Update on the Beam-Related Backgrounds in the LDC Detector

Exploring the Parameter Space

Adrian Vogel
DESY FLC

Background Sources at the ILC

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

- beams have to be focused very strongly (σ_y = 5 nm)
- beam-beam interaction creates beamstrahlung
- beamstrahlung photons scatter to e^+e^- (10^5 / BX)
- e^+e^- smash into forward calorimeters (BeamCal) and magnets of the beam delivery / extraction line
- lots of photons, neutrons, and charged particles

Other sources are supposed to be negligible (beam dump, synchrotron radiation, . . .) or have to be studied in further detail (beam halo, extraction line losses)

Problems with Background

Inner silicon trackers (VXD, SIT, FTD)

- hits from charged particles (direct / indirect)
- silicon bulk damage from neutron fluence

Main gaseous tracker (TPC)

- Compton scattering, photon conversion
- neutron-proton collisions (recoil) with hydrogen
- additional primary ionisation, field distortions

Calorimeters (ECAL, HCAL)

- more photons from nuclear reactions, neutron capture
- random low-energy hits, radiation damage (?)

Simulation Tools – Guinea Pig

Input

- set of beam parameters (E, $\vec{\sigma}$, $\vec{\beta}$, Q, $\ldots$)

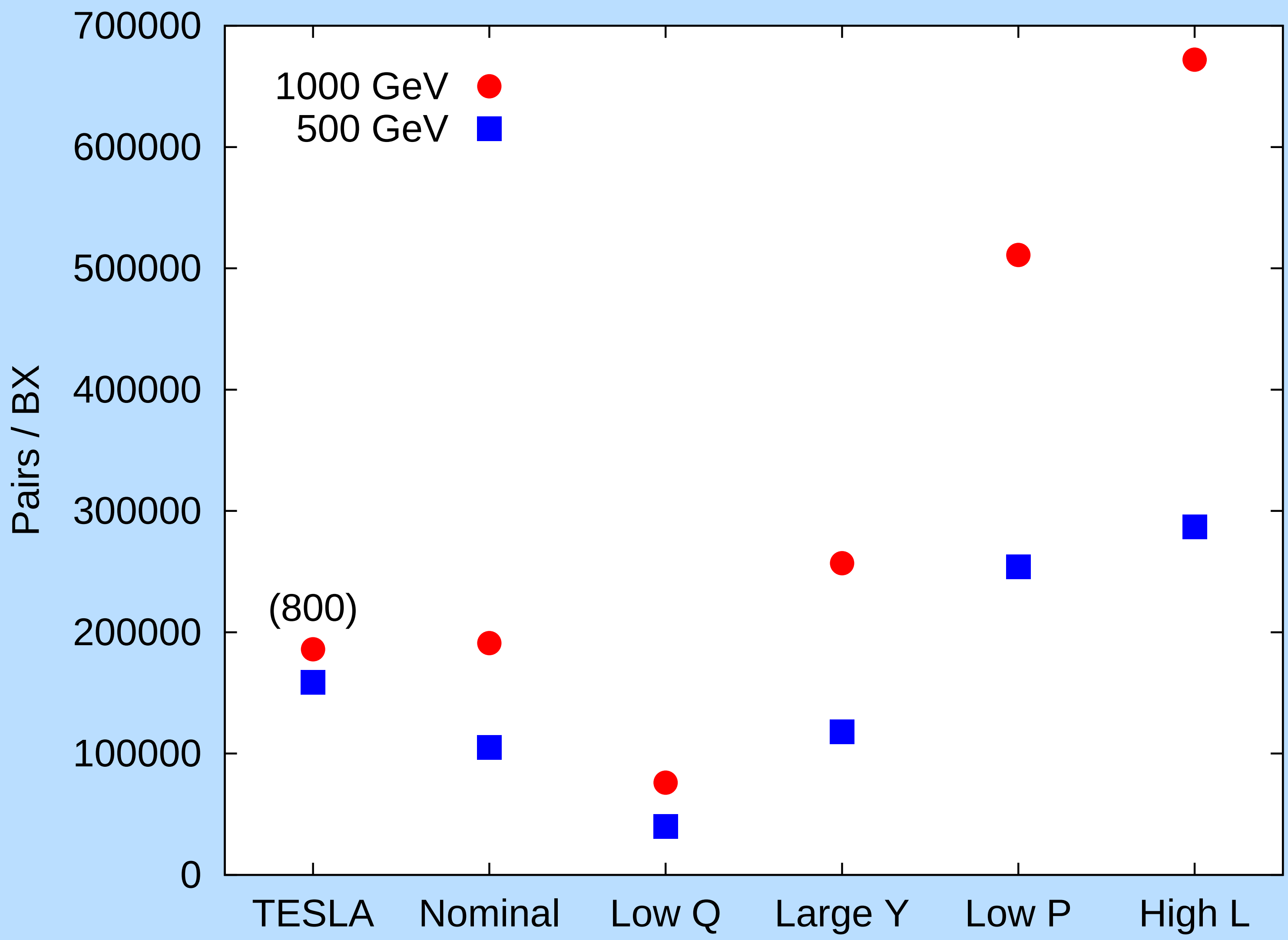
Output

- particles in the disrupted beams
- beamstrahlung photons
- e^+e^- pair particles
- hadronic scattering products (“minijets”)

Existing simulation data

- TESLA beam parameters (500 GeV, 800 GeV)
- various ILC parameter sets (500 GeV, 1 TeV)

