The New H1 Luminosity System For HERA II

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for the H1 Luminosity Group

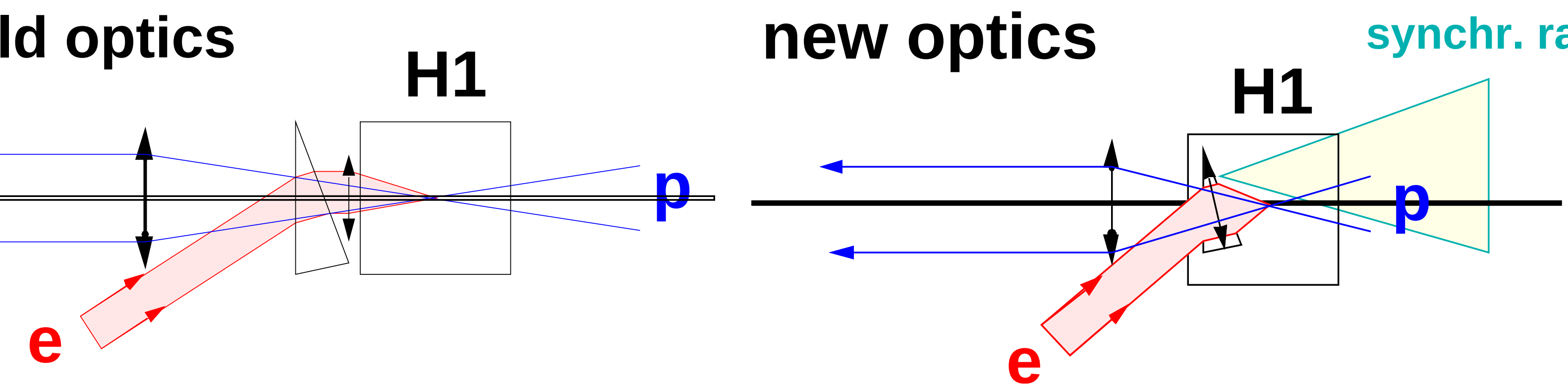
- Luminosity measurement at HERA II
- Overview of the New H1 Luminosity System
  - Fibre detectors
  - Fast Electronics and DAQ
- first HERA beam as seen by the Lumi system

The HERA II Luminosity upgrade

IERA II running: 2002−2006

oal: L = 7.6 x 10^{31} $cm^{-2}s^{-1}$ (equivalent 250 pb^{-1}/year)

low? stronger beam focusing at interaction points



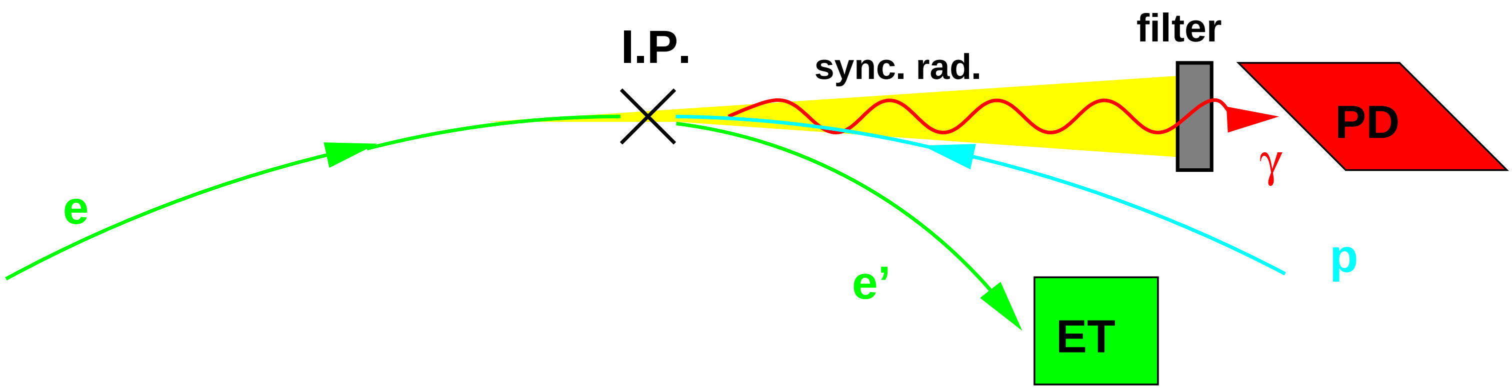
C combined function magnets in H1 (and ZEUS)

longitudinal polarization "for all or for none"

stronger bending ⇒ increased synchrotron radiation lev

The Luminosity Measurement Method

Principle: bremsstrahlung process $e\ p \rightarrow e'\ p\ \gamma$



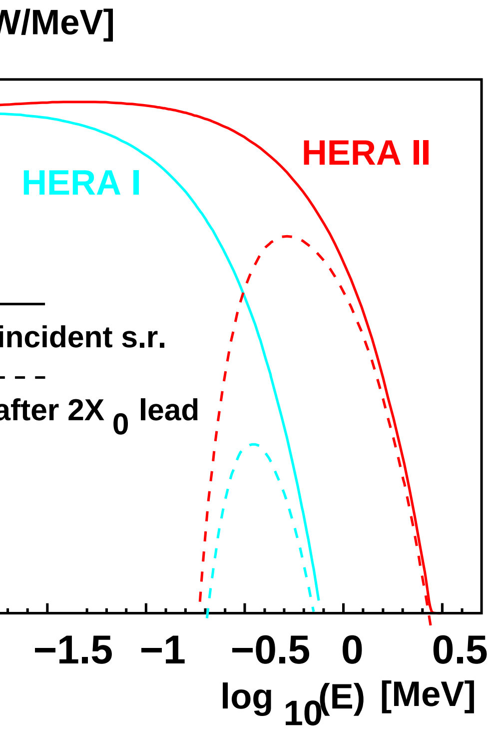
counting and Bethe−Heitler Cross−section

$$L = \frac{\Delta N(E > E_T)}{\Delta t} \div \int_{E_T}^{E_0} \frac{d\sigma_{BH}^{vis}}{dE} dE$$

