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Hera-B trigger system: Higher levels

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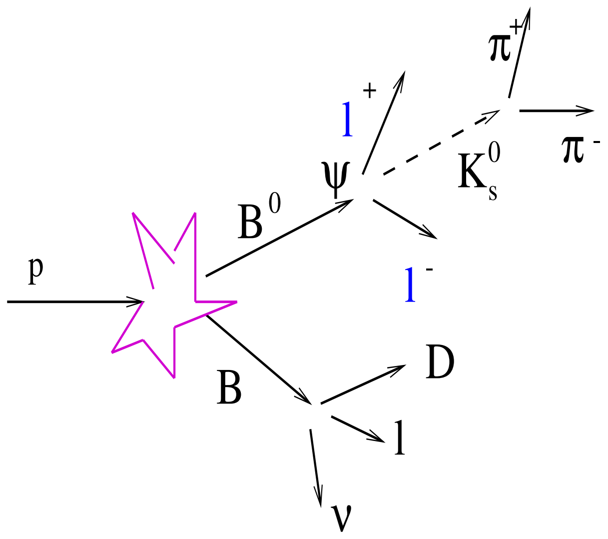
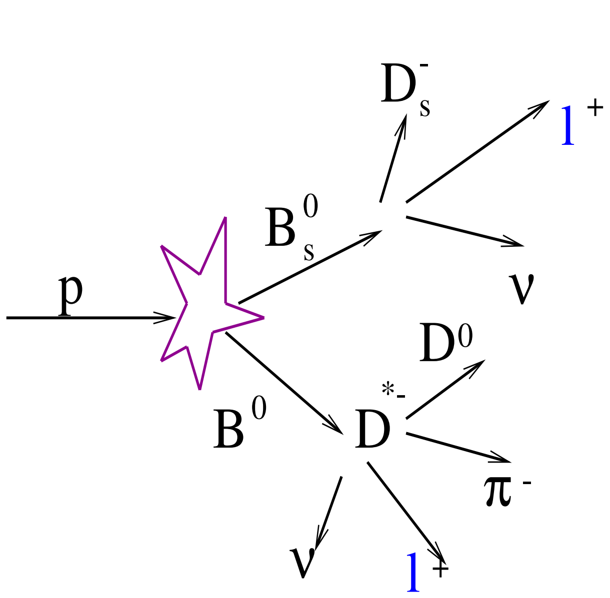
Hera-B Physics Goals (1)

- CP Violation (a)

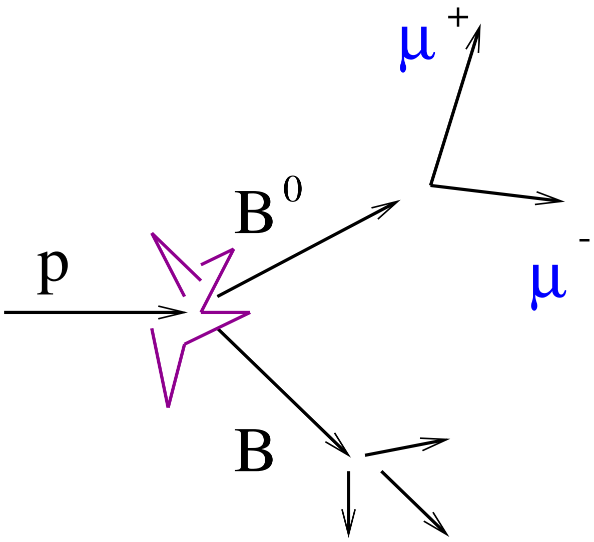


- B_s Mixing (b)



Hera-B Physics Goals (2)

- B **rare decays (c)**



In a period of 10^7 sec ($\simeq$ 1 year),
with interaction rate of 40 MHz:

proc	σ/σ_{inel}	**yield**
a	10^{-11}	$4 \cdot 10^3$
b	10^{-9}	$4 \cdot 10^5$
c	10^{-14}	4

