Overview and Performance of FNAL KTeV DAQ System

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1.0 Introduction to KTeV

KTeV(FNAL E799/E832):

Study of CP Violation in Neutral Kaon System

E799: Search for rare CP violating K_L decays:

K_L -> $\pi^0 e^+ e^-$ [O(10^{-11})], etc.

E832: Measurement of direct CP violation parameter

Re(ε'/ε) [ΔRe(ε'/ε)~10^{-4}] in K_L,K_S->2π system.

- High Resolution CsI Calorimeter (ΔE/E<1.0%)
- High Performance DAQ
  (Average Throughput= 160Mbytes/sec)
- High Flux two K_L beams ($3*10^8$ K_L/spill)
- K_S is regenerated from one K_L beam(E832)
- Detecting Neutral and Charged Decays simultaneously.

2.0 DAQ Requirements in KTeV

- Average Event Size ~ 8kbytes
- Average Trigger Rate

  Level 1: ~100kHz (Dead time = 10~20 %)

  (Total Energy, Trigger Counters, etc.)

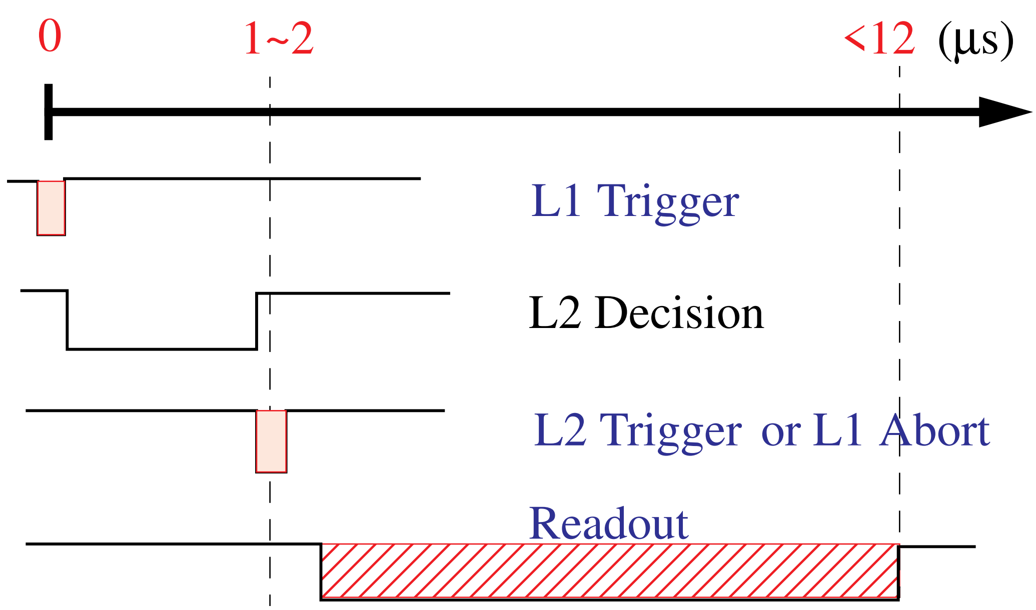
  Level 2: ~20 kHz (Dead Time = 20 %)

  (Hardware Hit Counting, Cluster Counting, etc.)

  Level 3: ~2 kHz

  (Software trigger on UNIX workstation)

Trigger Timing



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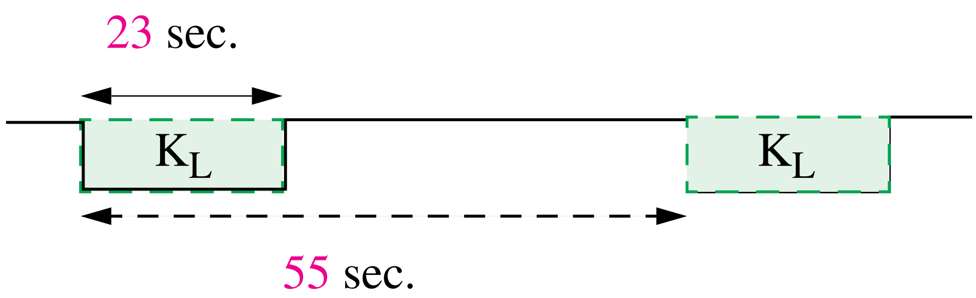
FNAL Tevatron Spill Structure



DATA are stored in buffer memories.

(55 sec. for readout/processing/logging)

DATA Flow into DAQ

~ 8kbyes * 20 kHz = 160Mbytes/sec.

