The HERA-B Tracking System

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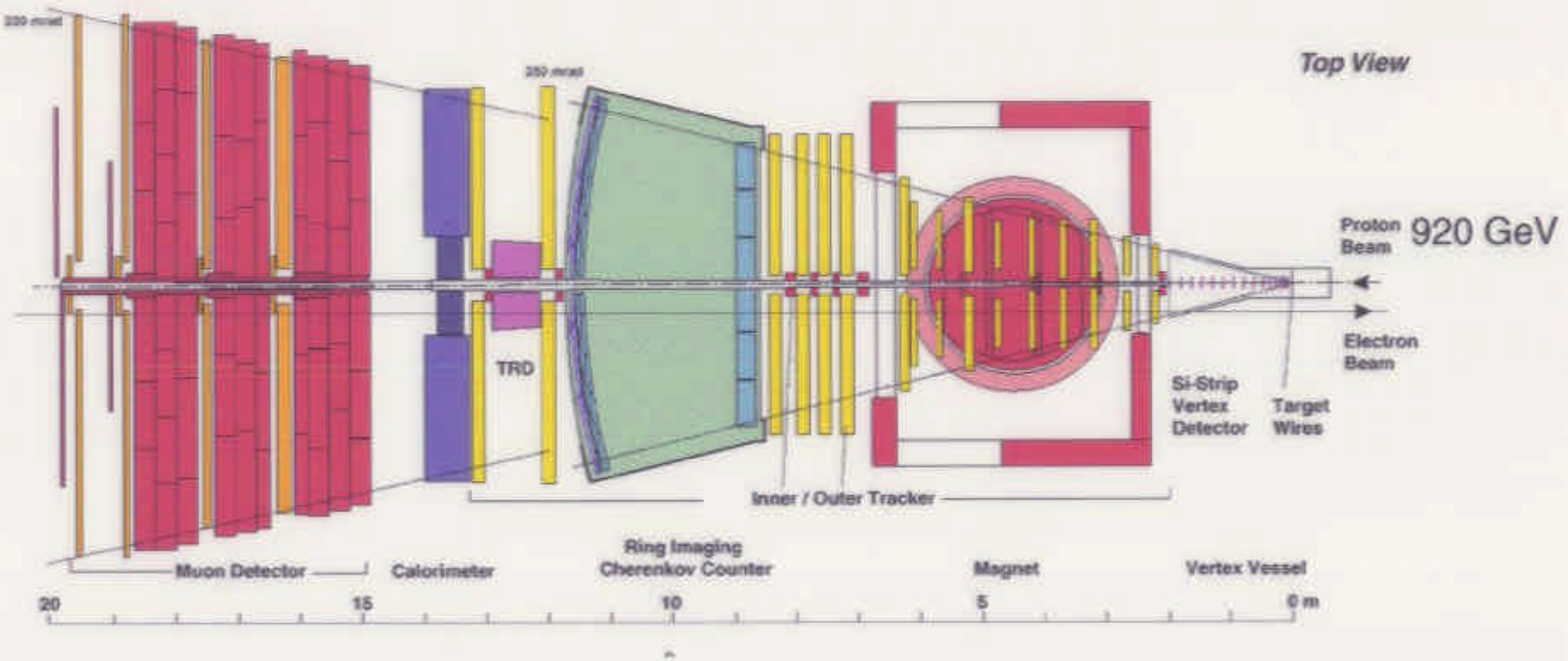


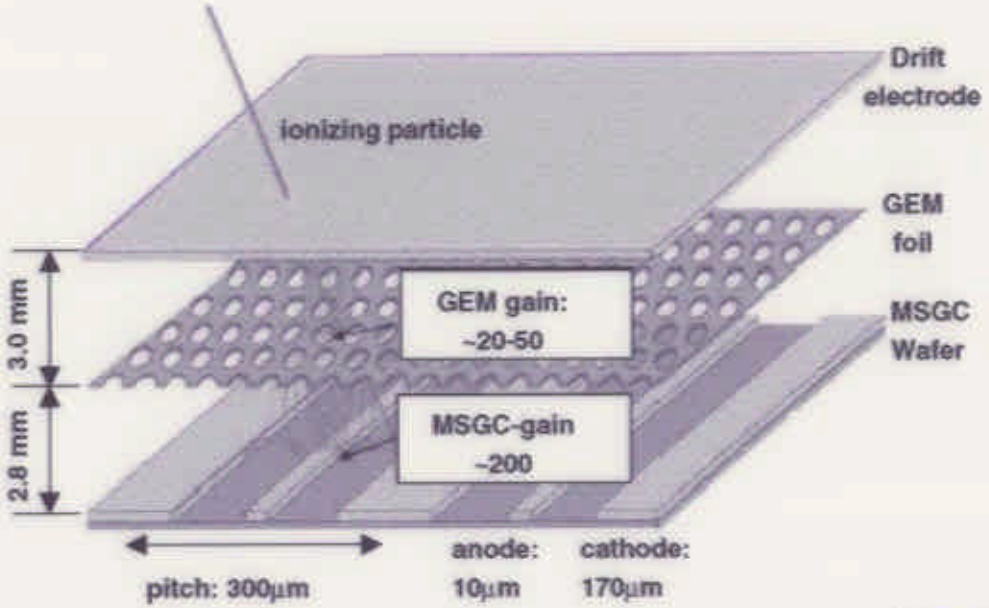
- Good acceptance: large area, instrumentation close to beam: high track densities
- Acceptable occupancies: varying granularities