ILC Beam Parameters



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

Simulation Tools – Mokka

Mokka is a full detector simulation

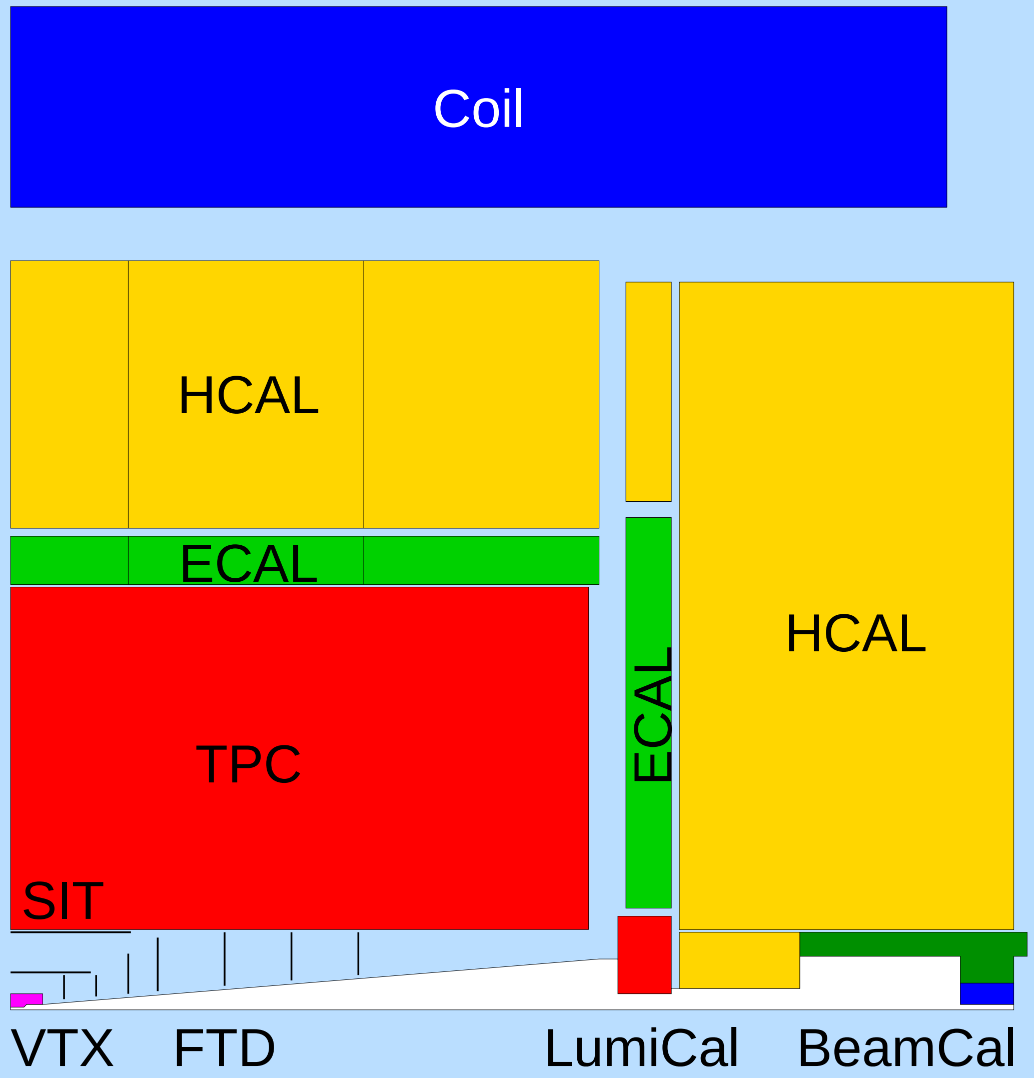
- based on the Geant 4 framework (currently 8.1.p01)
- written in C++, contains various detector geometries
- main development at LLR, France
- now: contributions from many different users
- successor of Brahms (GEANT3, Fortran)

Mokka uses LCIO as a persistency framework

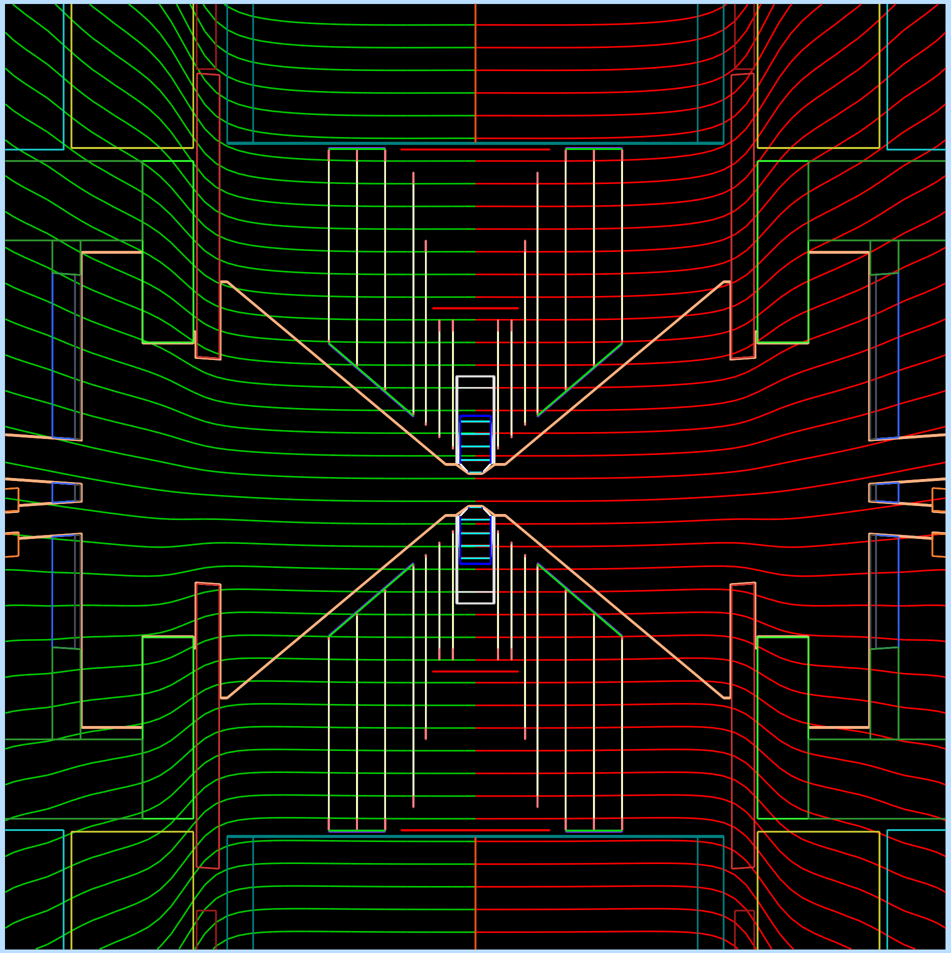
- predefined storage classes (particle, track, hit, . . .)
- lightweight and robust, cross-platform design
- supported by large parts of the ILC community