Memory Storage

160Mbytes/sec * 23 sec. = 3.7 Gbytes

DATA Flow out of DAQ

~8kbytes * 2 kHz * (23/55) = 6.7 Mbytes/sec.

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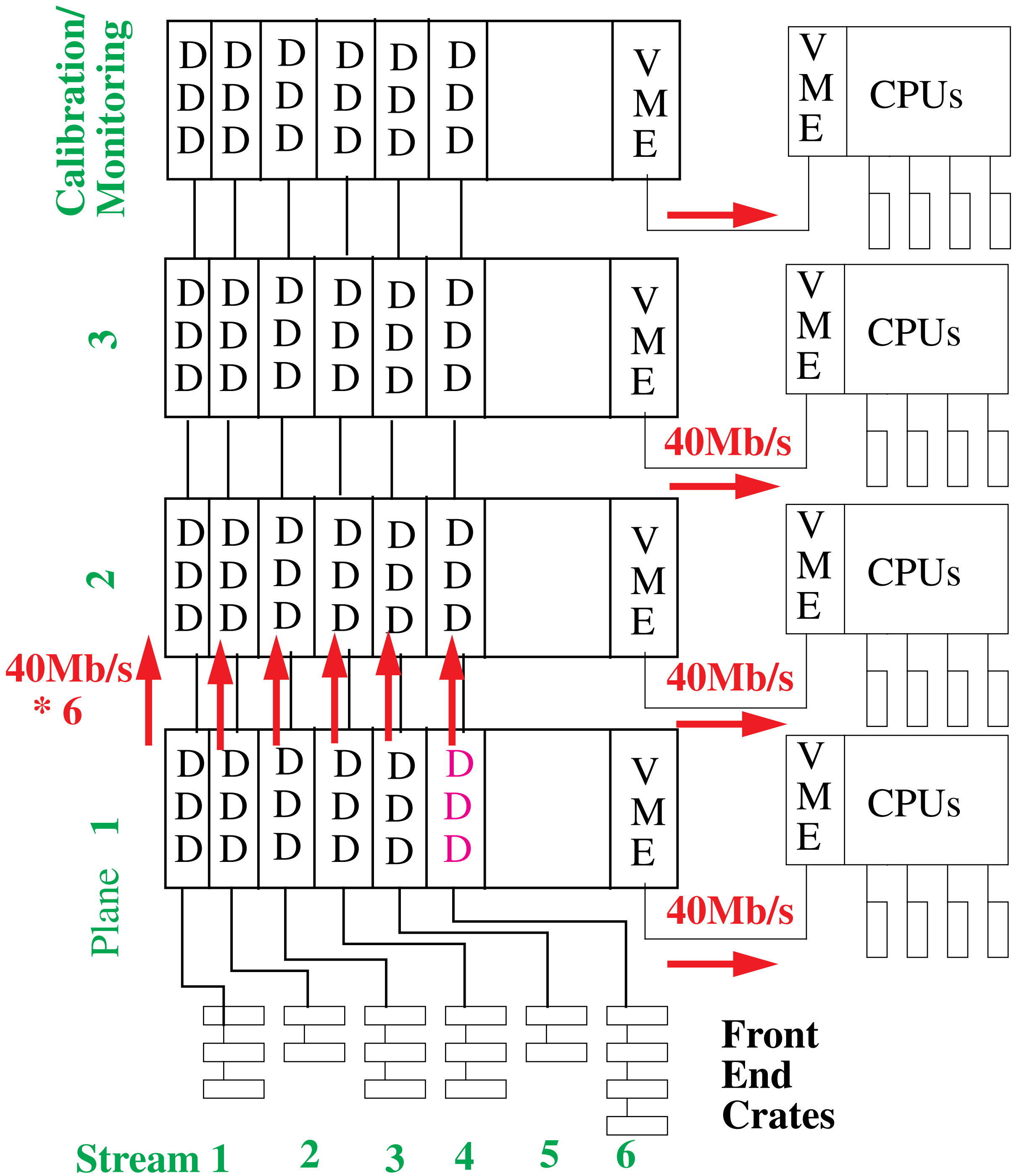
3.0 Structure of KTeV DAQ (a part of FNAL DART Project)

The KTeV Data Acquisition System



DDD: Buffer Memory

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Memory “matrix” divided into planes and streams

- Events are divided into 6 streams (subevents).

  filled in parallel

  160Mb/s / 6 streams= 27Mbytes/sec /stream

- Each event goes to one plane.