Hera-B Trigger Goals

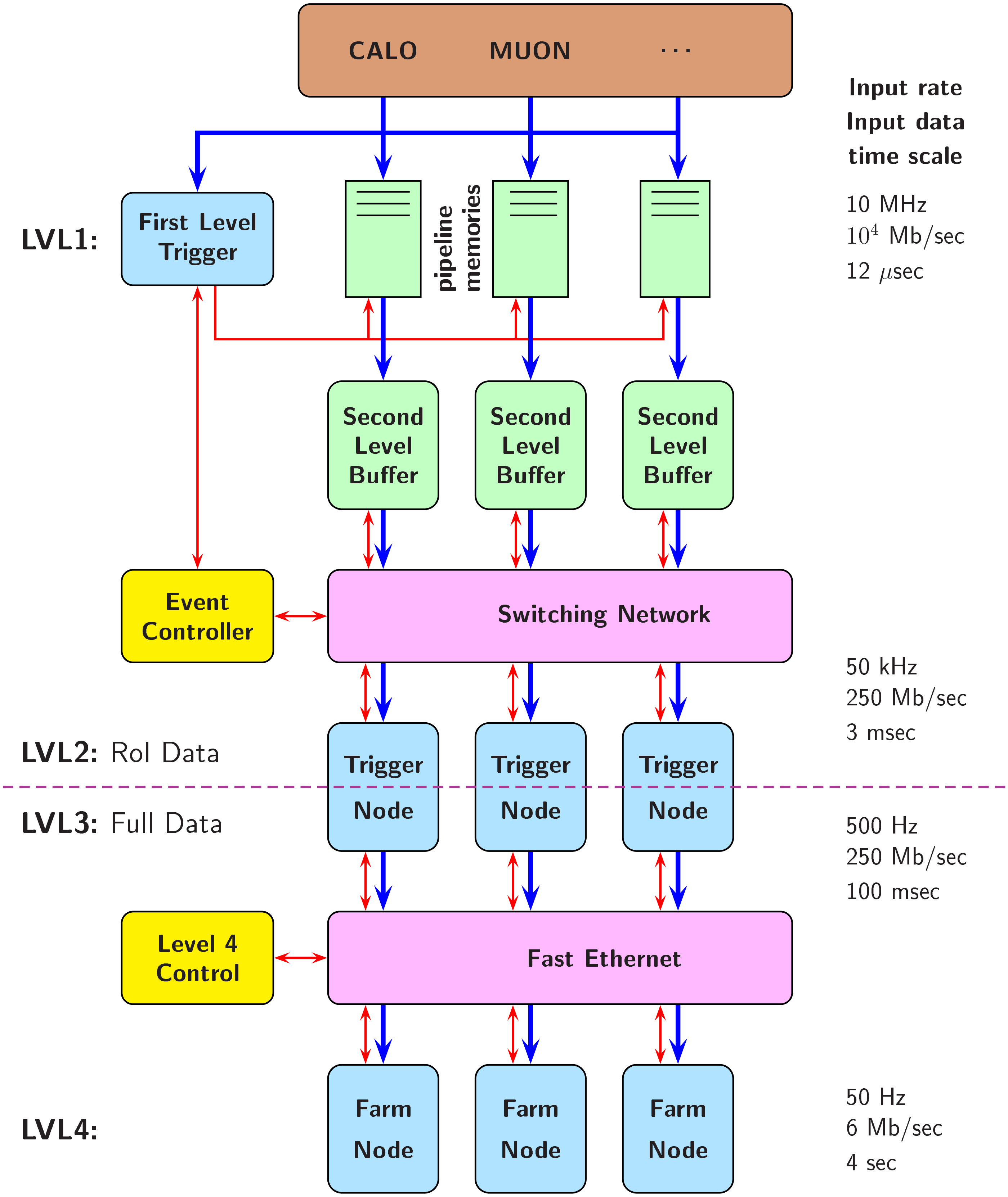
- Ensure an event rate reduction
  10MHz $\rightarrow$ 20 Hz
- Ensure maximal signal/background

$\Rightarrow$ Physics analysis online !

How? Putting requirement on ...

- N_{tracks}, ID type
- p_T, M_{ij}, $(Q_i \cdot Q_j)$
- N_{hits}, χ^2
- z_{ij}/σ_z

Trigger Overview



Data Path Components

- Super Harvard ARChitecture (SHARC) board
  170 units, 1000 DSPs, 384 events depth
  time for an event to be in buffer =
  384/50KHz = 7 msec
  $\Rightarrow$ Safety factor = 7 msec/3 msec = 2.33
  - Second Level Buffers
  - Fast switching network
  - Event Control

- Pentium II processors (300 MHz and higher)
  440 units = $\sum_{levels}$ Input rate $\cdot$ time scale
  - L2/L3 trigger farm: 240 units
  - L4 trigger farm: 200 units

- SHARC/PCI interface card
  240 units
  - Bridge: Second Level Buffers $\leftrightarrow$ Pentium processors

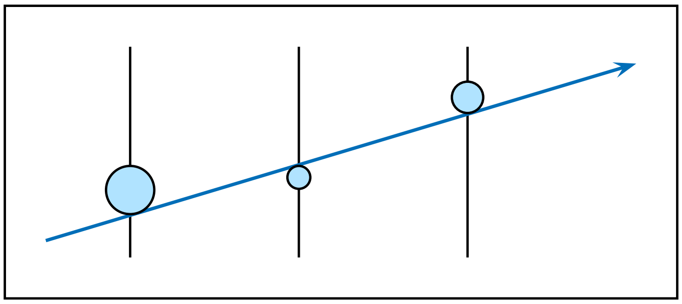
- Fast ethernet
  - LVL 3 $\leftrightarrow$ LVL 4 connection

- SHARC links
  - LVL1 $\leftrightarrow$ LVL2/LVL3 connection, LVL2 interconnection

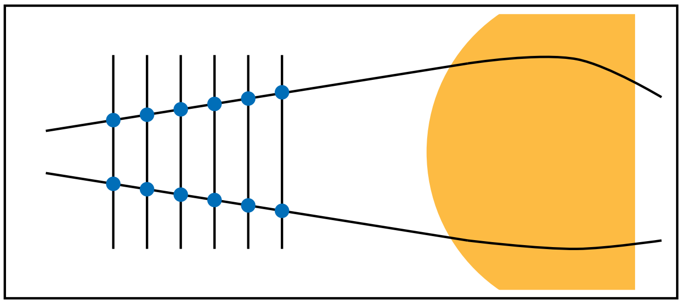
Trigger Algorithms

Level 2 (RoI based)

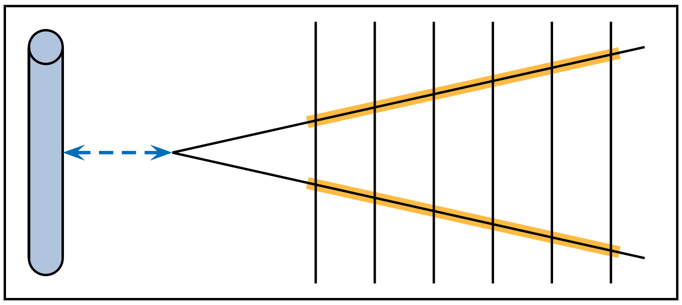
- Refine L1 tracks, i.e.
  refine request of charged track:
  - add chambers
  - drift times
  - χ^2 cut