“Small” LDC Detector Design

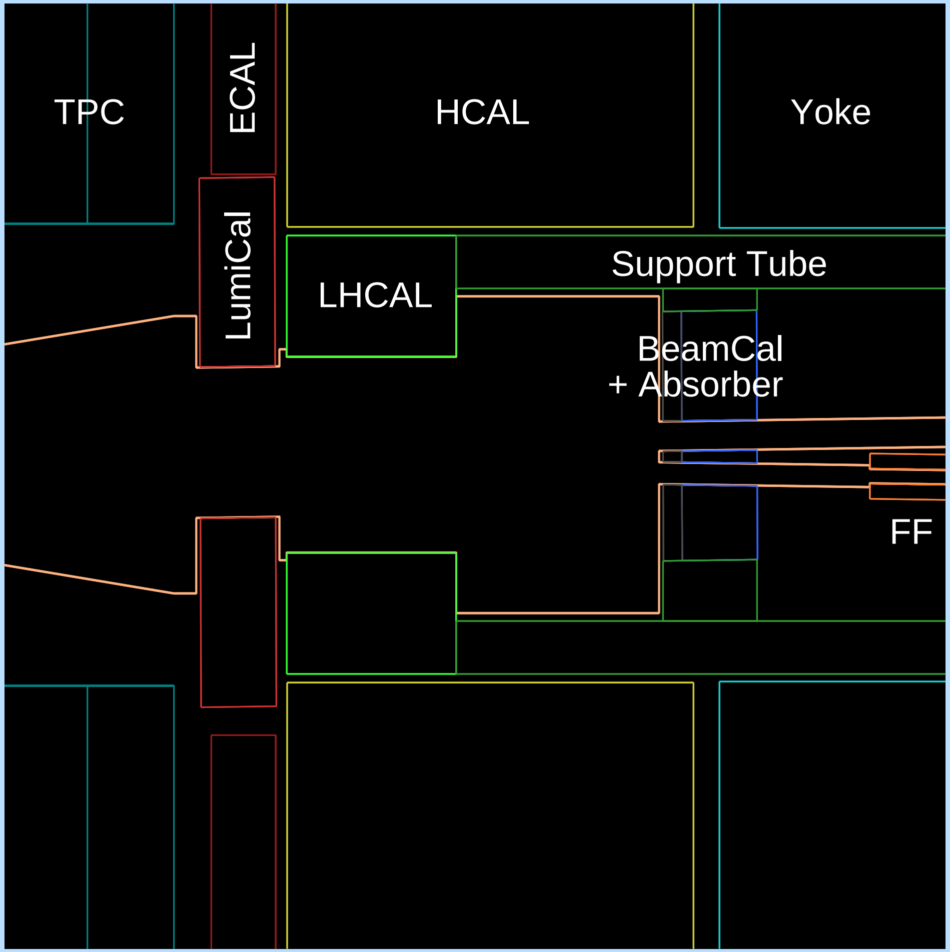
- Coil and TPC have been shortened
- ECAL and LumiCal have been pulled towards the IP
- FF at $L^* = 4.05\,\mathrm{m}$ remains unchanged
- BeamCal stays where it was
- New layout of the forward region



LDC Detector Geometry



14 mrad crossing angle with anti-DID field (1:10)



Forward region design (compressed view 1:2)