  3 “DATA” planes and 1 “Monitoring” plane.

  Events are sent to specific plane.

  depending on the trigger type.

  All events are buffered during spill.

  4 Gbytes Memories

  160Mb/sec / 3 planes *(23/55) = 22 Mb/sec / plane

  ([on spill]/[spill cycle])

- Total CPU Requirements.

  20kHz * 23 sec * 3 msec/event = 1380 CPU.sec/spill

  (on spill) (process time) (55 sec.)

  Multi-processing Challenge machines with 8 CPU each

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- Logging requirements

  2kHz * 8kbytes * (22 / 55) / 3 planes = 2.2Mbytes/sec

  5 Exabyte 8505 8mm / Challenge,

  or 1 DLT4000 / Challenge

- On-line DATA Splitting

  Events are written to specific tape(s) depending on the trigger type for quick analysis.

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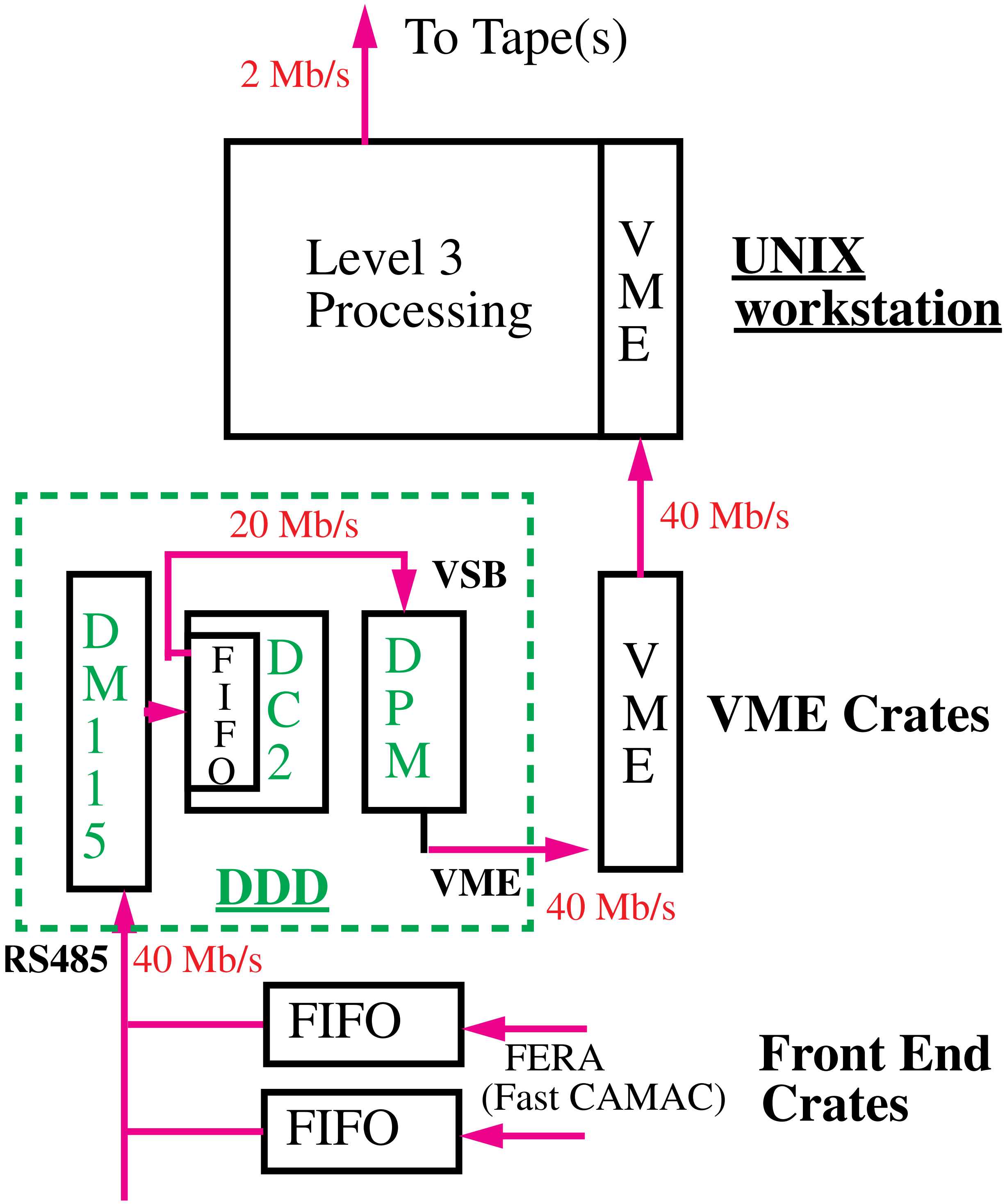
3.1 The KTeV DAQ System Building Blocks



