Background Studies for the Large Detector Concept

Guinea Pig Meets Mokka

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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 can cause silicon bulk damage in the VTX

Simulation Tools

Guinea Pig

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

Brahms

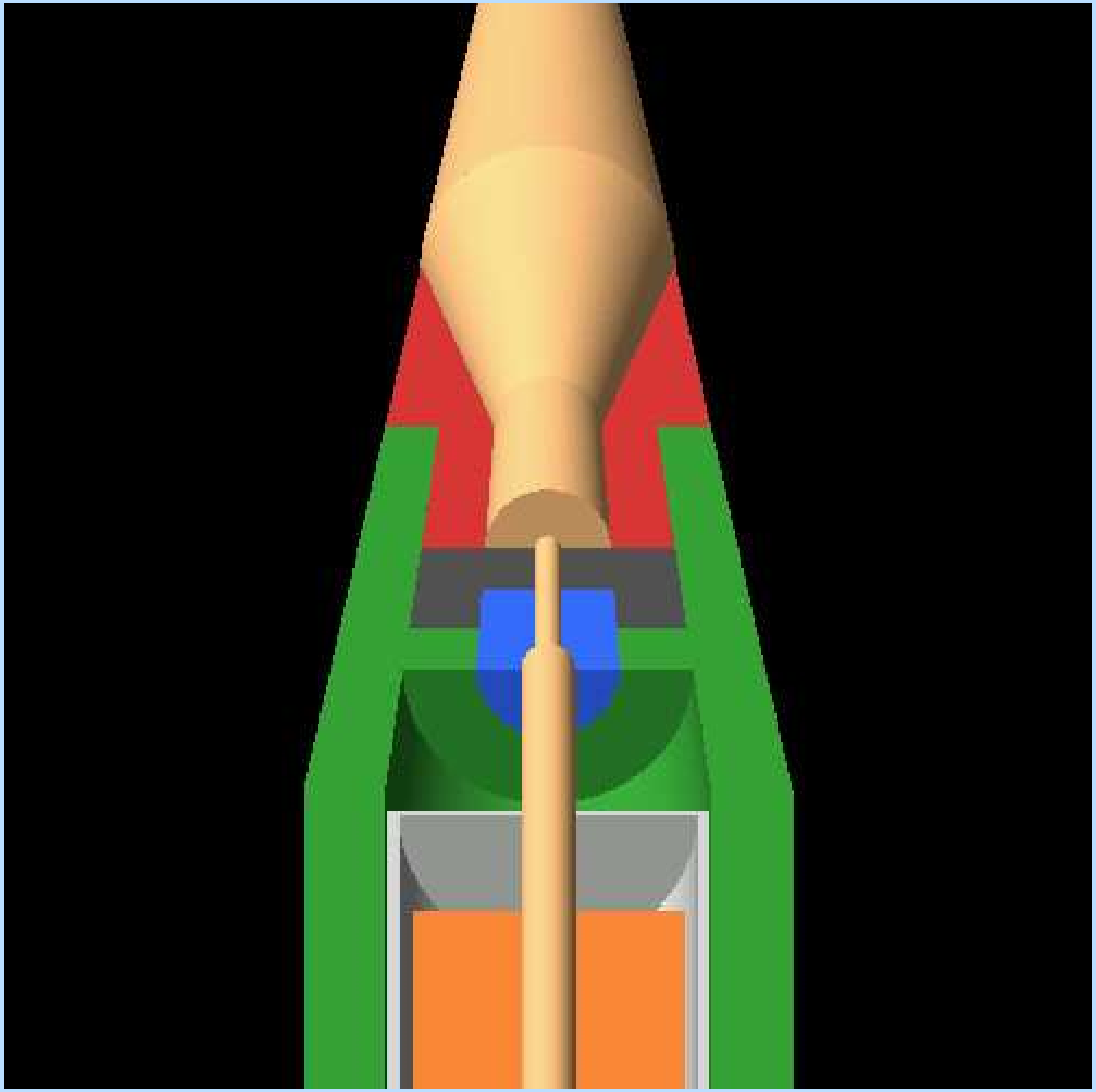
- simulates interaction of particles with the detector
- based on old Geant 3, Fortran