eam gas background subtraction, acceptance correc

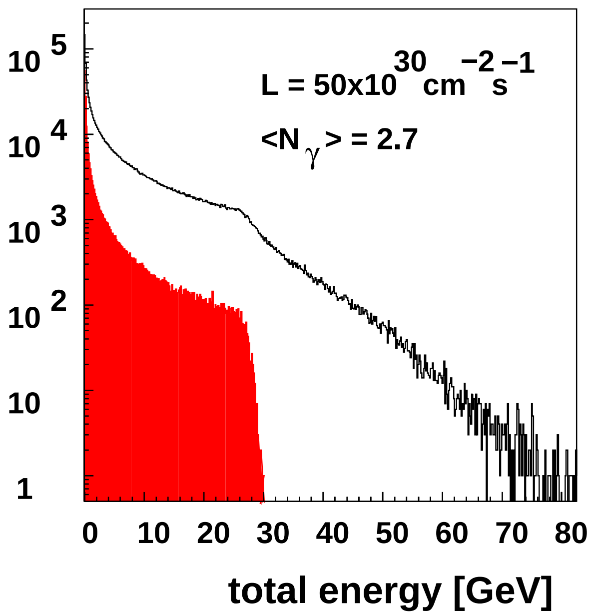
ile−up effect correction at high rates

pact of the HERA Upgrade on the H1 Lumi Syste



Synchrotron radiation

- higher total power: P = 400W $\rightarrow$ 3.8
- harder spectrum: EC = 35keV $\rightarrow$ 160
- Dose = O(Trad/year) if unshielded



High event rate $\rightarrow$ pile−up

- BH edge washed out
- $L \neq N / \sigma$

Requirements for the New Luminosity System

ton Detector

- ynchrotron radiation filter ➔ 2 X0 of Be: dose reduced by ~ 10
- st response ➔ Cherenkov calorimetry
- diation hardness ➔ sampling calorimetry with quartz fibres
- ood energy resolution ➔ maximal light yield + fine sampling
- osition measurement of γ beam ➔ fine granularity in x and

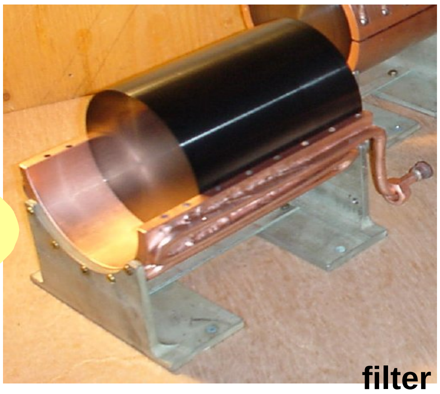
ctron Tagger

- side GI1 (1st warm) quadrupole magnet gap ➔ compactness
- ood energy and position resolution ➔ scintillating fibre calorim

ctronics and Data Acquisition System

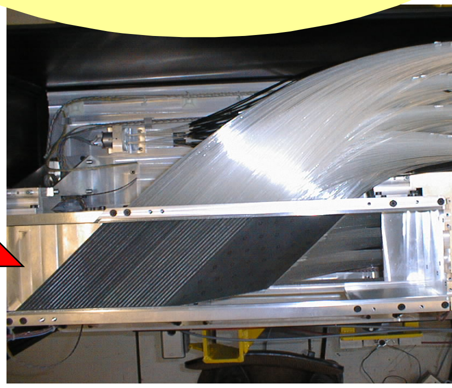
- st pulse shaping (<96ns) and digitization ➔ avoid pulse overla
- ual read−out ➔ H1 main DAQ (slow) and Lumi−DAQ (fast)
- st histogramming DAQ ➔ Online/Offline Luminosity
- vent readout ➔ position measurement + monitoring

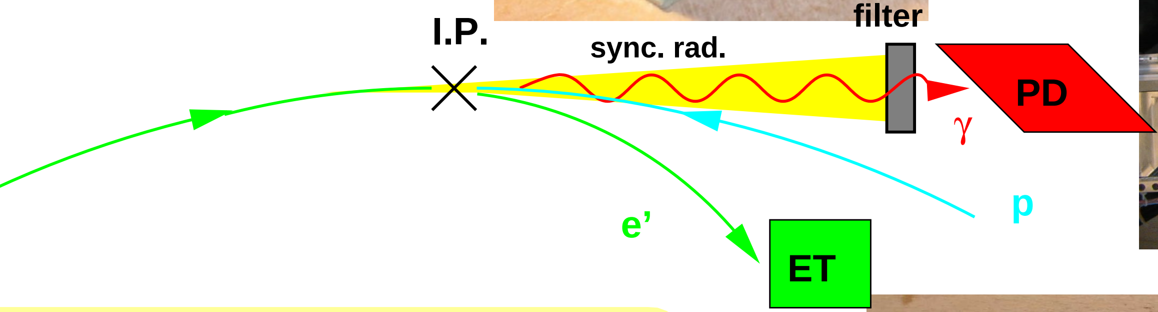
Overview of the New H1 Luminosity System



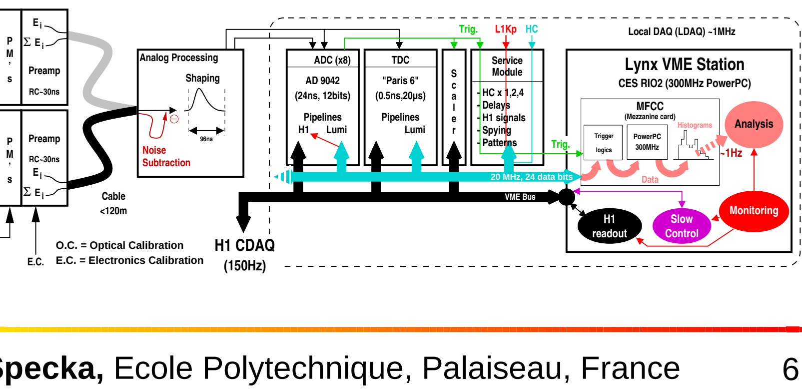
Synchrotron radiation filter: 2 X_0 Beryllium