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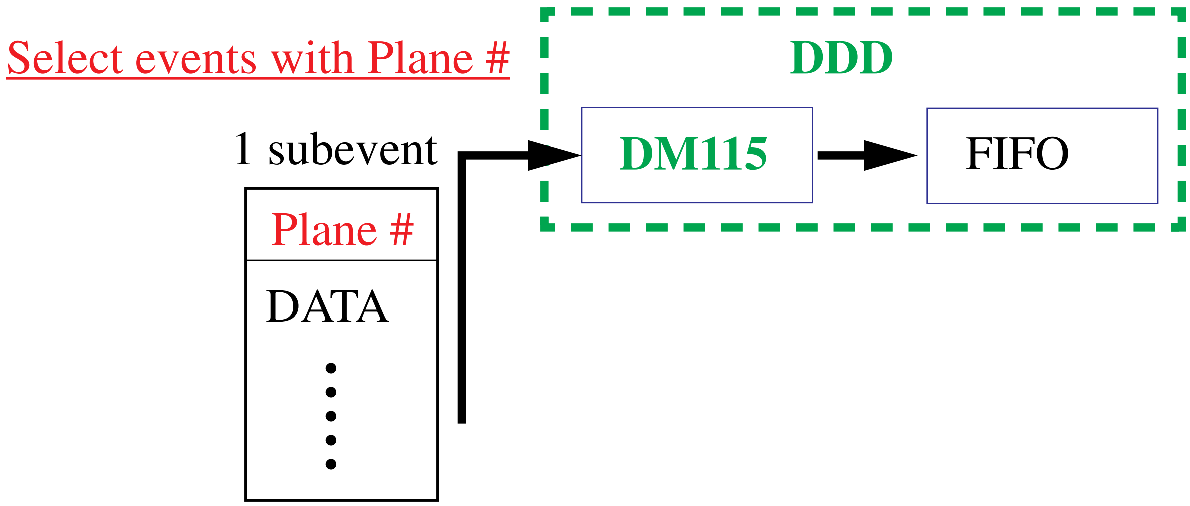
3.1.1 DDD (DM115/DC2+DPM)

Made by Access Dynamics

- **DM115**

Accept events from RS485 with plane information.

If plane # matches DM115 plane #(hardware dipswitches), then push events into DC2 FIFO



- **DC2 (Intelligent Module)**

writes events from FIFO into VME Memory.

attaches event size to the top of each subevent.

makes a table at the beginning of VME memory with VME address of each event.

