Simulations of the Neutron Background at the ILC

Getting into Mokka

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Neutron Sources at the ILC

Main beam dump and beamstrahlung dump

- huge amounts of neutrons after every BX
- but: far away from the detector

Electron-positron pairs from beamstrahlung scattering

- slam into forward calorimeters and quadrupoles
- create neutrons inside the detector
- main source of neutron background in the TPC

Radiative Bhabha scattering and various other processes

- negligible because of larger production distance

Simulation Tools

Guinea Pig

- simulates beam-beam interaction
- generates e^+e^- pair particles

Brahms

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

Mokka

- successor of Brahms, still under development
- but: based on Geant 4 / C++

Generator Interfaces

Choose a generator for primary particles with the Mokka command `/generator/generator`

- `particleGun` – Geant 4 built-in gun
- `*.stdhep` – binary HEPEVT common block (PYTHIA)
- `*.HEPEvt` – ASCII HEPEVT common block (reduced)
- `*.pairs` – ASCII Guinea Pig output (new)

Mokka and MySQL

Management of geometry setup

- Mokka contains many “geometry drivers”
- several drivers are plugged together to form a geometry model (kept in a database)

Management of geometry data

- each driver has its own custom database
- drivers of the selected model are called and read the actual geometry data at runtime

Easy access from C++ through `MySQLWrapper`

Creating a Local Geometry Database

Get MySQL running

- MySQL is preinstalled at `/opt/products/mysql`
- Set `PATH`, `LD_LIBRARY_PATH`, and `MYSQL_PATH`
- Create and initialize a local MySQL data directory
- Start the MySQL daemon
- Configure users “root” and “consult”

Get the geometry data

- Get a dump of the central Mokka geometry database
- Do some fine-tuning of the dump by hand
- Import the dump into your local database system

Using Your Local Geometry Database

Inspect database contents with `mysqlcc`

- graphical user interface
- allows reading (easy) and writing (clumsy)

Modify database contents with the `mysql` monitor

- write MySQL scripts with your favourite editor
- feed them into `mysql`'s standard input

Use database contents with Mokka

- specify “localhost” as Mokka's MySQL server

New Geometry Drivers

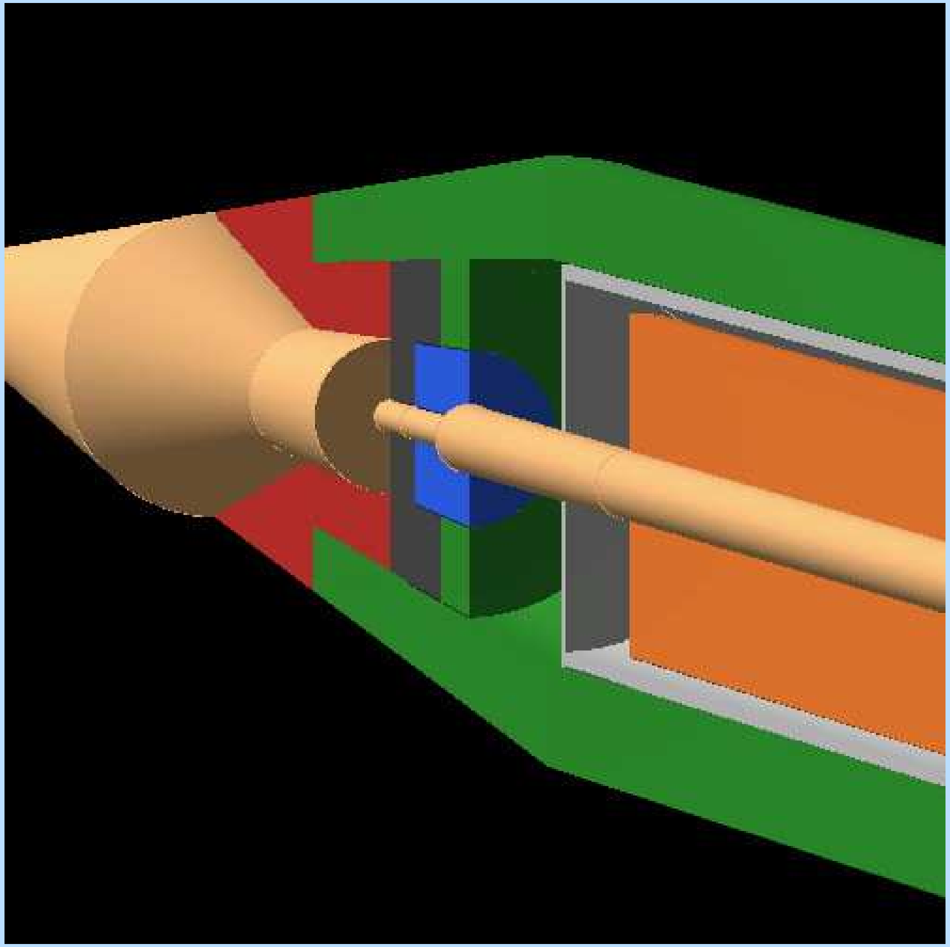
Modify existing detector model ("D10", TDR-like) by replacing some ingredients with new drivers:

- beam tube (from IP up to z = 10 m)
- mask (forward calorimeters, absorbers, support tube and shielding, quadrupoles, . . .)
- final focus quadrupole fields inside the tube (essential for background studies)

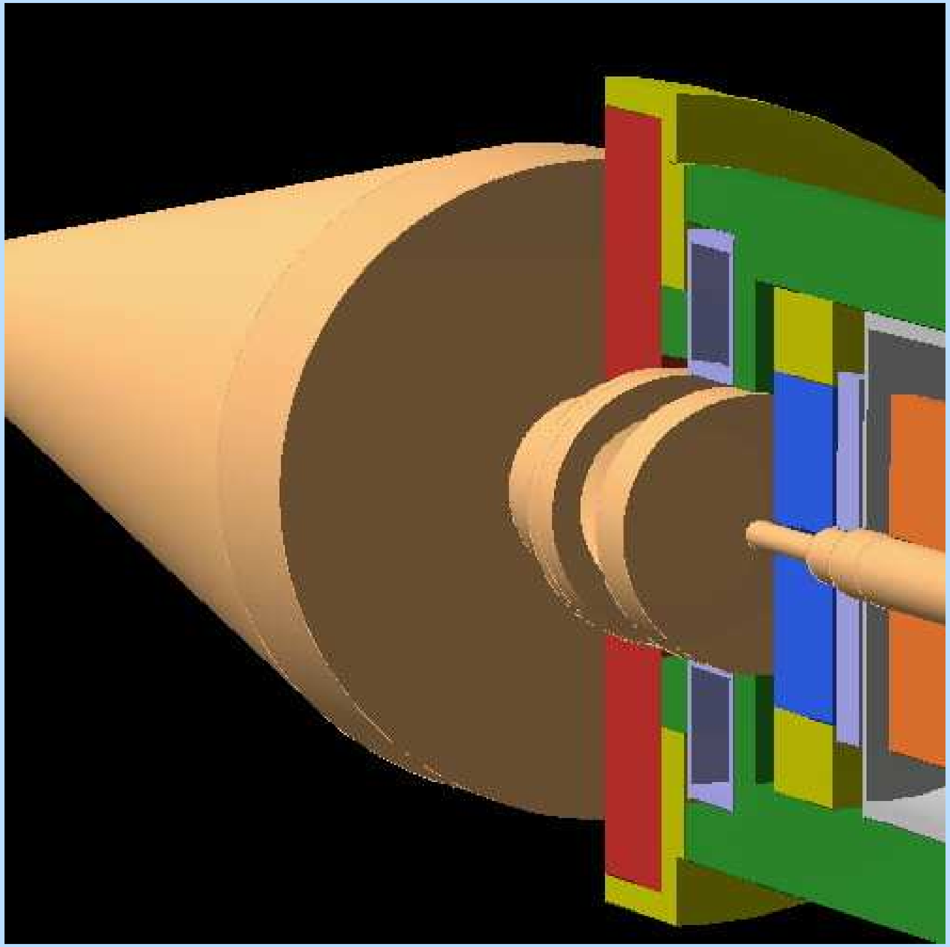
Geometry data exists for two detector layouts

- TDR layout (LAT and LCAL, L^* = 3.00 m)
- Stahl proposal (LumiCal and BeamCal, L^* = 4.05 m)

New Geometry Drivers – 3D Views



TDR layout



Stahl proposal

Physics Lists

`PhysicsList` (Mokka built-in)

- doesn't support neutron production at all

`LCPhys` (dedicated Linear Collider physics list)

