

# FPS FE and Trigger Electronics

Review of the PS electronics for the upgrade meeting on May 28.

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Geometry and Definitions

The PS electronics system and what it does

The hardware used by the PS electronics system

Data transfer design for L1 and L2

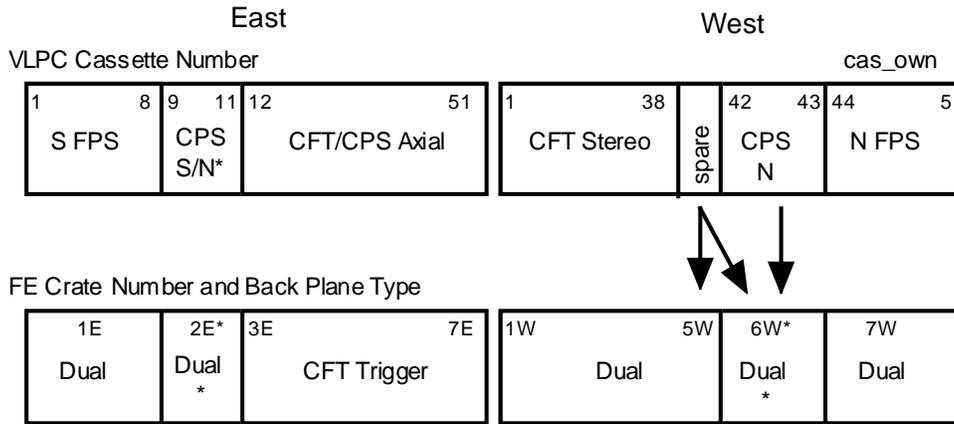
Data flow on the FE board

The information contained in this note includes contributions from the D0 Electronics Group and the PS Detector Group.

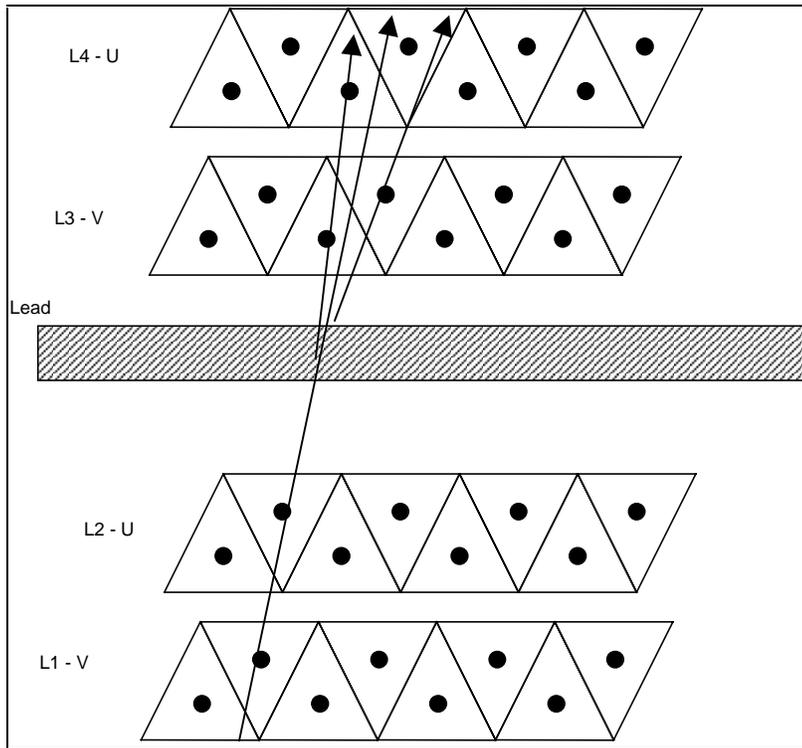
All errors are my responsibility.