- Request of track crossing the whole detector:
  traverse magnet and perform tracking through silicon vertex detector

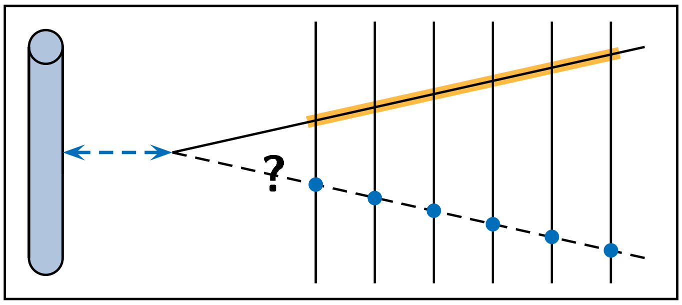


- Request of detached vertex (J/ψ) or two tracks with non-zero impact parameter (semileptonic B decays)



Level 3 (Full Data available)

- Search silicon for other tracks forming detached vertex with L2 impact parameter tracks



Expected Performances

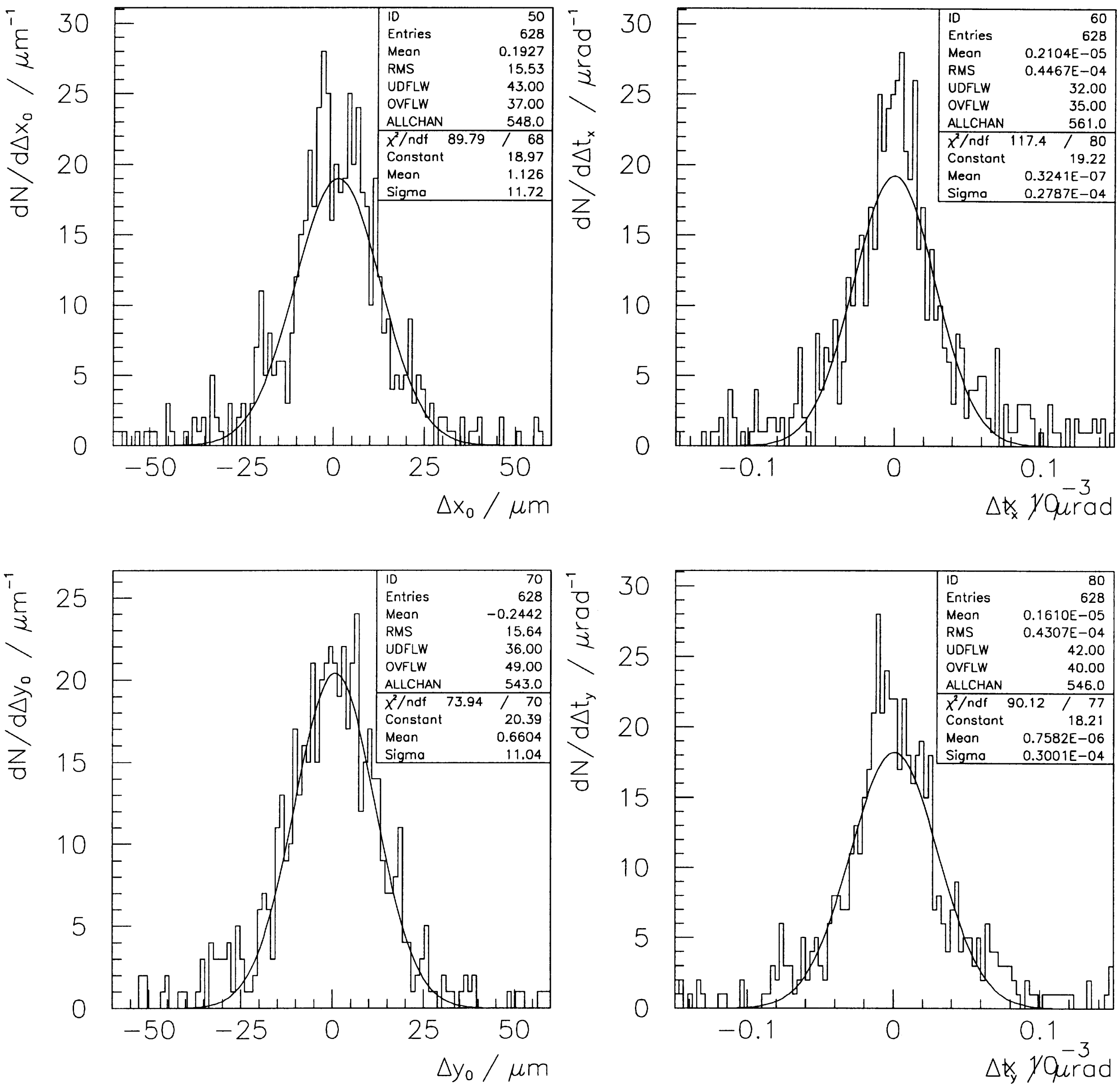
- Test of LVL2/LVL3 algorithms on MC data with full detector

