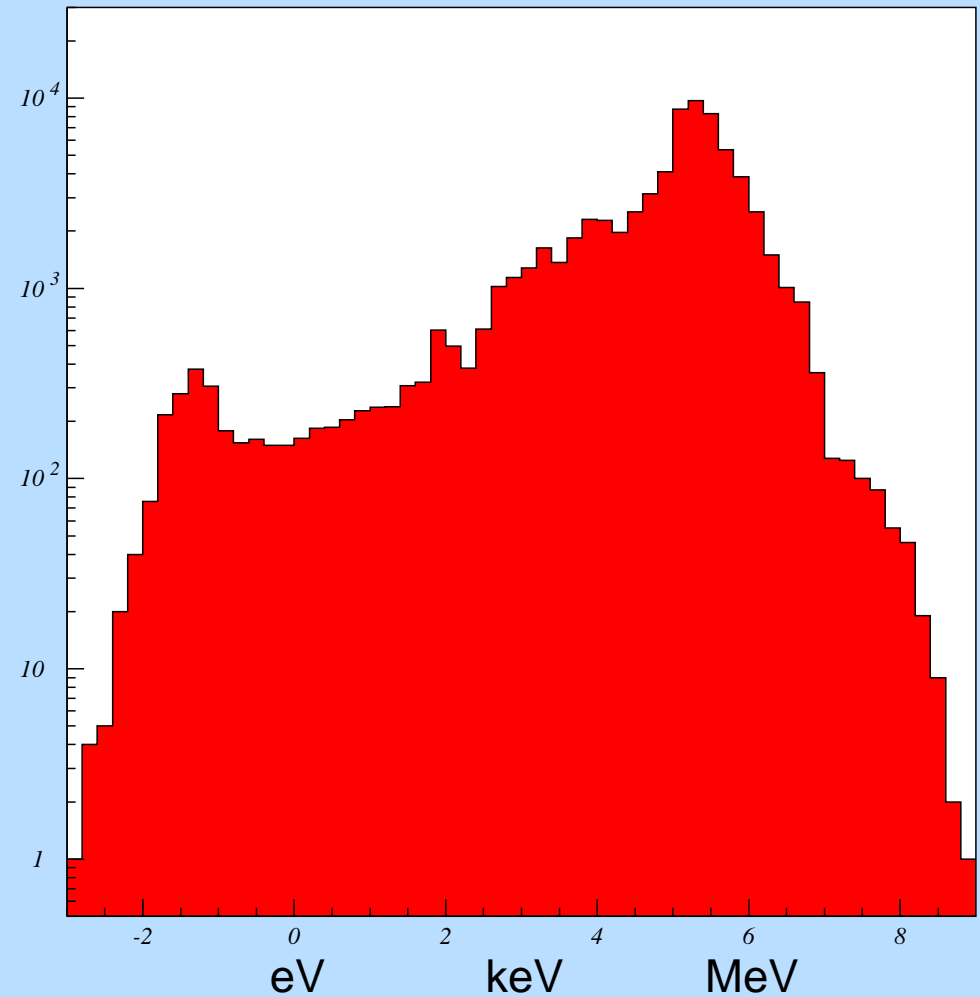
Stahl layout

# Neutron Production – Energies

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



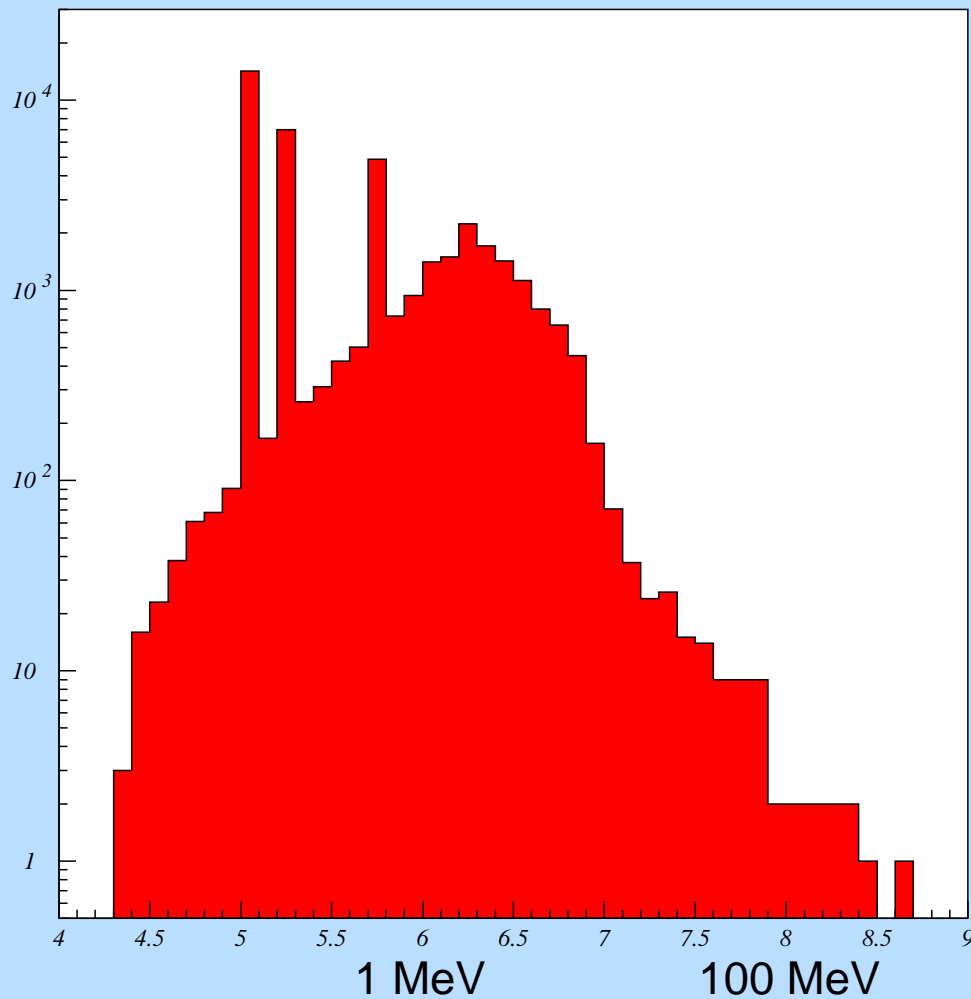
Energies of neutrons...