### Geometry and Definitions

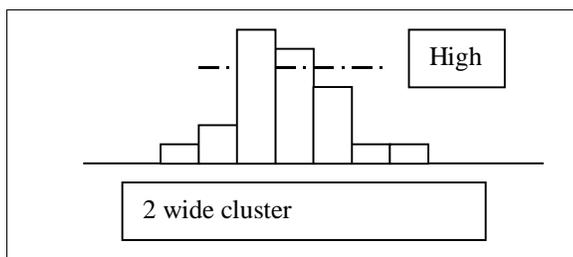
The FPS is divided into two parts. North and South.  
 Each of these parts has 16 sectors that subtend 22.5 degrees each.  
 The sectors are separate physical modules that overlap slightly and contain four layers of scintillating strips.  
 Layers 1 & 3 (counting from interaction point) are U stereo, 2 & 4 are V.  
 Layers 1 & 2 are the forward layers and detect MIPs, Layers 3 & 4 are the backward layers and detect showers.  
 Layers 1 & 2 have 101 strips each, Layers 3 & 4 have 135 strips each.  
 Each detector sector is a stand-alone trigger sector.  
 Each trigger sector is contained on one FE board.  
 The sectors are arranged in 2 FE crates.



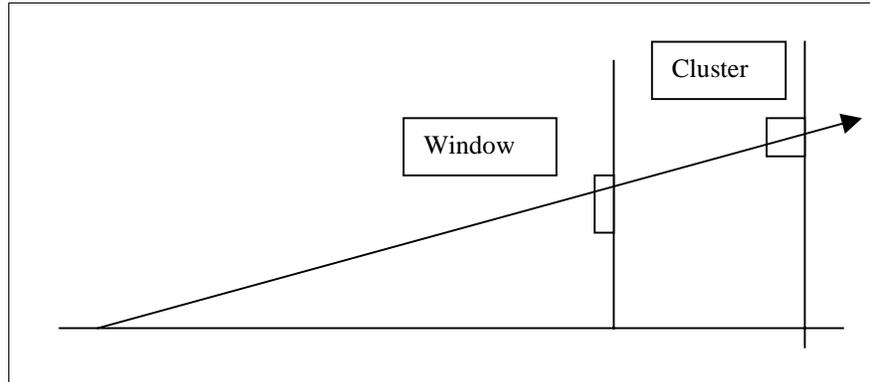
The cassette assignment for the PS detectors



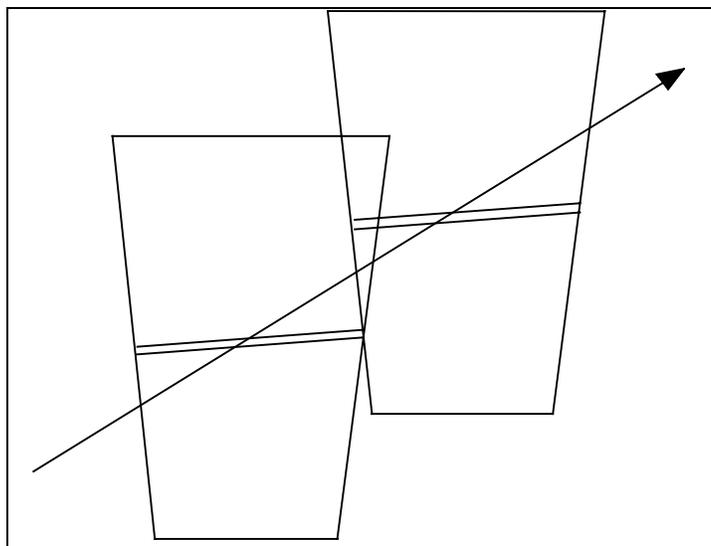
The detector is constructed of four layers of scintillator. Two in front of a lead radiator and two behind. Each pair of layers has a U layer and a V layer. There are 101 strips in the forward layers (L1 & L2) and 135 in the back layers (L3 & L4).



Definition of a Cluster in either of the two back layers. A cluster is one or more strips above the HIGH threshold. Found are cluster edge and width.



