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The HERA-B Experiment

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for the HERA-B Collaboration

- Motivation, aims
- HERA-B spectrometer
- Recent modifications
- Results of tests (96/97 run)
- Outlook

The HERA-B experiment

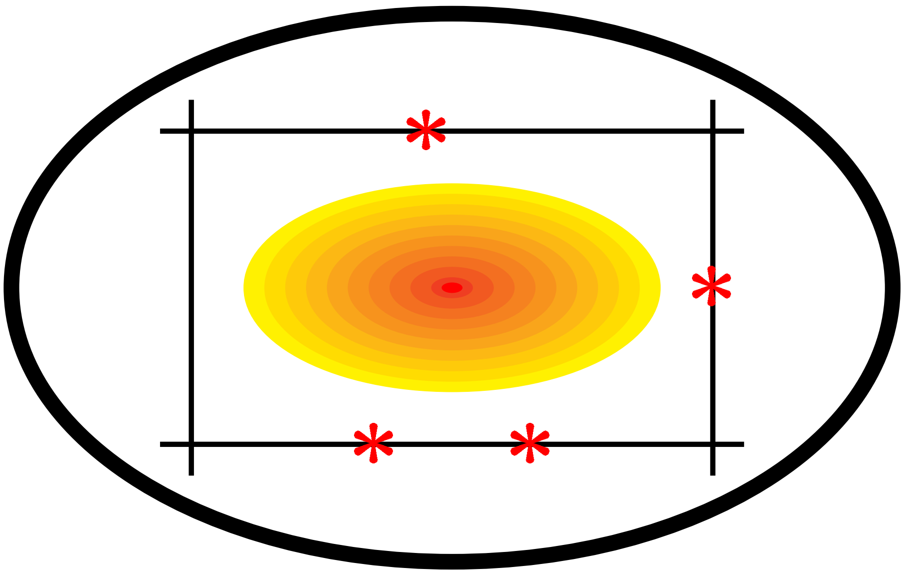
Aims at measuring:

- CP violation in $B^0 \to J/\psi K^0_S$ and $B^0 \to \pi^+\pi^-$ decays,
- $B^0_s \bar{B}^0_s$ mixing,
- $+ \; B\bar{B}$ decays with two leptons in the final state,

by making use of B mesons that are produced in collisions of 820 GeV/c protons with a fixed target.

Protons: halo of the HERA proton beam.

Target: wires (ribbons) in the halo of the beam



The HERA-B spectrometer

- Magnet: dipole, 2 Tm
- Tracking: Si-strip vertex detector, outer tracking system (honeycomb drift chambers), inner tracking system (Si-strip and MSGCs)
- Kaon identification: RICH, C_4F_{10} gas radiator, PMT photon detector
- Electron identification: electromagnetic calorimeter (W/Pb shashlik), in addition at small angles TRD (fiber radiator, straw chambers)
- Muon identification: muon system (gas tubes, pad and pixel chambers)
- High p_T trigger ($B^0 \to \pi^+\pi^-$): gas pad and pixel chambers

Multi-level trigger scheme

Huge background of inelastic proton-nucleon scattering over the signal (10^{11}): need a highly selective and efficient trigger.

1 pattern recognition, track reconstruction, J/ψ mass

- calorimeter, muon system, tracking system
- latency: 12 μs
- rate reduction: 200

2 track fitting, common vertex/impact parameter

- tracking system, vertex detector
- latency: 5-50 ms
- rate reduction: 25

3 match information, global refit

- latency: 100 ms
- rate reduction: 20

4 complete event reconstruction

- latency: 2 s
- rate reduction: -

Major modifications since proposal

- RICH: photon detection
- Inner tracking system: microstrip gas chambers

RICH: photon detection

Initially foreseen wire chamber based detectors abandoned due to:

- fast ageing (TMAE)
- problems with high rate operation, insufficient number of detected photons (CsI)

Instead: multianode PMTs (Hamamatsu R5900-M16 and -M4) with a two lens optical system (2:1) demagnification to adjust the detector pitch to the PMT pad size.