Photon Detector at 103m: tungsten/quartz−fibre sampling calorimeter



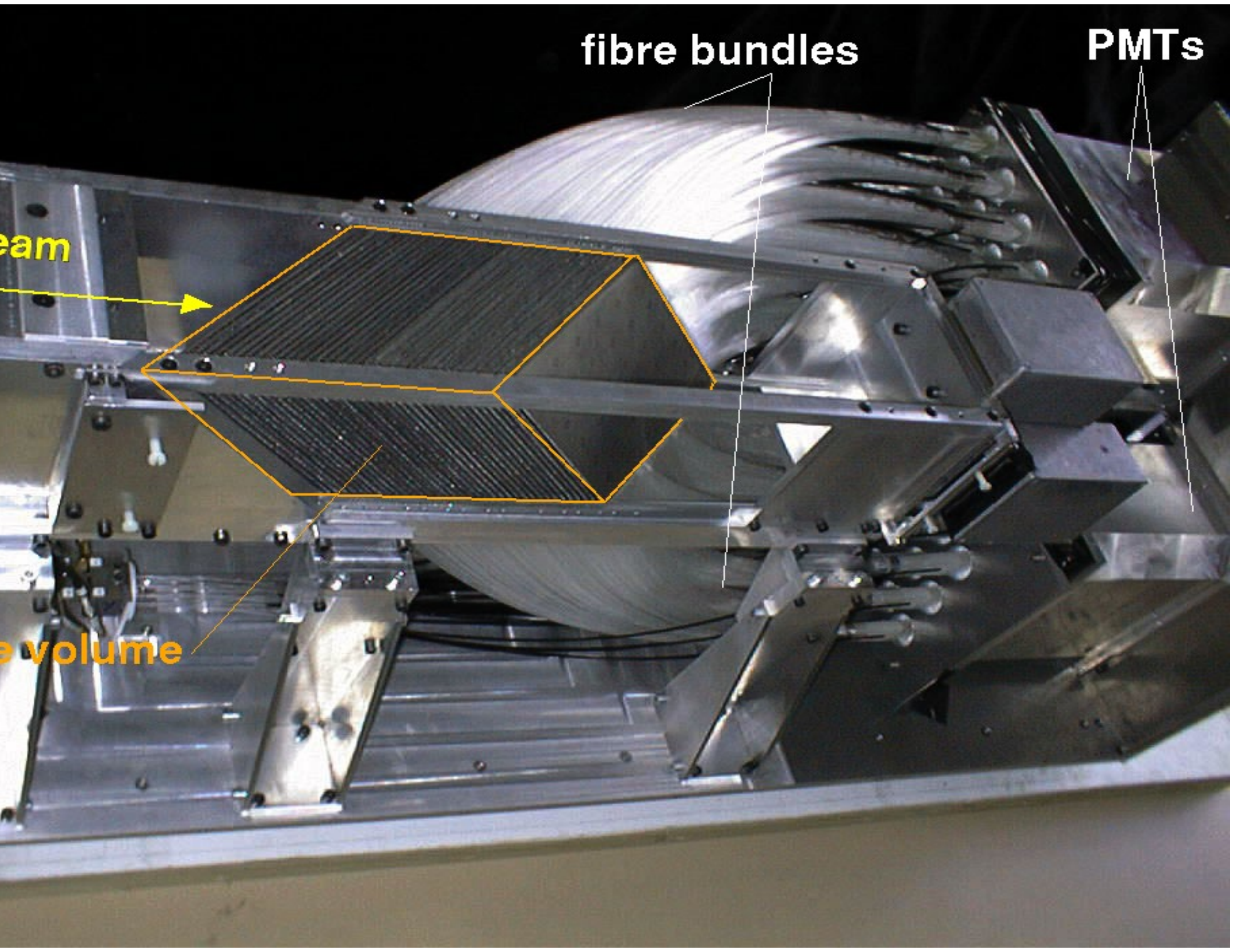


t electronics and histogramming DAQ



Electron tagger at 6 compact lead/scintil fibre SpaCal

Photon Detector: W/Quartz−fibre Calorimeter



Key Parame

- 15422 quartz f
- (total length ~11
- **W/fibre V ratio**
- total depth:
- **sampling freq.**
- average $X_{0::}$
- Moliere radius:

Geometry

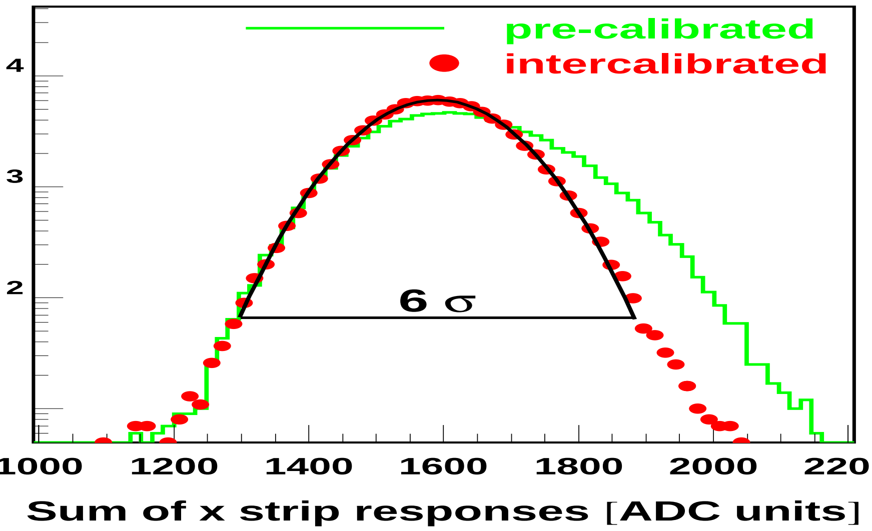
- **12(x)+12(y) 1cn**
- **alternating laye**
  ⇒ indep. sam