Computing

Simulations need a lot of computing time

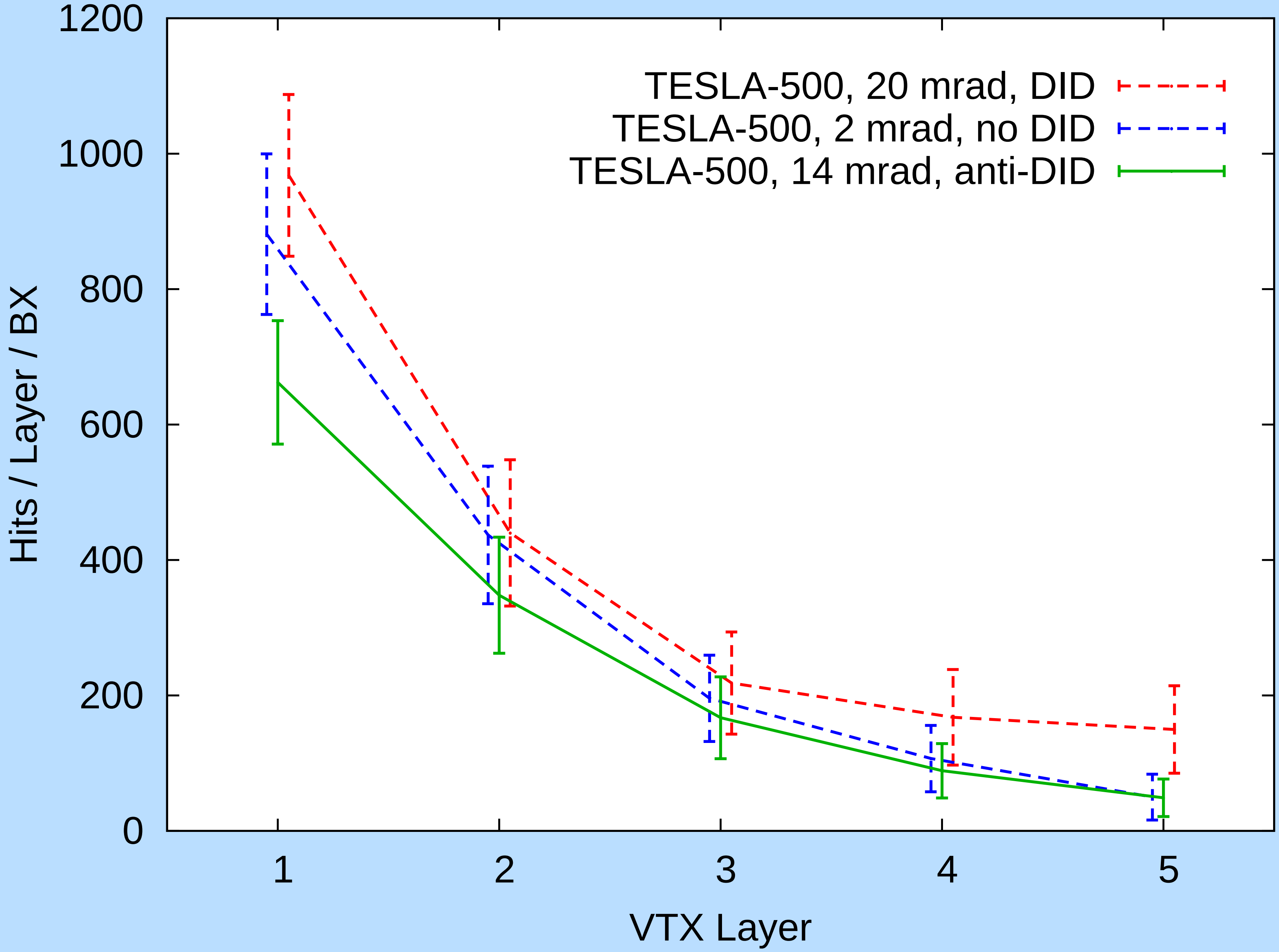
- $\mathcal{O}(10^5)$ particles per BX, many create EM showers
- full simulation is required: looking for “rare” incidences
- run time is 12 h to 48 h per BX (depending on settings)

Jobs are run on the Grid

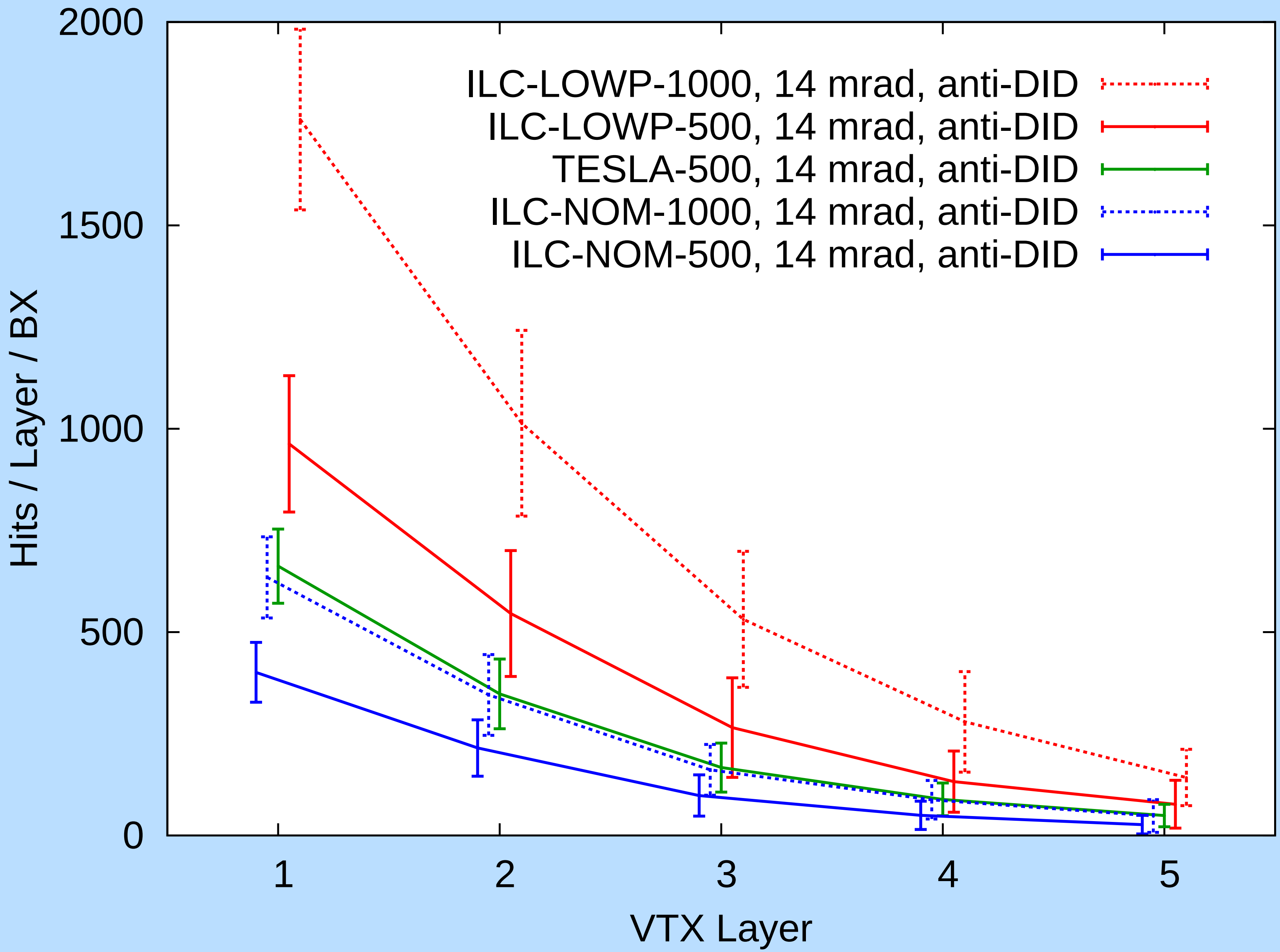
- more than 20 computing centres support the ILC
- over 8000 CPUs are available (shared with other VOs)
- data for this talk was produced in HH, Zeuthen, Lyon
- 100 BX can easily be processed in a single day

