Simulation of Machine Background in the TESLA TPC with GEANT4

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DESY

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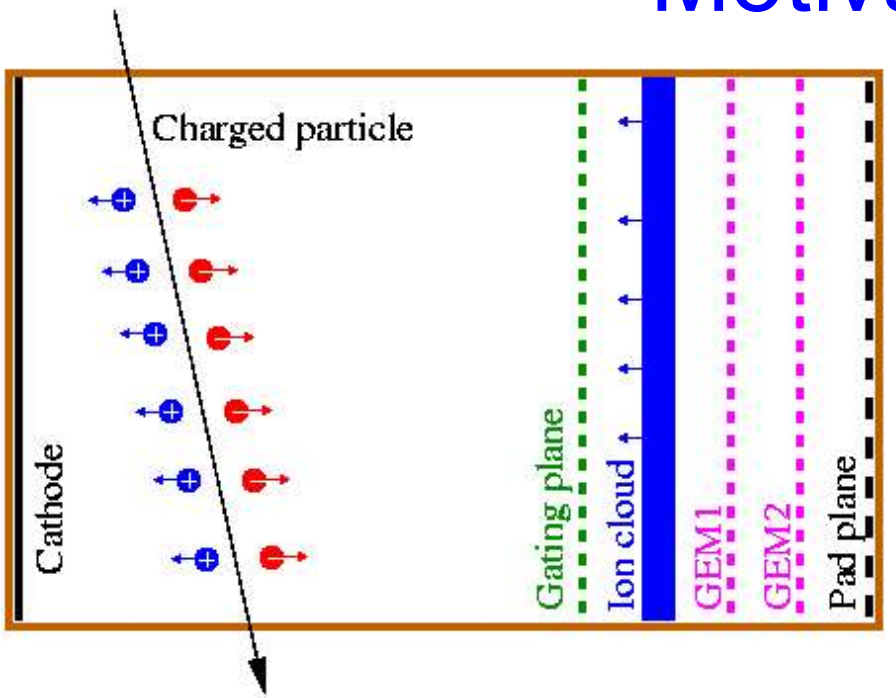
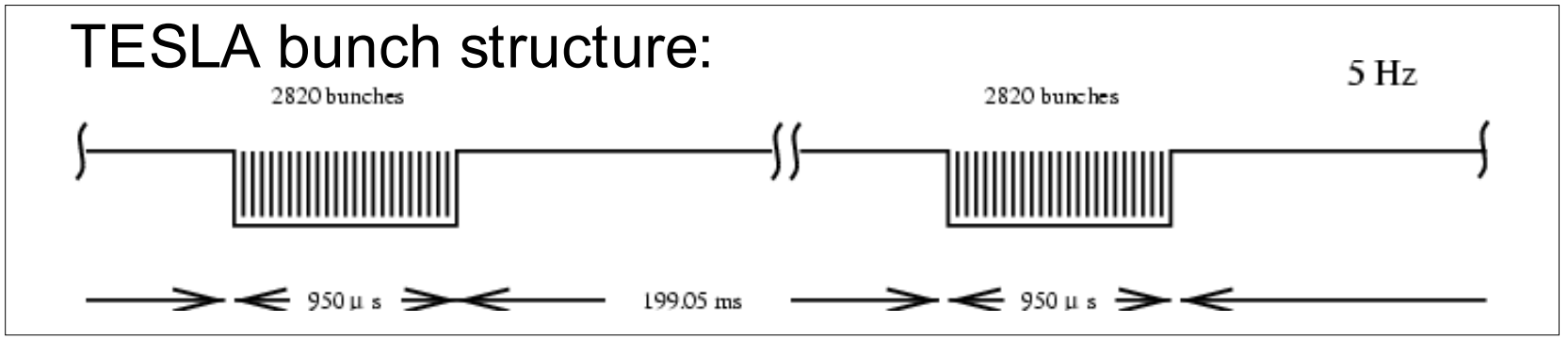
Motivation