Mokka

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

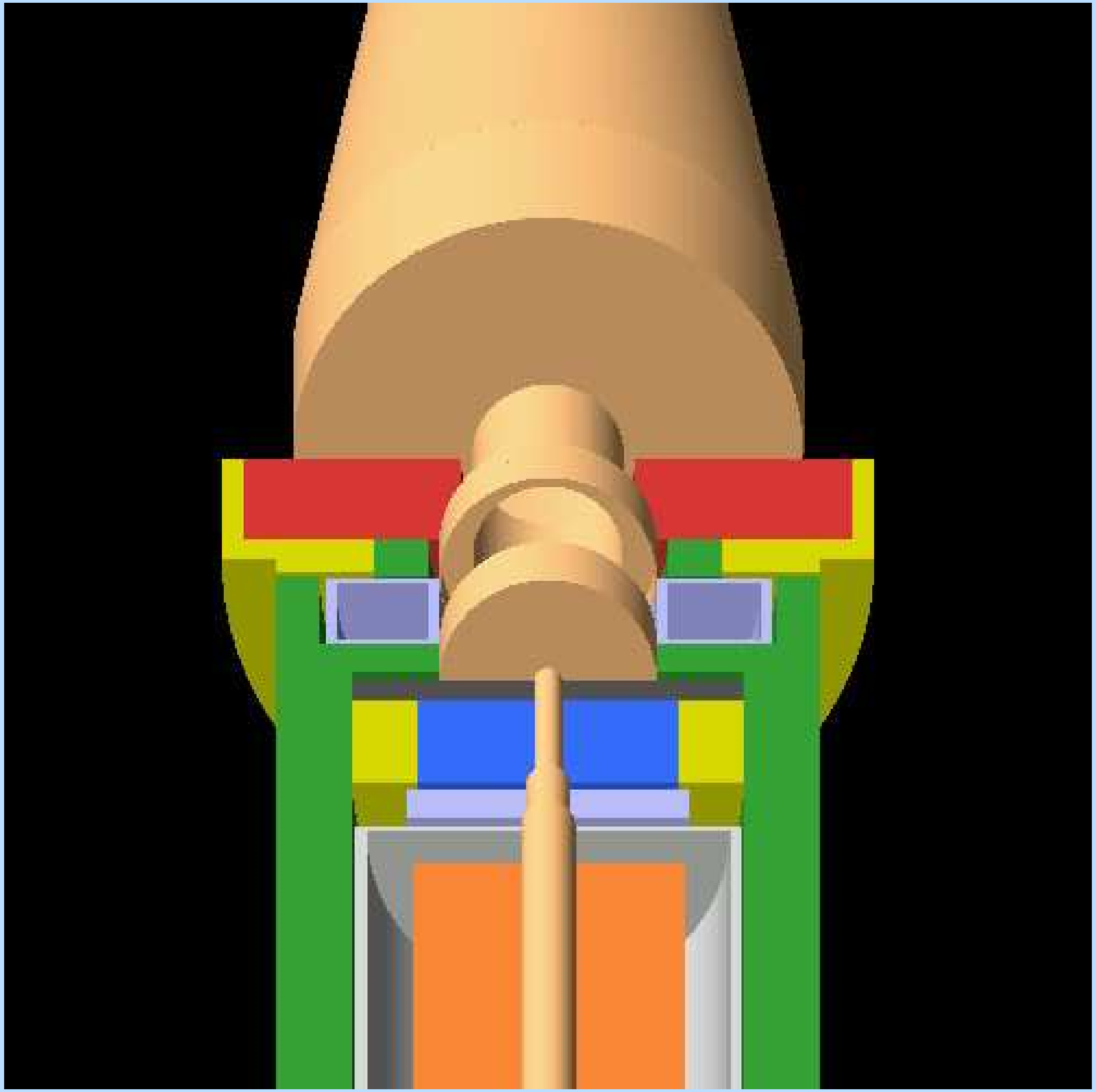
Detector Geometries – TESLA TDR

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



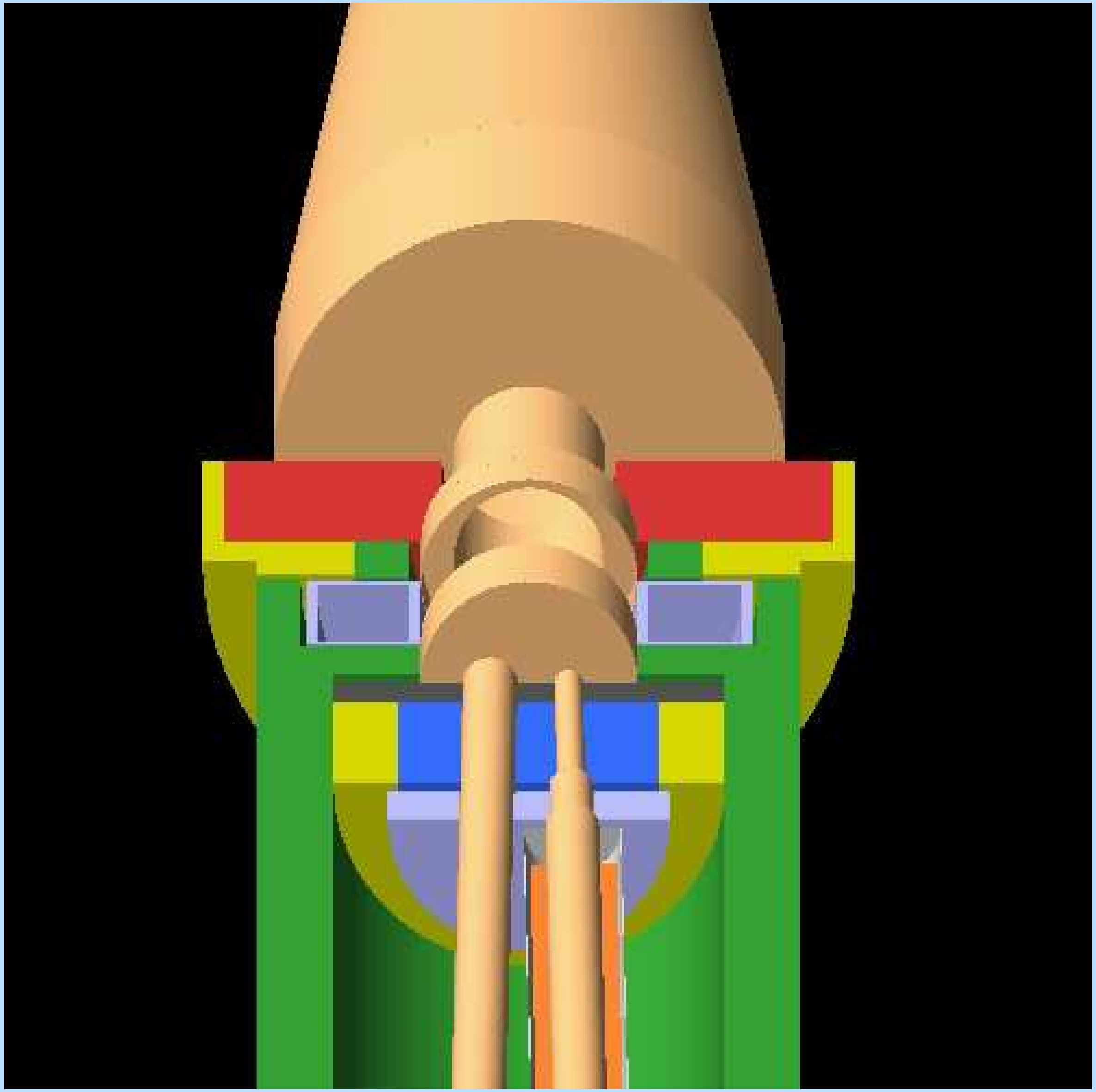
Detector Geometries – Stahl Layout

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

