Triggering charm at H1

- Introduction – Why charm ?
- The Fast Track Trigger (FTT)
- FTT-L3: Full reconstruction of (charmed) final states

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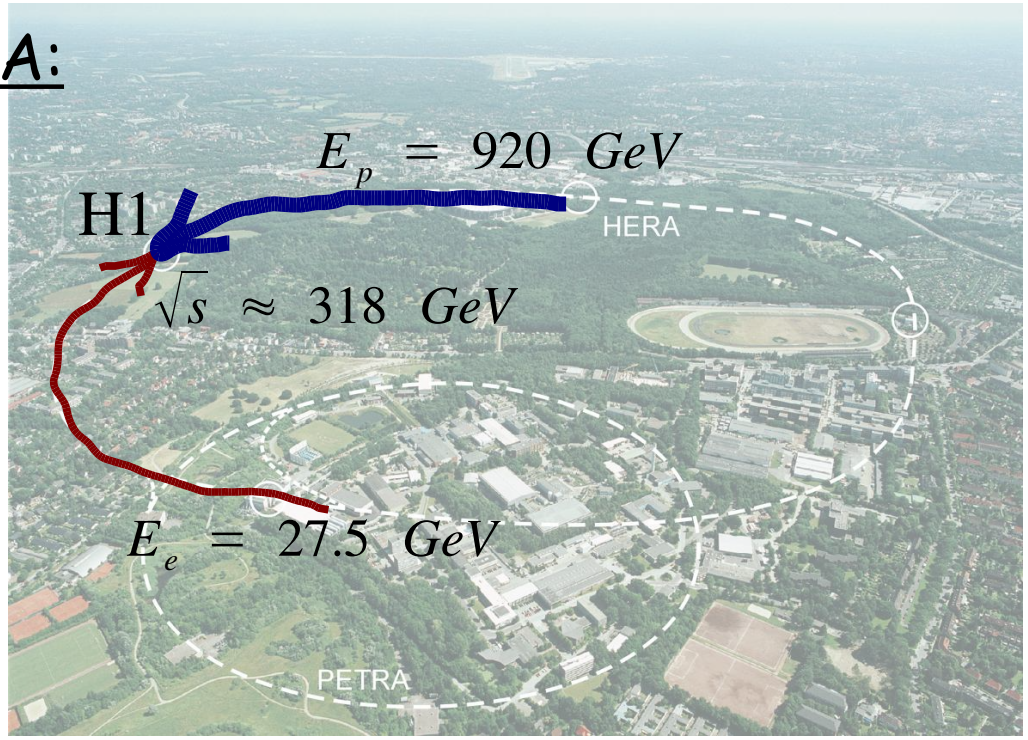
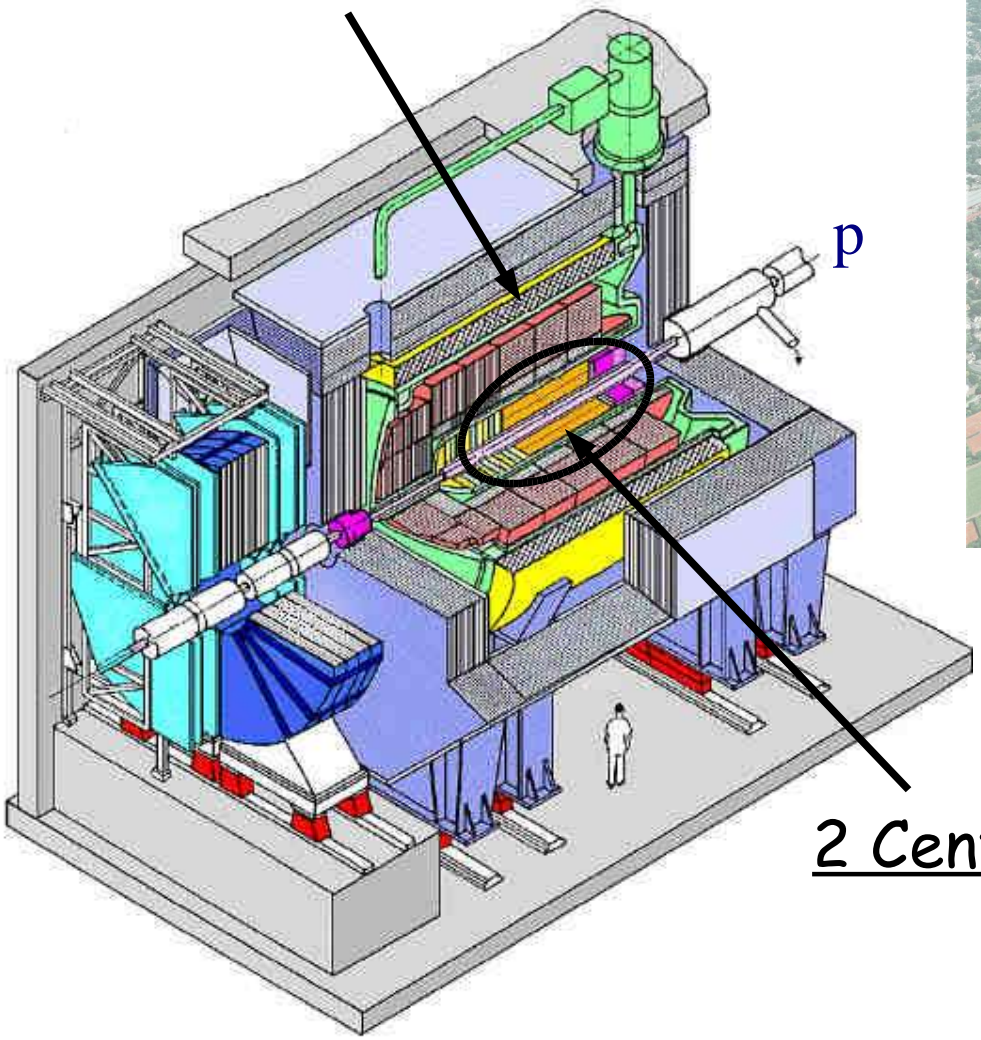
Introduction: The H1-Detector

HERA:



1.2 Tesla Coil

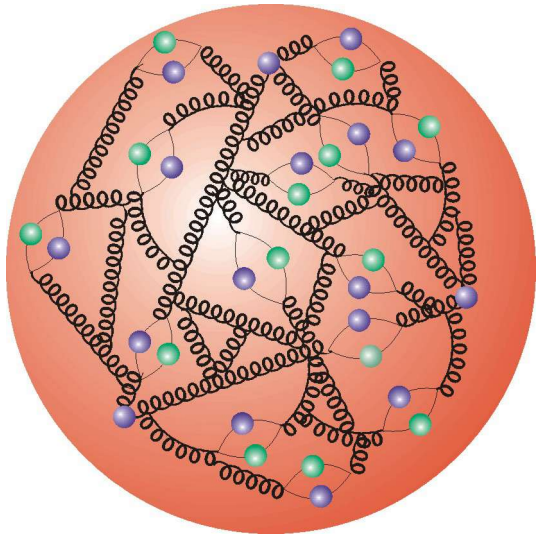


2 Central Jet Chambers: (CJC1 & CJC2)

- 2640 Wires parallel to beams
- Readout at both ends

Introduction: Why charm ?

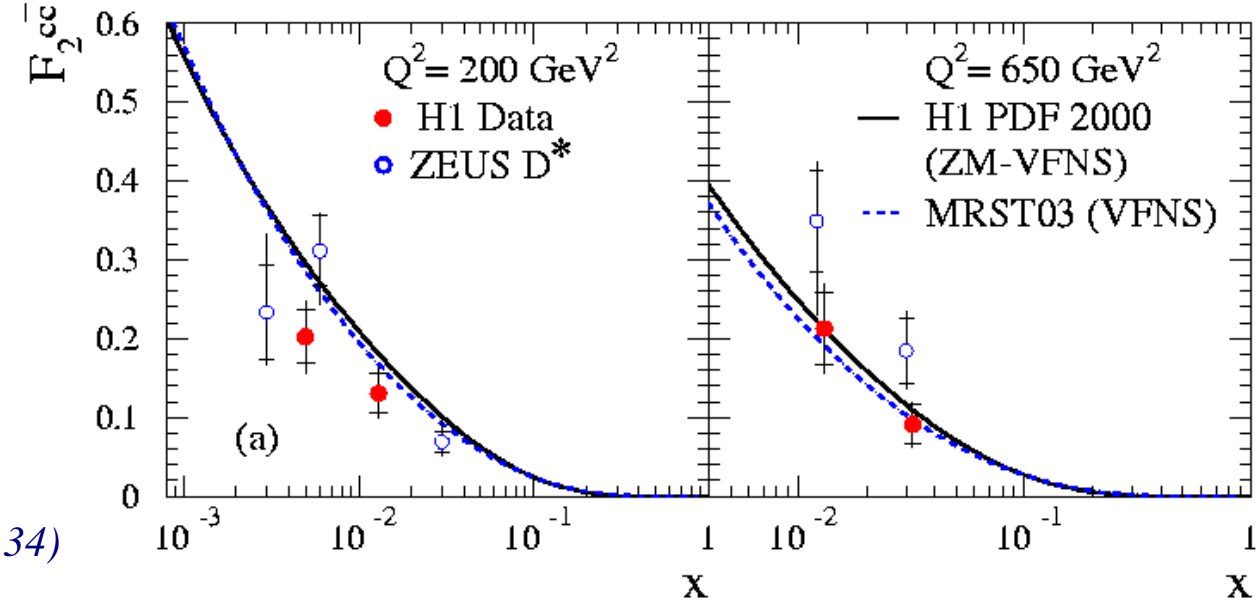
Today's artist's view of the proton:



- Test pQCD and access the gluon content

indirect: $ep \rightarrow eX$ (inclusive)

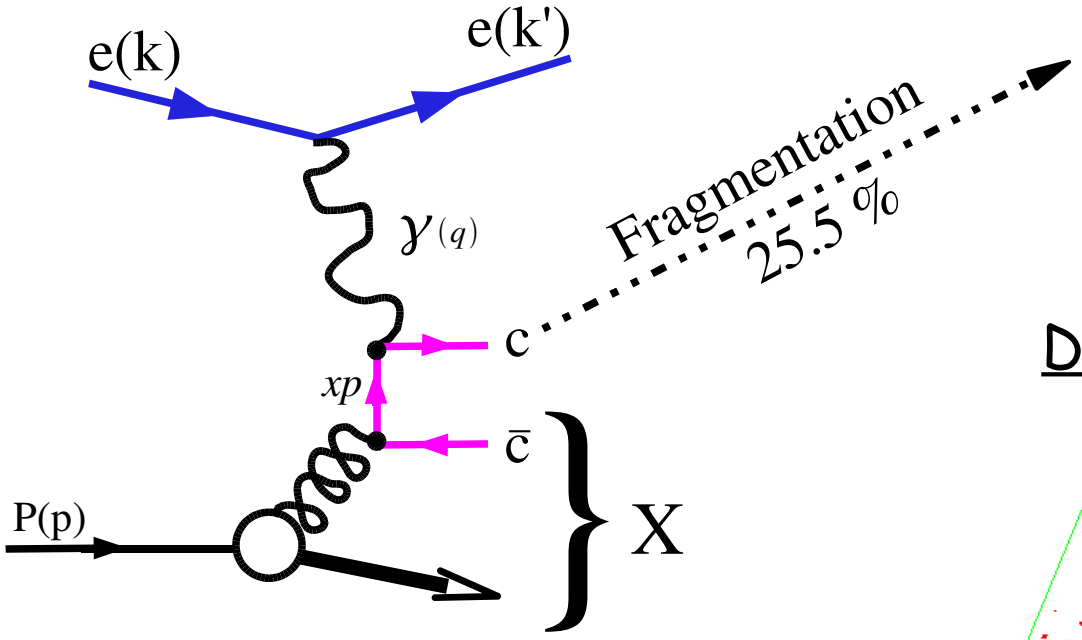
direct: tagged charmed Mesons



(hep-ex/0411046 H1 134)

Introduction: Charm at H1

Production of heavy quarks at HERA:

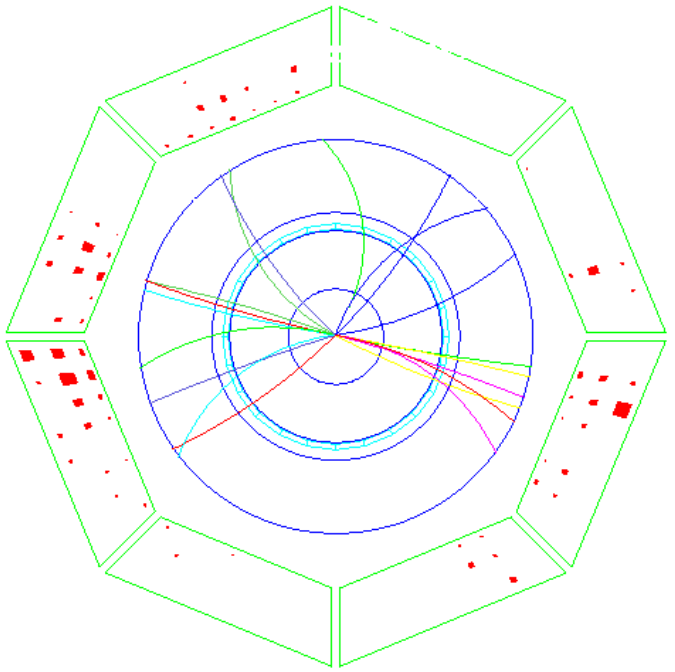


Fragmentation 25.5 %

$$D^{*\pm} \rightarrow D^0 \pi_s^{\pm} \quad \hookrightarrow K^{\mp}\pi^{\pm}$$ BR: ~ 2.5%

(Photon-Gluon-Fusion)

D*-Event in CJC1 & 2:

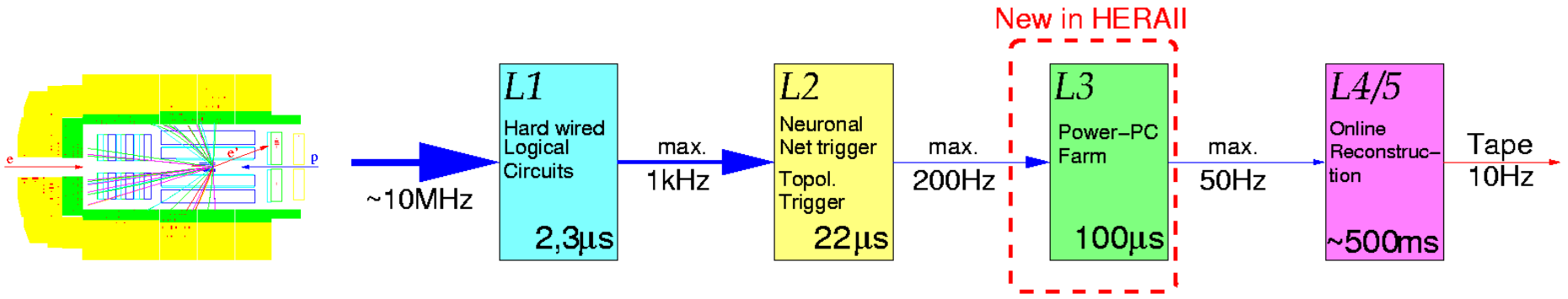


→ Invariant mass calculation

Introduction: Triggering at H1

These events are rare and in addition:

- HERAII has higher Luminosity (and bg x 5)
- present L1/L2 not able to proceed the rate reduction

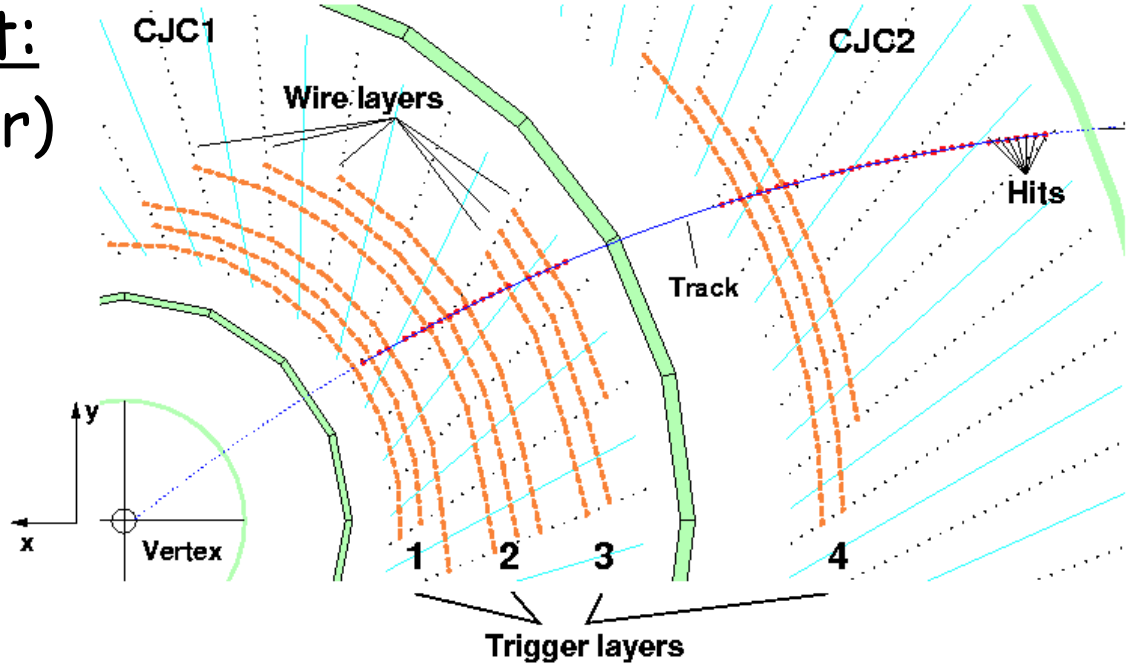


Fast selective multi-stage track Trigger:

in special: track based Event reconstruction with invariant mass cuts

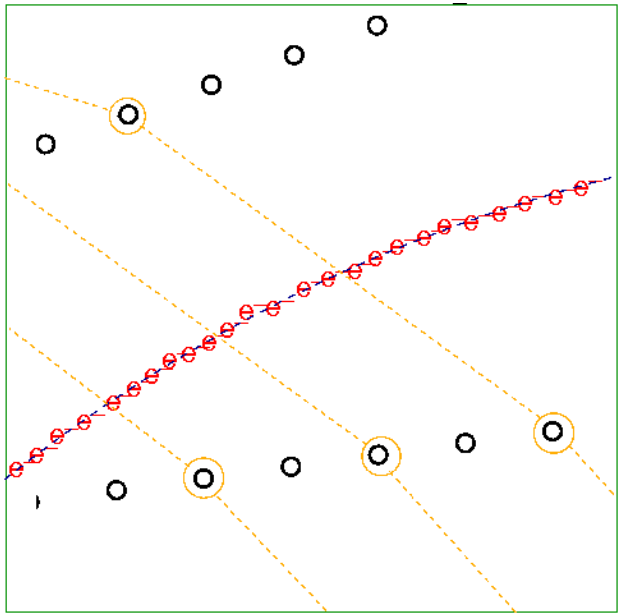
The Fast Track Trigger (FTT)