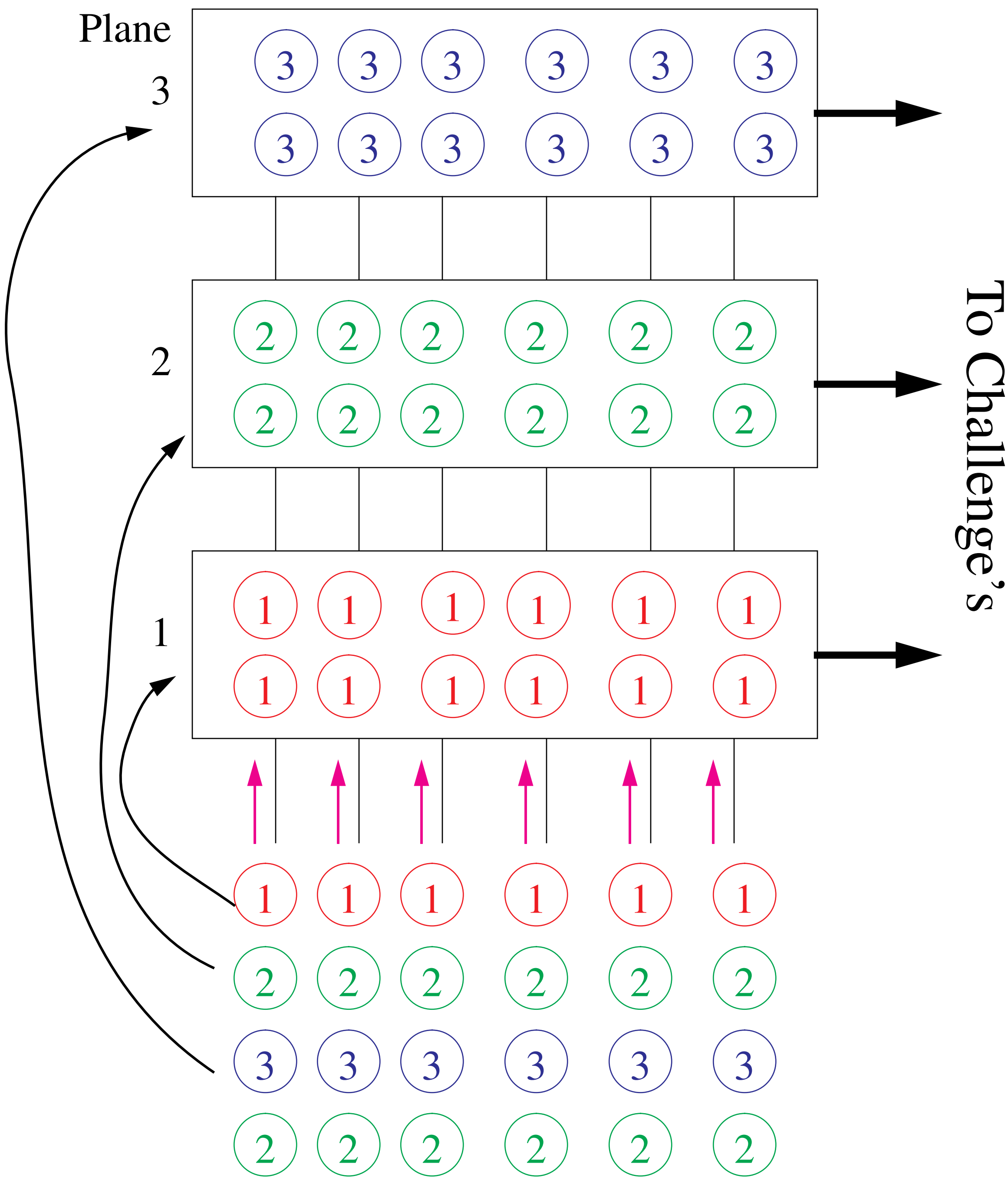
counts # of events written into VME memory.

clears memory after spill is processed.

- **DPM(VME/VSB Dual Port Memory)**

Micro Memory Inc. 6390

3.2 Plane Destination Logic



Events are sent to specific plane depending on the trigger type.

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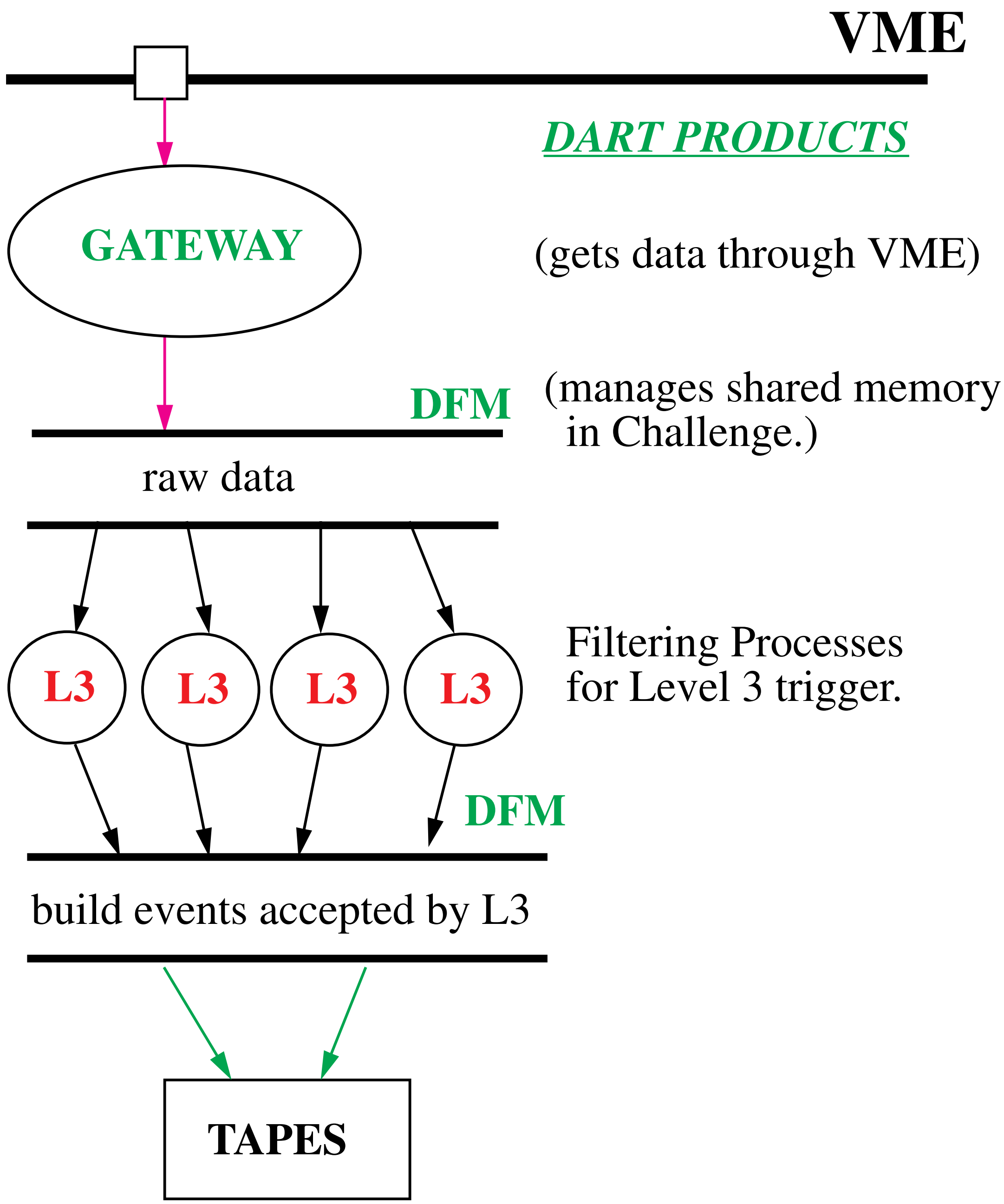
3.3 Inside UNIX workstation (Challenge)