The Grid also provides mass storage for simulated data

VTX Hits – Geometries

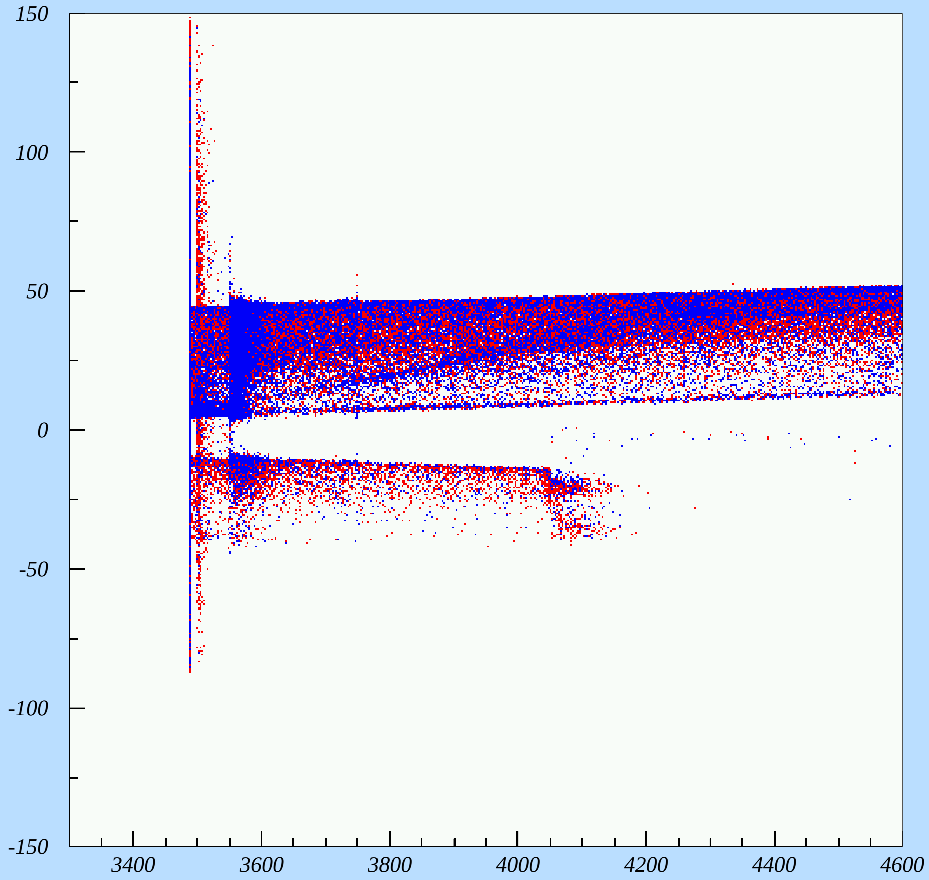


VTX Hits – Beam Parameters



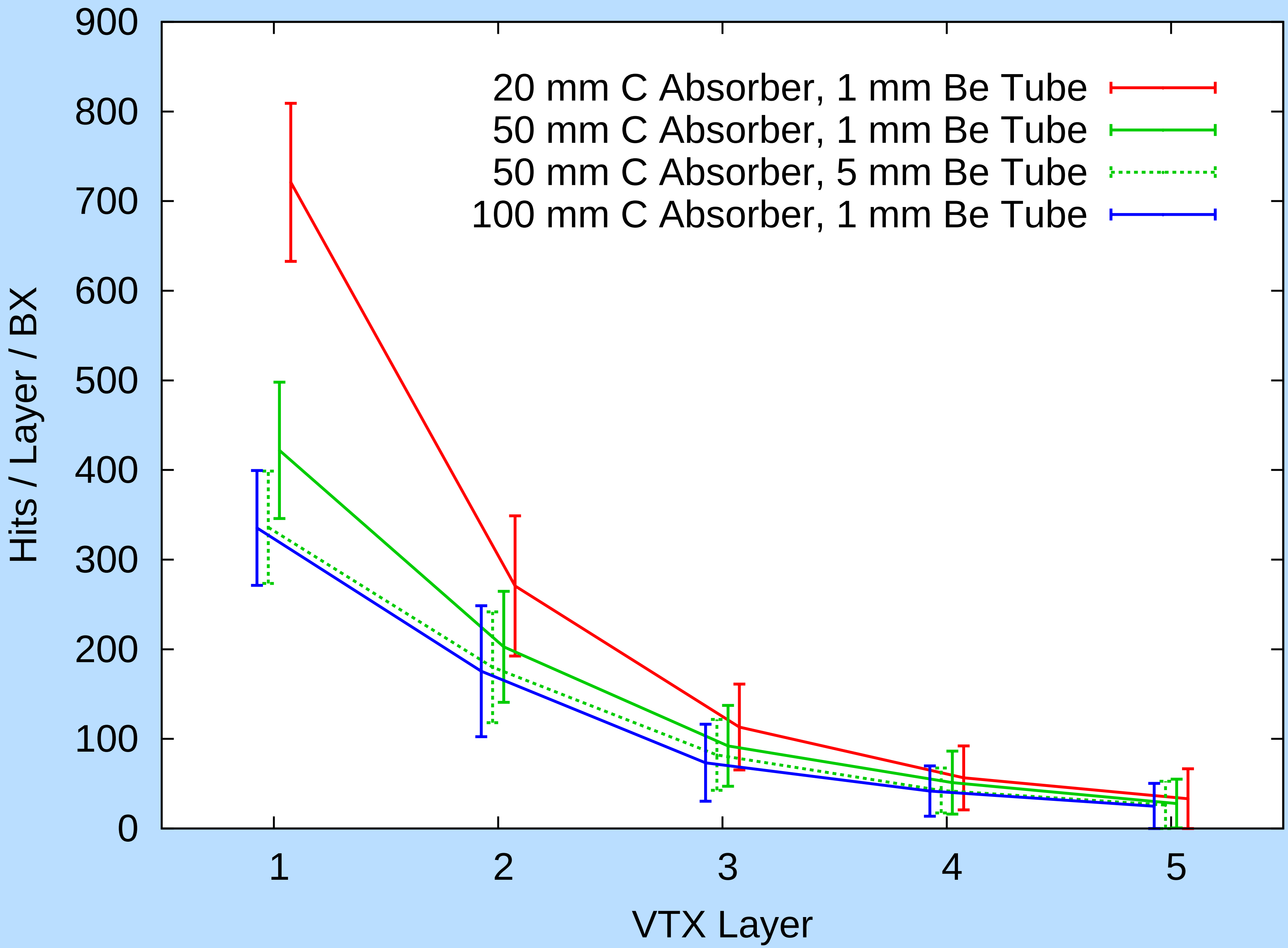
Backscattering Sources

- Many backscatterers come from the BeamCal
- Low-Z absorber suppresses that
- But: too much material will disturb the BeamCal
- How thick should the absorber be?