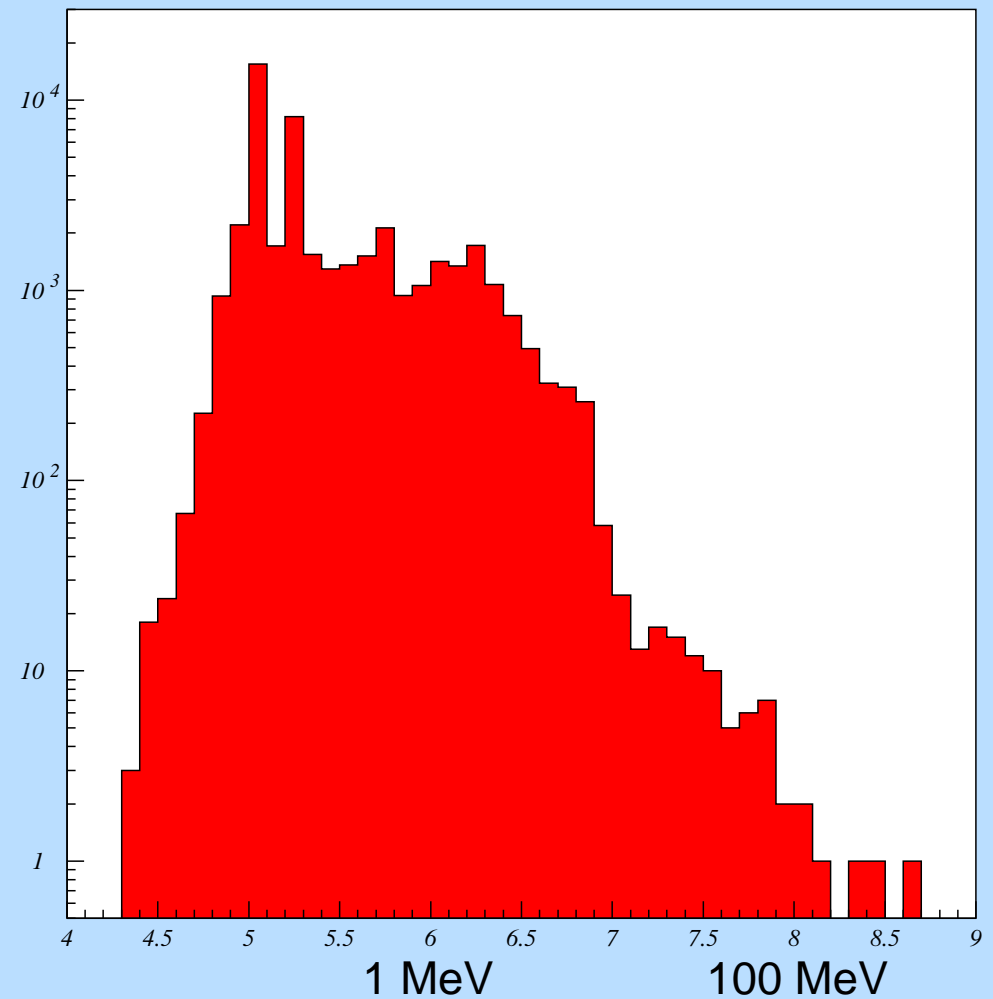
... when entering the TPC

# Photon Production – Energies