All Processes are connected with DART Run Control

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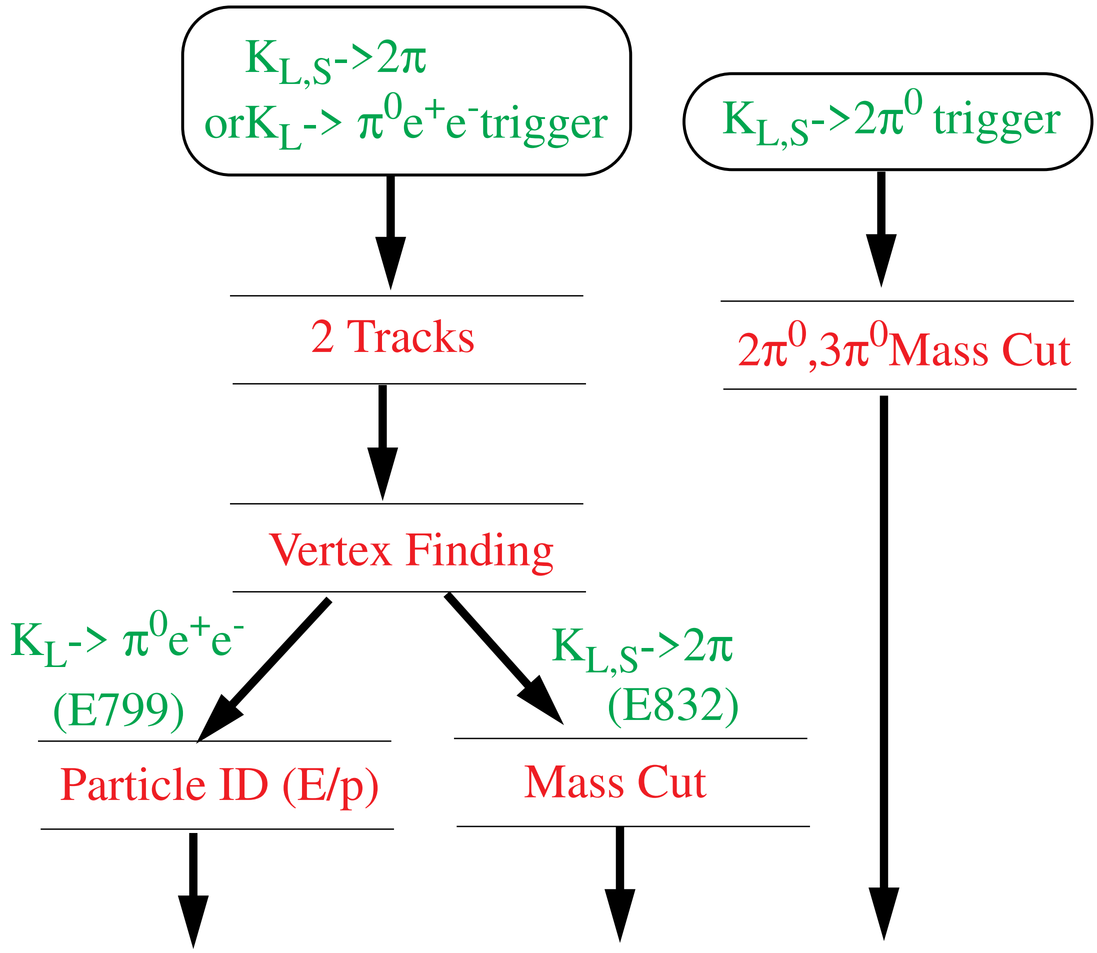
3.4 Level 3 Filtering