Inner tracker: MSGC-GEM Detector
pitch: 300 μm, size up to: 56 cm x 56 cm
102,000 channels

Outer tracker: Honeycomb Drift Chamber
pitch: 5 and 10 mm, size up to: 4.6 m x 6.5 m
115,000 channels

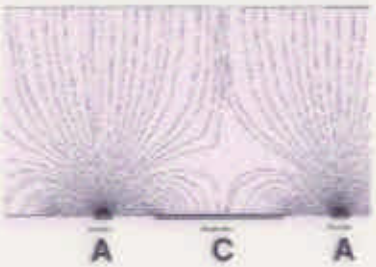
- $\sigma_{b\bar{b}}/\sigma_{total} \approx 10^{-6}$: event rate 40 MHz, high radiation dose, challenging trigger
- 96 ns bunch crossing time: fast detector response

Construction of the inner MSGC-GEM detector:

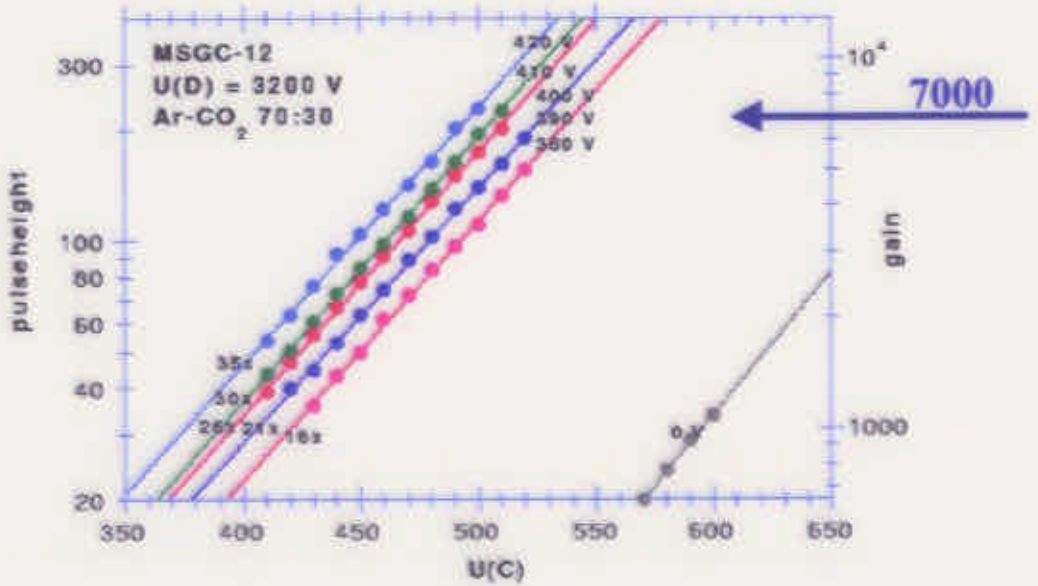


Gas Electron Multiplication

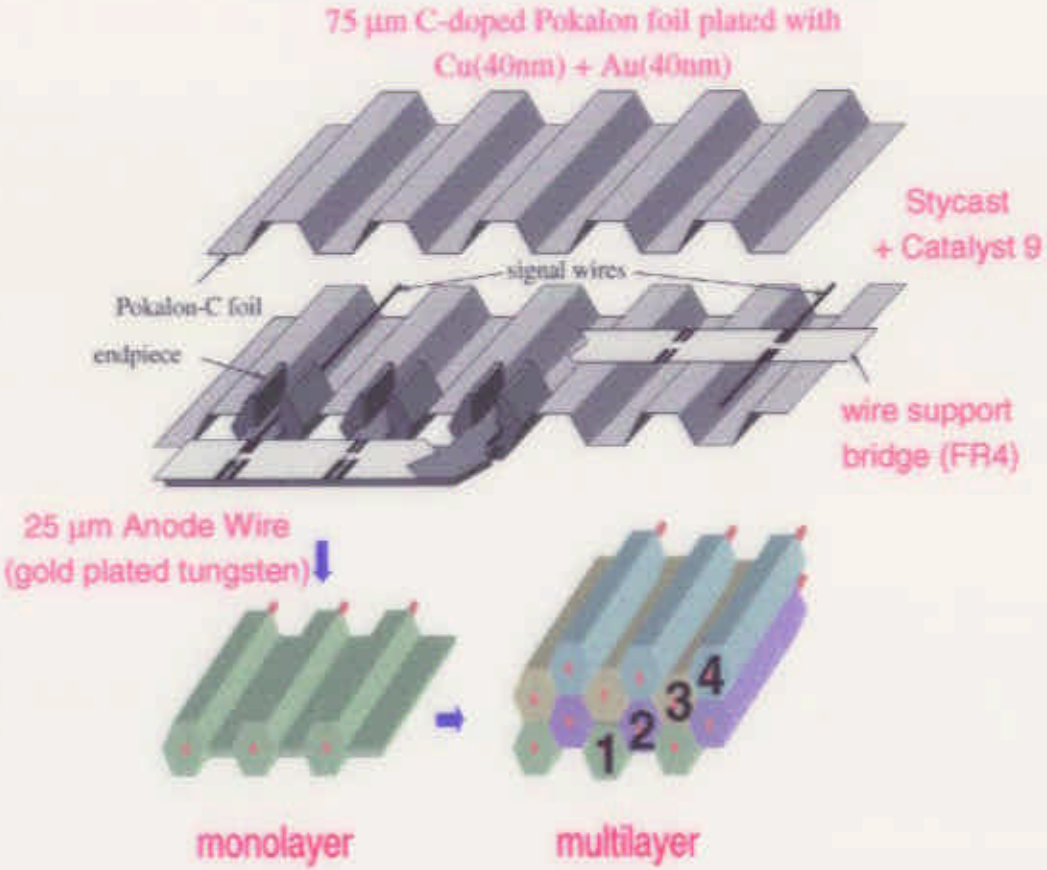
Micro Strip Gas Chamber



hit resolution: ~100 µm
hit efficiency: 98%
occupancy < 5%
dose: 1 Mrad/year over 5 year



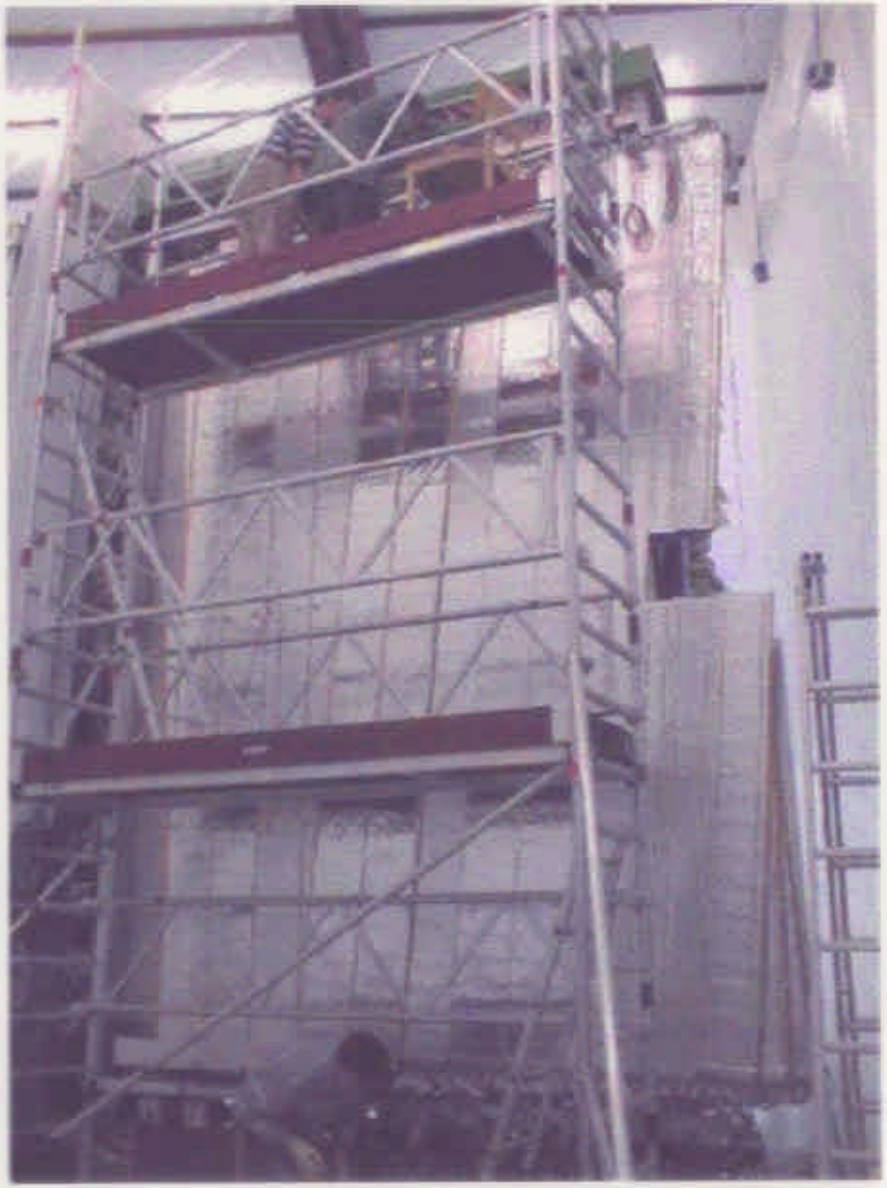
Construction of the outer honeycomb drift chamber