The granularity (9 mm x 9 mm and 18 mm x 18 mm) matches the occupancy and resolution needs.

Beam tests: figure of merit $N_0 = 45/\mathrm{cm}$ $->$ expect about 38 detected photons per a $\beta = 1$ particle.

Sufficient for a K identification efficiency around 80% (at 5% pion missid. probability) up to 50 GeV/c.

Inner tracking system

MSGC's, the originally foreseen detector, were tested for ageing

- with X rays: OK
- heavily ionizing particles: discharges destroy anodes
- other anode materials were tried instead of gold: e.g. Ro, Cr. No cure was found: Cr is not destroyed (smaller conductivity) but gives too small signals

Two lines are followed

- scintillation fiber tracker: use the recently developed 64 channel Hamamatsu MA PMTs with 2 mm x 2 mm pad size to read out the fibers: a backup solution (c.f. J. Baehr et al., Cont. paper 726, PA17), expensive, performance marginal - rad. damage of fibers
- combine the MSGC with a preamplifier stage GEM (gas electron multiplier, F. Sauli et al., see also the talks by A. Sharma, PA17, and R. Cashmore, PL13): tests look very promising, more long term high rate exposure tests needed, answers expected by the end of August

Results of the 96/97 measurements

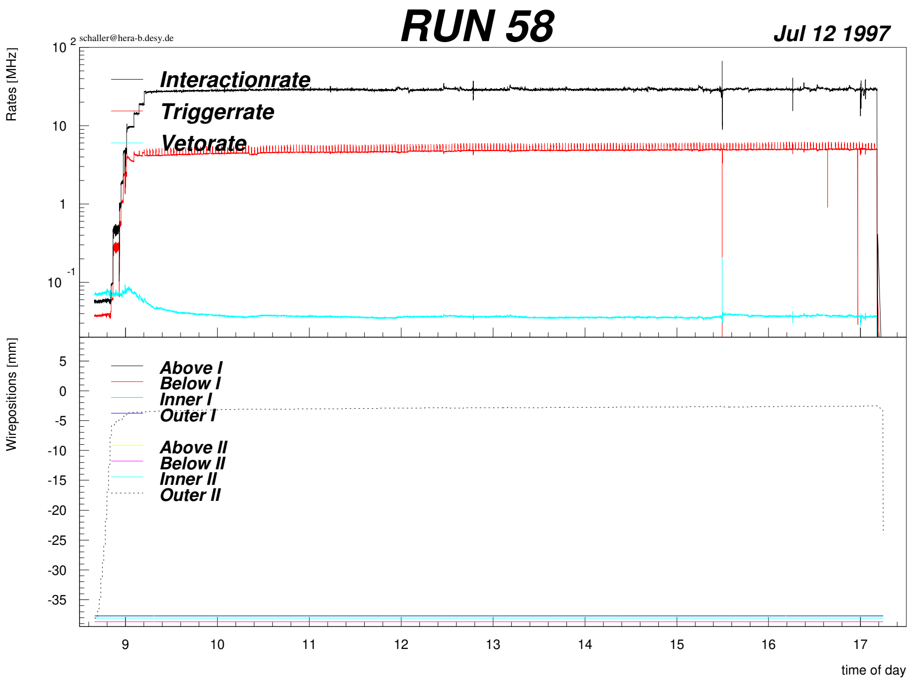
- Target
- Vertex detector system
- Occupancy: tracking system
- Calibration: electromagnetic calorimeter

Target

94/95 tests have shown that the concept is OK, rates of 40 MHz were reached

96: design close to final, two stations of four wires, various target materials (C, Al, Cu)

- automatic steering of wires at fixed rate works OK
- rates around 40 MHz could be kept over several hours