< 3 msec/event

Reject 90% Background events

with 95% Signal Efficiency

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4.0 Milestones

4.1 Hardware

- Tested DAQ building block

  Front End -> VME Memory:

  19 Mbytes/sec (Event size = 1,600 bytes)

  => maximum 40 Mb/s when 3 planes can be reached.

- Tested two (up to three) plane DAQ

  34 Mbytes/sec (Event size = 780 bytes)

  Destination Plane Logic works!

4.2 Software

- Fed MC events to GATEWAY instead of real events from VME and wrote them onto tapes.

  Event Building/ Filtering (~3msec/event)

  Calibration/ Monitoring

- Tested both Exabyte 8505 and DLT4000

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4.3 Hardware + Software

- Read Data from various front end modules.

  TRD Chamber via FERA ADC's

  Drift Chamber via FERA TDC's

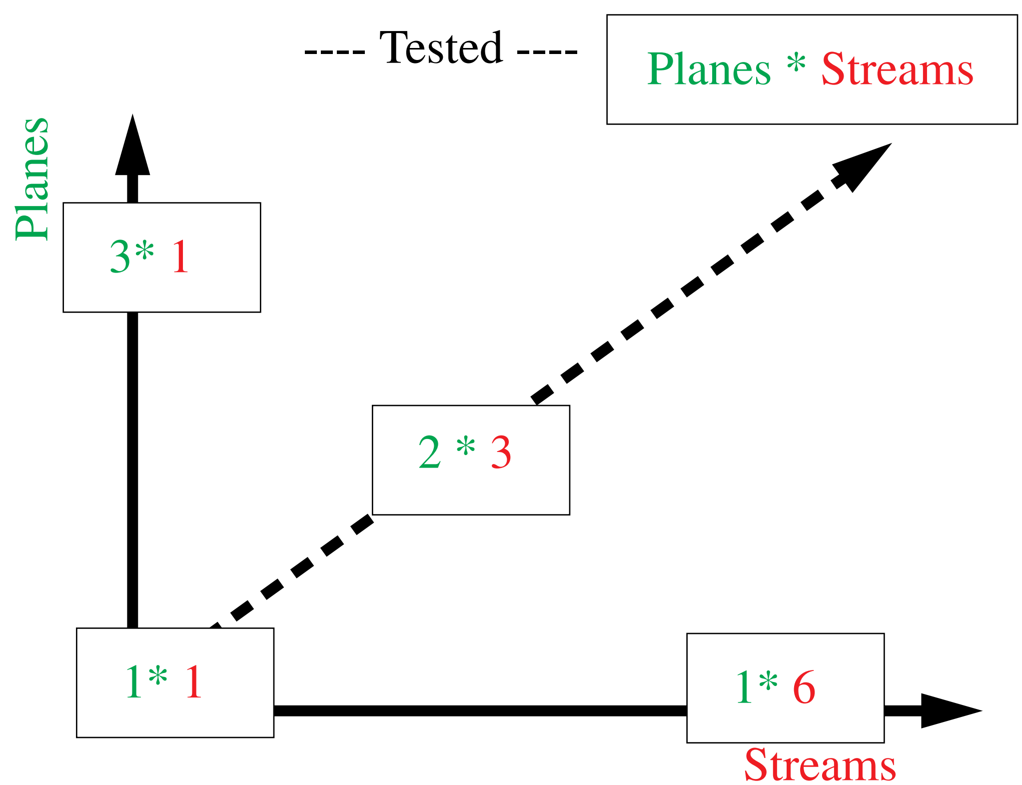
- Read Data with Multi-streams (up to 6)

  Event Building succeeds!