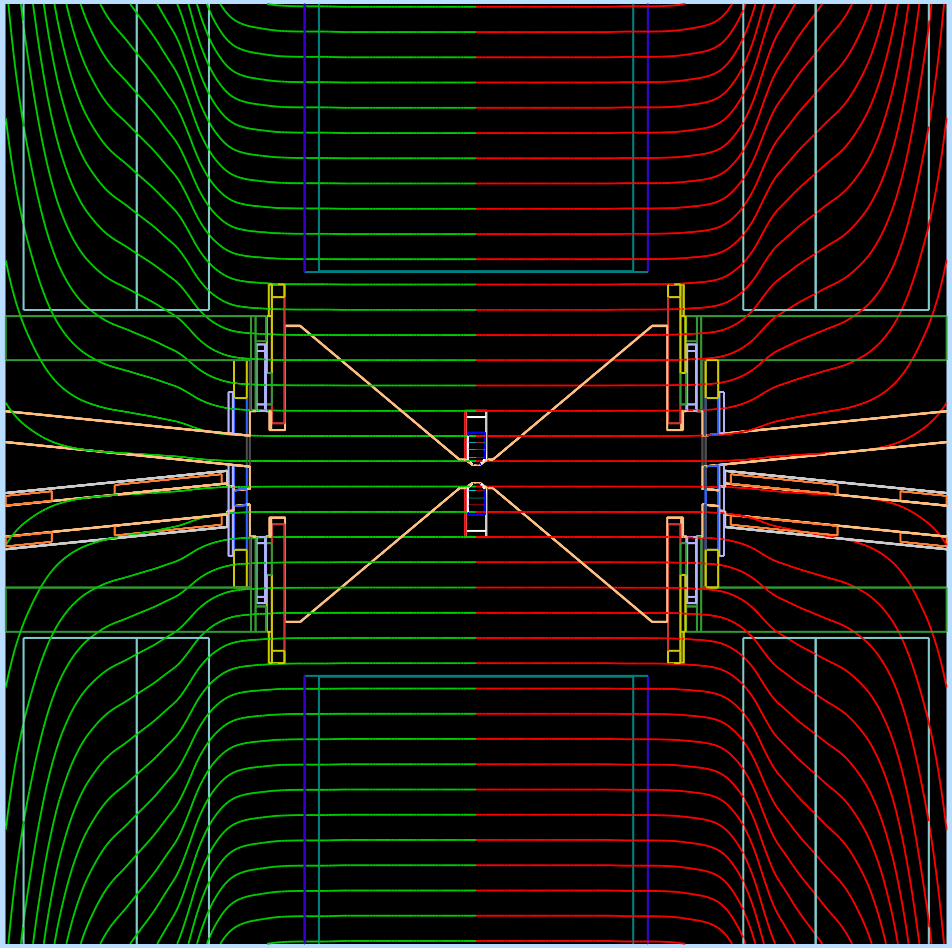


Detector Geometries – Crossing Angle

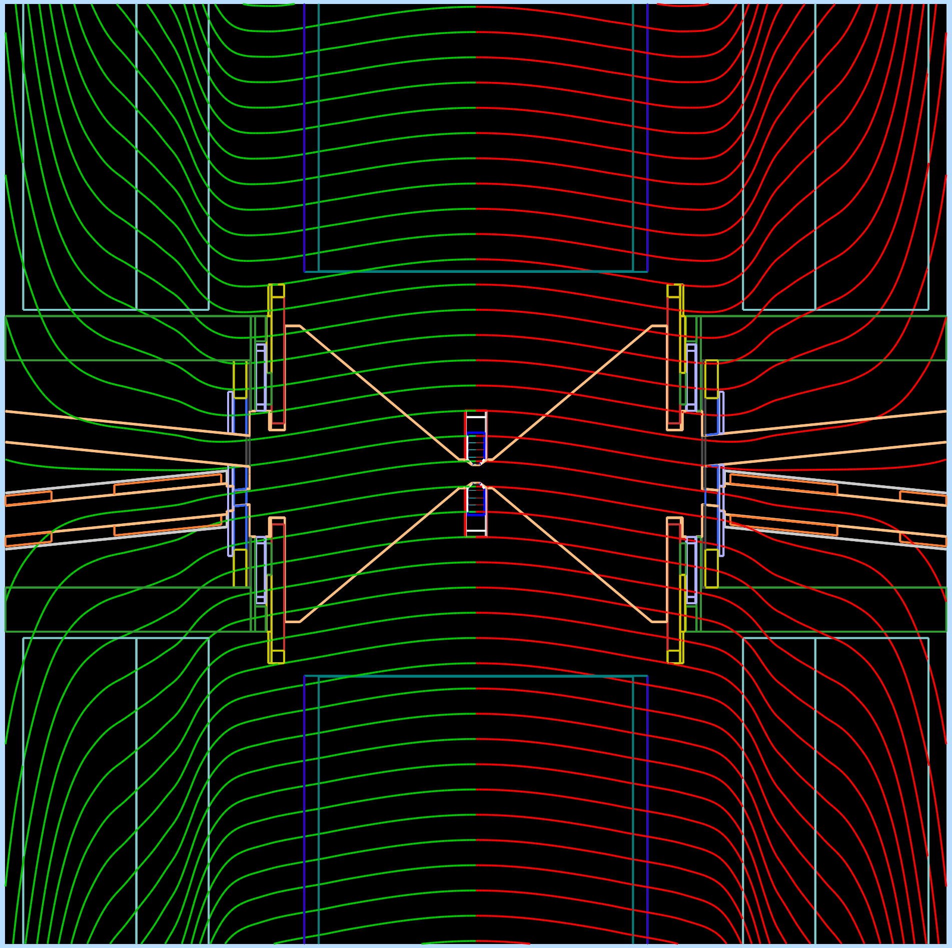
- 20 mrad
- LumiCal (red)
- Low-Z absorber
  $\varnothing_1 = 26$ mm
  $\varnothing_2 = 50$ mm
- BeamCal (blue)
- Quadrupoles
  $L^* = 4.05$ m
- with or without additional DID