hit resolution: ~200 μm

hit efficiency: > 95%

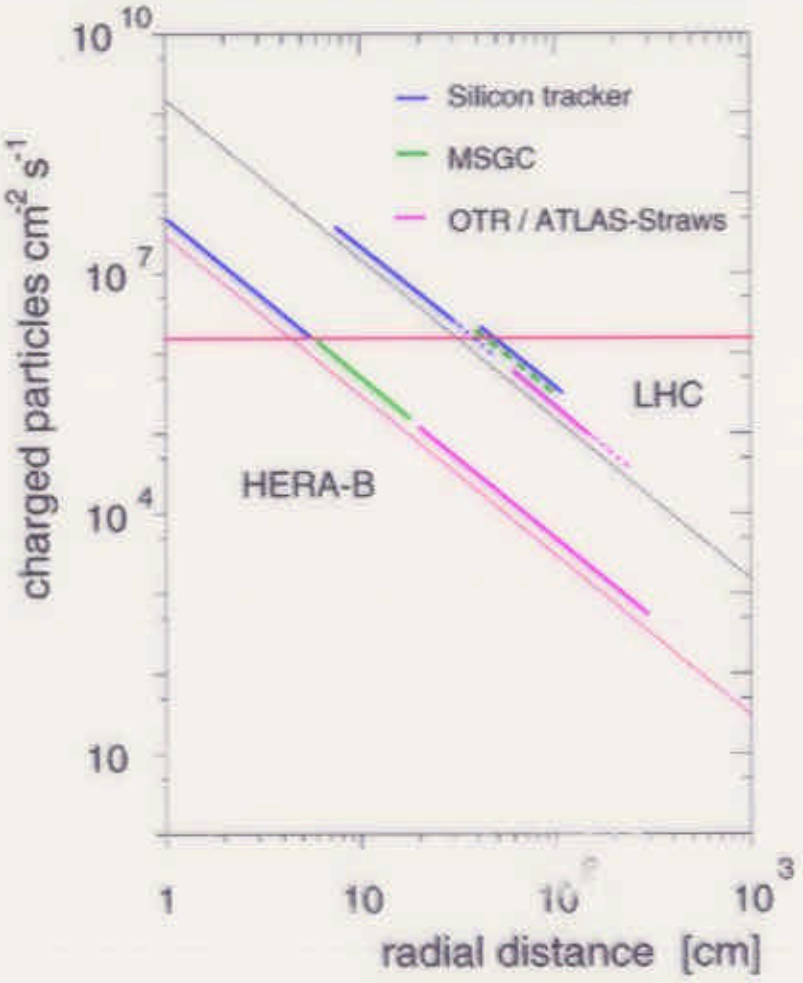
dose: 0.5 C/cm/year over 5 years



Radiation hardness

X-rays simulate hadronic radiation insufficiently

Radiation dose similar to LHC experiments



Inner Tracker:

- Charge up of insulating surface
  diamond coating of MSGC surface
- Sparks destroy MSGC structure:
  add preamplification in gas (GEM)
- Anode aging:
  use Ar:$C0_2$ (70:30) gas mixture

Outer Tracker:

- Malter Effect with pure Pokalon-C cathode:
  Au/Cu coated Pokalon-C surface
- Anode aging with Ar:CF_4:CH_4:
  use Ar:CF_4:CO_2 (65:30:5) gas mixture
- Dark current with CF_4 based gas:
  water concentration < 500 ppm

New version of HELIX-chip

Problem of old HELIX chip:

Feedback of comparator output to input signal:

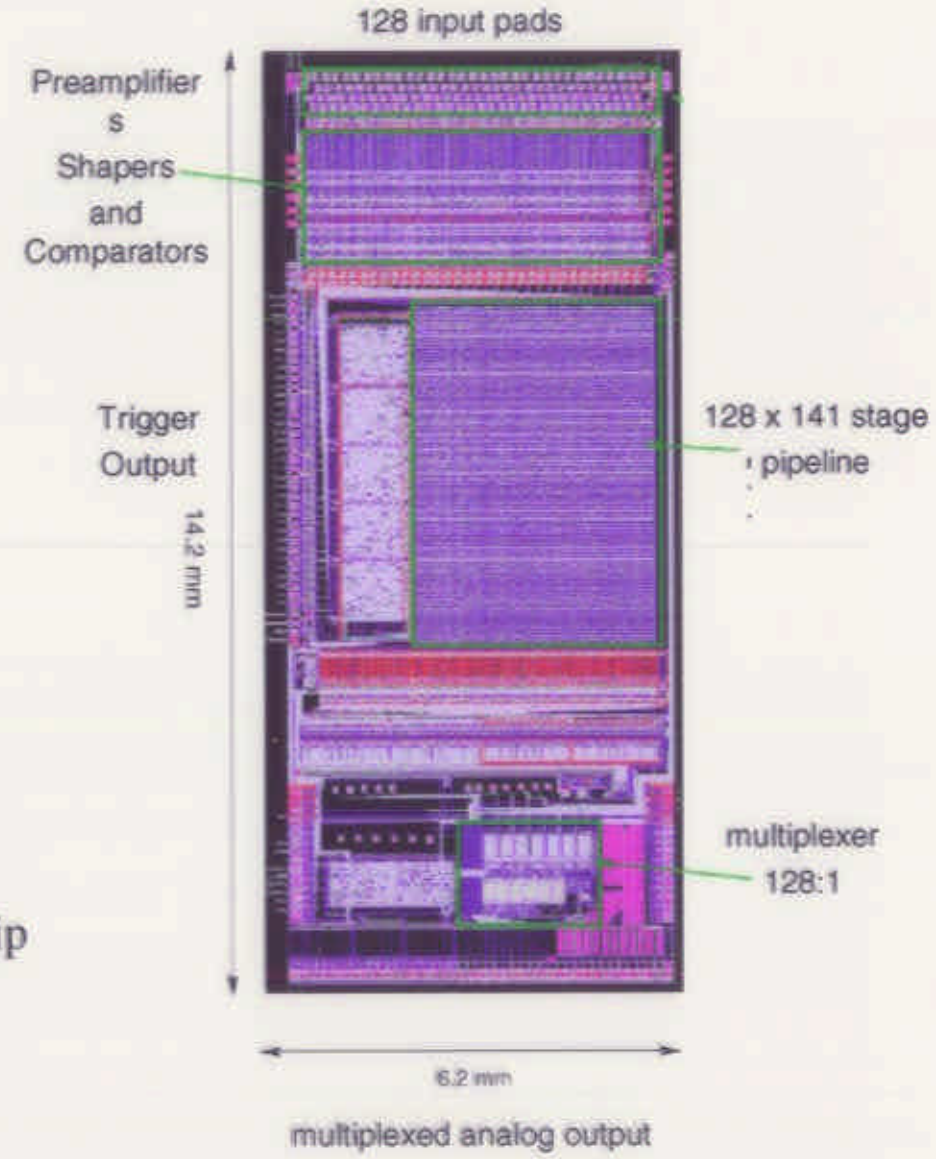
Operation of trigger part is impossible

Solution:

- New version 3.1 of HELIX chip with reduced swing of trigger output voltage (2V instead of 5V).
- Improved ground connection to chamber, which might also decrease the general noise level

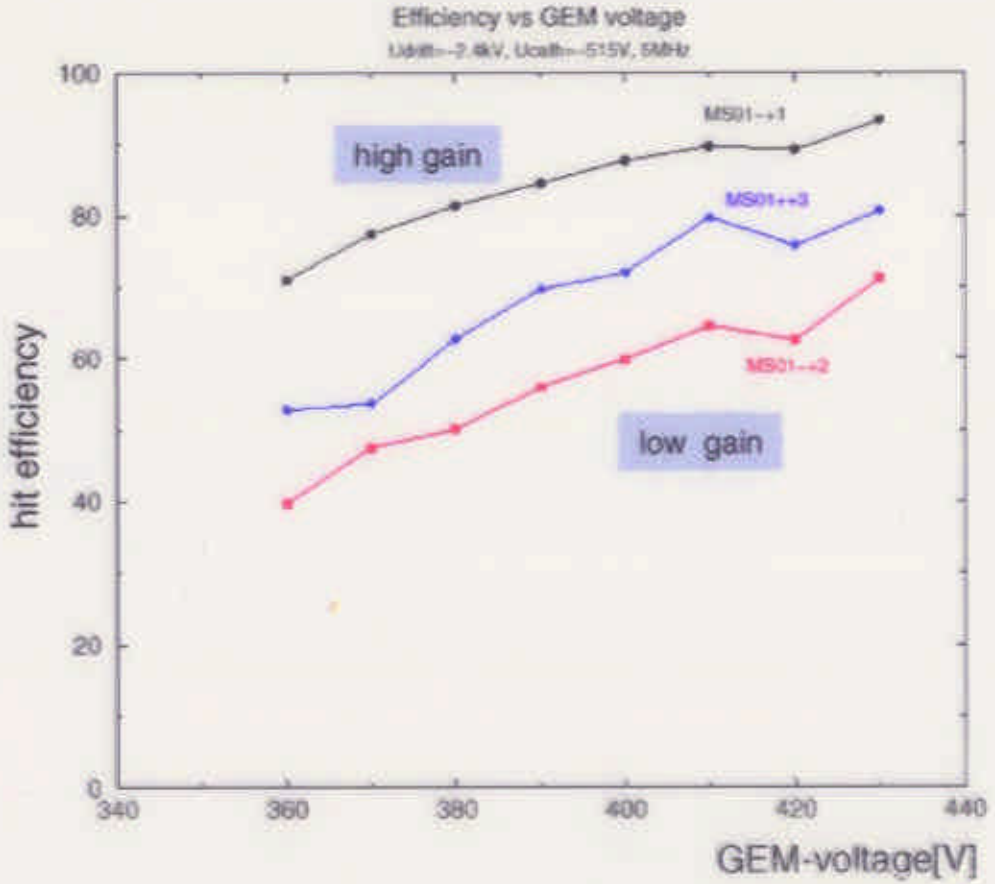
- Successful operation in a test set up
- Detailed efficiency studies ongoing

Installation of trigger chambers with new HELIX-chip during the HERA Luminosity shutdown



Inner tracker operation

- MSGC-GEM chambers need careful HV-training in the beam.
- Detectors are in stable operation.
- Hit efficiencies up to ~90% reached. Efficiency optimization still ongoing.
- New: Individual adjustment of GEM-voltages ⇨ Efficiency variations reduced to ~10%.