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



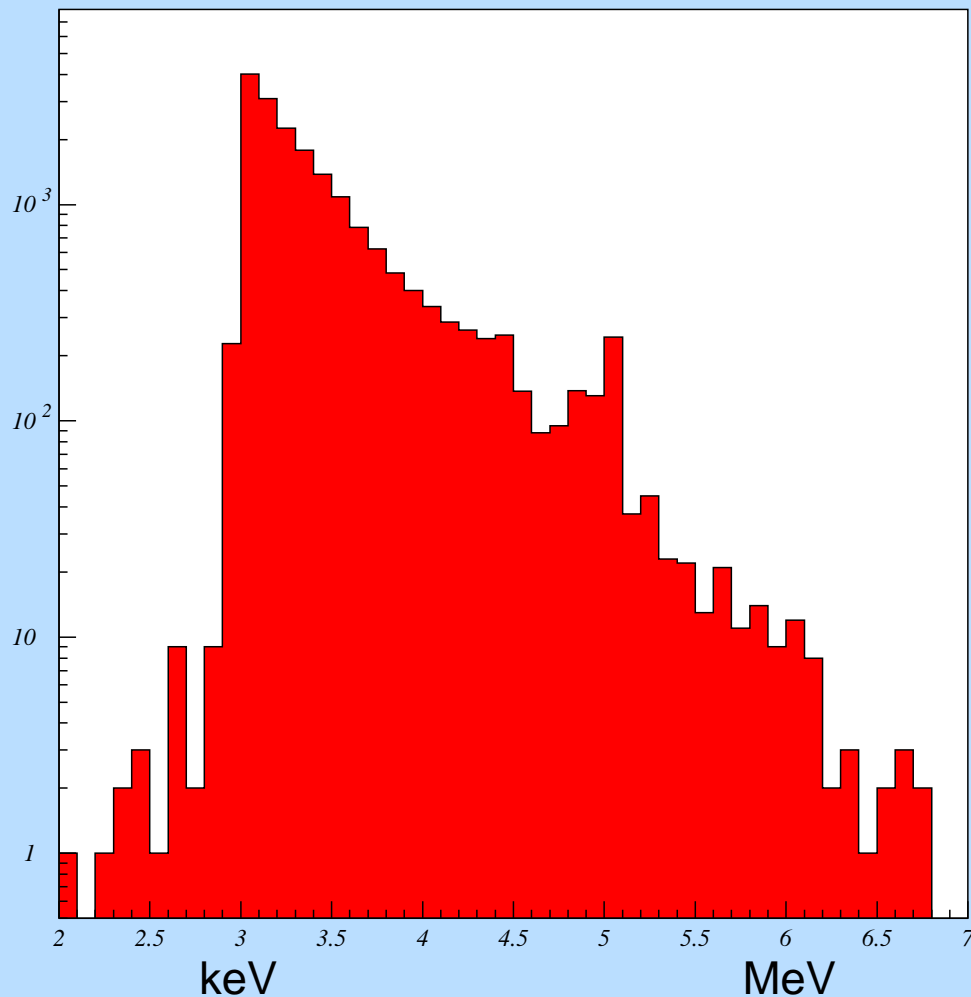
Energies of photons...