	$B \to J/\psi K \to \ell\ell\pi\pi$	$B \to D^*\ell\nu \to D\pi\ell\nu$
LVL2: eff	80%	90%
res(x,y)$_\ell$	12 μm	12 μm
res(z)$_\psi$	400 μm	
LVL3: eff	100%	17%
res(x,y)$_{\pi,\ell}$		30 μm
res(z)$_B$		700 μm

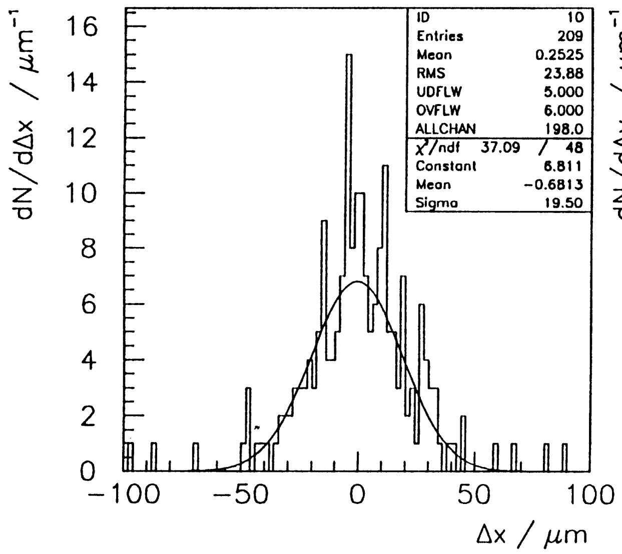
- Good compromise of speed and efficiency
- Resolution achievable allows high purity on B sample selected, for heavy quark background
- Non heavy quark, inelastic background not investigable in realistic way via MC (too high statistics needed). Attempt done, and reduction factor necessary to write to tape seems achievable without penalizing signal severely

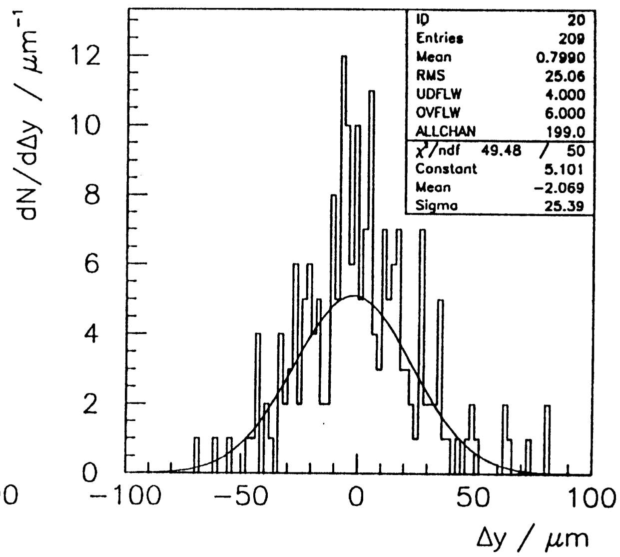
References:
Hera-B note 98-148
Hera-B note 98-132