Magnetic Field Maps



Plain solenoid



Solenoid with DID

Realistic field maps (plus simplified quadrupoles)

Running Mokka

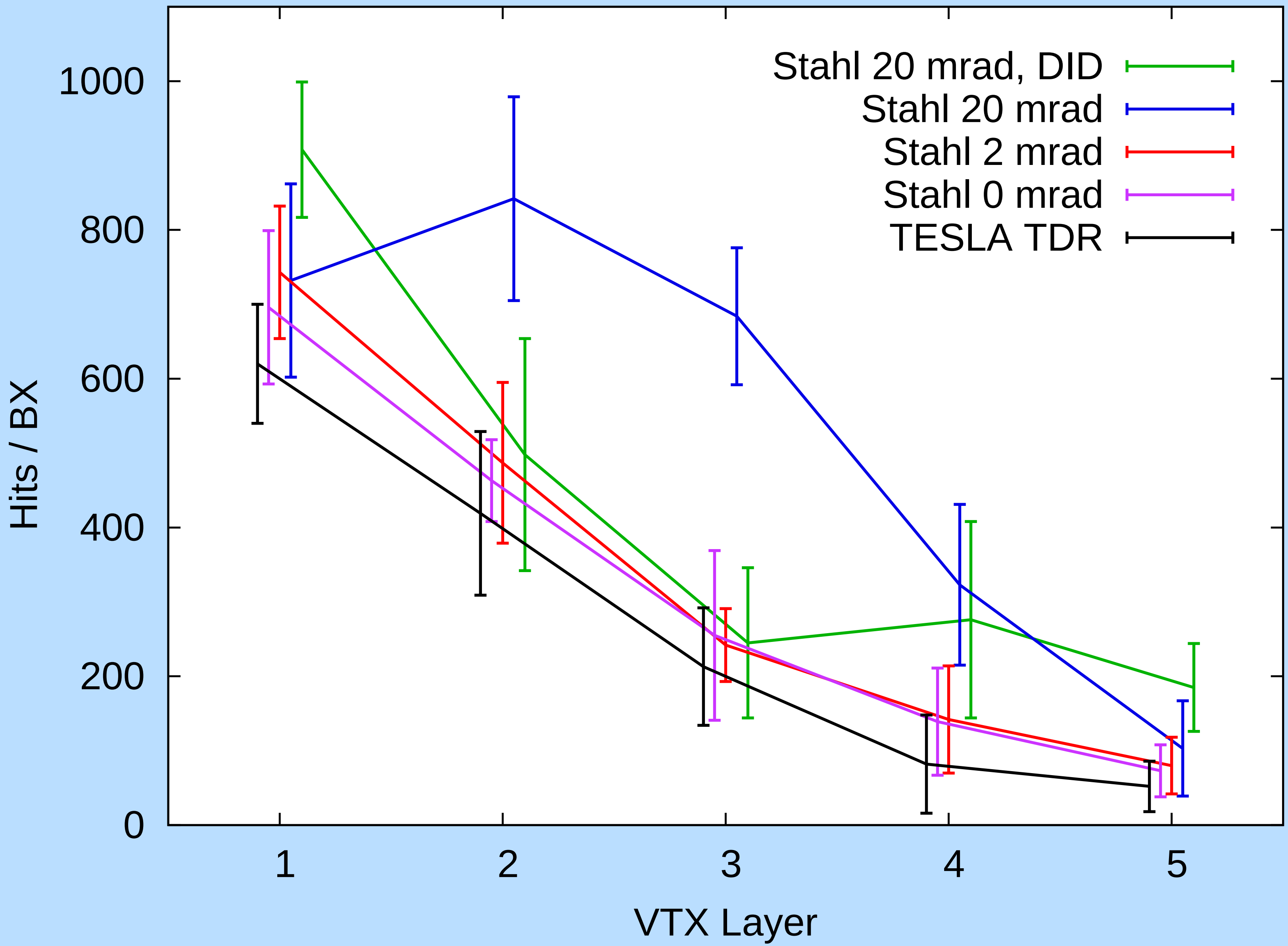
Input

- 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 – Backscattering from the Mask