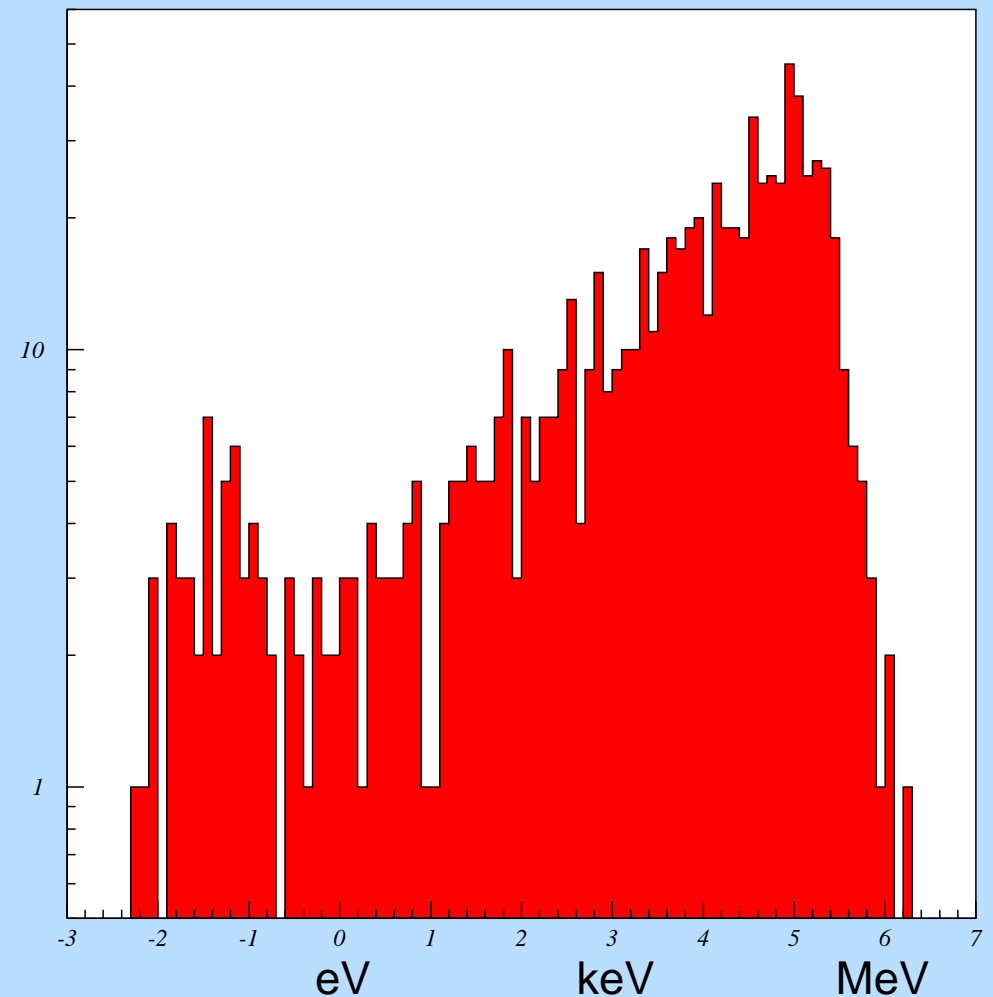
... when entering the TPC

# 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:

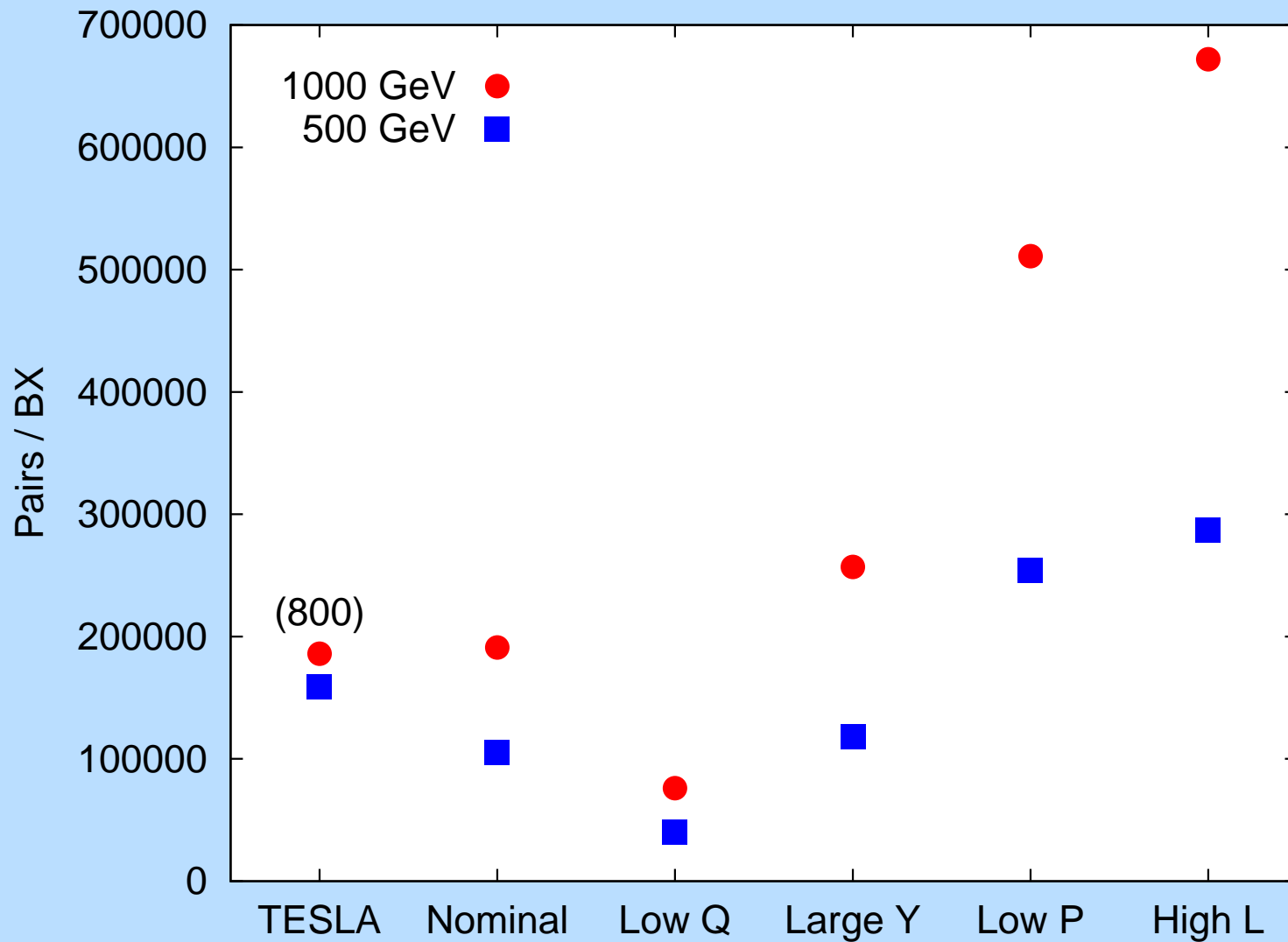
- use a dedicated, detailed TPC simulation (A. Münnich)
- get a better understanding and handling of neutrons (low-energy behaviour, diffusion, decay) – use Fluka?
- get more statistics (unleash the power of the Grid!)

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 ...



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