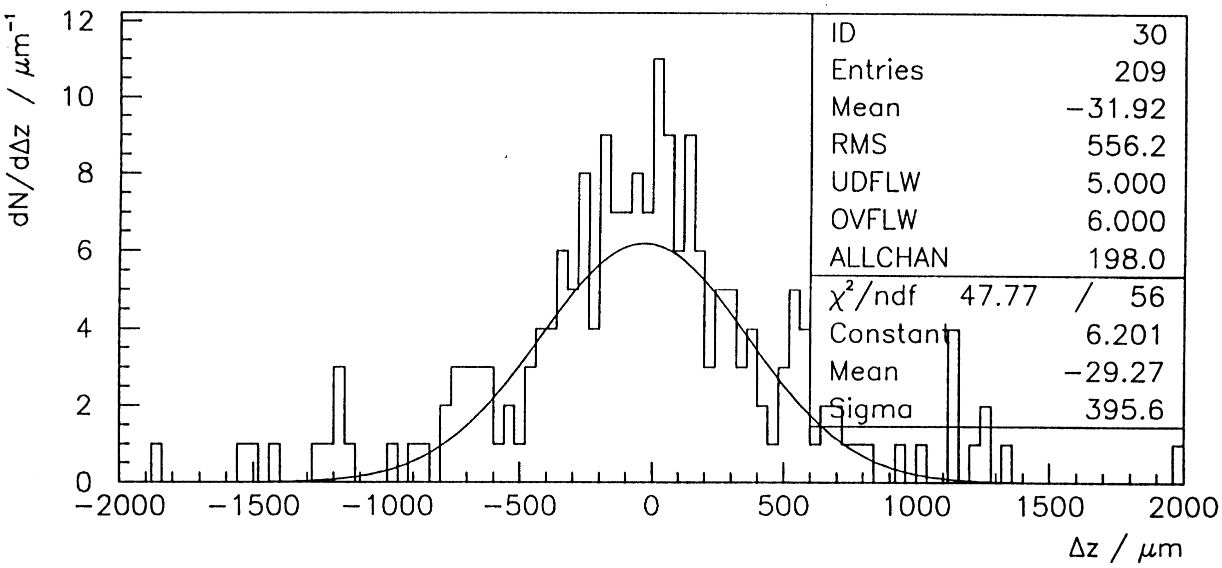
MC LVL2 resolution



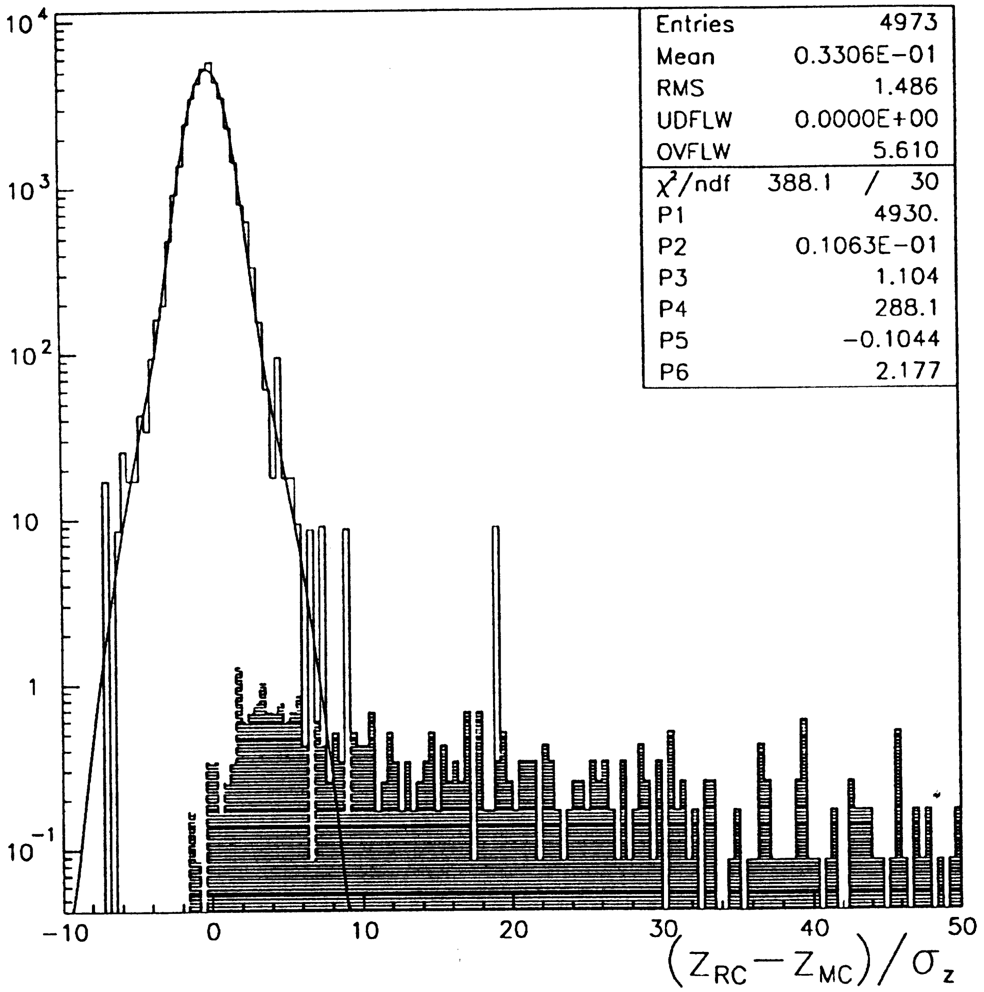
MC ψ vertex resolution (LVL2)







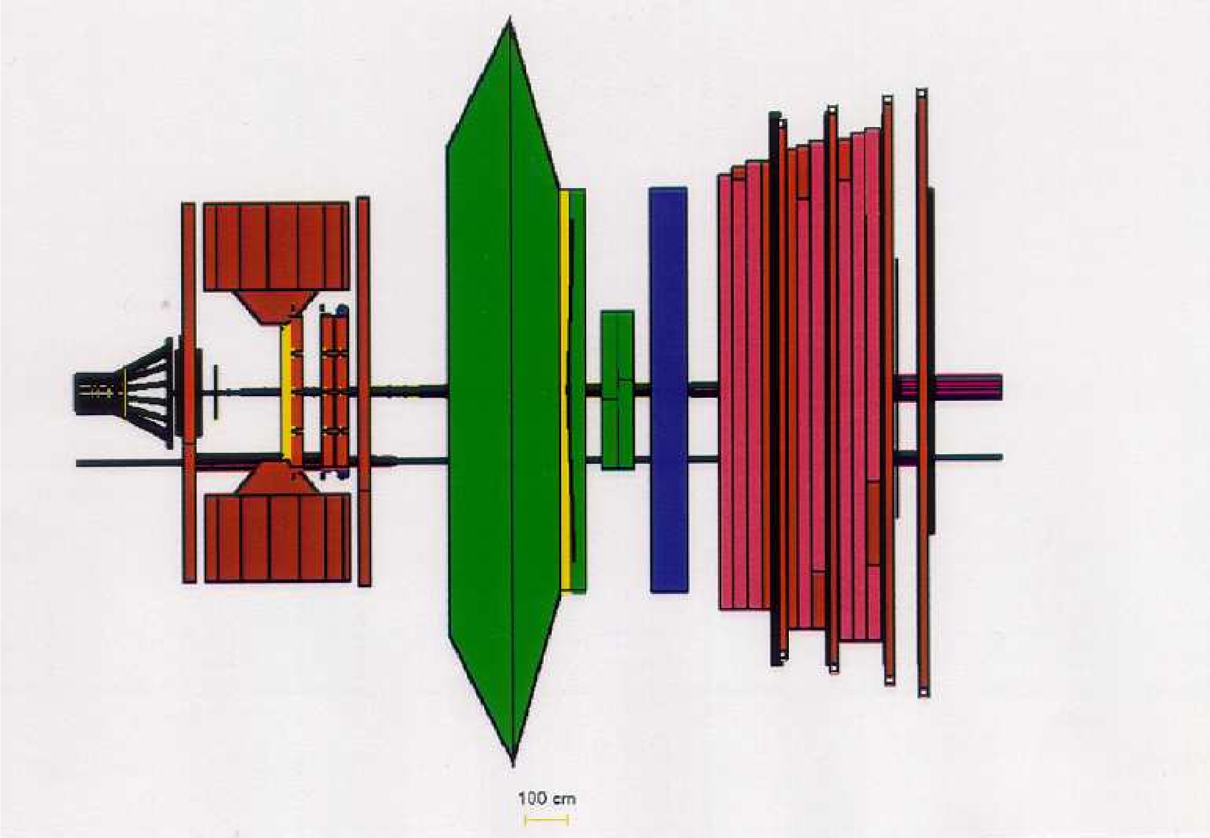
MC ψ vertex distr. (LVL2)