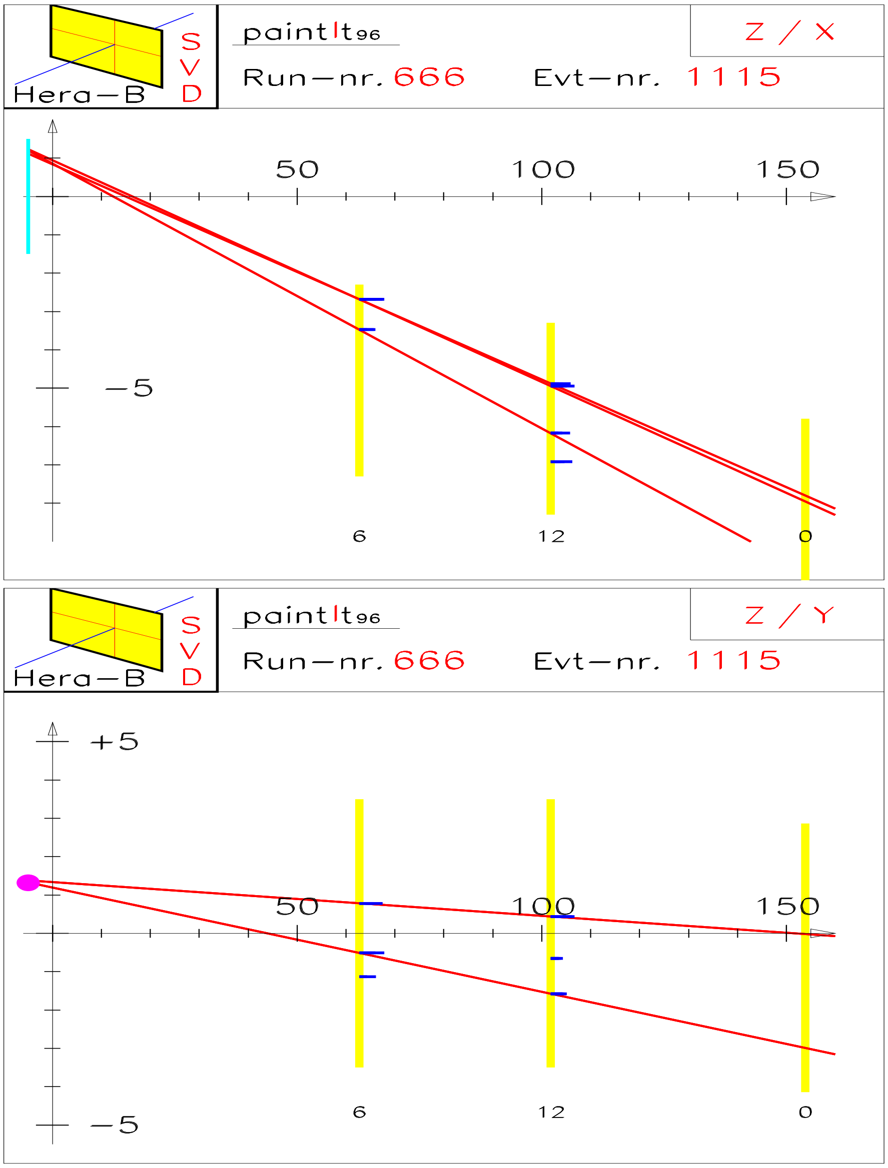


- cohabitation with other HERA expts. established
- C wire gives best target efficiency (probability that a halo proton interacts), but Al has a higher b production cross section
- under study: rate fluctuations

