HERA-B STATUS REPORT

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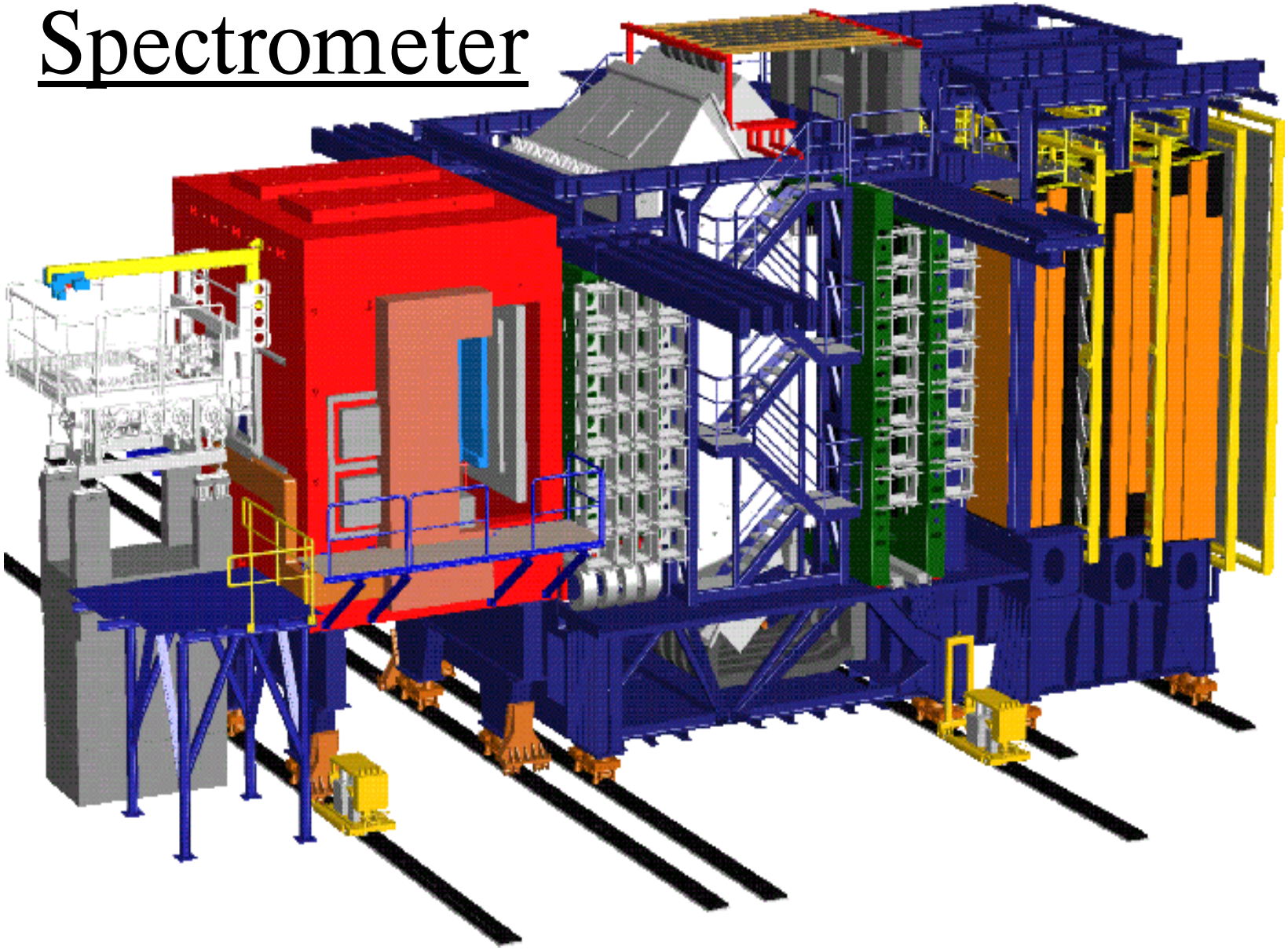
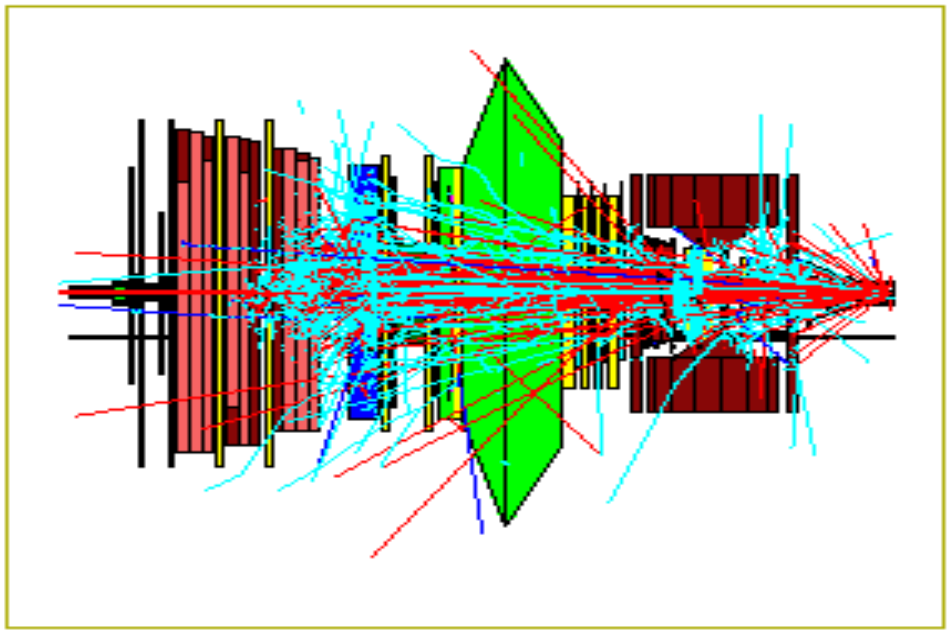
PRC Open Session 8/7/98