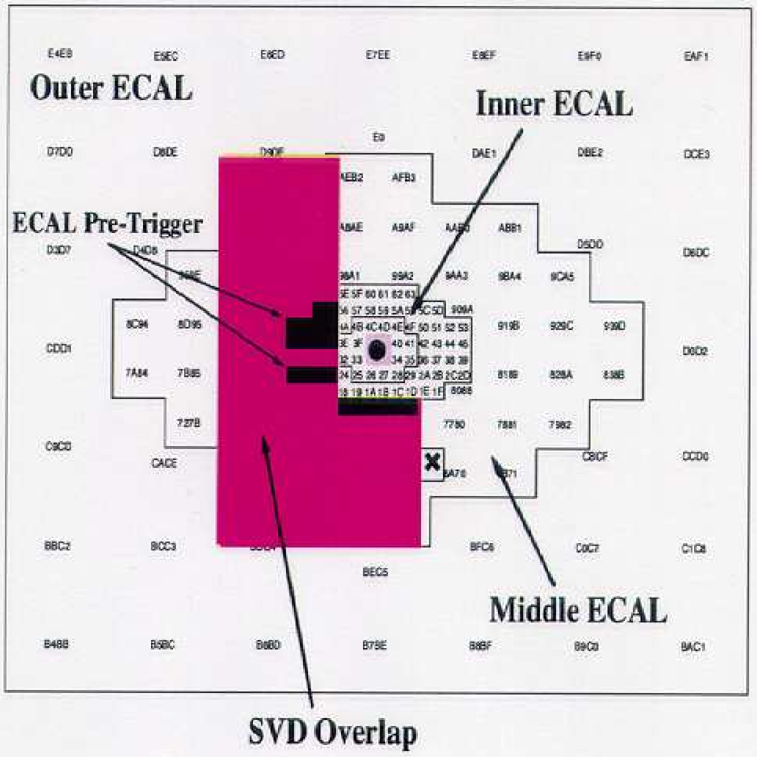


Black : $B \to \psi$

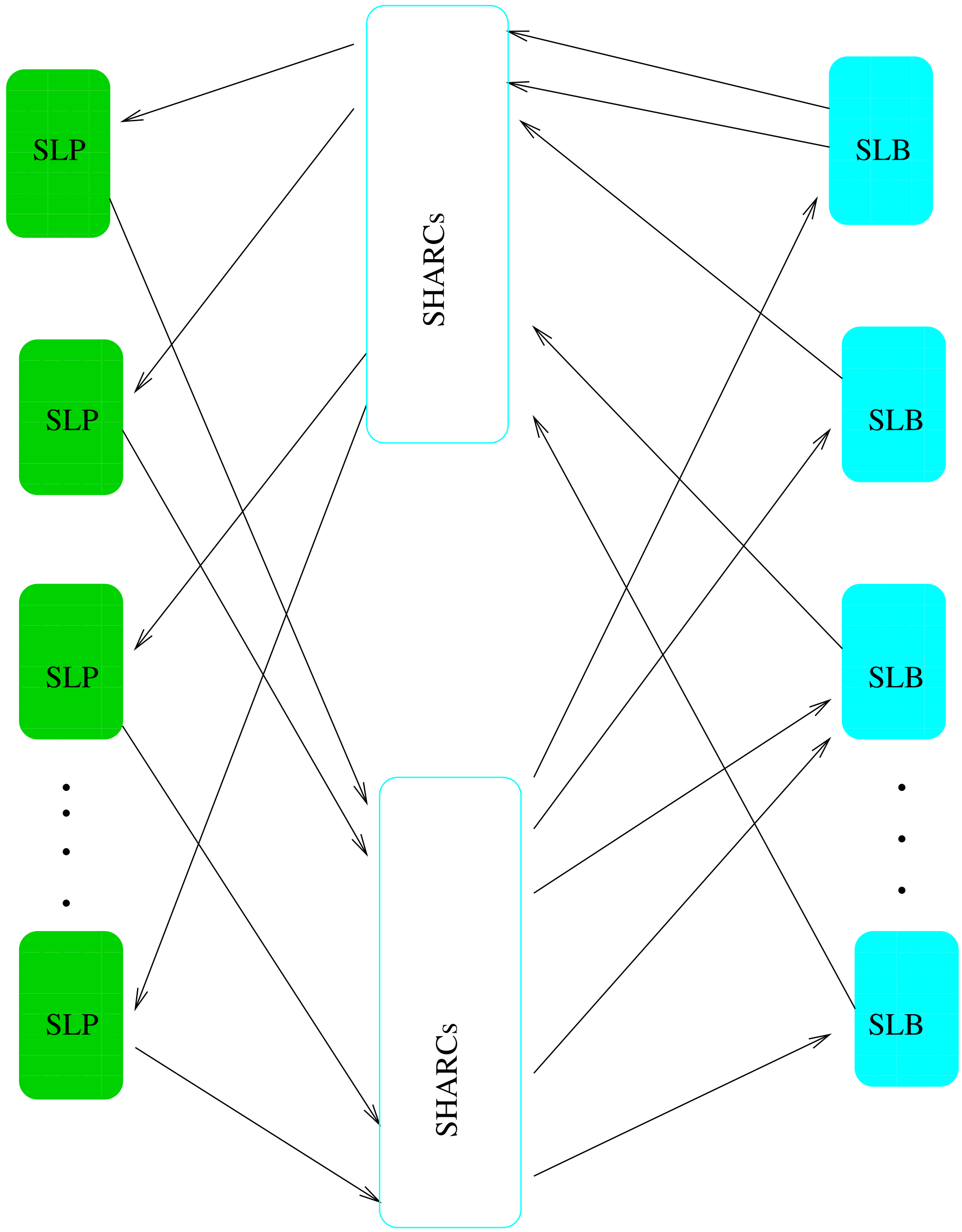
White : direct ψ

DETECTOR IN 1998-1999