  VME Memory -> L3 Processing: ~30Mbyes/sec

- Integrated 2 Plane * 3 Stream DAQ

  Stable running for 3 days



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5.0 Count Down

-------***KTeV is coming up*** (Start in April, 1996)-------

- Setting up final configuration

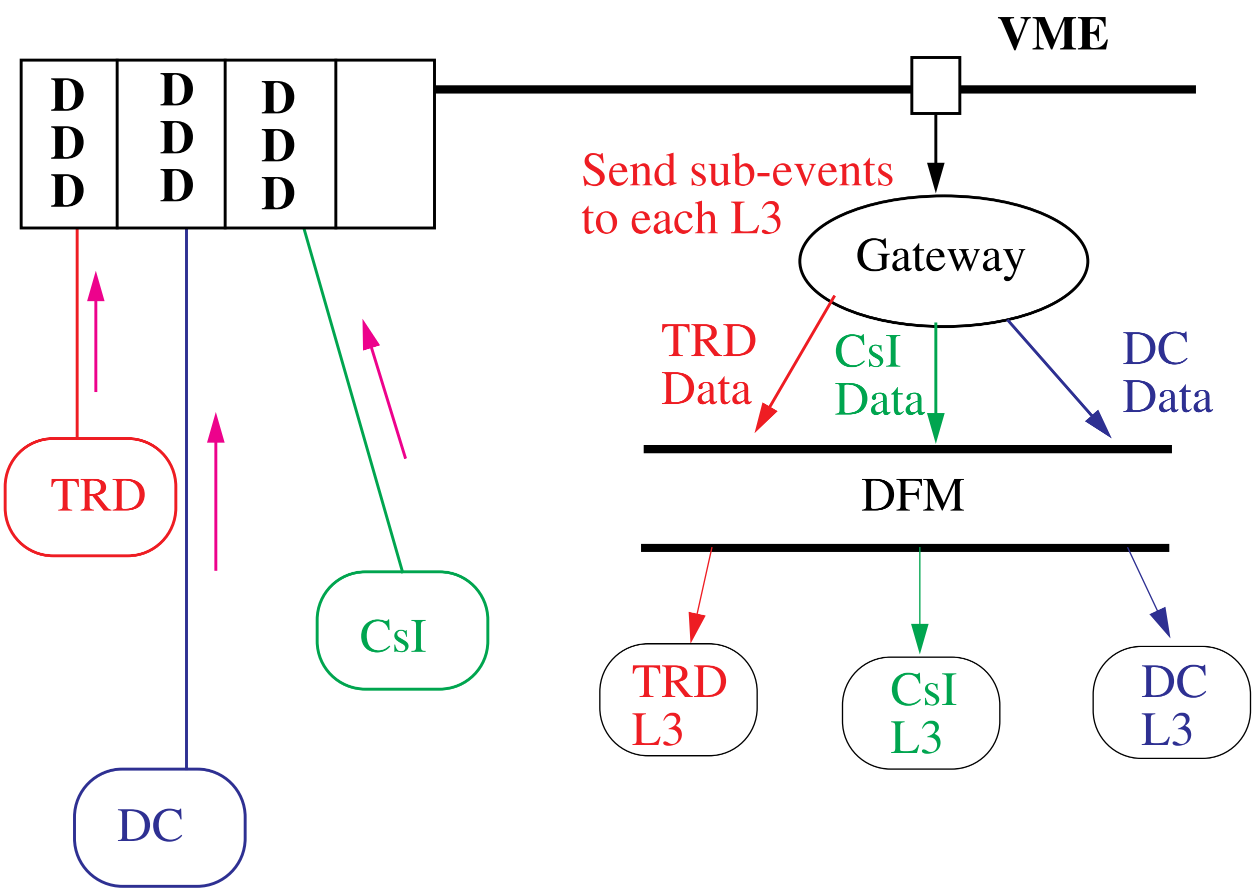
  4 SGI Challenge machines

  4 VME crates and all memories

  6 Stream * 4 Plane DAQ

  Commissioning with trigger

- Detector Commissioning Configuration



can read out several detectors independently
at the same time.

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6.0 Summary and Conclusion

- KTeV DAQ can handle:

  160 Mbytes/sec Data flow in Tevatron spill cycle

- Structure is simple and extension is easy!

  Increase number of planes, number of streams or both.

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