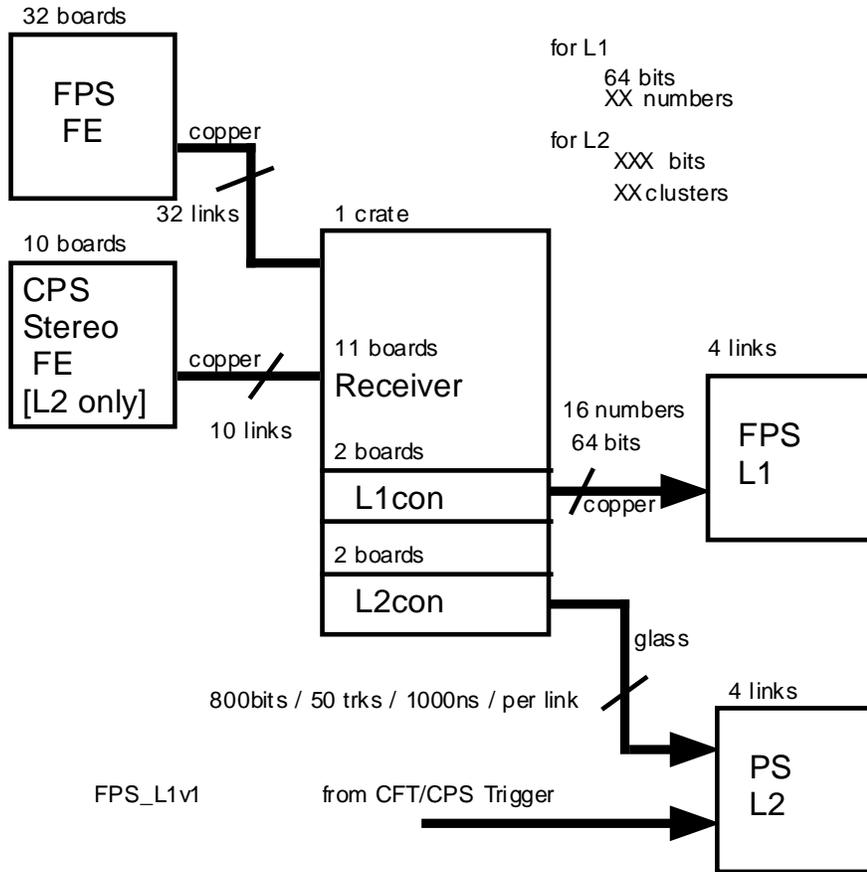
A U(V) electron candidate consists of a cluster in a back U(V) layer in coincidence with a MIP in the WINDOW in the Front U(V) layer. A photon candidate is similar but with a VETO from the WINDOW in the Front layer.



All U e-candidate clusters are kept if there are one-or-more V e-candidates. All V e-candidate clusters are kept if there are one-or-more U e-candidates. The same for gama-candidates.

**The Preshower system,**

- 1 Includes all of the Forward Preshower channels.
- 2 Includes Central Preshower stereo channels.
- 3 The CPS part of the system has no L1 trigger capabilities.
- 4 In each of the PS channels the signal is divided into a low and high range and both are digitized.