Low-energy particles

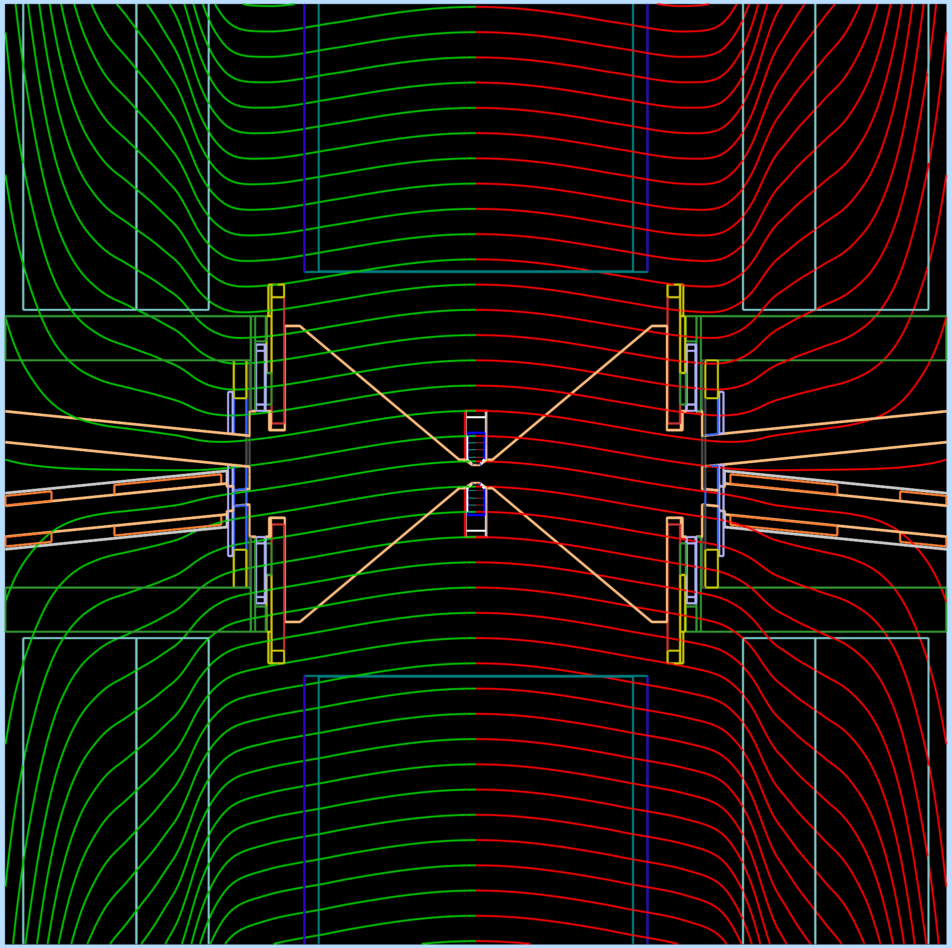
- enter IR through holes of the BeamCal
- follow magnetic field

Without DID:

- hit VTX layers 2 and 3

With DID:

- downstream particles miss the VTX (mostly)
- upstream particles return to VTX center



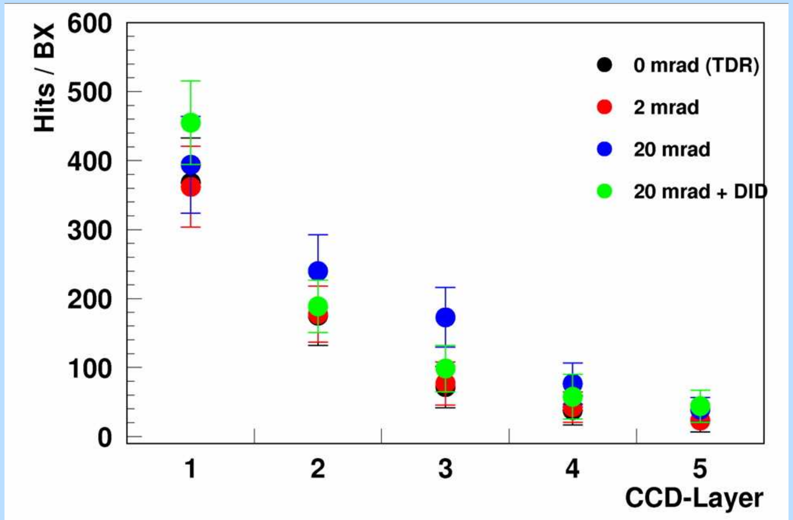
Results – Comparison with Brahms

Qualitative agreement

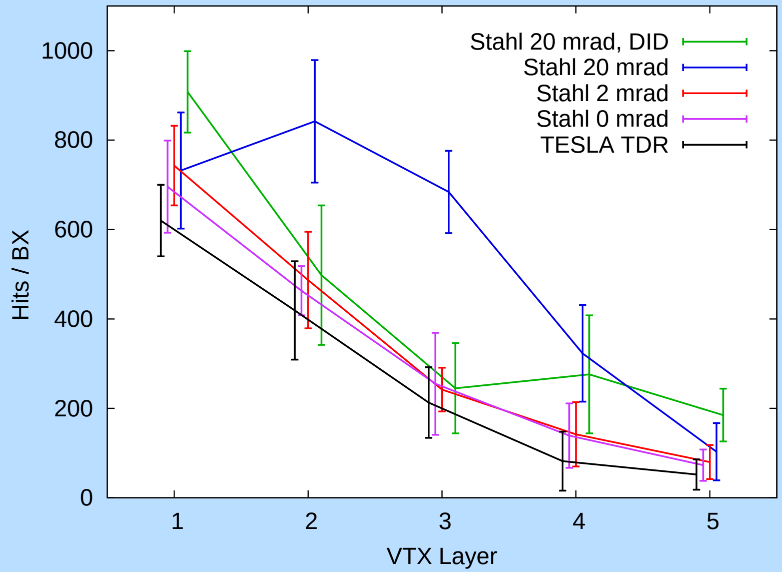
- backscattering is a geometrical effect
- Brahms and Mokka have similar geometries