- Can a cladding of the inner surface help?



Origins of backscattered electrons and positrons

VTX Hits – Low-Z Absorber



Hadronic Physics Lists

Processes can be implemented by different models

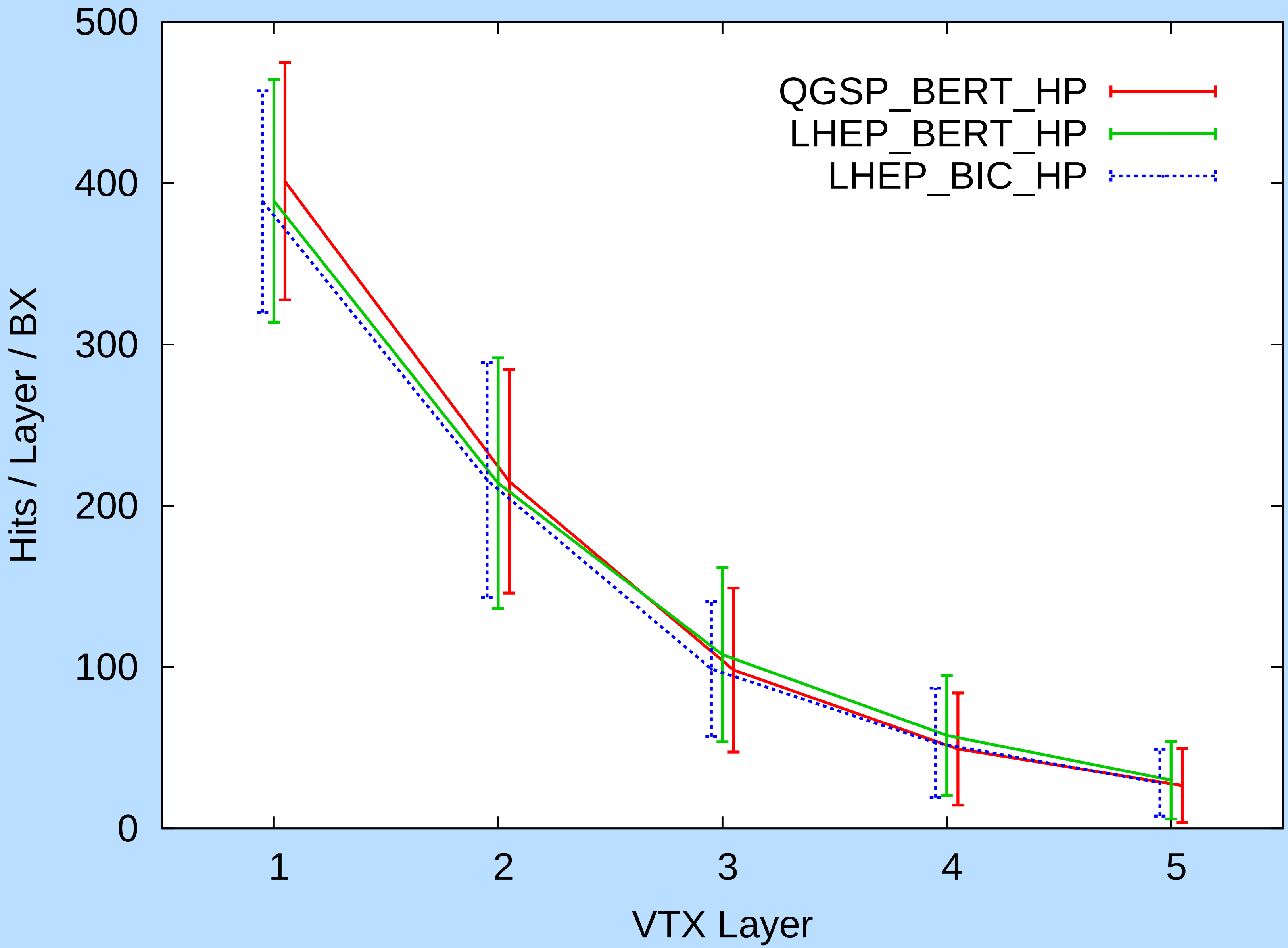
- electromagnetic physics are well-understood
- hadronic physics have a significant uncertainty
- neutron transport is the most difficult issue