Status of Hard- and Software 1998 Run

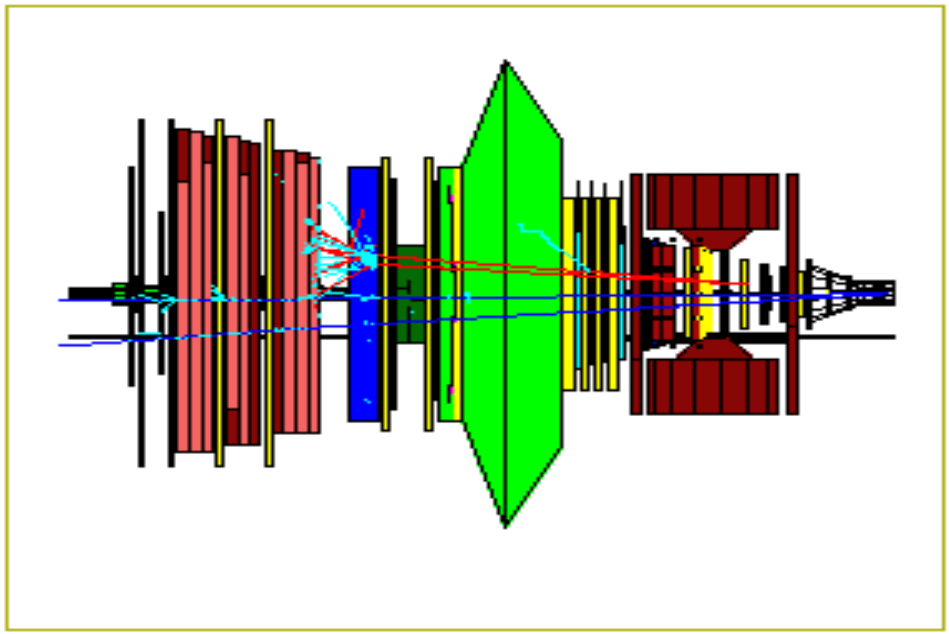
HERA−B Spectrometer



MC Simulation



1 bb + 4 minimum bias reactions



$B^0 \rightarrow J/\psi\, K_S$

$\hookrightarrow \pi^+\pi^-$

$\hookrightarrow \mu^+\mu^-$

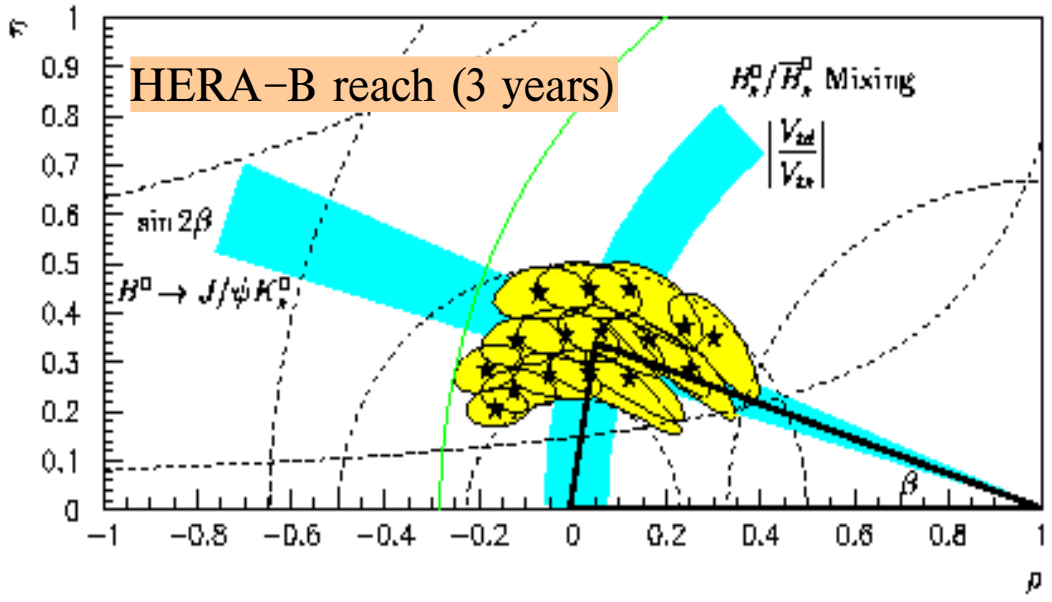
Physics Goals

Main physics goals:

CP violation in $B^0 \rightarrow J/\psi\, K_S$
Measure asymmetry of $B^0 \rightarrow J/\psi\, K_S$ and $\bar{B}^0 \rightarrow J/\psi\, K_S$

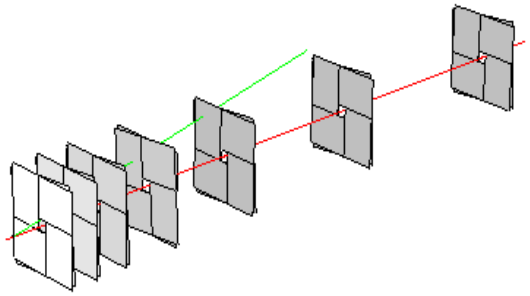
CP violation in $B^0 \rightarrow \pi^+\pi^-$

B_S mixing



Status of Hard and Software

Component	*Current Status*	*1998*	*1999*
Target	Stable operation, improved monitoring	✓	✓
Tracking			
Vertex Detector	Final infrastructure and readout chain	**1/4**	✓
Inner Tracker	Mass production for 1999	**8 MSGC**	✓
Outer Tracker	O(100) improvement in lifetime (1.5 y)	**prototypes**	**PC/TC+?**
Particle ID			
ECAL	Installation finished	✓	✓
Muon System	1 superlayer installed, pretrigger in 1999	**1/2**	✓
RICH	Installation finished	✓	✓
TRD	4 modules built and tested	**80 %**	✓
Trigger			
High pt	Assemble chambers	**1 module**	✓
FLT	Preparing test of full FLT chain	**Test setup**	✓
SLT/TLT	100 node farm running	✓	✓
4LT	Mini farm of 15 PCs (+10 in autumn ?)	**10 %**	✓
DAQ	Full data path (SLT → 4LT → tapes)	✓	✓
Software	Most modules available, optimization	**in progress**	✓



Vertex Detector

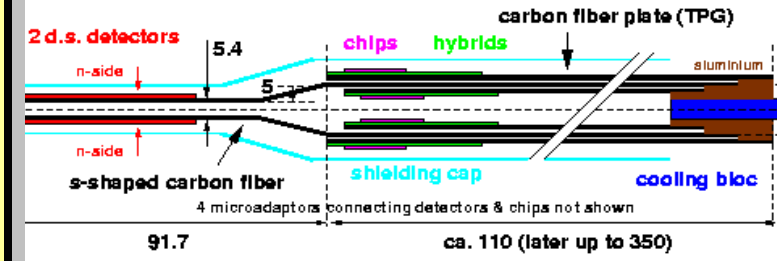
Installation Status:

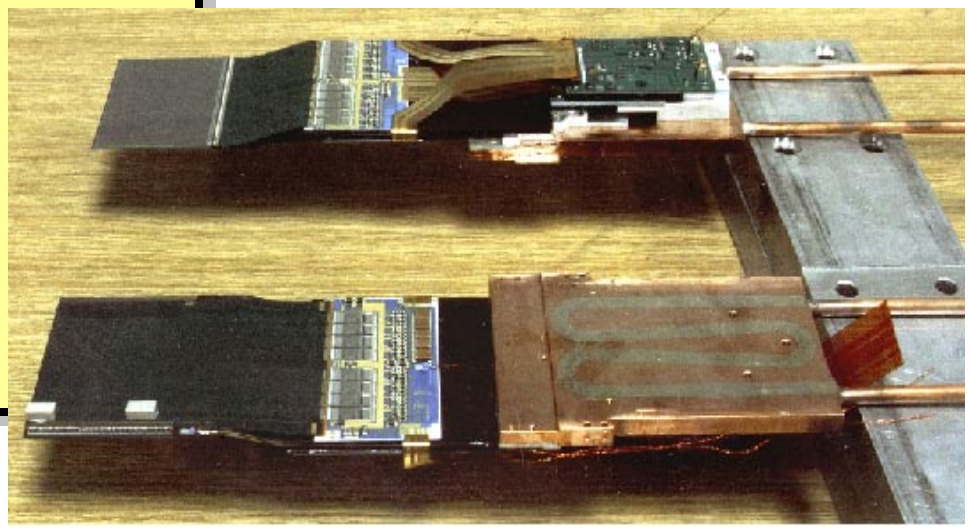
- **final infrastructure**
- **12 double sided detector modules installed** (+ 5 in August)
- **final readout chain**