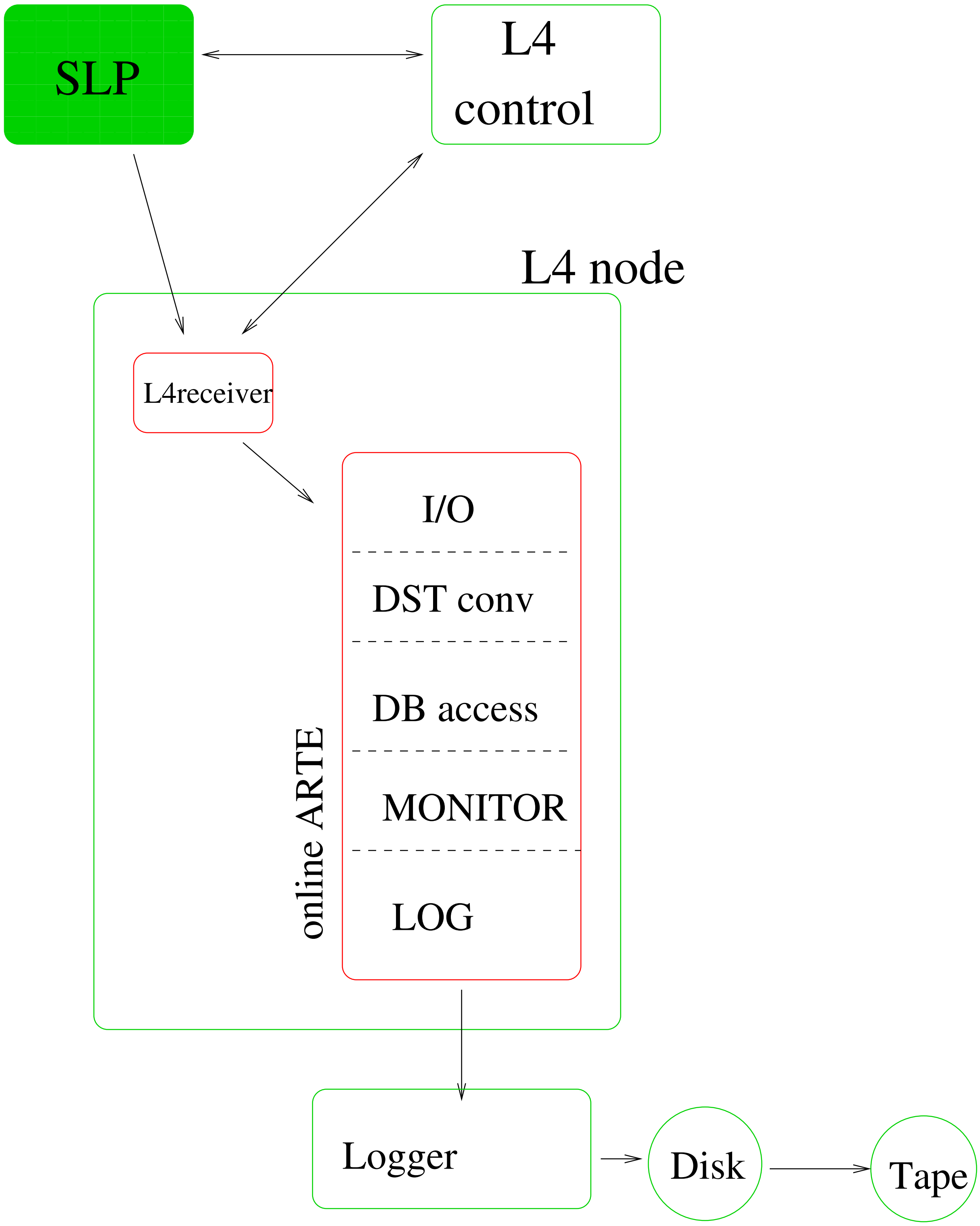


Run 1998 - 1999 (1)



80 (240) 72(240) 20 (120)

Run 1998 - 1999 (2)



Run 1998 - 1999 (3)