Quantitative differences

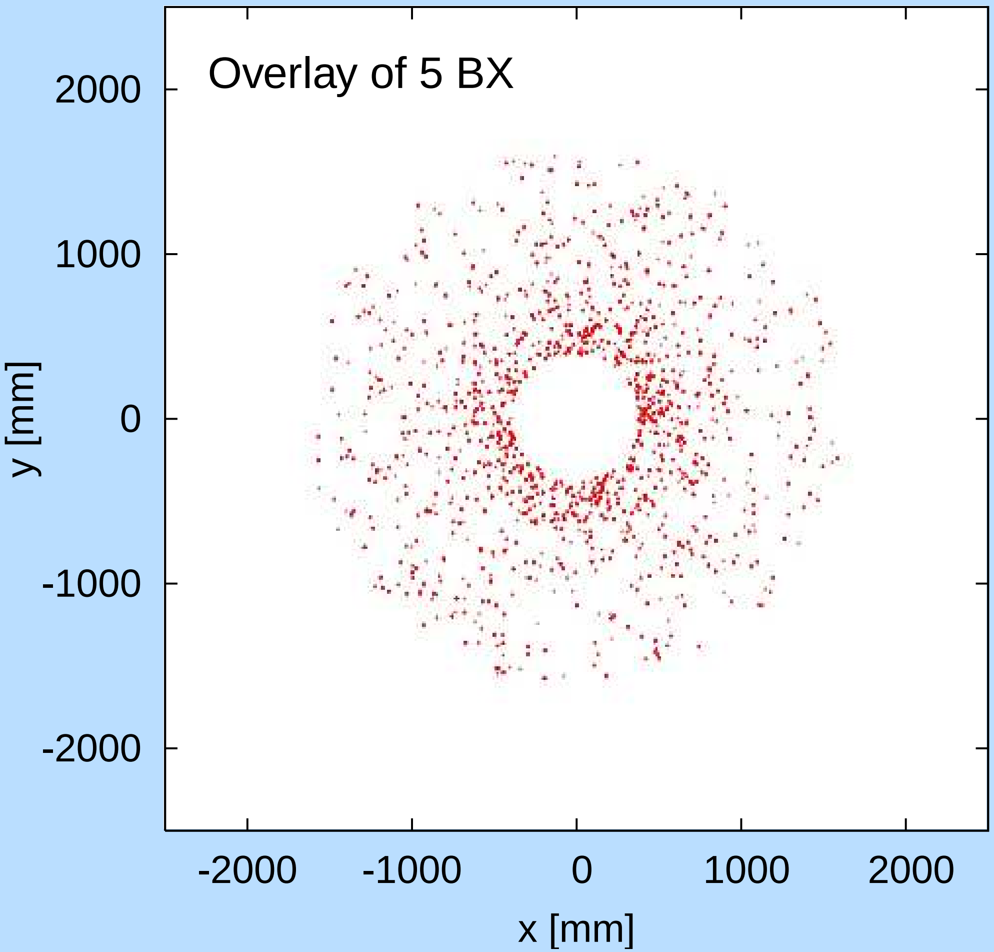
- Mokka has new VTX model (larger sensitive area)
- neutron contributions
- different cut mechanisms

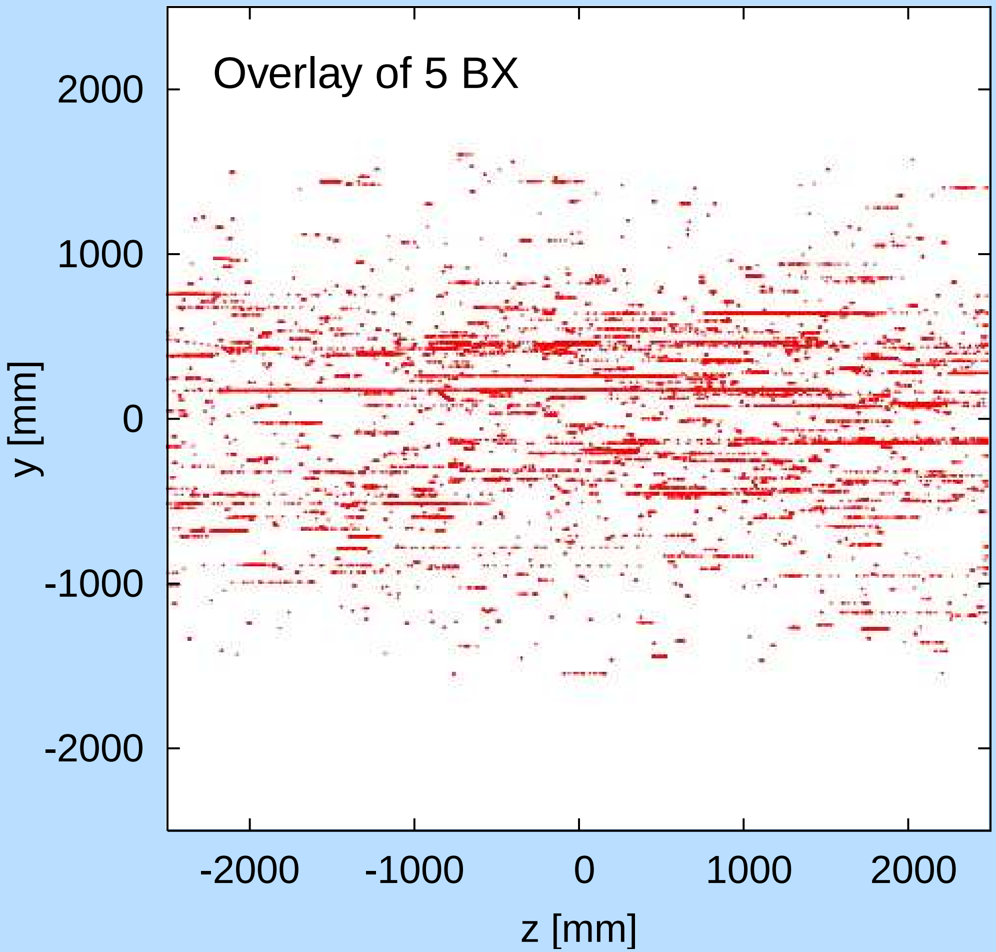


Brahms (K. Büßer at Snowmass)