Design Perforn

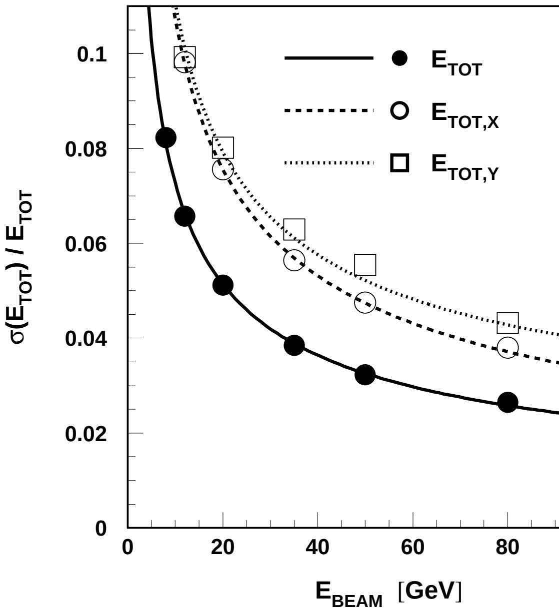
stoch. term:	**19.8**
sampling:	16.4
photostat.:	11.1

Photon Detector Performance: Energy Response

in CERN test beam 1999 + 2000 electrons 6−100GeV



E−Sum	stoch. term A	const. t
x strips	27.58(47)%	0.1(
y strips	27.37(26)%	0.65
all strips	19.24(12)%	0.52



ercalibration by iterative method
earity: 1% for 8 GeV < E < 100 GeV
ergy resolution compatible with design value
lependent sampling by x and y layers
otostatistics measured with LED
ibration system: 130 p.e./GeV

hoton Detector Performance: Position measurem

igh sensitivity to the shower core

narrow apparent showers

econstructed impact point position:

weighted sum of strip centres

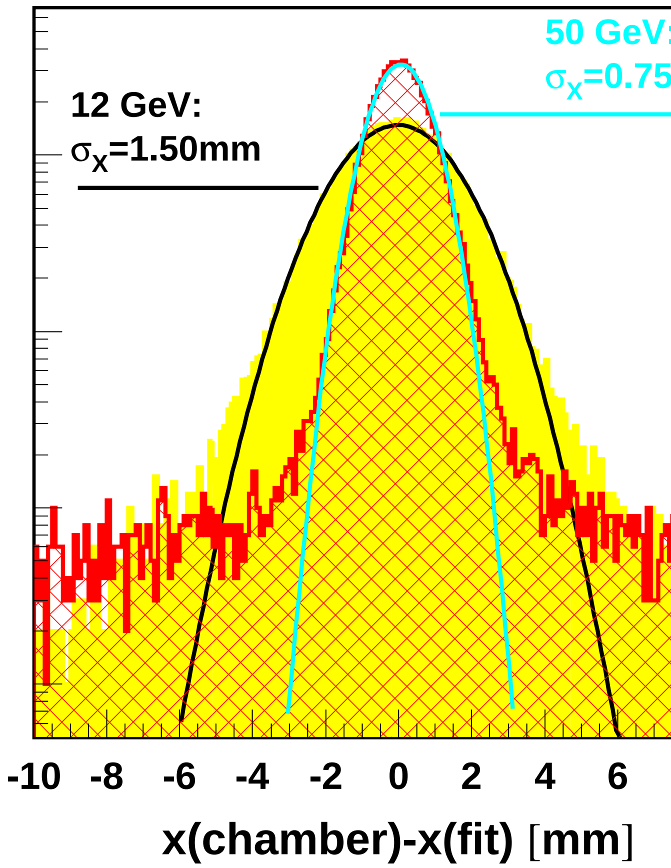
n CERN test beam:

co'd *x* v/s drift chamber *x*

t of a correlation function

sidues ➔ position resolution

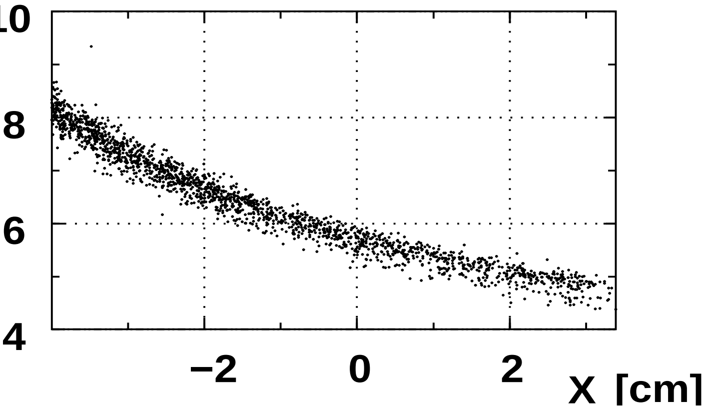
$$\sigma_x = \frac{5\,mm}{\sqrt{E\,[GeV]}}$$



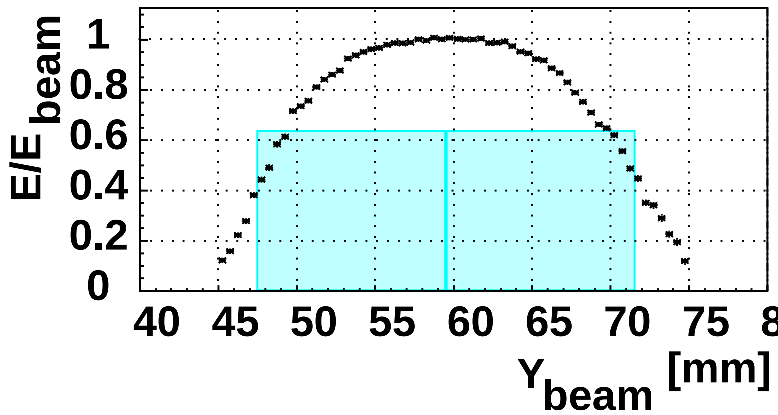
Electron Tagger: Pb/Scintillating Fibre SpaCal

easure scattered electron energy and position (γp and B
hoton detector cross calibration: E(γ)+E(e)=E(e−beam)