- movable RF shield (5 μm steel bands)
- vertex vessel vacuum worse than 1997, under investigation

August Shutdown:

- 5 more modules
- installation of laser system





Helix Readout Chip

Helix 128S−2.1 (used in 1998)

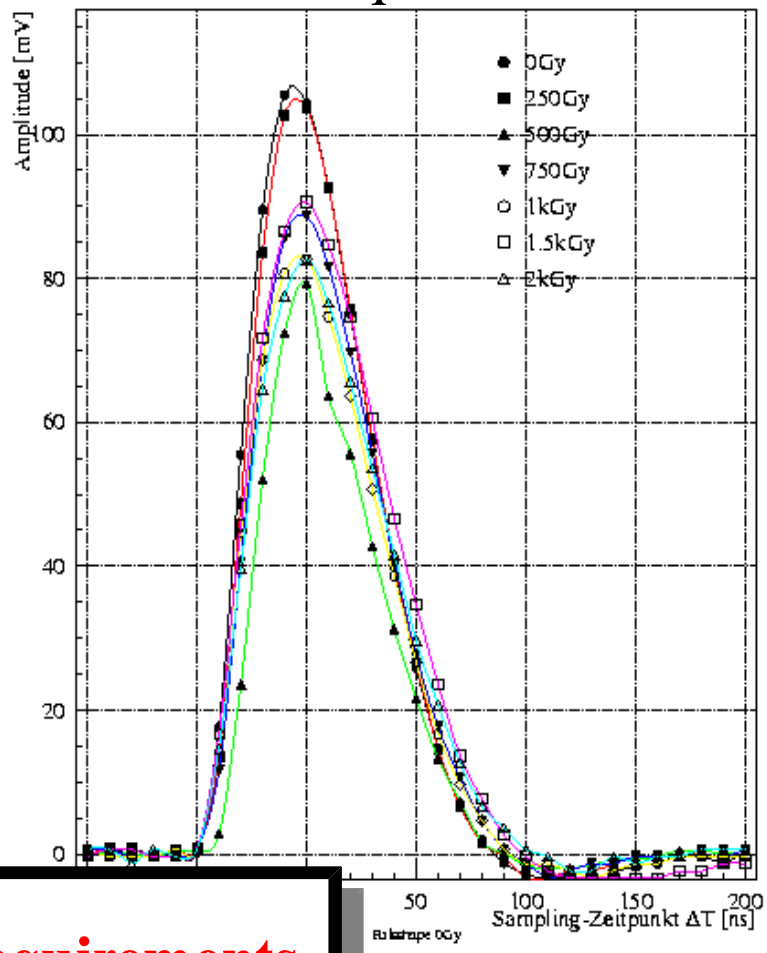
- reduced radiation hardness
- digital−analog cross talk

Helix 128S−2.2 (since April 1998)

- new pipeline design
  tested up to 400 kRad
- readout at 40 MHz
- acceptable cross talk
- **close to final readout chip**

Helix 128S−2.3 (under test)
Helix 128S−3.0 (in progress)

Puls shape / dose

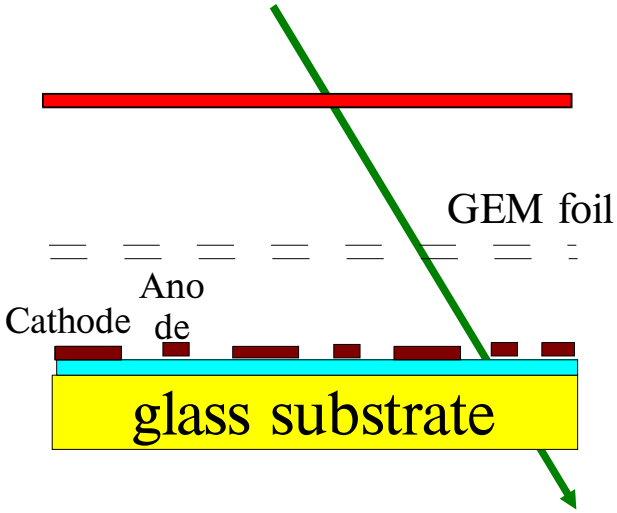


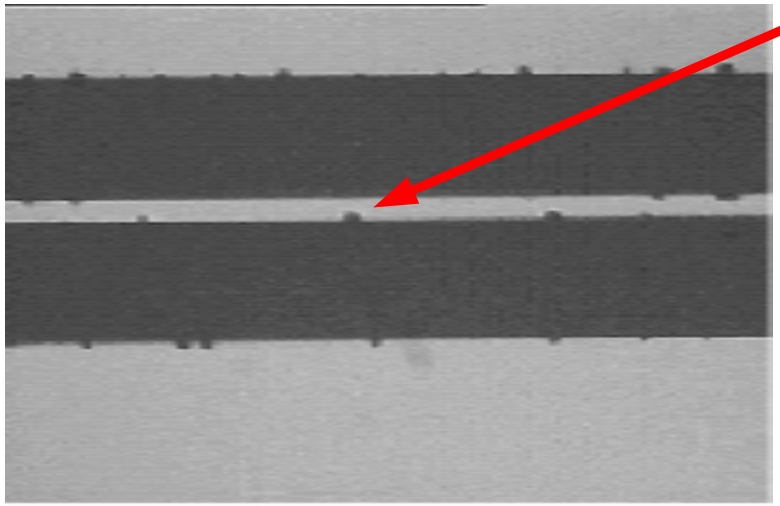
Version 2.2 fulfills HERA−B requirements

Inner Tracker

Design

- **M**icro**S**trip **G**as **C**hambers with **G**as **E**lectron **M**ultiplication foils
- tracking chambers, 6–19 cm to the beam
- 300 µm pitch





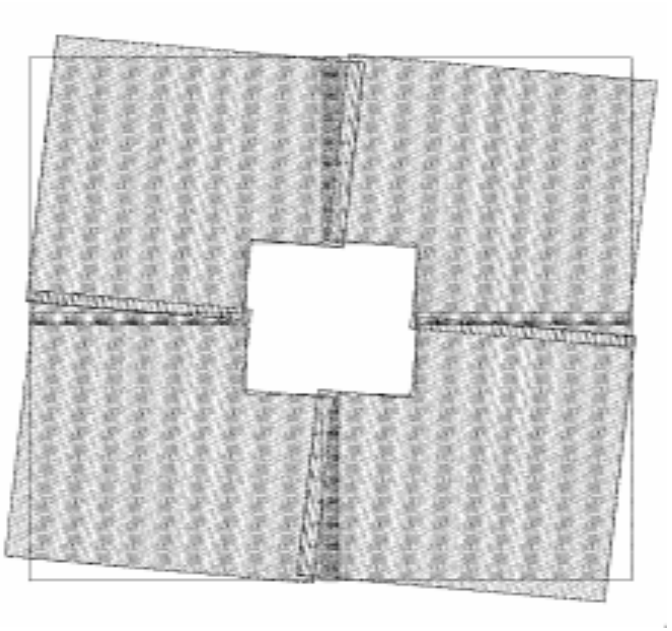
Induced Discharges without GEM:

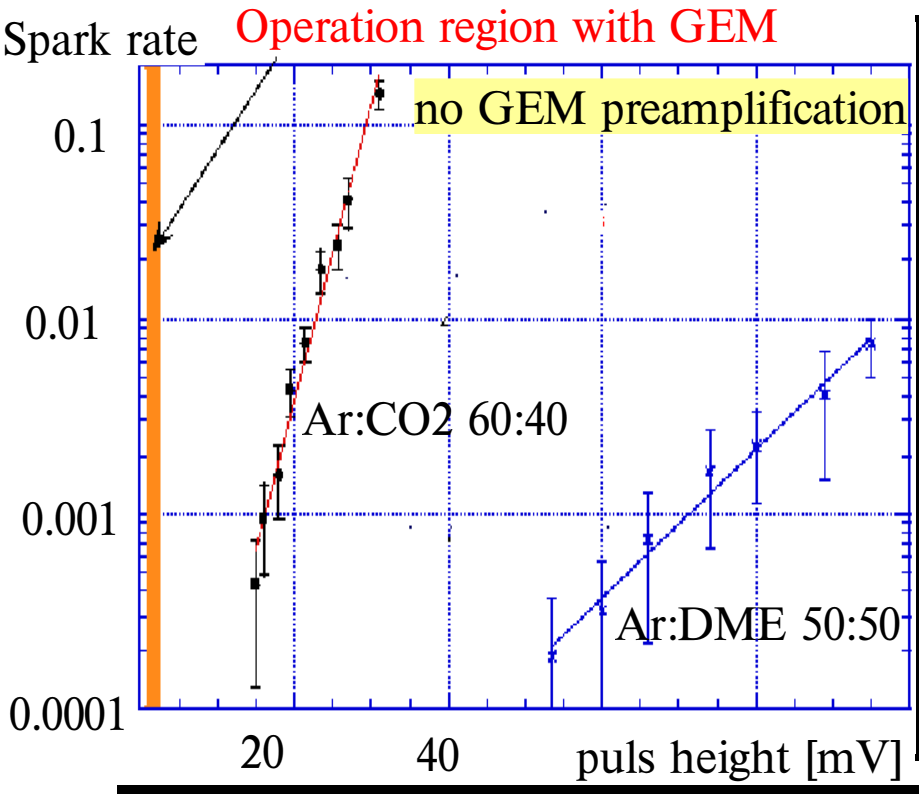
- no effect with X–rays
- sparks in HERA-B environment after few hours
- broken anodes

Problem solved by preamplification (GEM foil)

Test of full size chamber:

- no sparks observed (< 1 per day)
- tested with α source (**equivalent of 3.5 HERA-B years**)
- high rate operation
- gain rise in long term operation



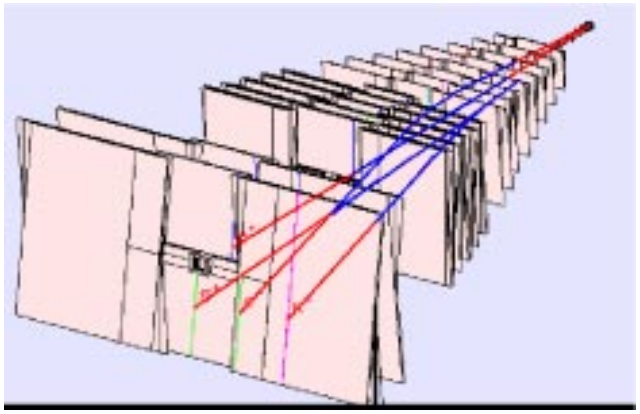


Installation status:

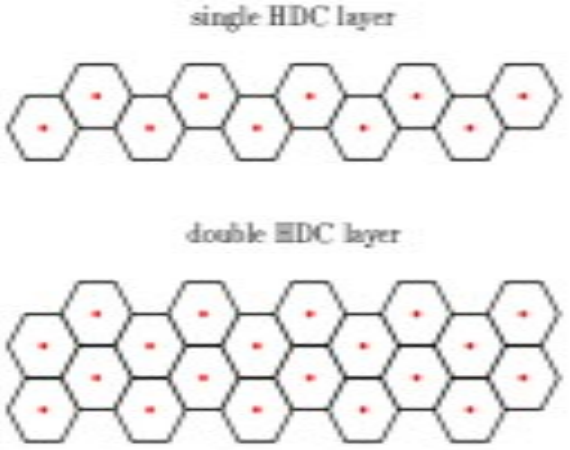
- one quadrant of 8 layer trigger modules
- final mechanics and gas system, full readout chain

1999 installation:

- production: 2 chambers/day
- trigger layers ready by Feb. 1999
- full inner tracker for 1999



Outer Tracker

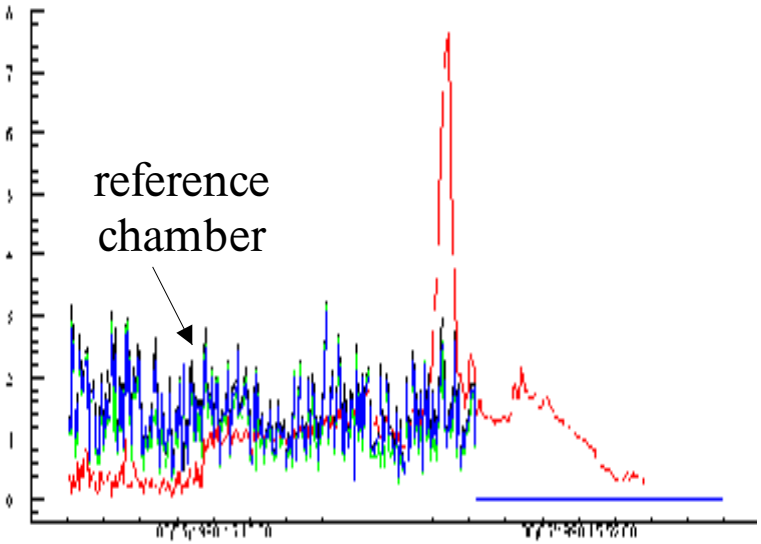


Design:

- honeycomb drift chambers
- Pokalon−C cathode foil (conductive)
- 5/10 mm cells
- fast drift gas: v < 65 μm/ns
  ⇒ CF_4 component required

History of aging effects:

A) Malter like effect (1996 run)
B) Anode aging (observed later)
C) Dark Currents

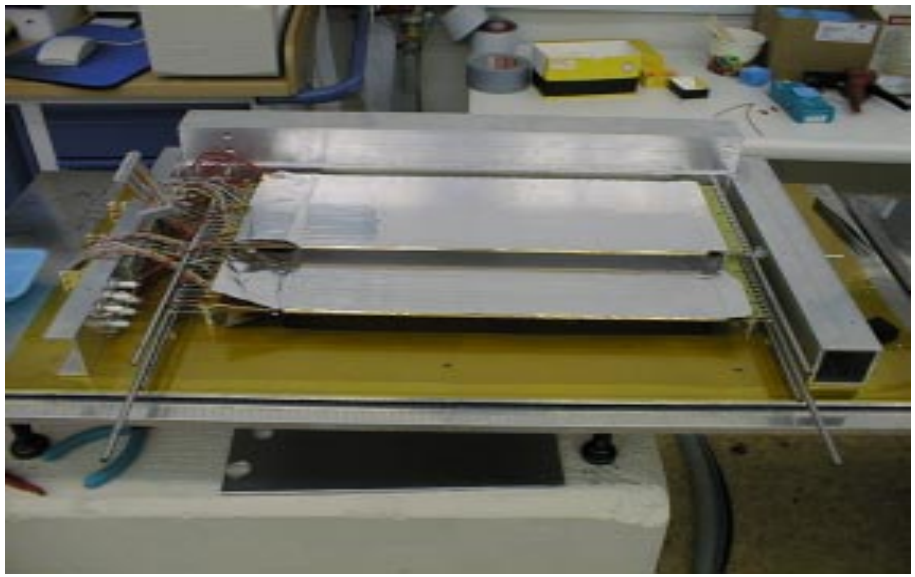


Karlsruhe test results (α beam)