FTT-Concept:
(multi-stage trigger)



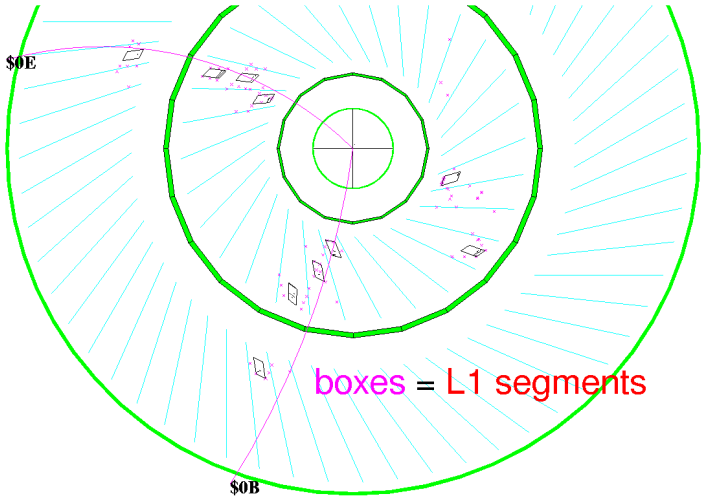
- Use signals from 12 wire layers grouped in four trigger layers
  - Find track segments in trigger layers
    - Combine track segments from trigger layers to valid tracks
      - Fit up to 48 tracks
        - Calculate invariant masses

Track segment finding (FTT-L1)

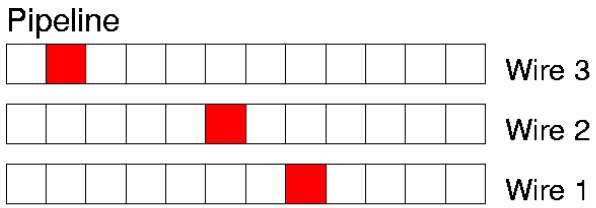


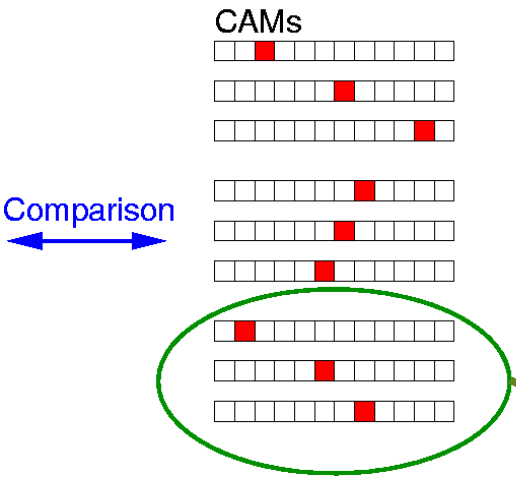
- Hit digitization
- Find track segments and filled them to histogram
- Coarse segment linking and track validation

Level 1: 2.3μs



One out of four Triggerlayers:





$$\phi, \quad p_t^{-1} = \kappa$$

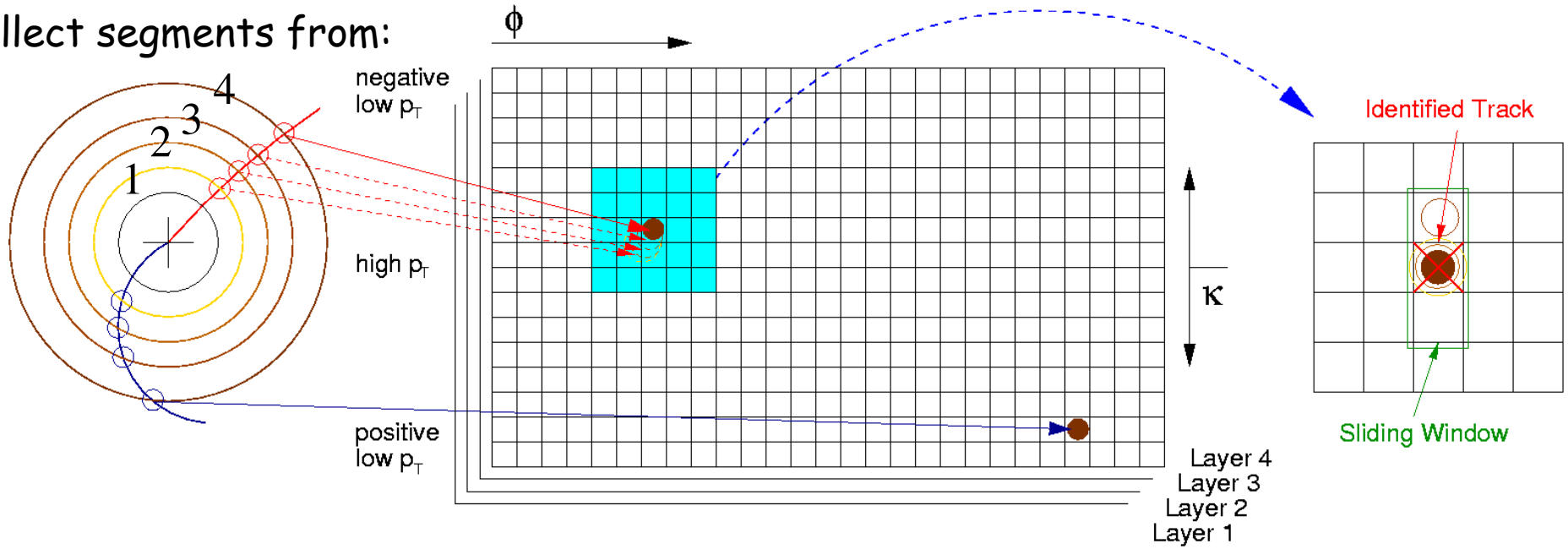
Pipeline storage:

Level 1: 20 MHz ~ 3000 masks

Level 2: 80 MHz ~ 100000 masks

Track segment linking (FTT-L2)

Collect segments from:

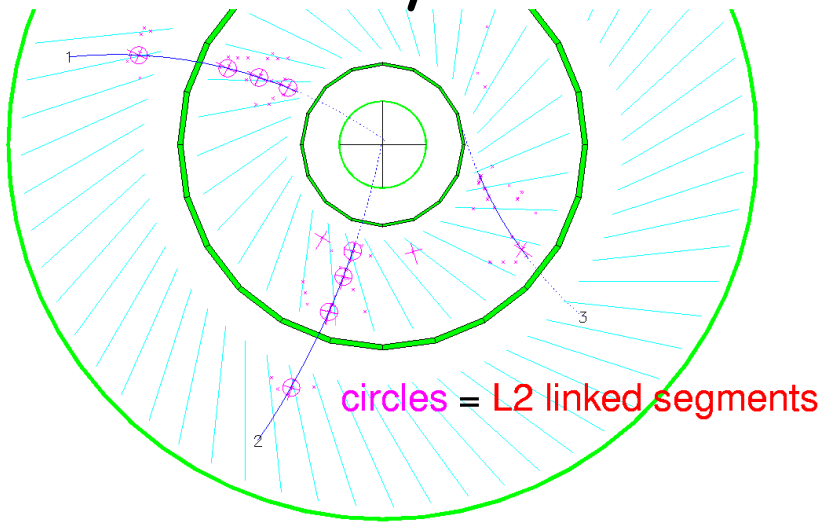


Histograms $(\kappa \times \phi)$:

Level 1: 16 x 60 bins

Level 2: 40 x 640 bins

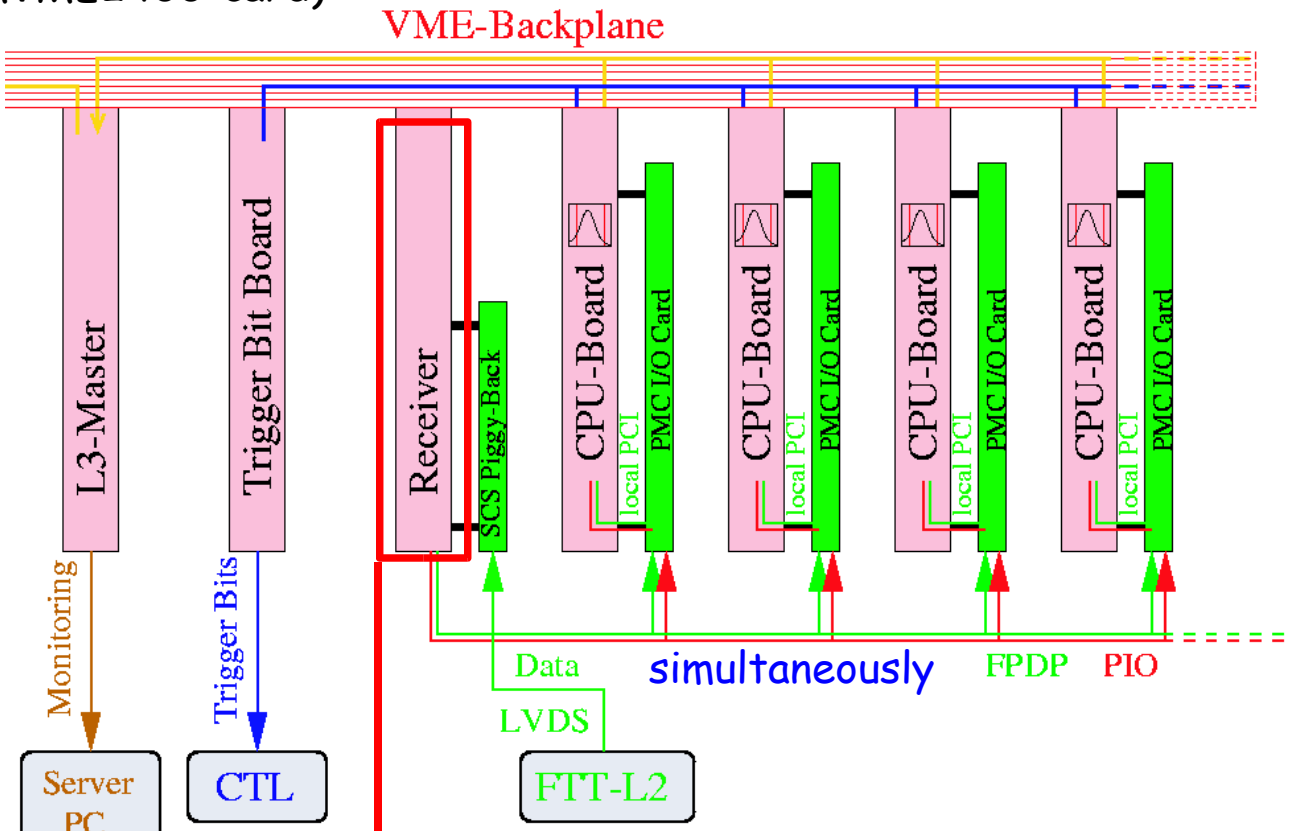
Level 2: 22μs



Matching in (κ, ϕ) require at least 2 out of 4 trigger layers

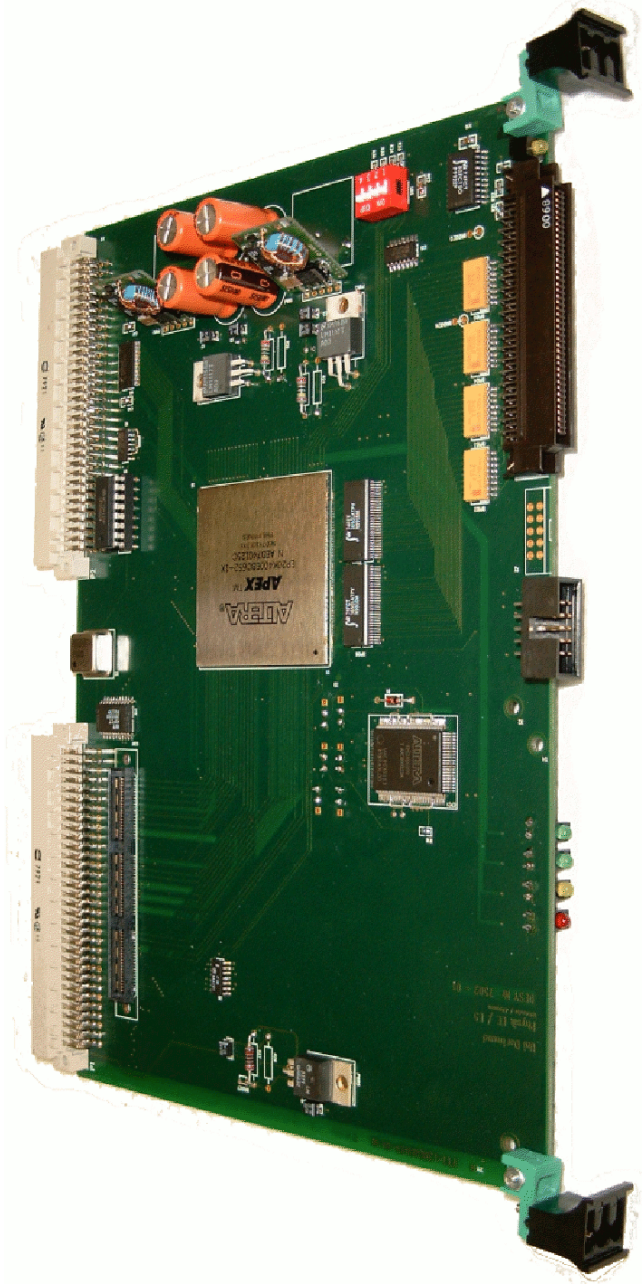
FTT-L3: Hardware

- Latency: 100 μs
- PowerPC-System
  (Motorola MVME2400-card)
- Real time operating system: vxWorks
- 16 different routines for selections



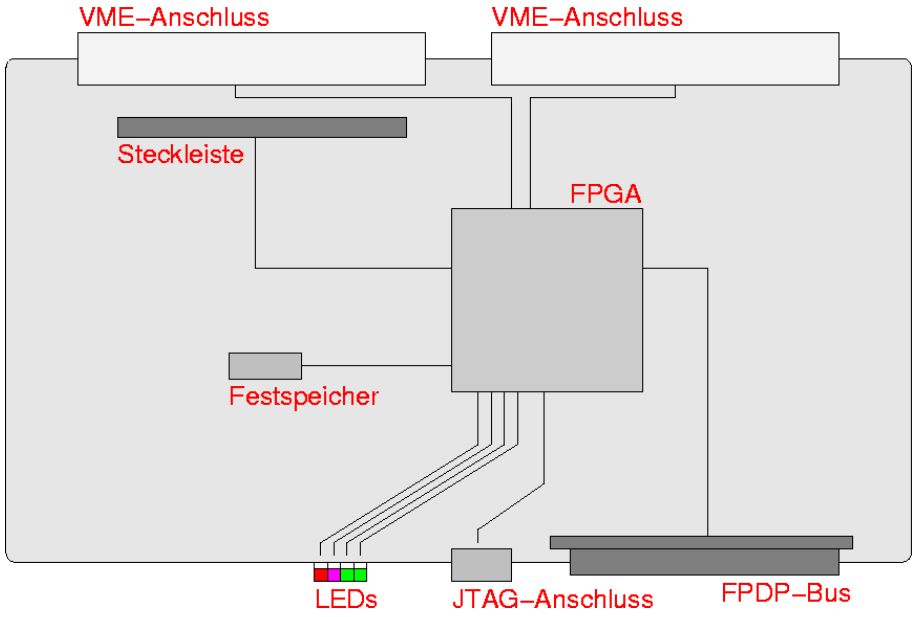
Receiver card: Translation
LVDS to FPDP-Bus