- Common Run with VDS(25%), RICH(100%), ECAL(73%), HIPT(22%), MUON(24%), and small fraction of OTR, TRD

- SLT architecture very flexible.
  During Aug.1998 - Apr.1999 tested sensible fraction of final system.
  - Triggering
  - VDS data sparsification
  - High rate ECAL calibration
  - Distribution of geometry/target updates to processing nodes

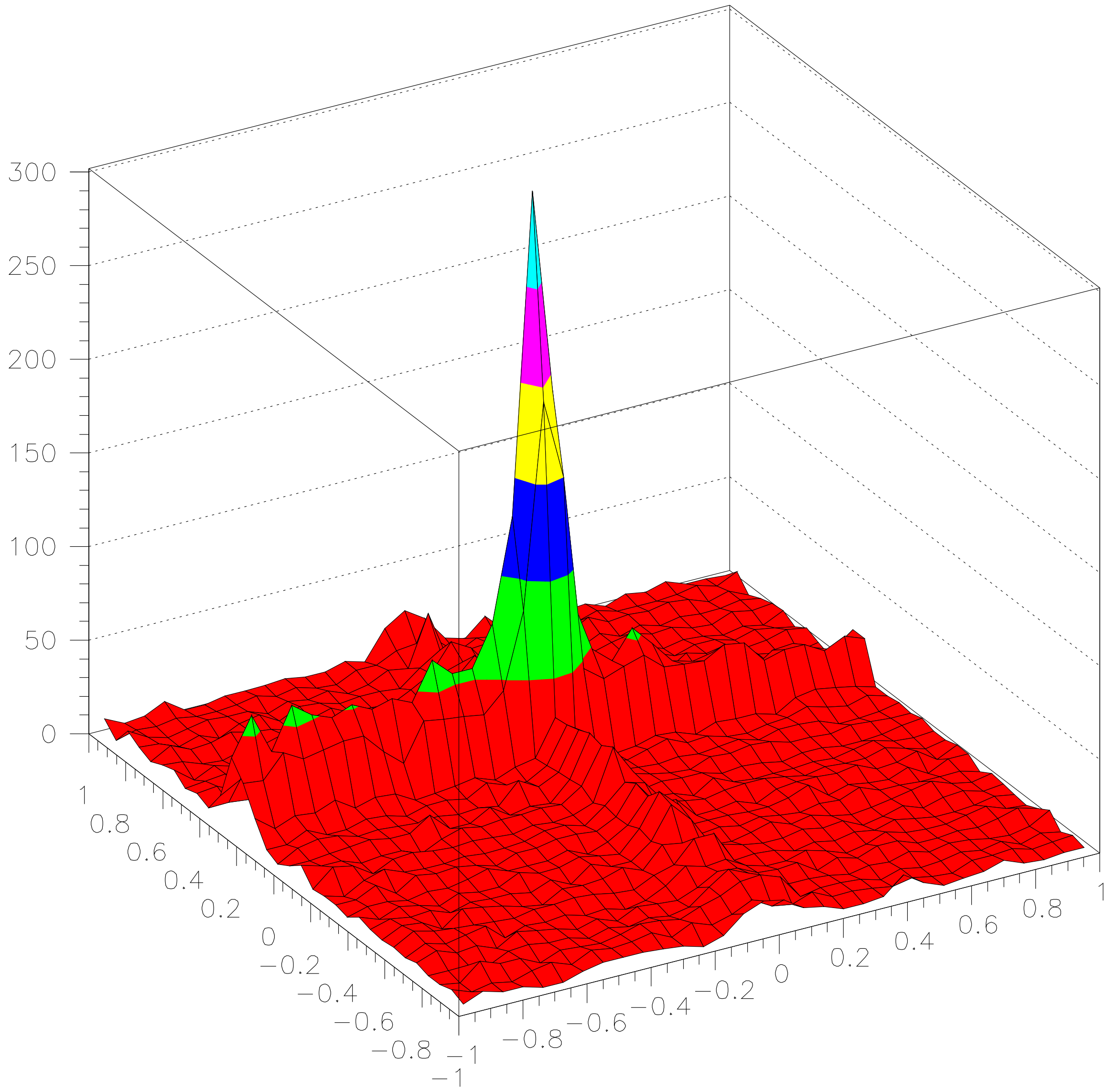
  DAQ/SLT system cycled for long runs ($\simeq$ 5 hours) at input rate to SLT of $\simeq$ KHz (50 Mbytes/sec into the switch). Stress test.

  SLT algo (not final version) :
  - Triggering on $e^{+}e^{-}$ used during whole run
  - Triggering on $\mu^{+}\mu^{-}$ tested successfully
  - Triggering using ECAL and RICH, or ECAL and VDS tested successfully

  $\Rightarrow$ we have a reasonable physics trigger even with reduced detector setup

- TLT
    - TLT code tested online successfully.
- 4LT:
    - Procedure to save data to tape completely automatic and stable.
    - First attempt to reconstruct data online succesfull.

SLT tracks online



Conclusion

- Higher Level Triggers hardware/software basic structure exists, and has been tested successfully during run period August 1998-April 1999.

- Next run period (July 1999 - May 2000) will allow to finalize the test of the system, in its full scale

- Higher Level Triggers algorithms have been tested via MC simulation on physics signals of main interest ($B \to \psi K_s, B \to D\ell\nu$) and have shown a good efficiency. The processing time needed is reasonable. From MC study and from the reduction factor measured during the last run, it is realistic to expect a sufficient reduction factor with the final system, without penalizing the interesting signal.