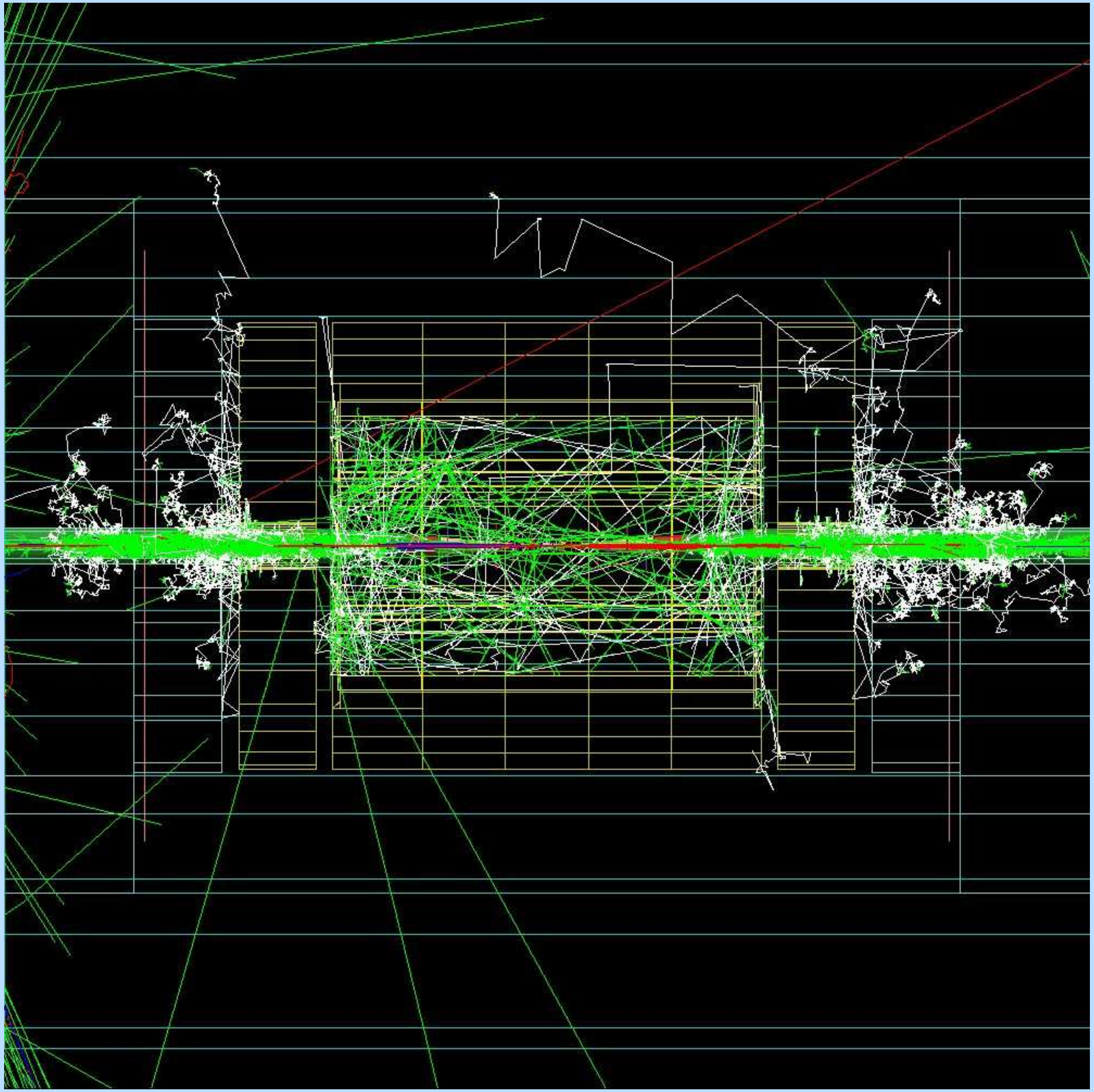
- latest version supports neutron production
- but: uses poor models for low energies (up to now)

`PhysicsListNeutrons` (extended `PhysicsList`)

- enables electro-nuclear processes
- uses high-precision neutron models (`QGSP_HP`)
- shows scattering and moderation of neutrons

Example Events

- 1000 particles ($\approx$ 1/100 BX)
- TDR layout, new drivers
- Physics list with neutrons
- TPC filled with pure Argon



Short-Term Questions

- How many neutrons are produced?
- What energy do they have?
- Where are they produced?
- Where do they go?
- How often are they reflected by the ECAL?
- How many background hits do they produce in the vertex detector and the TPC?
- What density and distribution does the accumulated “neutron gas” have?
- How much other background can be seen?

Analysis Tools

Mokka plugins

- can simply be activated before runtime
- are called by the Mokka kernel
  for each run, event, track, and step
- provide a hook to the full power of Geant 4

Linear Collider Input / Output

- Mokka has already built-in LCIO support
- straightforward to use for beginners (really!)
- powerful tool for experienced users

Long-Term Goals

Differences between detector layouts

- TDR is almost ruled out, but earlier results exist
- small or large crossing angle? serpentine field?

Drift gas for the TPC

- hydrogen may lead to many knock-on protons
- different gas mixtures? even without CH_4?

Background tracks in the TPC

- proton tracks and neutron decay (after 15 min)
- will the occupancy still allow tracking?