Try out different hadronic physics lists provided by Geant4

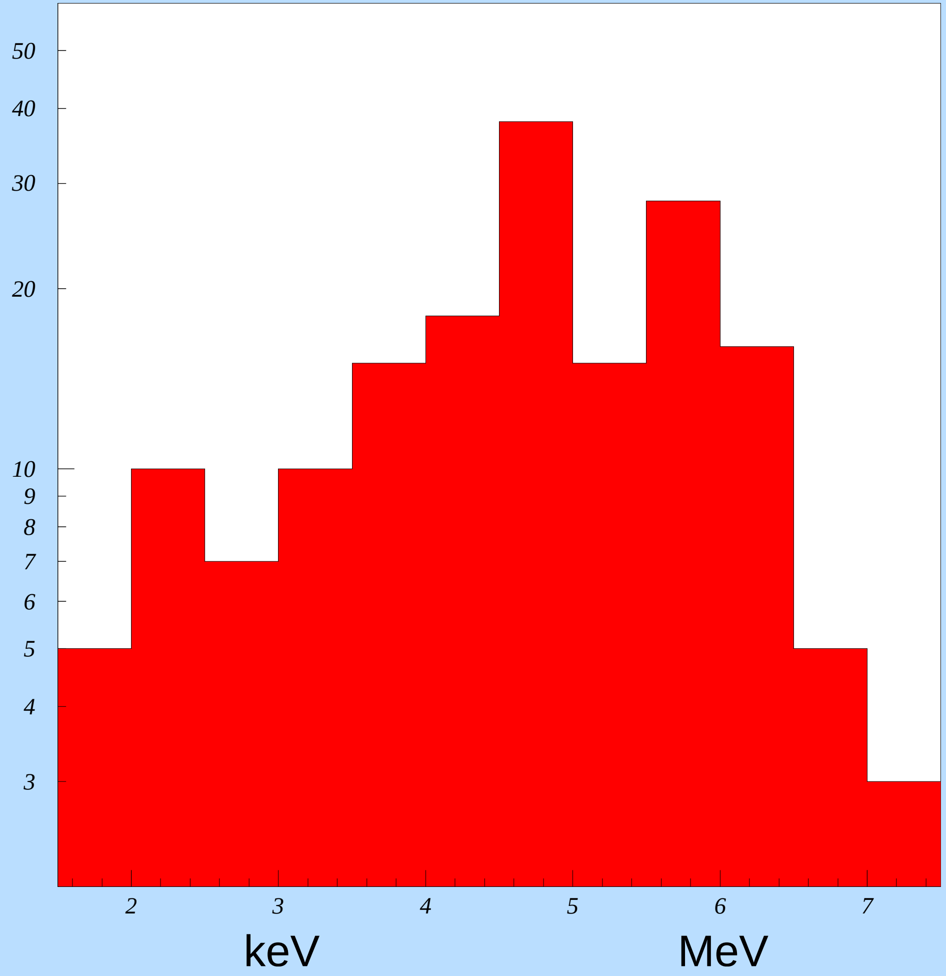
- `QGSP_BERT_HP` – Bertini nuclear cascade
- `LHEP_BIC_HP` – binary nuclear cascade
- “HP” physics use a large cross-section database
- these are recommended for low-energy neutrons

Does the choice actually matter for our purposes?