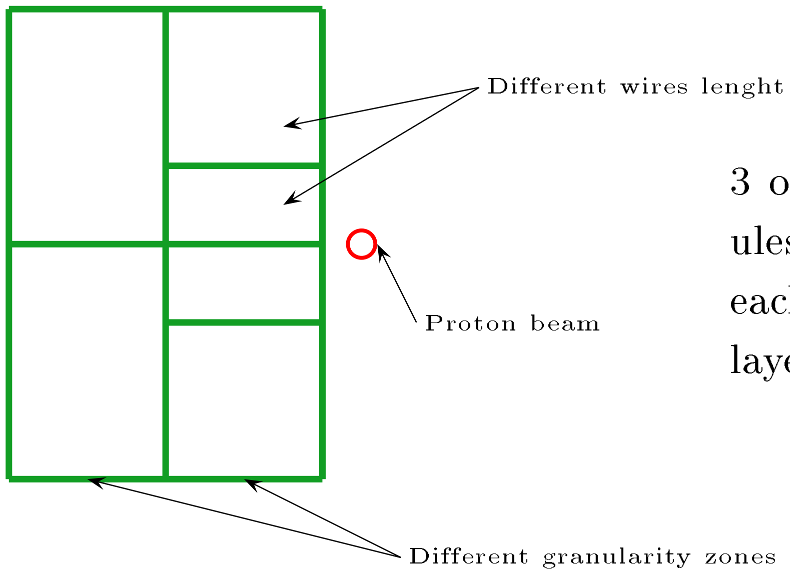
Vertex detector system

96/97: Three double sided silicon detectors

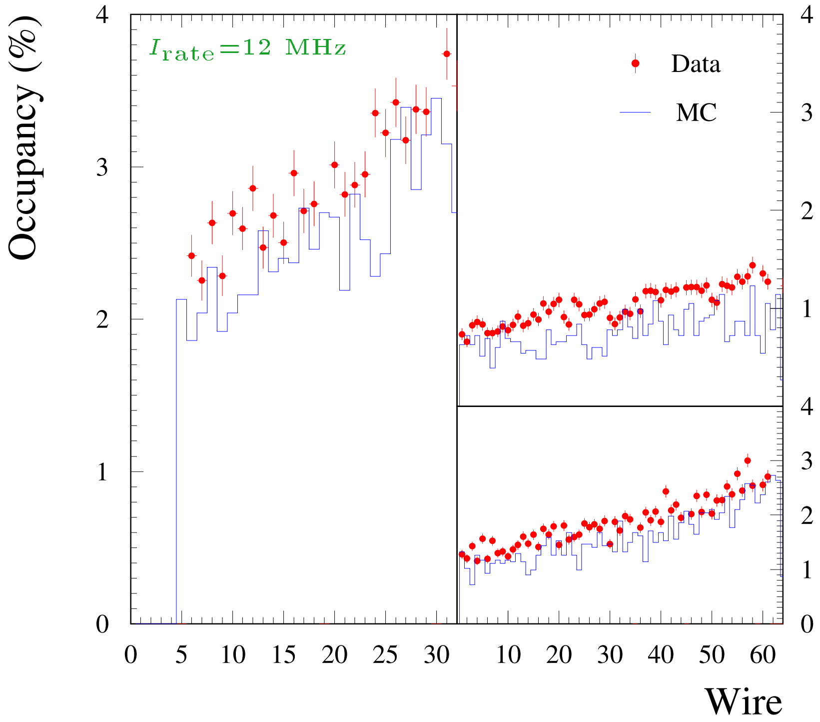
- S/N ratio: around 15
- tracks reconstructed: event display
- beam profile on target wire plane