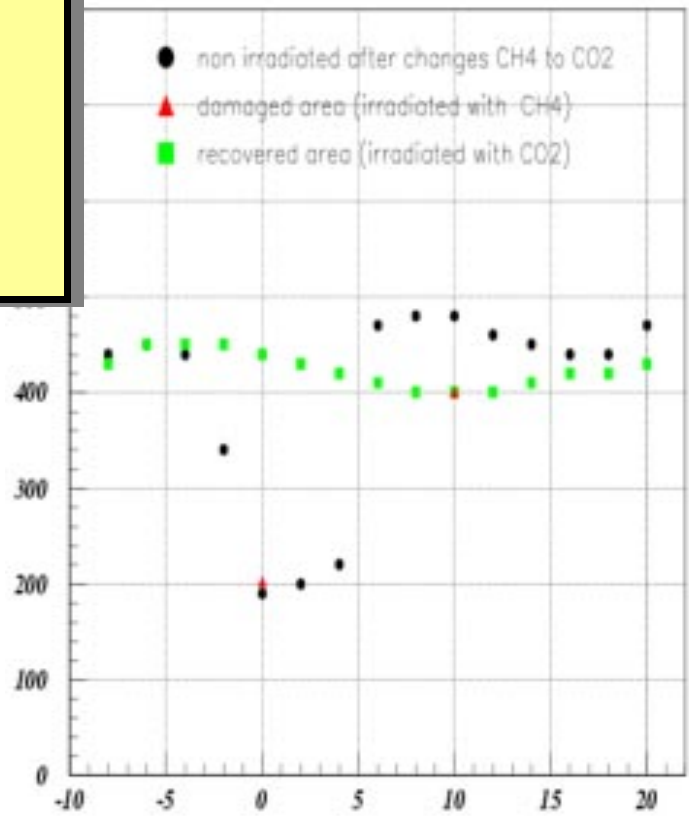
+ no Malter effect in gold coated chambers
+ no anode aging with Ar:CF_4:CO_2
+ damaged chambers recover with Ar:CF_4:CO_2
− dark currents after ”1.5 HERA−B” years

Summary:

- **present chamber survive equivalent of 1.5 HERA−B years**
- **deposit on G10 strips and endpieces**
- **test of kapton strips in 2 weeks**



Fe55 peak position



chamber area

Backup Solution: Straw Chambers

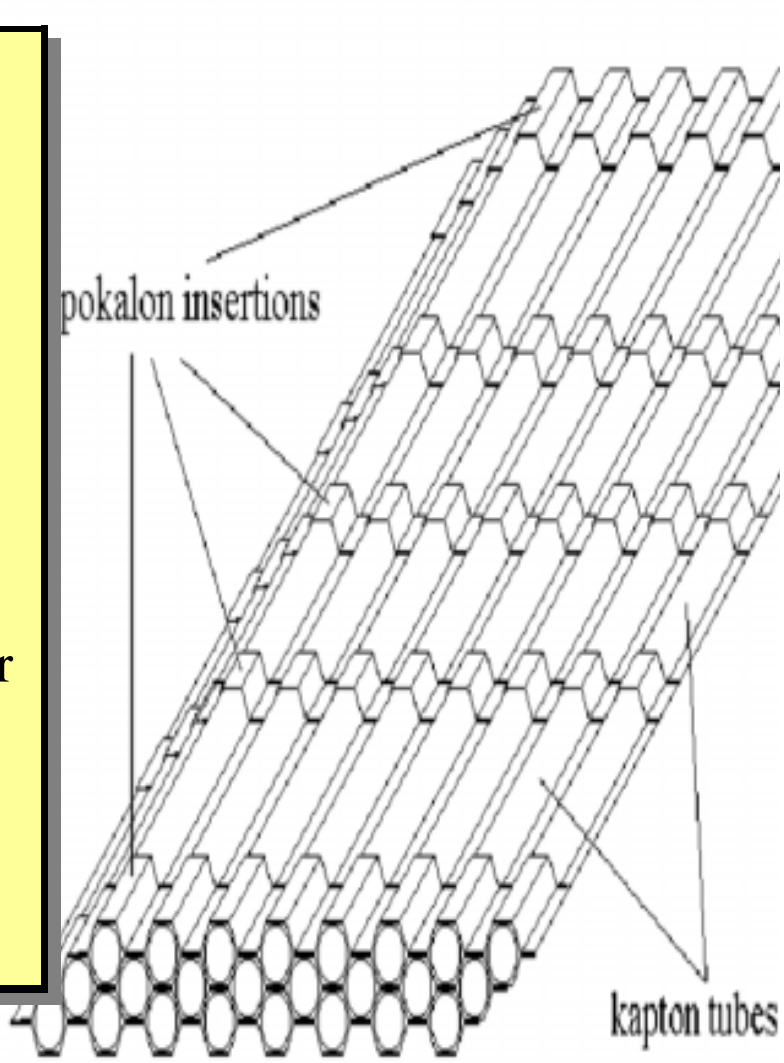
Design of backup solution:

- Kapton tubes
- Pokalon carrier
- similar to TRD at HERA−B and ATLAS design

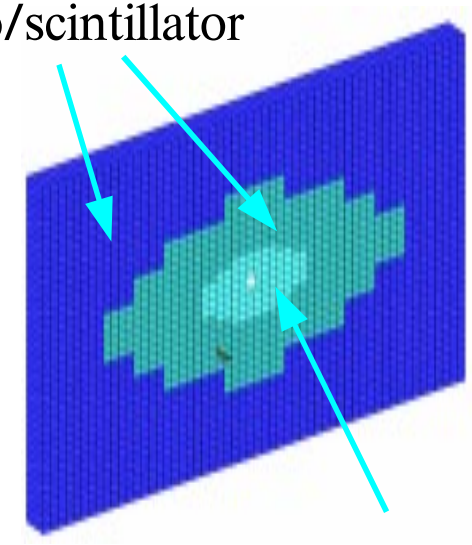
Tests and experience:

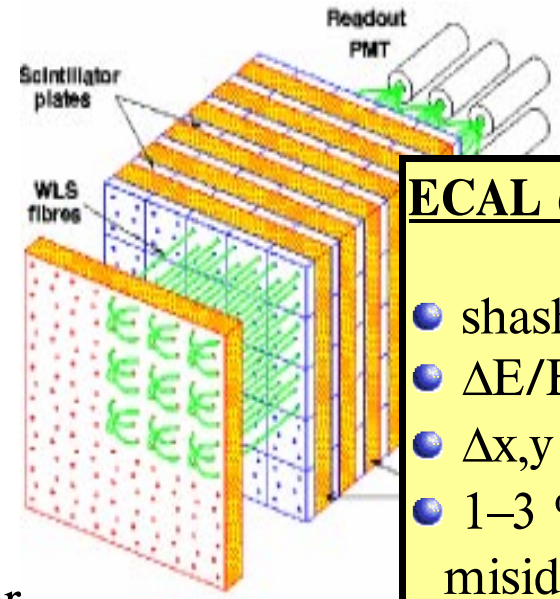
- TRD tubes survived 1/4 HERA−B year
- prototypes saw more alpha irradiation than coated honeycomb chambers

not ready for 1999 run



Electromagnetic Calorimeter



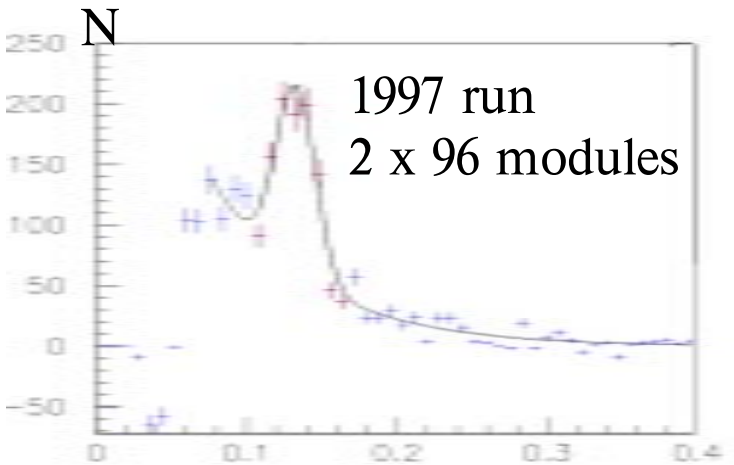


ECAL design:

- shashlik calorimeter
- $\Delta E/E \approx (17–9.5)\ \% / E^{1/2}$
- $\Delta x,y \approx 1.2–10$ mm
- 1–3 % h→e misidentification ≈ 1 ‰ with TRD

Installation Status:

- ECAL modules installed
- readout: 60 boards at DESY
  1/2 by October
- pretrigger: 20 boards by August
  1/2 by October
- fully operational for 1999



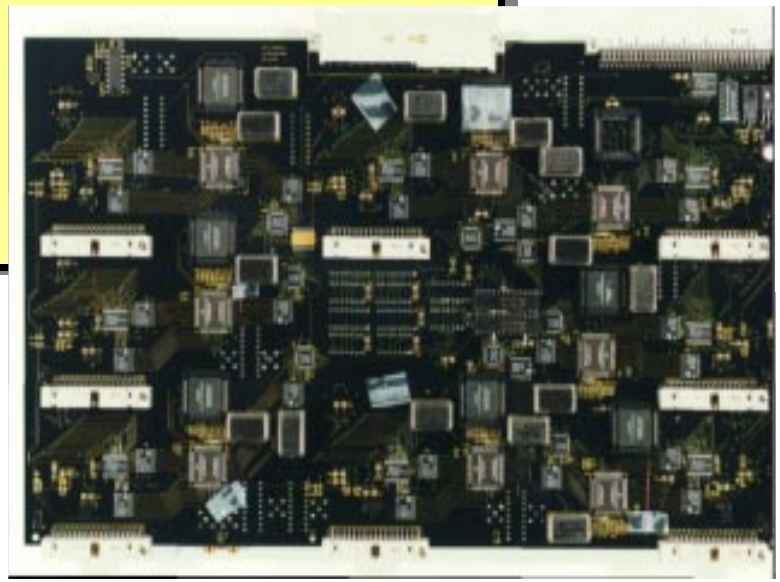
Muon System

Muon chambers:

Superlayer	*# layers*	*Pretrigger*	*L1 trigger*	*1998 installation*
MU1	3		wires	installed
MU2	3			1999
MU3	1	pads	wires	1/2 n iAugust
MU4	1	pads	wires	1/2 in August

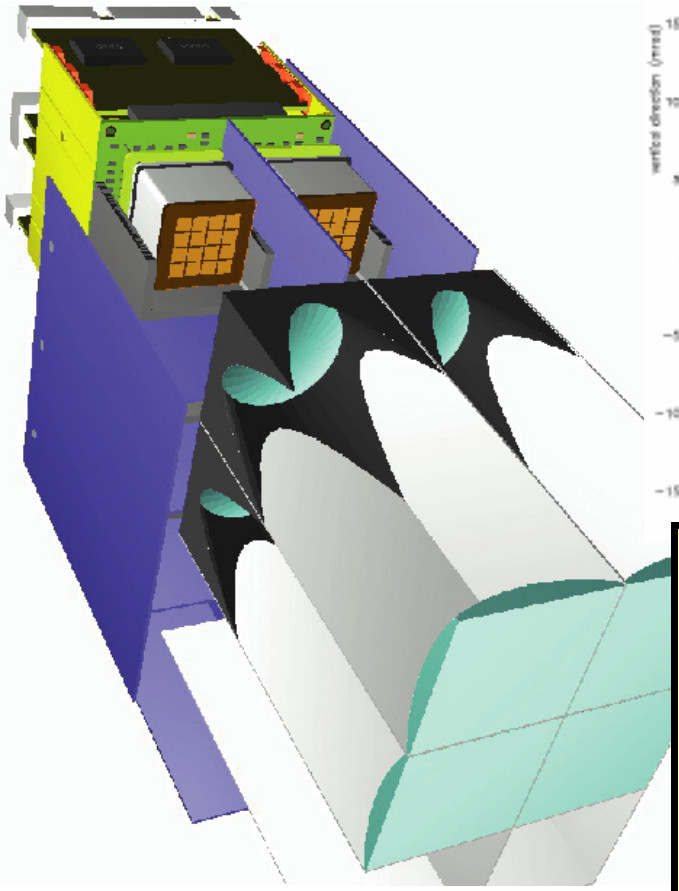
Pretrigger:

- design finished
- test series production by industry
- 2 slices (10 %) ready by November
- full system for 1999