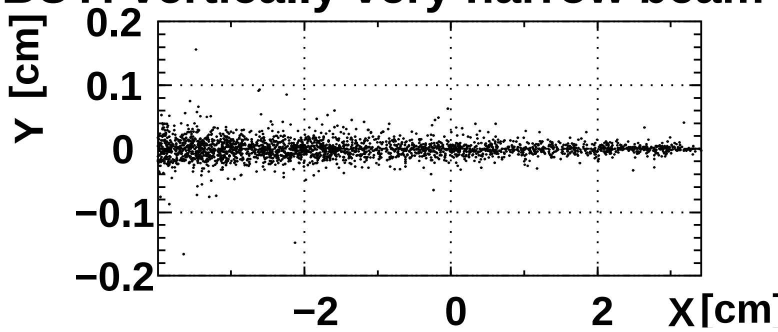
- ead/scintillating fibre spaghetti alorimeter (1:2.26 Vol. ratio)
- (*x*) x 2(*y*) cells 13x12x200mm^3
- otal depth: 22 Xo
- ocated inside the gap of GI1 HERA uadrupole magnet at 6 m from IP



Main issue: vertical E leakage



BUT: vertically very narrow beam



agger Performance: Energy and Position Resolut

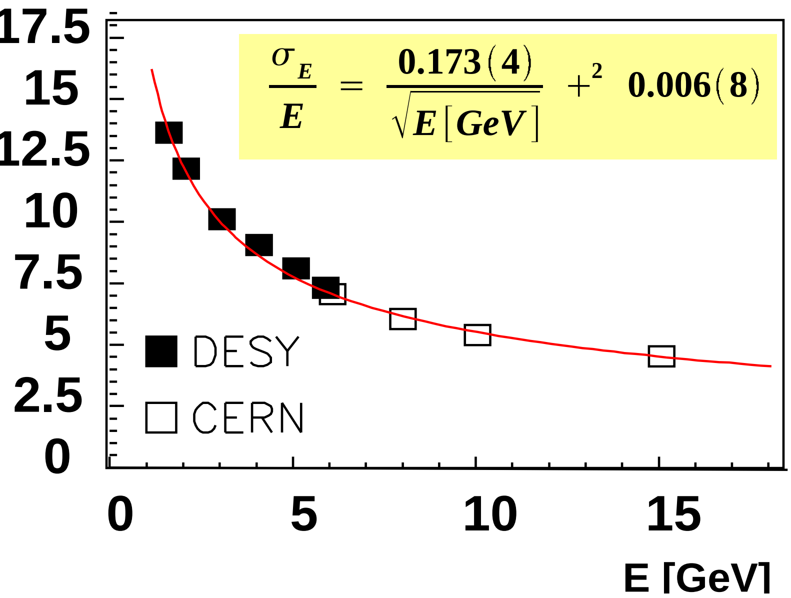
RN test beam data:

nearity: 1% for 6 GeV < E < 15 GeV

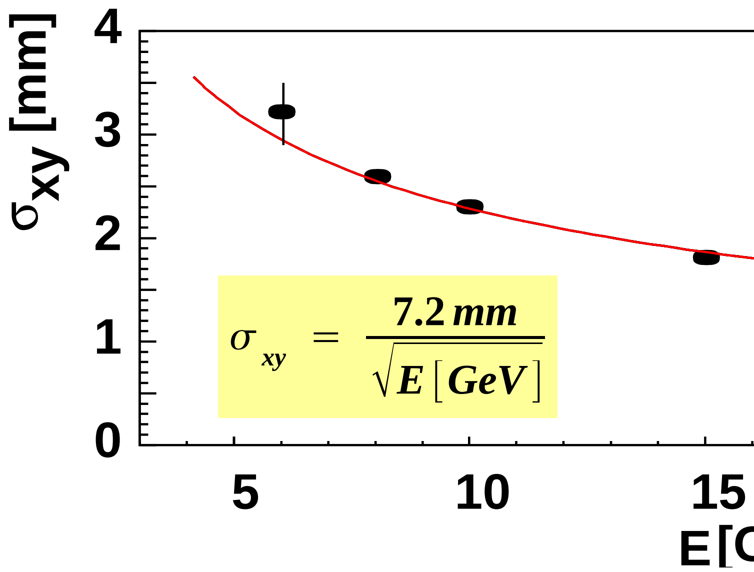
nergy resolution depending on photomultiplier tubes:

gher E resolution and good agreement achieved in DESY test beam with Philips PM

Energy resolution



Position resolution

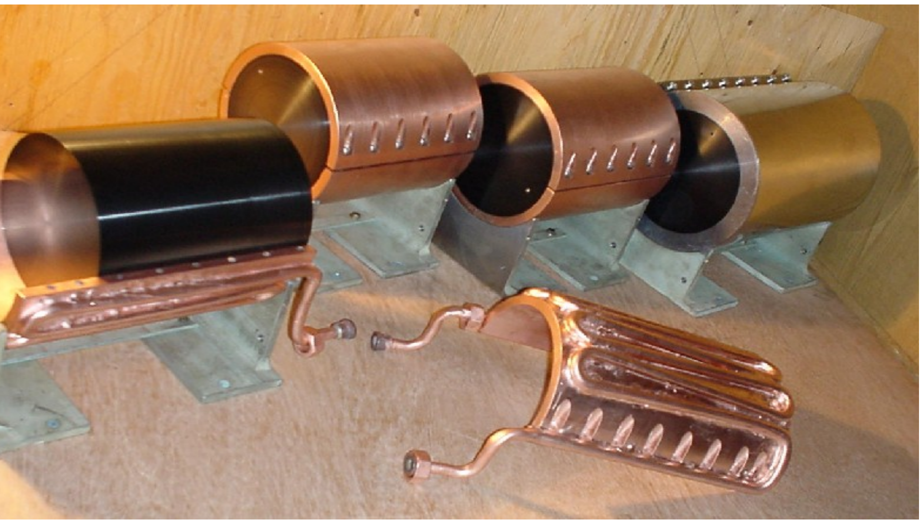


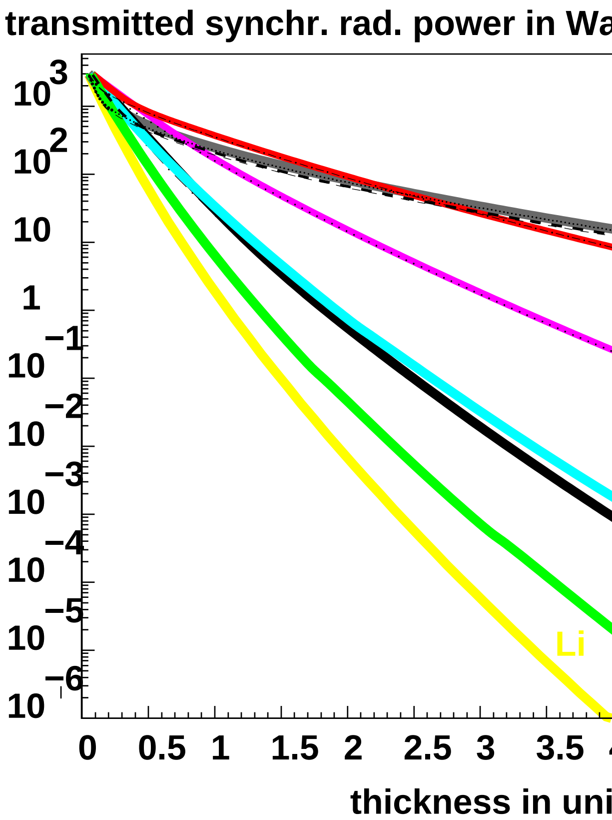
Beryllium Synchrotron Radiation Shield

reduce radiation dose on photon detector by 10^{-4}

acceptable dose on fibres: $\mathcal{O}$(50 Mrad/year)

material more efficient to absorb
rating 500keV~2MeV component of
rotron radiation with a given "X0−Budget"