Some ions from amplification process drift back into drift region

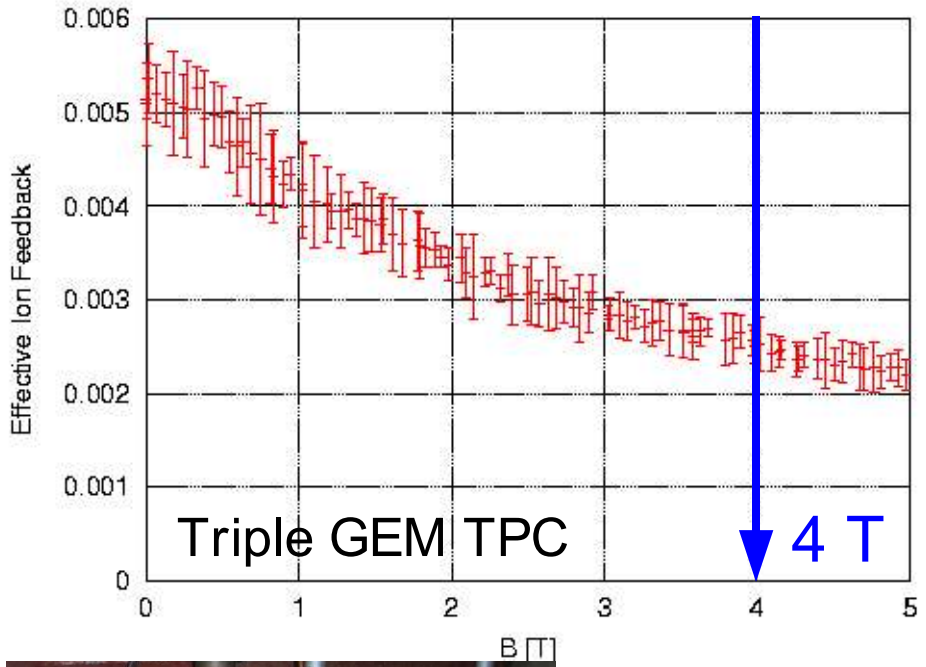
⇒ Build-up of ion cloud

Active gating impossible during bunch trains at TESLA

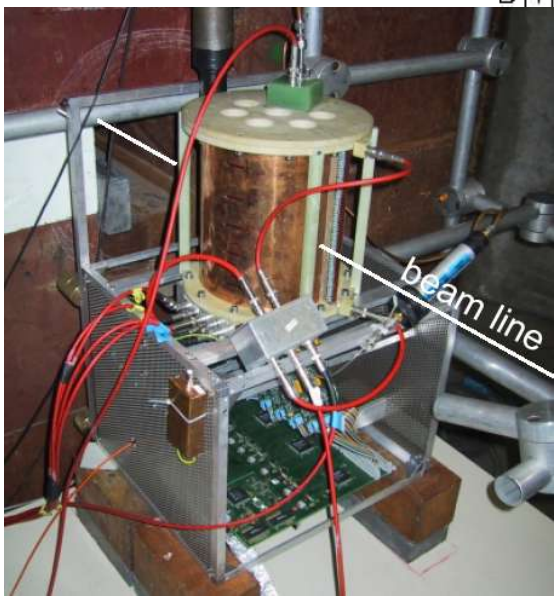


How much ion feedback suppression is necessary for a given gas to prevent severe field distortions?

Experimental Results



Ion feedback values
< 1 % are feasible



Severe track distortions
set in at charge densities
of order O(pC/cm^3)

What charge densities are expected
in the TESLA TPC?

Results from BRAHMS

Detailed GEANT3 based detector simulation for TESLA

Pairs from beamstrahlung are by far most important charge source in TPC

Assuming a gain of 10000 and an ion feedback of 1 %, BRAHMS predicts that charge densities of the order of pC/cm^3 are possible

CAVEAT:

- Large spatial variations
- Neutron production from pairs and their effects not simulated

  → Requires different simulation framework (FLUKA, GEANT4, ...)

Simulation with Mokka

GEANT4 based detector simulation for TESLA
(geometry description not yet as comprehensive as in BRAHMS)

Modified and extended beam line (beam pipe, mask with LAT and LCAL, quadrupoles, etc.)

Modified physics list to include photo-nuclear and electro-nuclear reactions (QGSP_HP)

Neutron Flux in TPC

GEANT version: 4.5.1.p01
Mokka version: 01-05

Reflected neutrons are counted multiple times

preliminary	$\sqrt{s}$ = 500 GeV	$\sqrt{s}$ = 800 GeV
GEANT4 [n/BX]	19204 ± 214	22218 ± 396
FLUKA* [n/BX]	$15070 \pm$ n. a.	n. a. $\pm$ n. a.

*FLUKA simulation by Gregor Wagner (LC-DET-2001-048)

Summary

- Prediction of charge production in the TPC is important for the layout of its gas amplification system and the choice of gas.
- Too few is known about the contribution of neutrons to the charge production in the TPC.
- First results show reasonable agreement between neutron fluxes from GEANT4 and FLUKA simulation.

Outlook

- Determine reactions of neutrons in TPC for different TPC gas candidates. How much CH_4 is acceptable?

- Simulate the impact of ion cloud on incoming tracks with finite element program MAXWELL to estimate track distortions.

- Provide input for final choice of TPC gas and design of gas amplification system.