Tracking system: occupancy



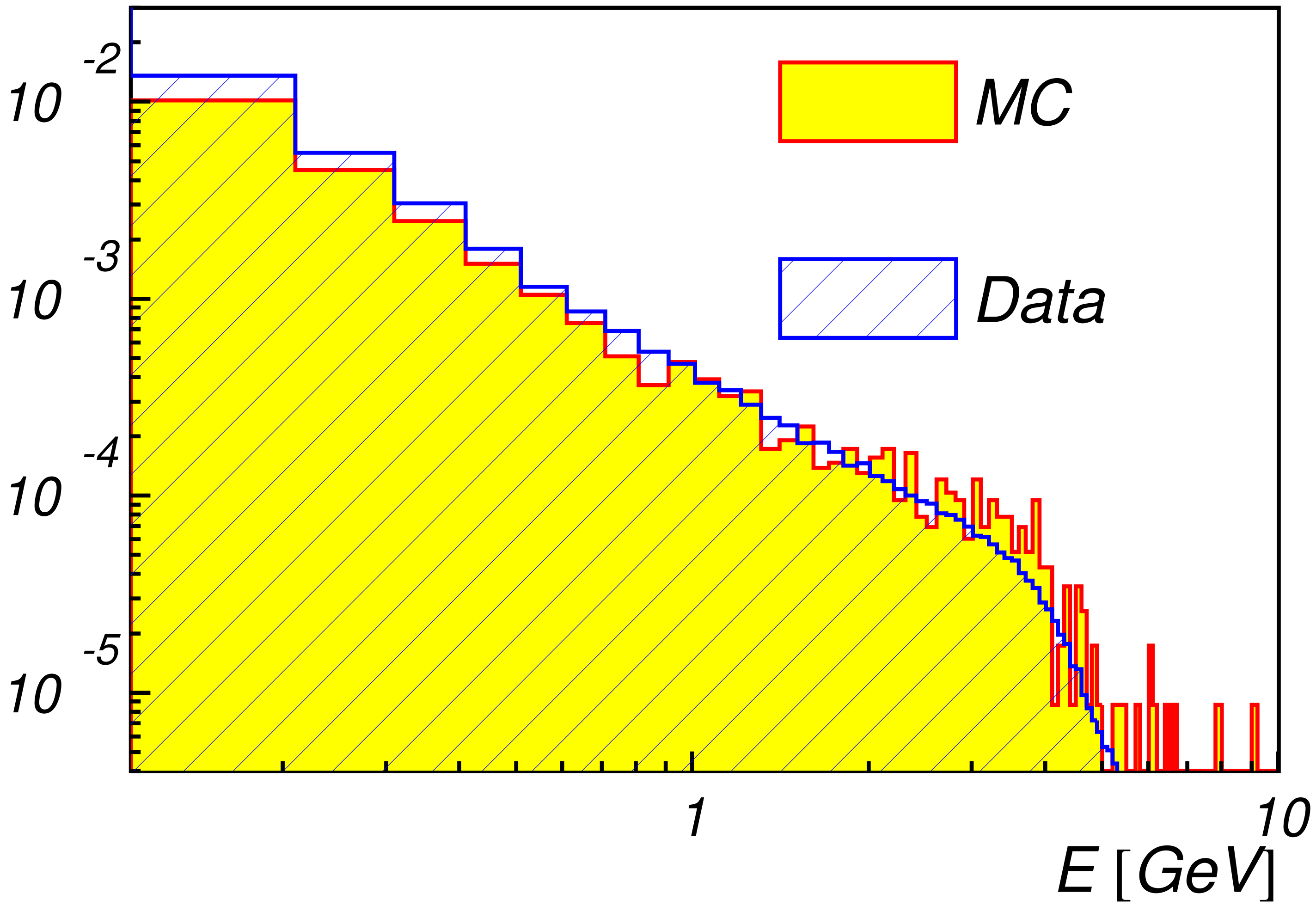
3 of such layer modules are installed in each of the 3 superlayers



Agreement of the order of 10-15% between data and MC

Calorimeter: calibration

- calorimeter



Good agreement with MC

Outlook: Time table

- 1997: continuation of the 96 run, establish common DAQ
- shutdown 1997/98: equip major parts of the spectrometer
- 1998: commissioning of the detector, measure $b\bar{b}$ production cross section
- shutdown 1998/99: equip the rest
- $1999->$: run for CP

Expected CP reach: $\Delta sin2\beta = 0.13$ after 10^7s.

Conclusions

- Cohabitation of four HERA experiments was established at 40 MHz HERA-B interaction rate..
- MC and data are in good agreement.
- Long term high rate operation of all sub-detectors was performed.
- Still a lot of work ahead.
- Tight time schedule.
- An enthusiastic team - good hope for success.