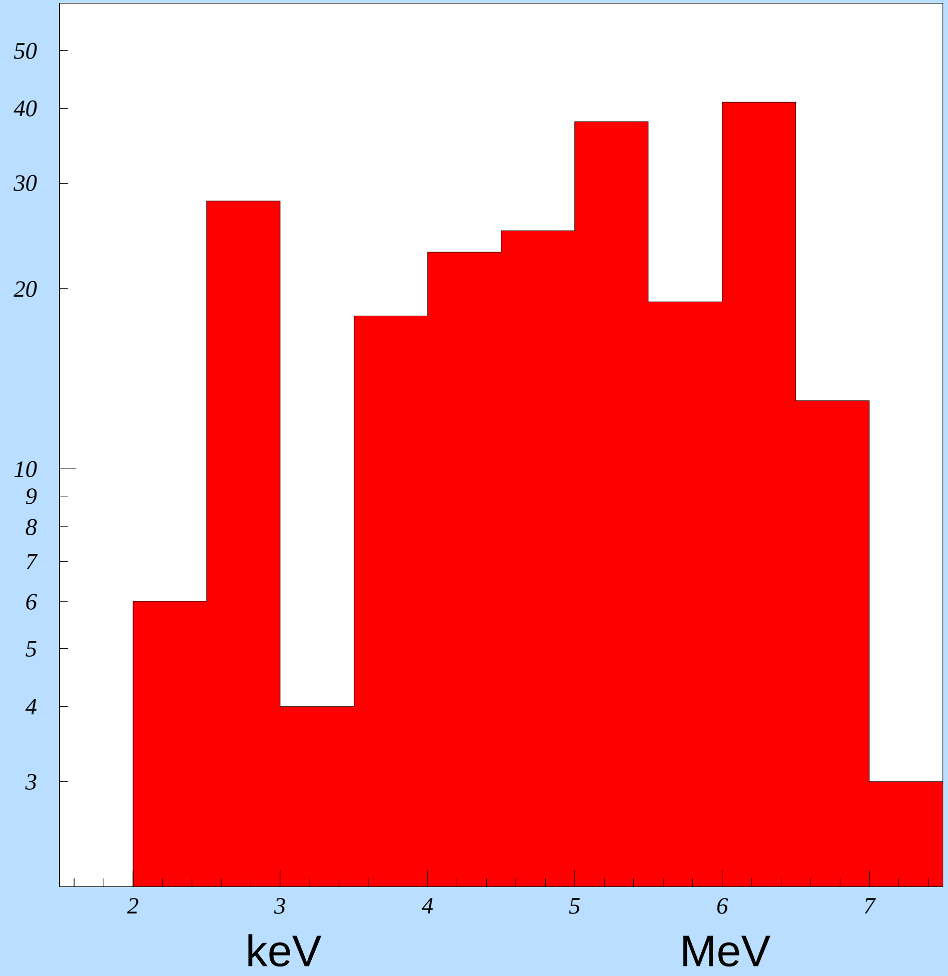
VTX Hits – Geant4 Physics Lists



VTX – Neutron Energies



QGSP_BERT_HP

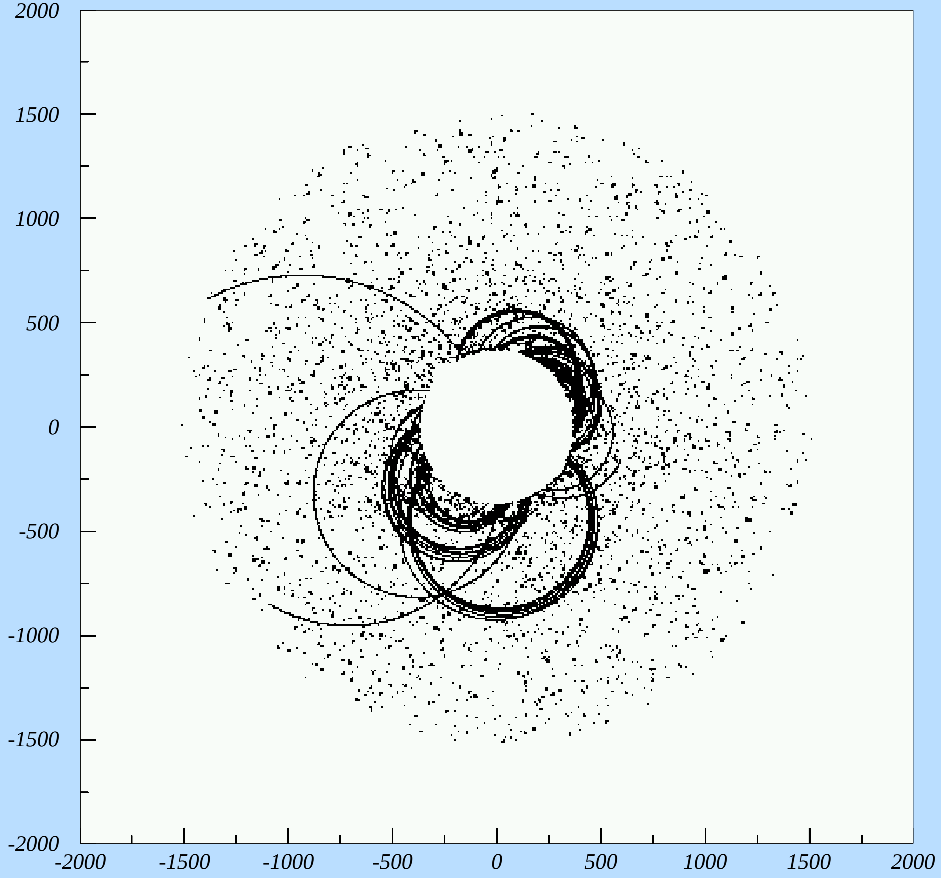


LHEP_BIC_HP

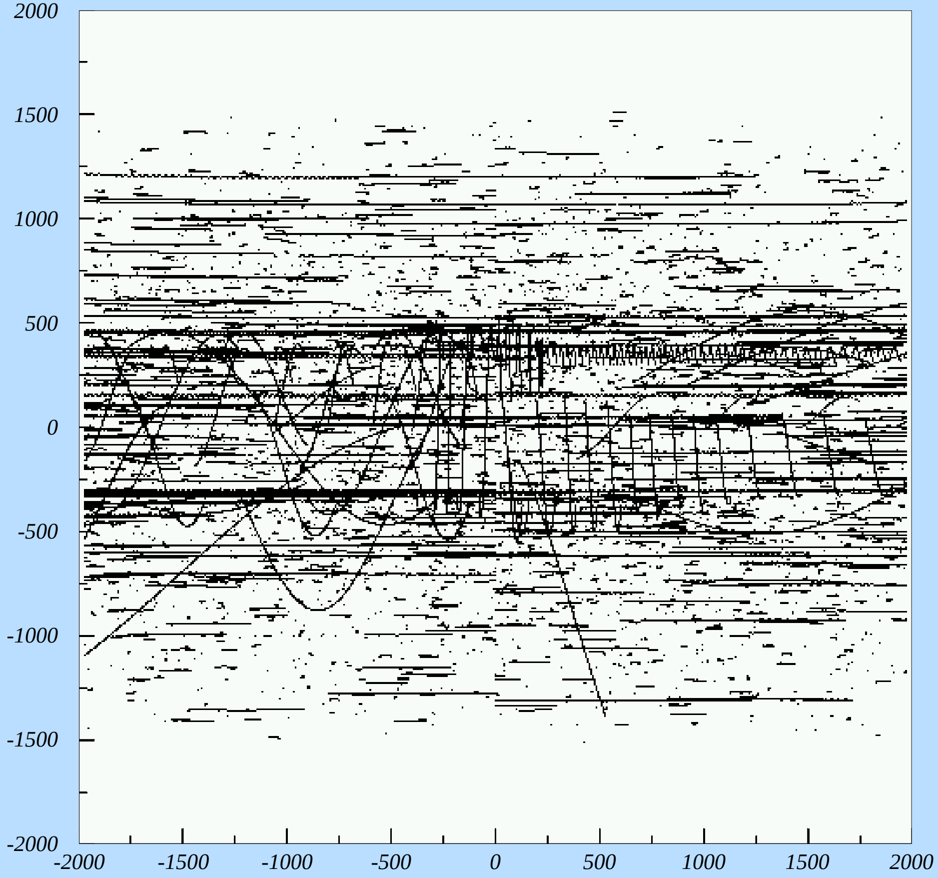
Energies of neutrons crossing the VTX (sum of 100 BX)

TPC Hits – “Salt and Pepper”

Mokka hits in the TPC (overlay of 100 BX)



Front view



Side view

Summary and Outlook

Backscattering is important, but can be suppressed

- optimisation of the forward geometry
- small modifications (e. g. radii) can have large effects
- anti-DID field prevents particles from hitting the VTX
- 50 mm low-Z absorber seems reasonable

Further plans: focus more on the TPC

- simulation of a whole bunch train
- make a “background library” to superimpose on events
- include background in the full reconstruction chain

No major suprises! The whole picture is settling down . . .