Results – TPC Hits

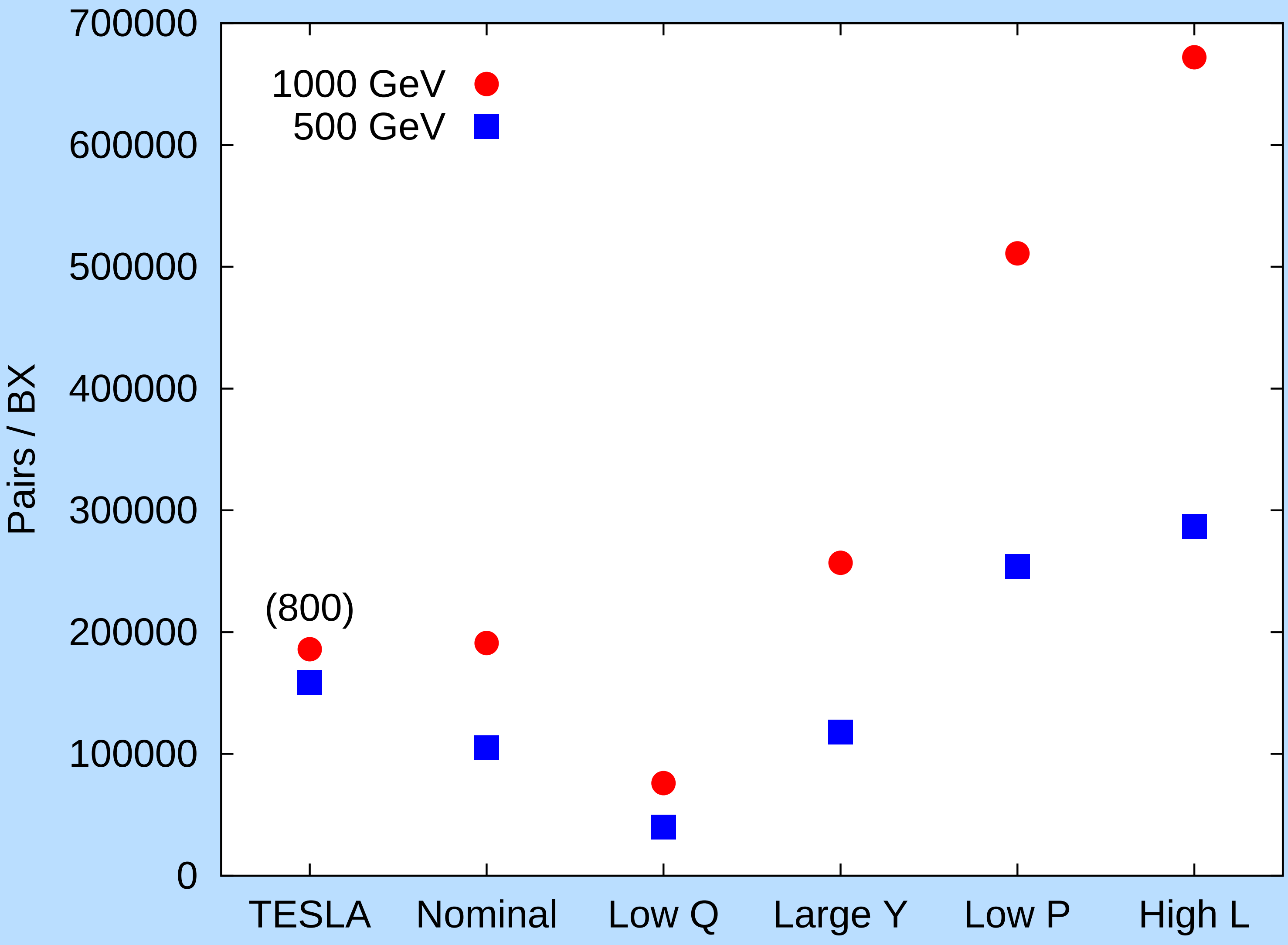




Stahl layout, TDR gas: 5500 ± 900 Mokka hits / BX

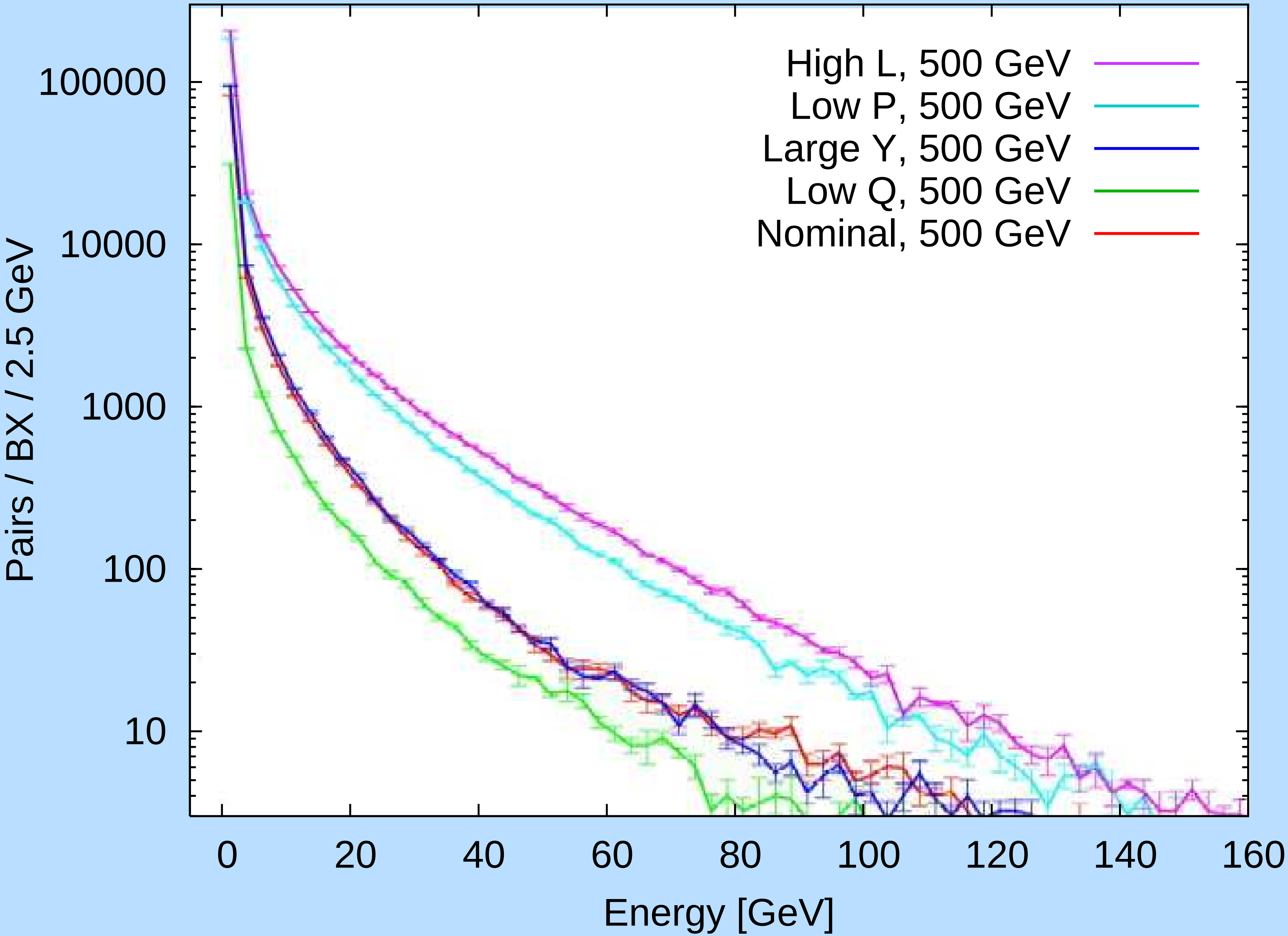
Stahl layout, P 10 gas: 5000 ± 600 Mokka hits / BX