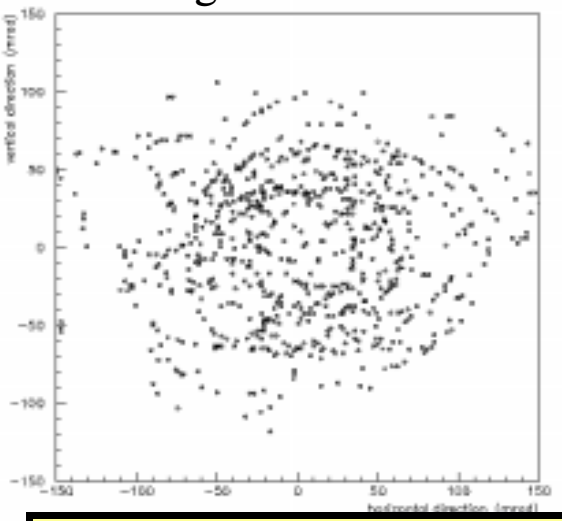


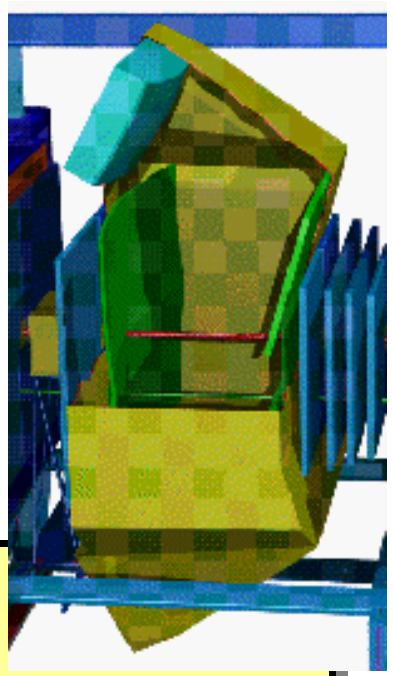
Trigger board

Ring Imaging Cherenkov Counter



single interaction



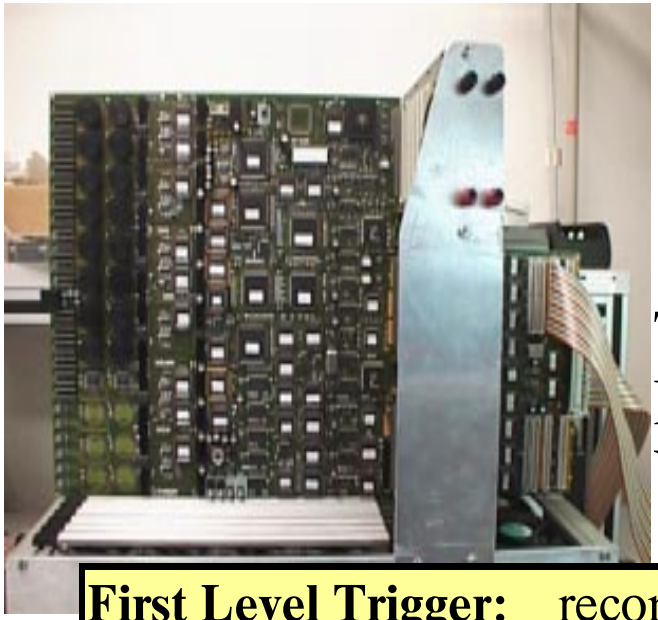


RICH design:

- C_4F_{10} radiator
- 4 or 16 channel photomultiplier
- K/π separation from 5−50 GeV

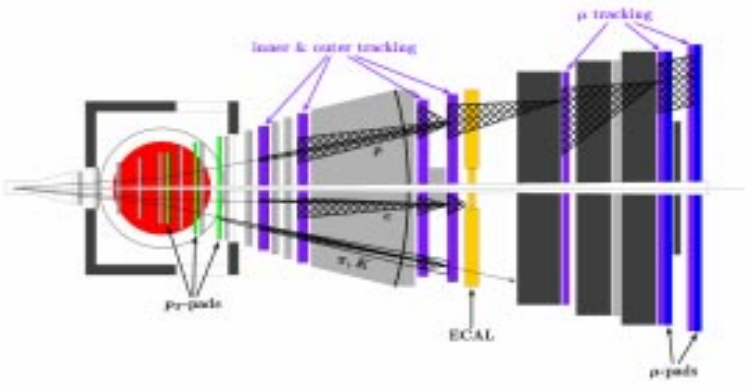
Installation Status:

- **installation completed**
- **stand alone tracking for 1998**



Level 1 Trigger

Track Finding Unit



First Level Trigger: reconstruct tracks behind the magnet

Component	*Task*	*1998 Status*
Pretrigger ECAL μ chambers high pt chambers	Track seeds (leptons, high pt tracks)	2 in October 1 slice in November maybe 1 slice
Track **F**inding **U**nit	track reconstruction	Up to 10
Track **P**arameter **U**nit	extrapolation to target	1
Triger **D**ecision **U**nit	J/ψ mass, trigger decision	1 (or 1 test board)

1998 run: test of full First Level Trigger chain
ECAL pretrigger for physics run (muon pretrigger test)

Higher Level Trigger

Second/Third Level Trigger:
tracing through magnet, vertexing

100 Linux PCs (300 MHz) running

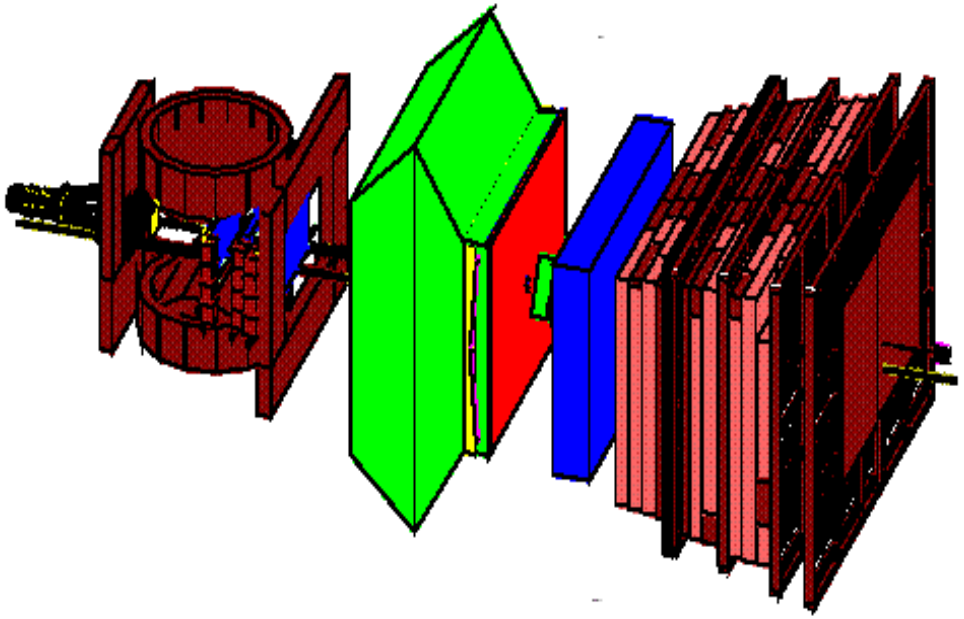
SLT software exists:
magnet tracing, vertexing for $J/\psi \rightarrow l^+l^-$
vertex resolution: $\sigma_{x,y} \approx 25\ \mu m$ $\sigma_z \approx 400\ \mu m$

TLT software exists:
full silicon reconstruction
has to be speed up by a factor 2

Online Reconstruction Farm:
hardware: ≈ 15 (+10?) nodes for 1998 (10 %)
1 data logger, 1 calibration node
software: data logger software,
data collection (calibration) exist
1998: full integration in data path