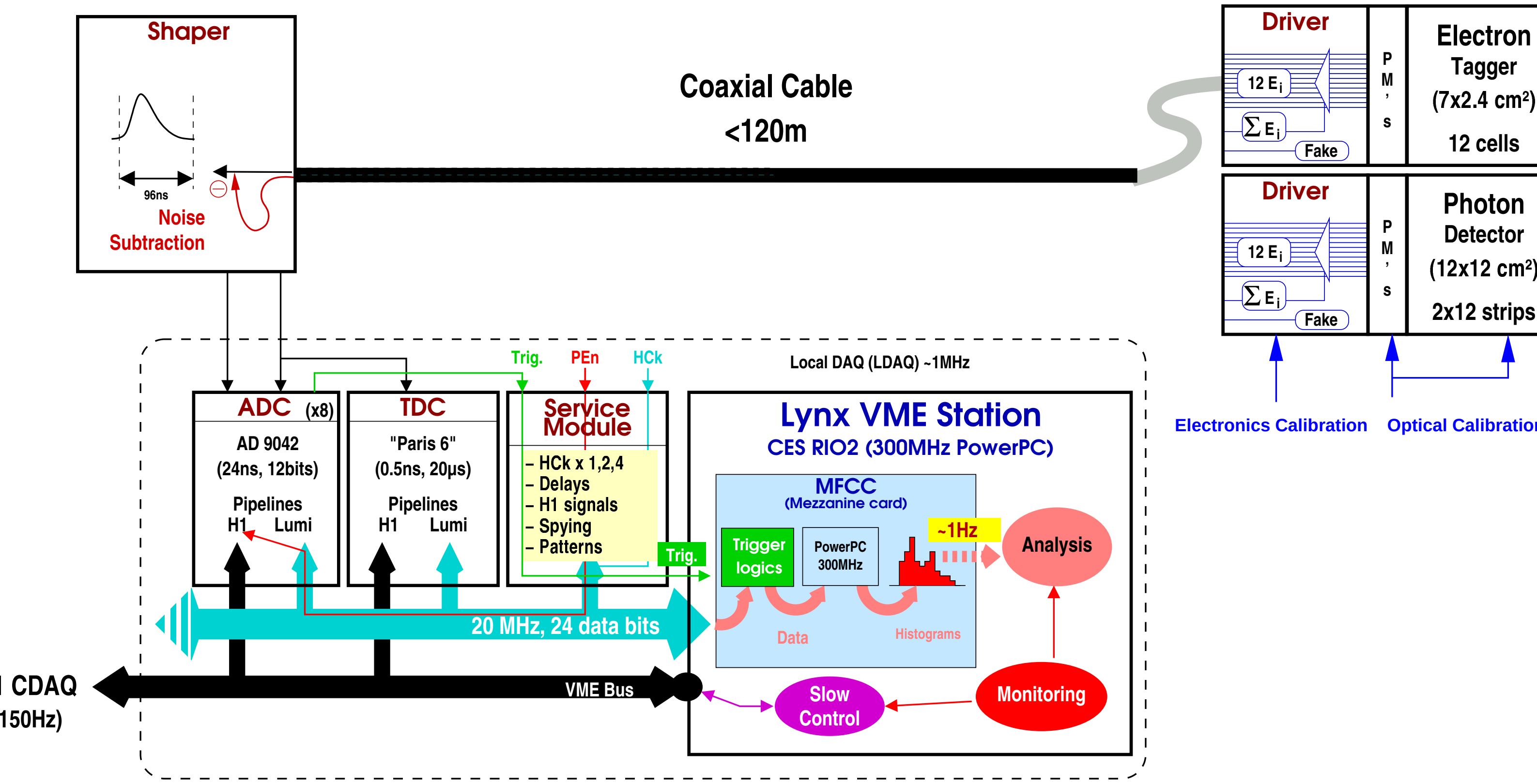


Electronics and Data Aquistion Overview

ast analog electronics and digitization, noise suppression

dual pipelined readout of ADCs

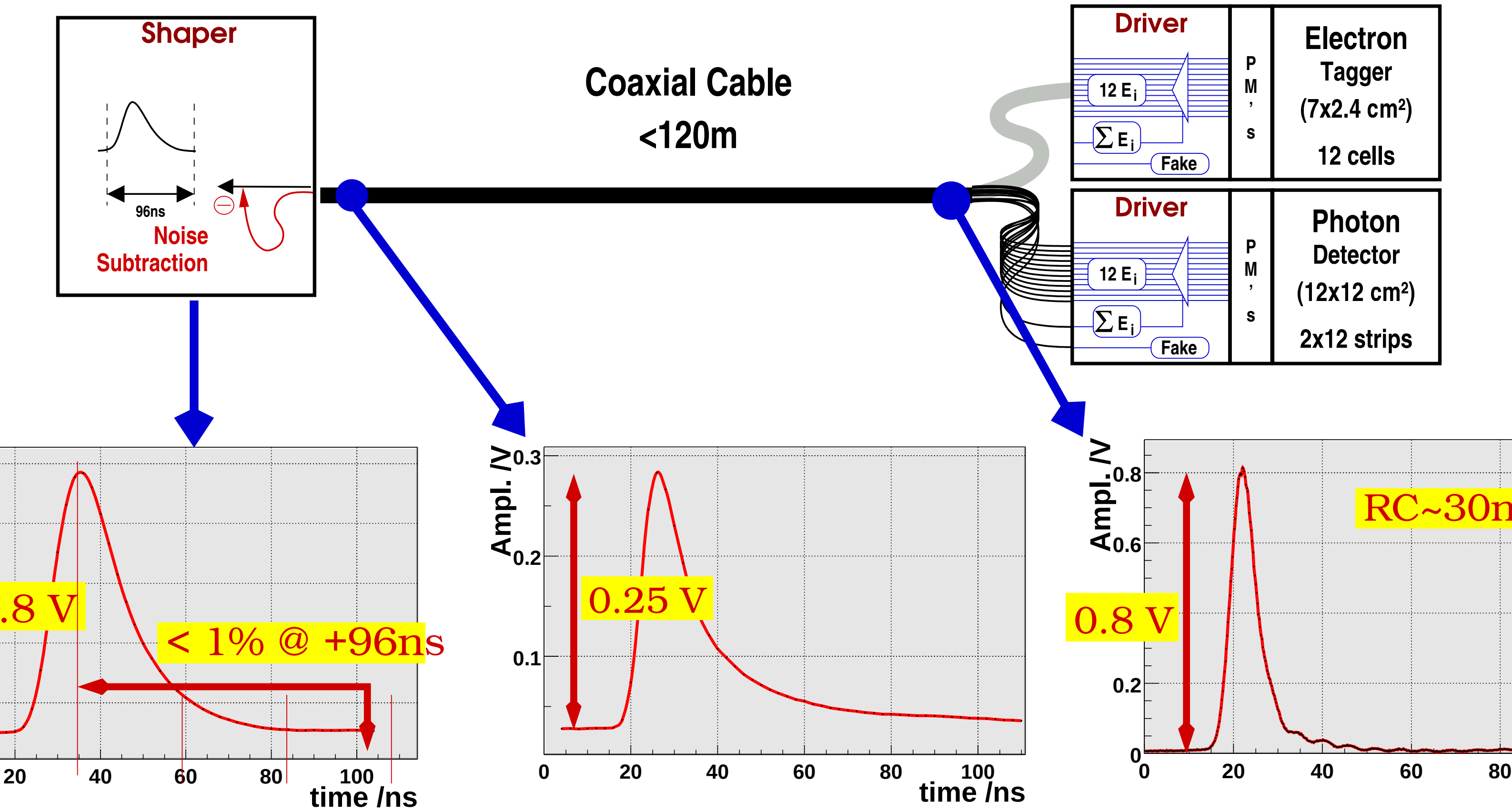
ast histogramming DAQ (Mhz)



Fast Pulse Shaping and Digitization

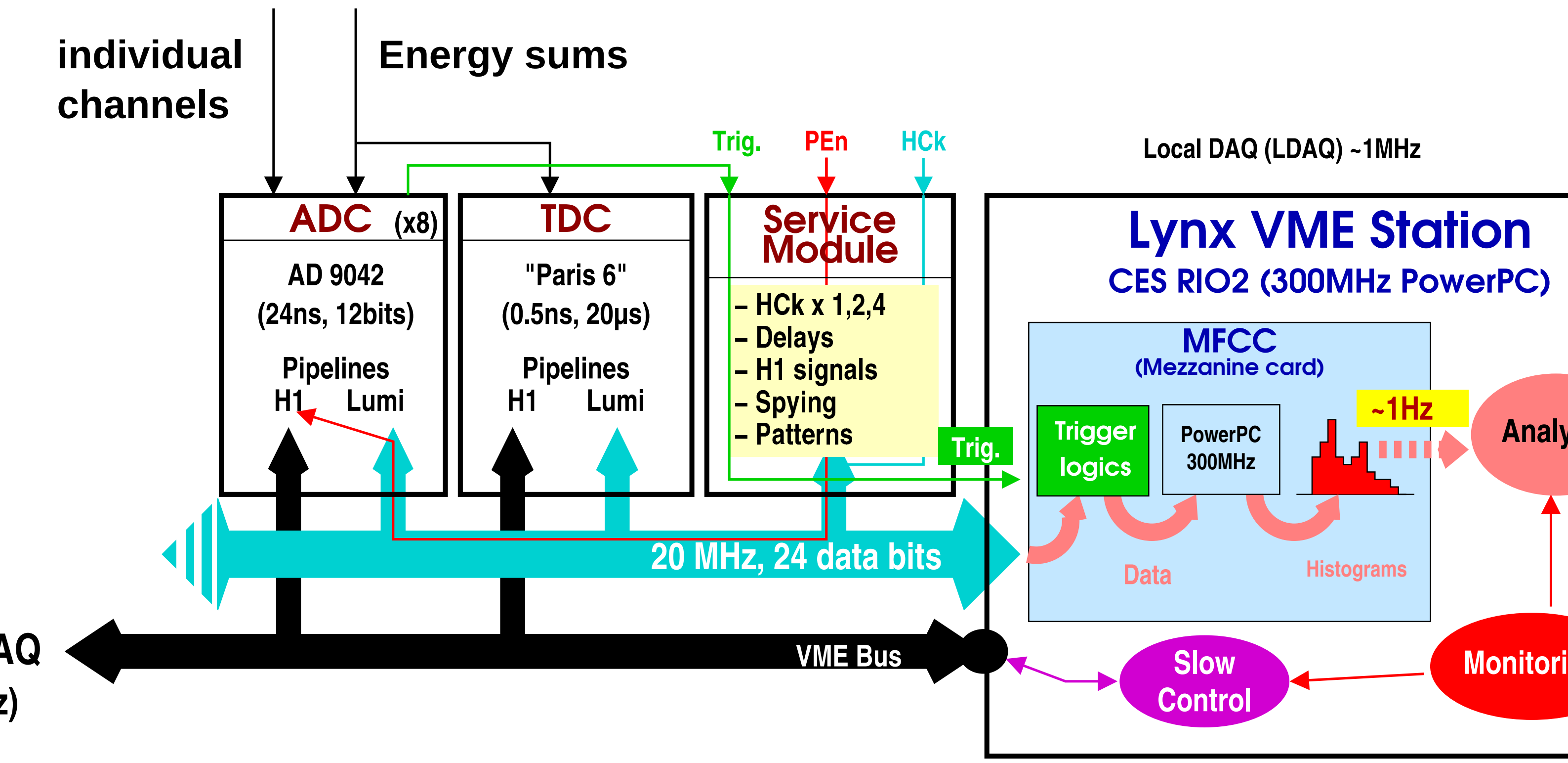
mplification, fast shaping + compensation of coax. cable