FTT-L3: Hardware

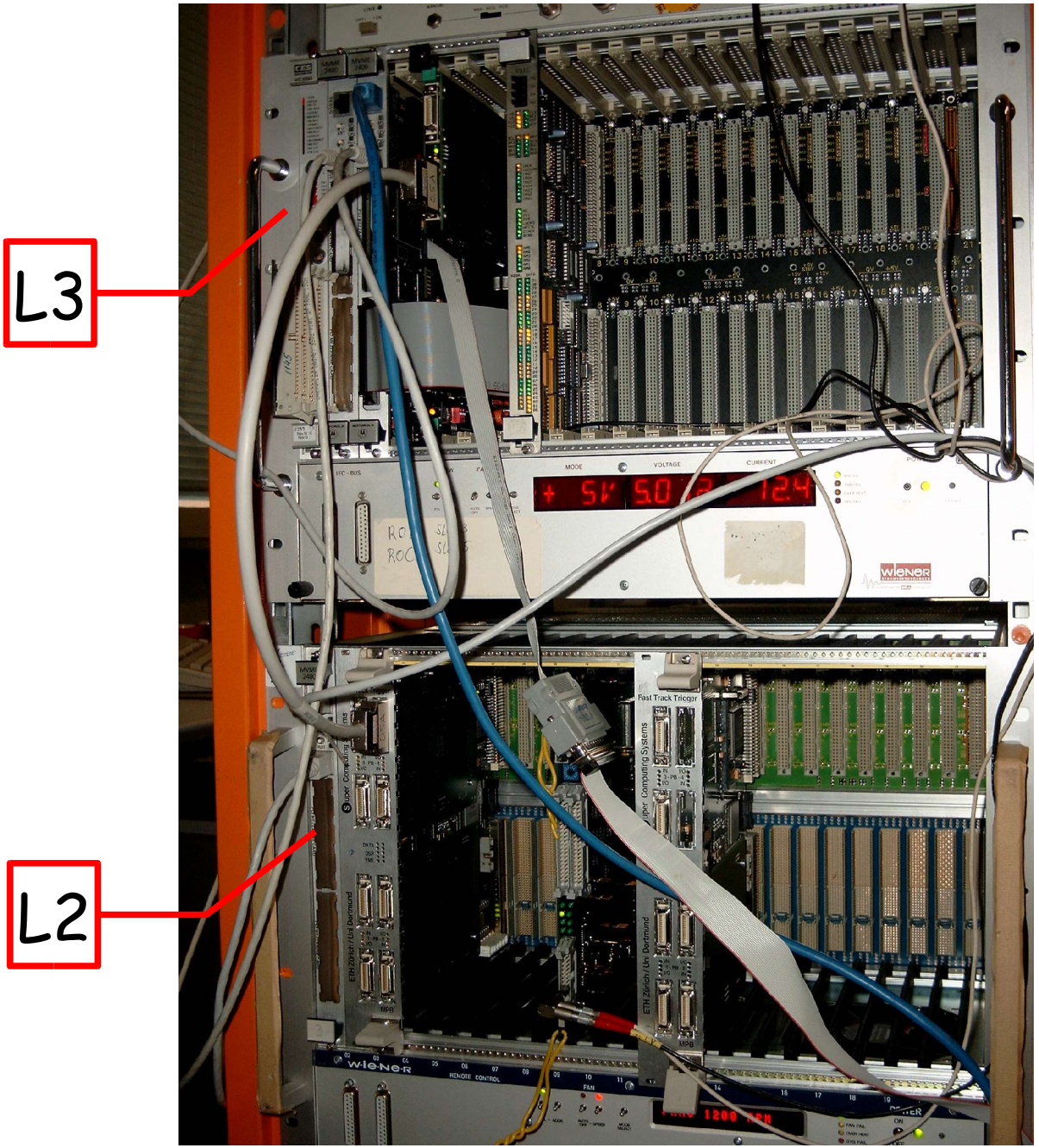


Facts:

- able to feed up to 8 Slaves
  - simultaneously - with data
- LVDS (100 MHz) to FPDP (20 MHz) translation
- big integrated FPGA



FTT-L3: Hardware test



Test runs for: 2 days

$$R_{error} = \frac{N_{error}}{N_{total}} = 3.2 \cdot 10^{-6}$$

<u>L1 simulations show:</u>

$$R_{error} \approx 1 \cdot 10^{-4}$$

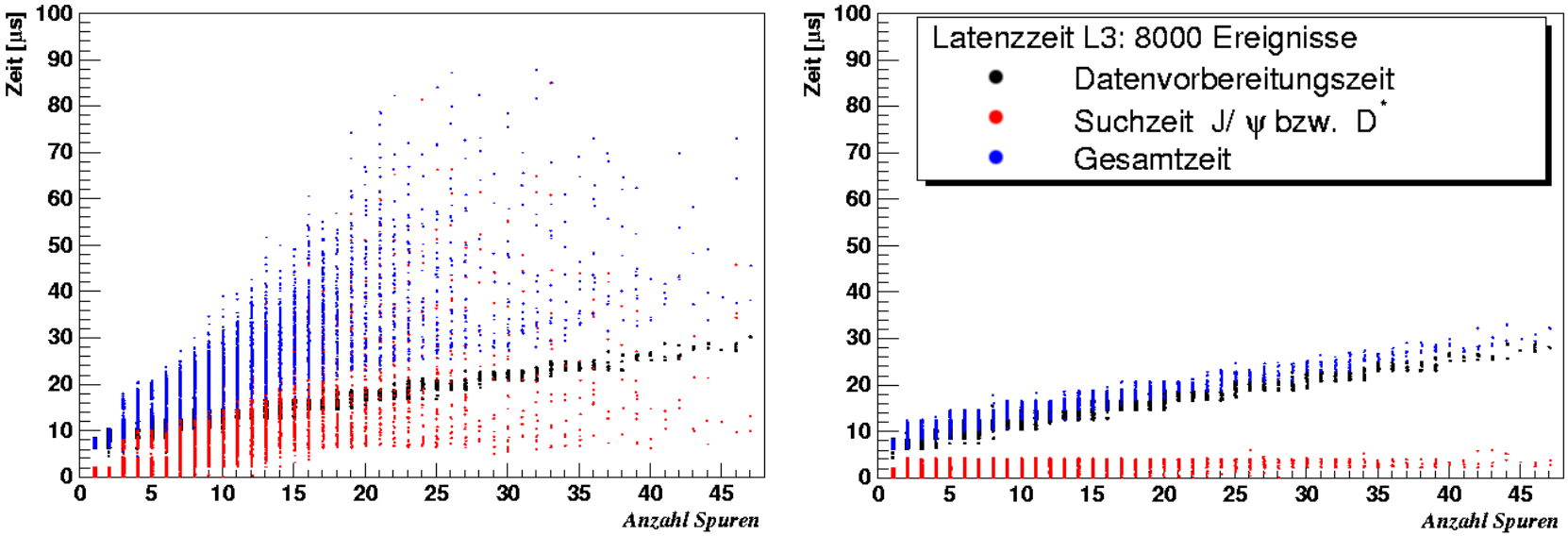
no visible influence to the L1-Trigger

work ongoing !

Latency – Minimum Bias Data (2004)

Searching for: $D^{*\pm} \rightarrow D^0 \pi_s^{\pm}$
$\hookrightarrow K^{\mp}\pi^{\pm}$