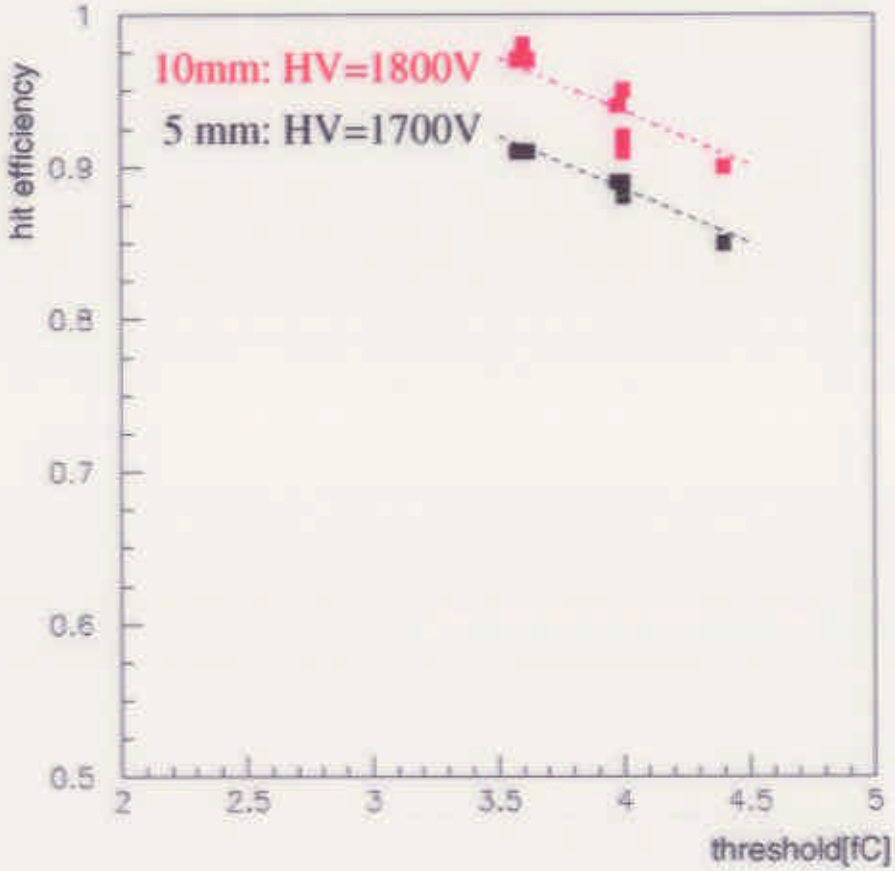


Outer tracker working point

Optimal working point not yet reached.

1) HV-settings close to limit, small steady loss of wires.
   Up to now: ~0.5% of the wires
   Due to 1:16 HV-grouping: ~8% dead channel
   ⇨ reduced HV, gas gain approx. two times lower.

2) Feedback of a TTL trigger output signal of TDC to input of ASD8-amplifier
   ⇨ threshold: 3.5 - 4.5fC (instead of 2-2.5fC)



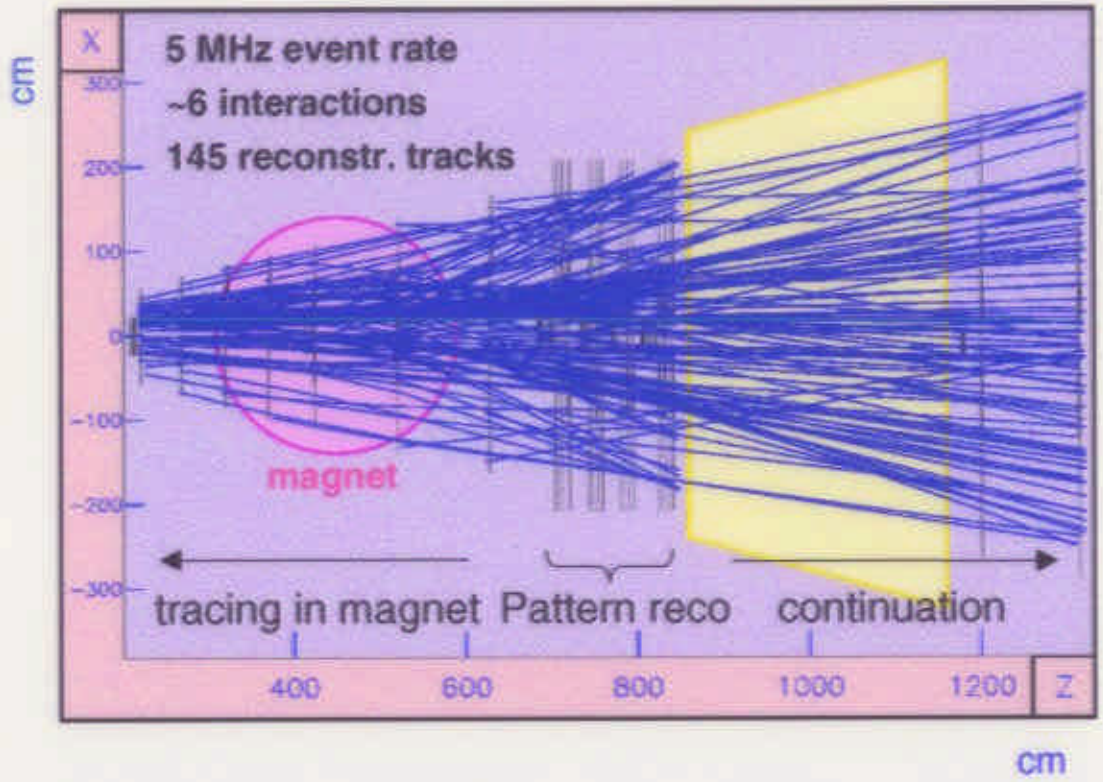
Consequently:

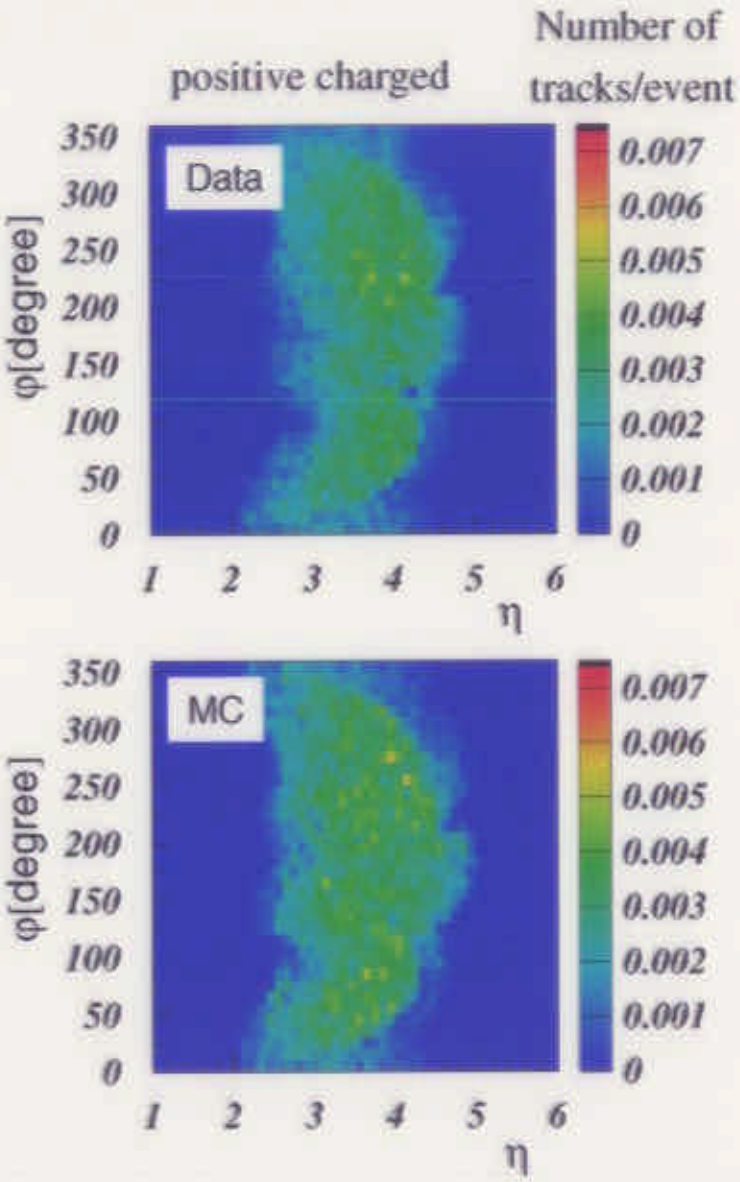
Hit efficiencies: ~ 90%
Hit resolution: ~ 400µm

Measures under consideration:

- Change to gas mixture with higher gas gain
  i.e.: Ar:CF_4:CO_2 (65:30:5) ⇨ (75:20:5) **5 times higher gain !**
- Improved grounding scheme on TDC-board