ILC Beam Parameters – Pairs

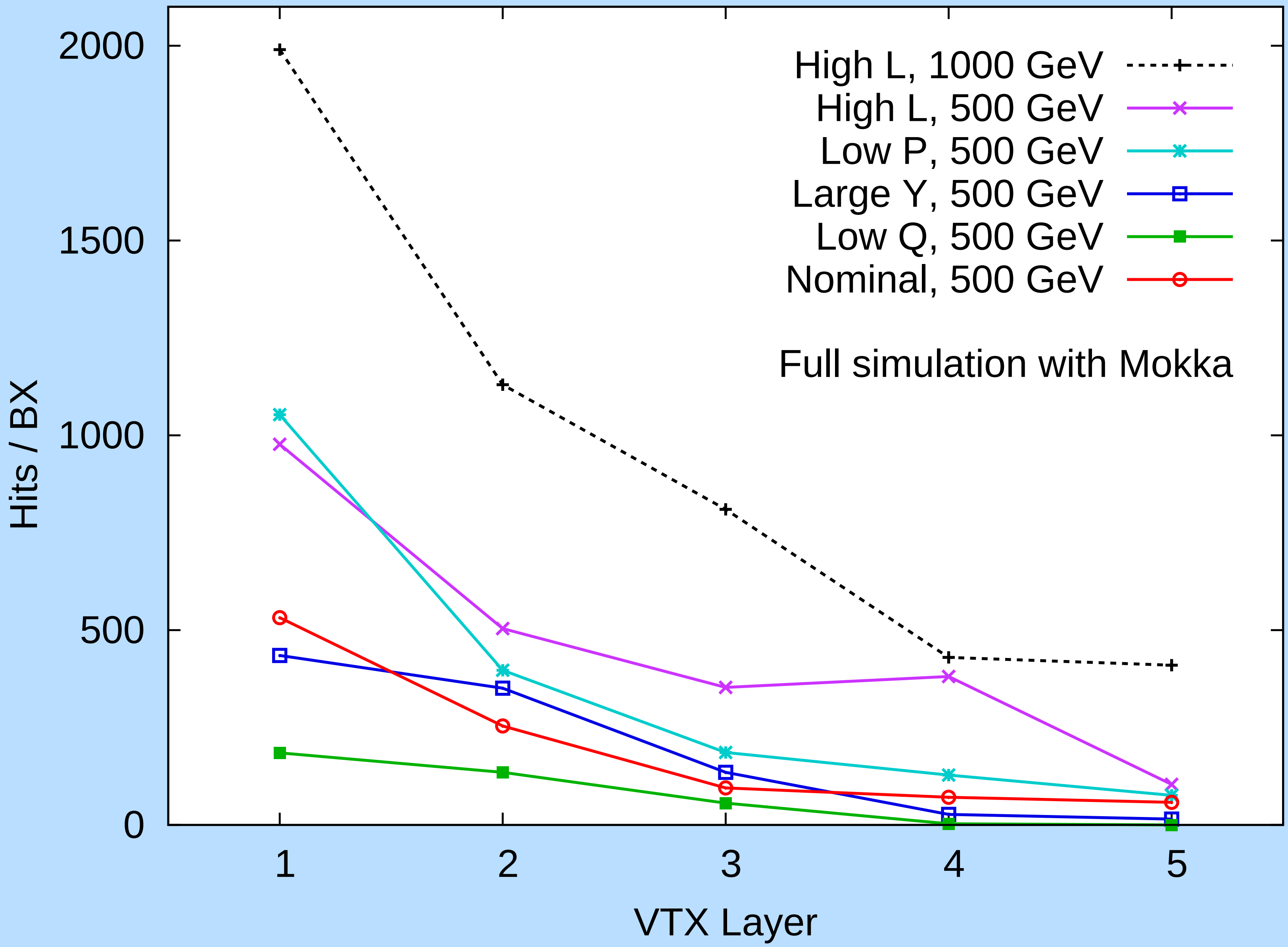


S. Gronenborn (EUROTeV-Memo-2005-003-1)

ILC Beam Parameters – Pair Energies



ILC Beam Parameters – Hits on the VTX



Conclusion and Outlook

Tools are developing

- Mokka has forward geometries and magnetic fields
- Brahms results can be reproduced (qualitatively)

Relate simulation results to detector tolerances

- hits on the VTX can be used as a benchmark
- but: TPC needs a more sophisticated simulation
- better understanding of neutron behaviour needed
- get more statistics (unleash the power of the Grid!)

Different geometries and beam parameters

- better be prepared for a factor of $\mathcal{O}(5)\ldots$