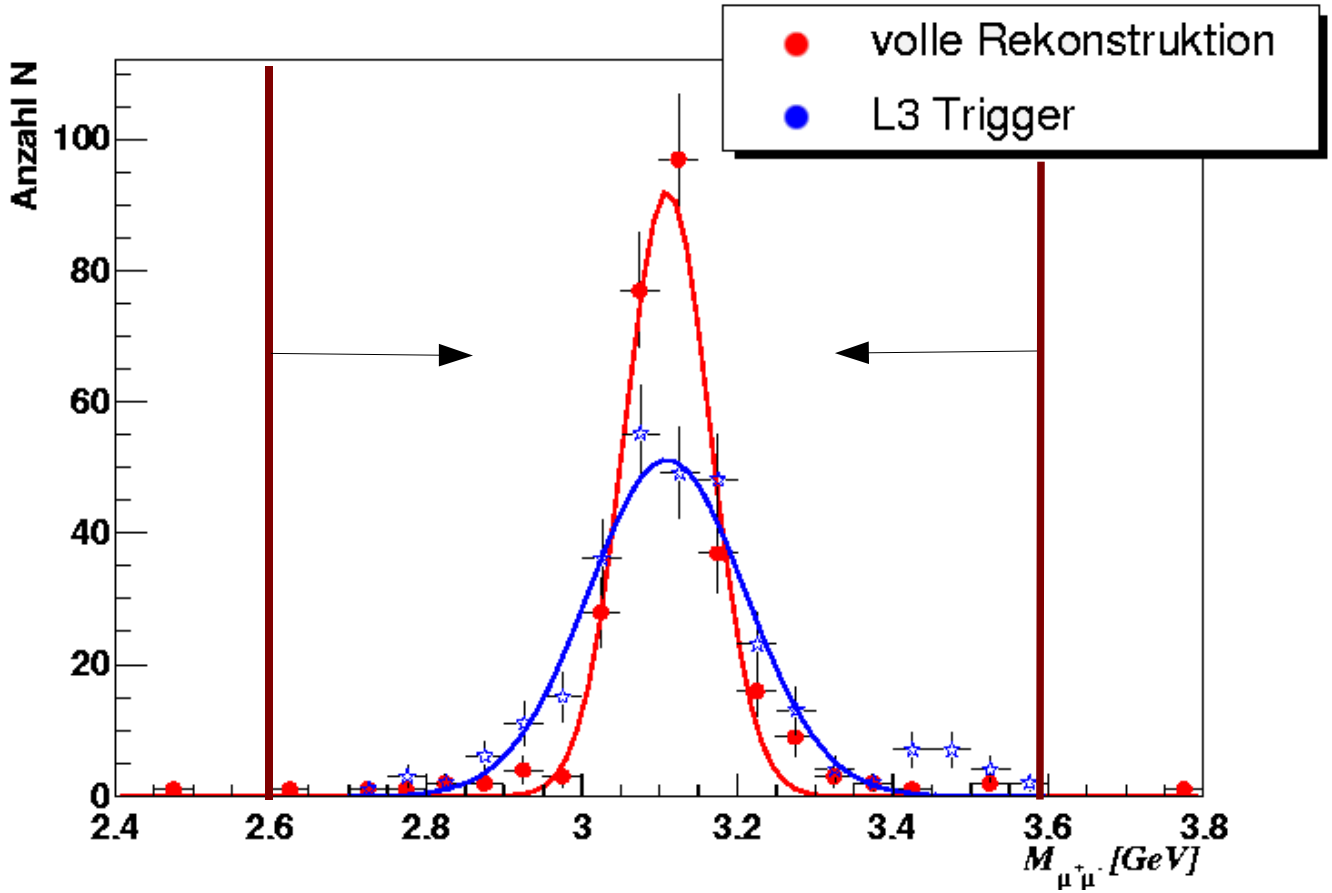
$J/\psi \rightarrow \mu^+\mu^-$



Latency defined through:
- Track multiplicity
- Number of particles
- Data preparation time independent from selection code

Resolution - preselected Data

$J/\psi \rightarrow \mu^+\mu^-$:
$(M_{J/\psi} \approx 3.1\,\mathrm{GeV})$



Resolution: $\sigma_{L3} = 101\,\mathrm{MeV}$ versus $\sigma_{offline} = 55\,\mathrm{MeV}$

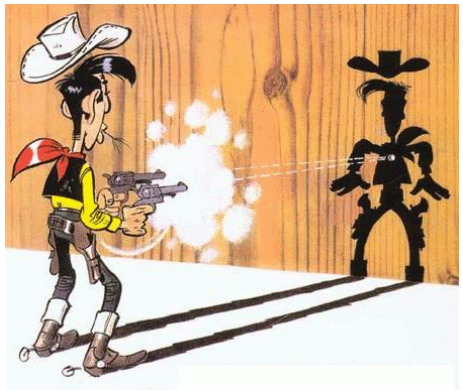
Full reconstruction of (charmed) final states at Trigger level

Summary

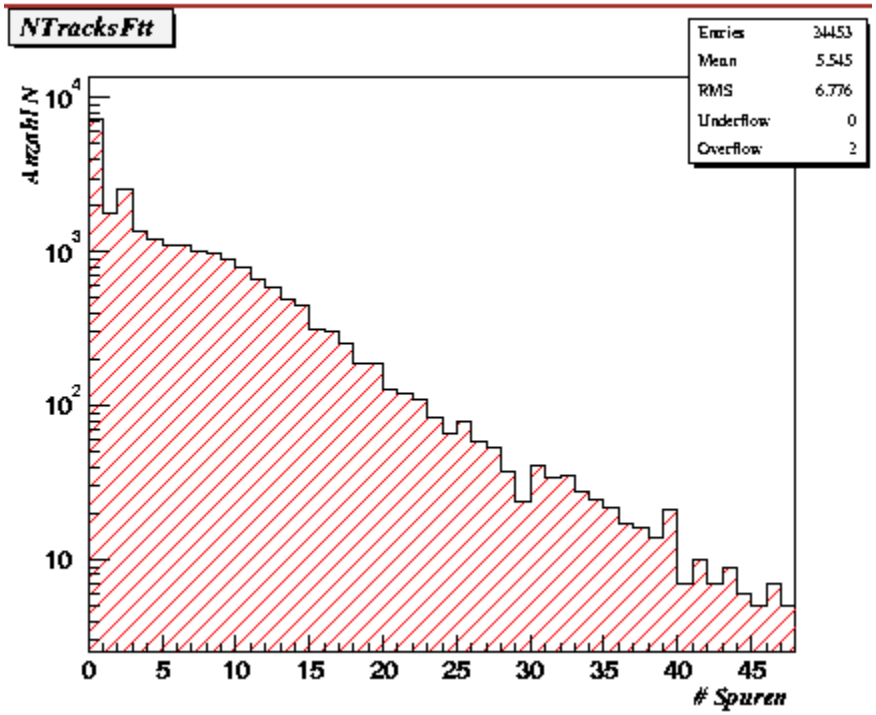
- FTT-L1: Triggering — OK
- Data from FTT-L2: — work ongoing
- FTT-L3: — waiting for tracks
- Testing L3-Trigger signals: In & Out — OK

Third trigger layer of the FTT at the H1-Detector

Commissioning ongoing



Appendix



- 90 % of the events have less than 20 tracks