Second Level Trigger Farm

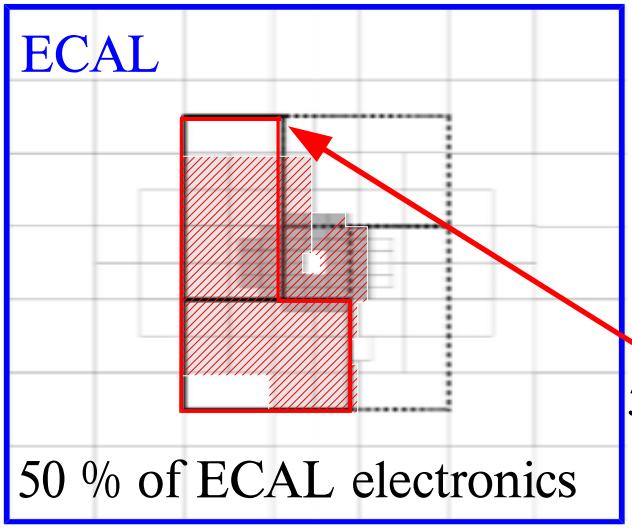
1998 Detector Setup



1998 run:

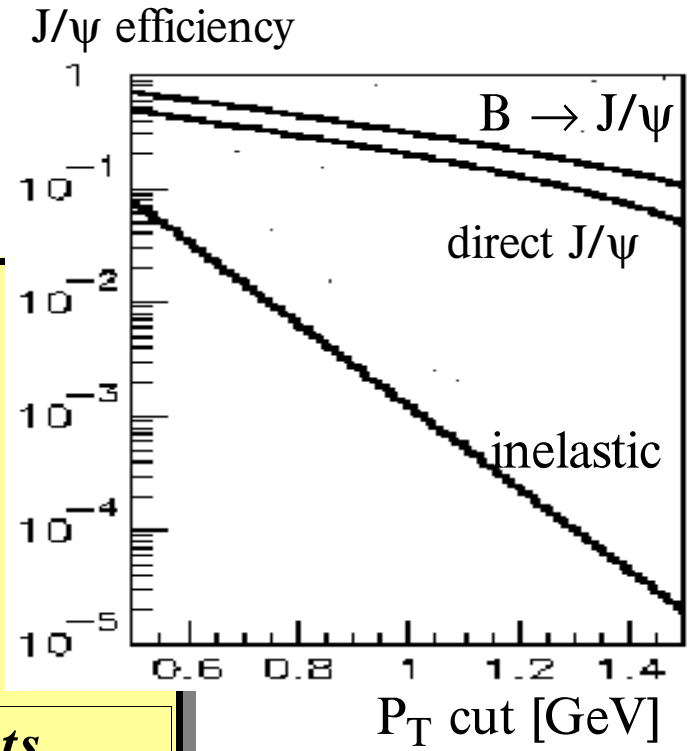
1) commission subdetectors:
- SLT−4LT−tape data path
- Trigger
- Slow control
- calibration, alignment
- online reconstruction test

2)physics run (Oct/Nov)
- charmonium production
- bb production (?)



perspective view

1998 Physics Prospects



Hardware restrictions:

50 % geometrical acceptance

ECAL trigger only ⇒ $J/\psi \rightarrow e^+e^-$

4 layers of silicon ⇒ $B \rightarrow J/\psi$ vertices

⇒ ≈ 1 % of final J/ψ rate

Input rate	*Component*	*Suppression*	*cuts*
5 MHz	Level 1 trigger	1000	2 cluster, p_T>1.1 GeV
10 kHz	Level 2 trigger	100	2 silicon tracks
100 Hz	Tape		

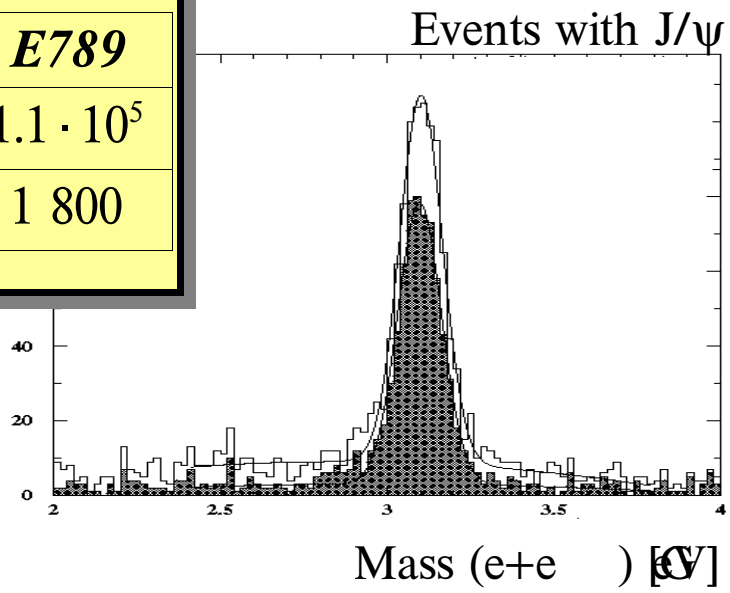
Physics Potential in 1998

direct J/ψ production

- efficiency ≈ few percent
- $S/B_{inelastic} > 1/100$ (> 50 σ)
  estimate limited by MC statistics
- 10^6 sec running time

No reliable estimates for **excited charmonium** due to limited MC statistics

	HERA-B	***E771***	***E772***	***E789***
J/ψ	$(1-6)\cdot 10^5$	12 000	$\approx 10^5$	$1.1\cdot 10^5$
ψ '	< 8000	220	12 000	1 800



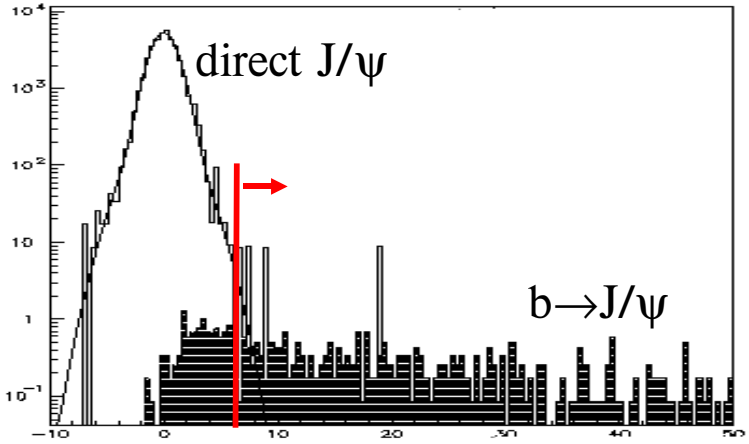
B Production

B→ J/ψ production:

electron reconstruction ($\varepsilon_{J/\psi}$= 0.7 %)

- ECAL cluster with p_T>1.5 GeV
- matching silicon tracks with ≥ 4 hits/view

	channel	***signal***	***backgr.***
E789	$J/\psi \rightarrow \mu^+\mu^-$	19	small
E771	$b\bar{b} \rightarrow \mu^+\mu^-$	6	1.2
HERA−B	$J/\psi \rightarrow e^+e^-$	13 (6 nb) 80 (40 nb)	4 (direct J/ψ) + inelastic



Conclusions

Substantial part of hardware installed
tracking chambers:

- **ITR** aging problems solved
  mass production started, 8 layers installed
- **OTR** 2 orders of magnitude improvement in lifetime (now 1.5 years)
  mass production as soon as possible

1998 run:

- commission most subdetectors
- DAQ/trigger data path, online software
- physics potential comparable to E771 and E789

1999 run:

- detector completed except OTR
- goal is to have OTR chamber behind magnet $\Rightarrow$ high rate running

goal for 1999: CP violation