/FE summation + common mode subtraction (fake channe



Fast Histogramming DAQ via Dedicated Bus

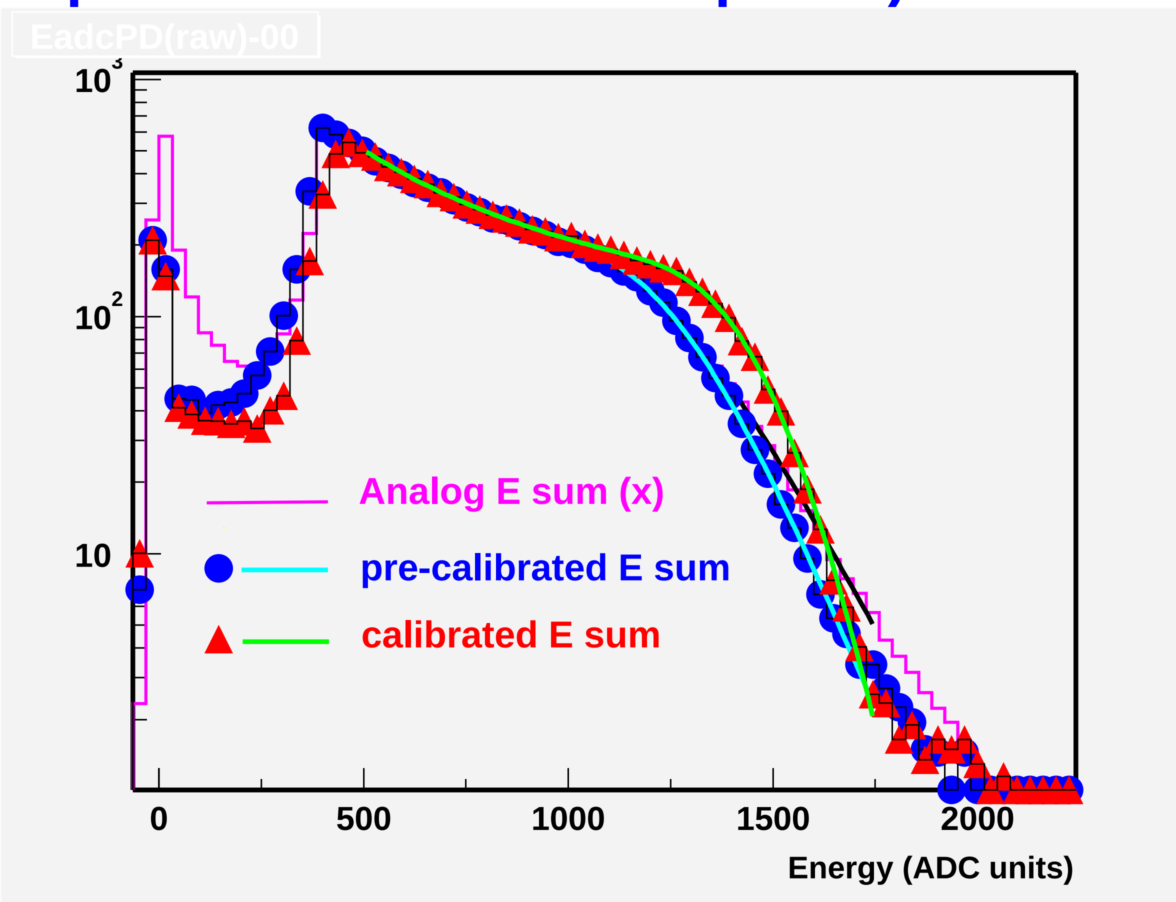
ADC: 24ns (4 samples per bunch crossing), 12 bits
ual pipeline read−out: H1 DAQ (VME) and LumiDAQ (Altera Bus
acq. modes: bunch train (unbiased, E sums, high statistics,1M
triggered event (all channels, monitoring)



First HERA Beam: Photon Detector Calibration

hannel intercalibration by iterative method

t of (BH spectrum ⊗ detector response) to E sums



Summary and Outlook

completely new H1 Luminosity system designed to meet harsh requirements of the HERA II environmen

radiation hard photon detector

dedicated Data Acquisition system

system has been installed in 2001

now in commissioning phase:

- detector calibration
- high current (= high rate) operation
- development of monitoring tools