Track reconstruction



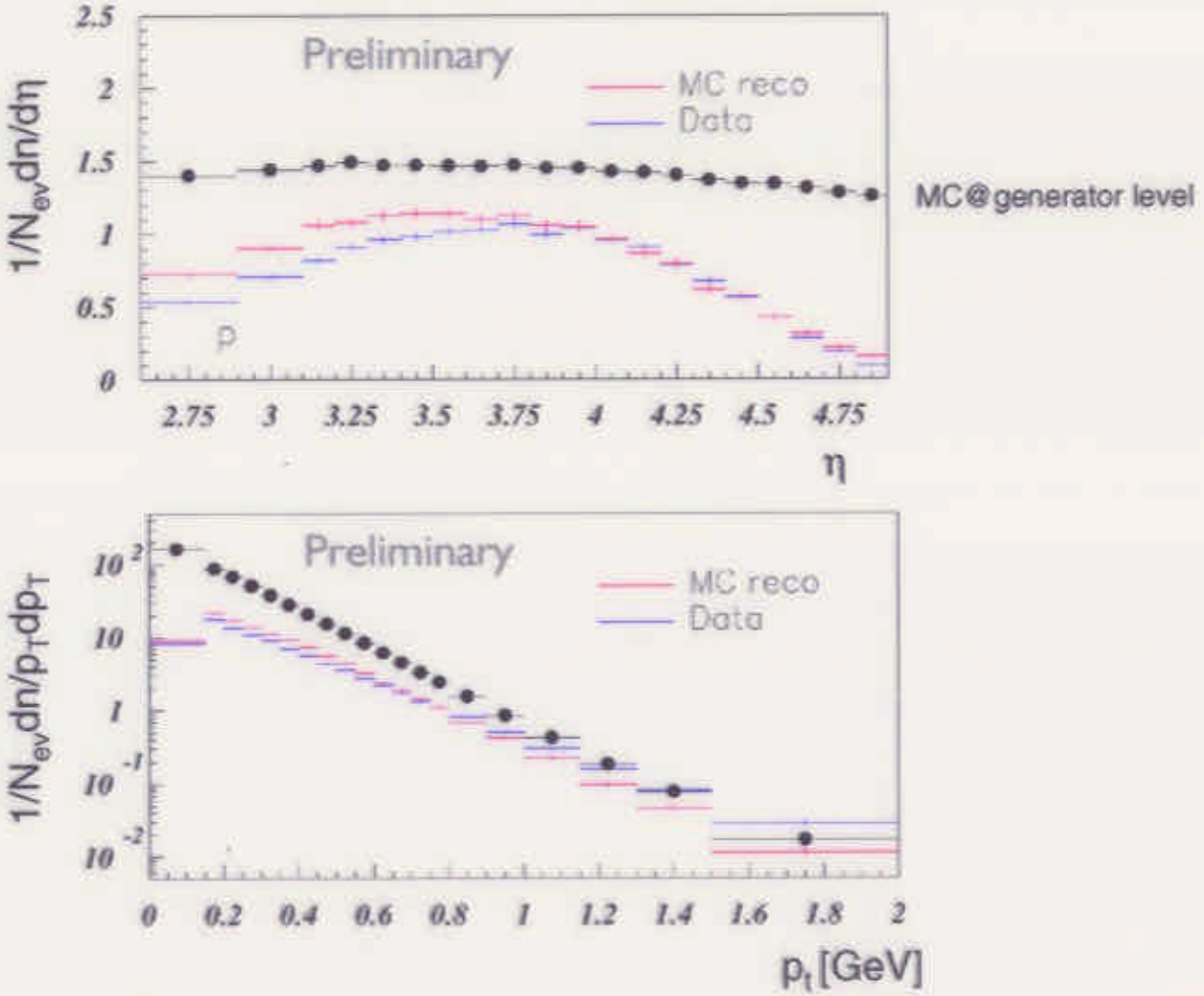


Reconstruction suffers from current chamber performance:

- improvements of the algorithms to reduce impact of dead channels , lower hit resolutions and hit efficiencies.

- track reconstruction efficiency with adapted MC:
  - 90% for tracks with at least 18 hits

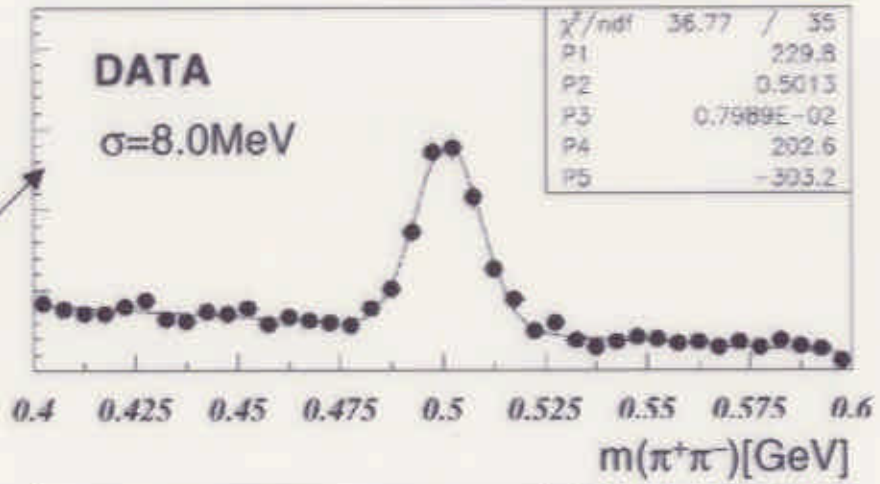
Inclusive particle spectra

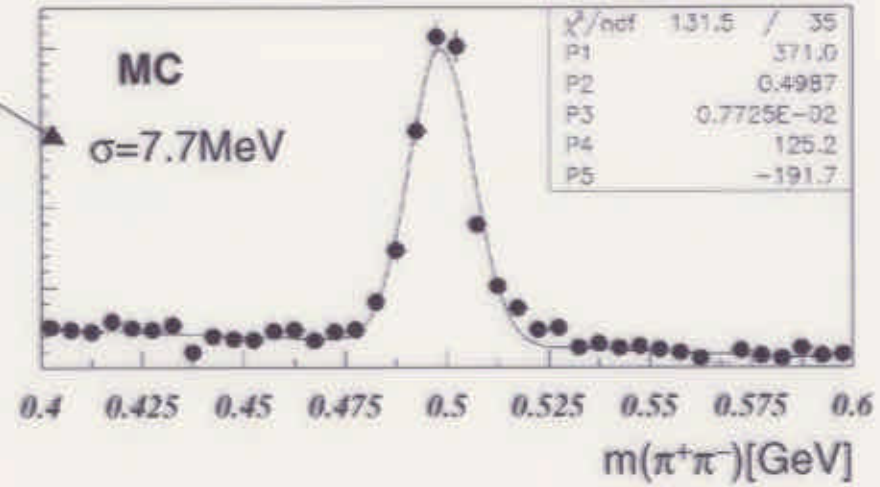


Agreement between data and MC: typically better than ~20%

K^0_S Signal

Good agreement
of
mass resolutions





Lower S/B need further study

(more tracks or ghosts, lower efficiency ?)

Summary

- The inner tracker MSGC-GEM detector and the outer honeycomb drift chamber were operated successfully under the hard radiation environment of HERA-B.
- Both inner and outer tracker are delicate devices with respect to their HV-stability. Careful training is necessary.
- The current status of the commissioning was presented. Further improvements of the efficiencies and resolutions can be expected.
- Considerable progress in the data analysis.