**PS Trigger System**

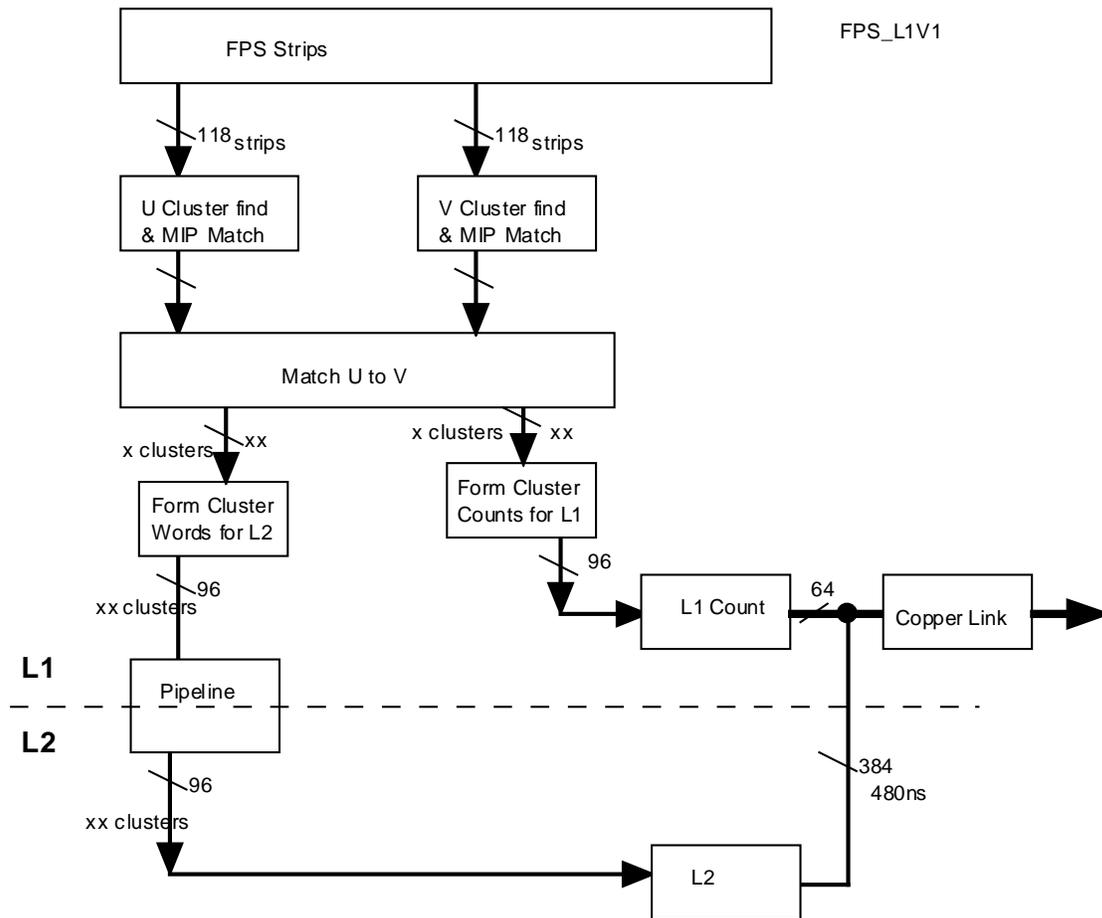
- 1 Provides the means for triggering at level 1 on the information from the FPS detector only.
- 2 Supplies information for the level 2 Preshower Trigger Preprocessor, PSpp, from both detectors.
- 3 Also supplies, from the FE boards, the raw data from the VLPC channels for the level 3 read out.

**For the L1 FPS Trigger**

- 1 Edge and width of clusters are found in each back layer.
- 2 Clusters are tagged with the absence or presence of a MIP in the forward layer to distinguish between electrons (e-) and photons (gamma-).
- 2 A loose match is required between clusters found in the U and the V layers.
- 3 *Counts the number of clusters found.* (different from web page)
- 4 The numbers of clusters found is forwarded to the FPS Trigger Manager, FPSTM, for the global L1 decision.

**For the L2 preprocessor the system**

- 1 Pipelines cluster information indexed by edge strip and width in the forward and central.
- 2 Upon the receipt of a L1 accept bit extends strip address and forwards information to the PSpP.



**Hardware Inventory**

The FPS/CPS Trigger system has:

- 1 GS with SCL
- 1 VRB Crate
- 1/2 Sequencer Crate
- 2 FPS Front End Crates, 8 cassette crates
- 2 CPS Front End Crates, 3 cassette crates
- 32 FPS FE Boards, 16 RHB & 16 LHB
- 10 CPS FE Boards, 5 RHB & 5 LHB
- 1 Broadcaster Crates
- 1\* MTM Crate

Each VRB crates has:

- 1 VRB Controller board with SCL receiver
- 11 VRB Boards
- 11 VEPA Boards
- 44 Optical link receivers (from Seq)

Each 1/2 Sequencer crates has:

- 1/2 Sequencer Controller Board with SCL receiver
- 11 Sequencer boards
- 11 Optical link transmitters (to VRB), 4 per board
- 44 50-Conductor Cables, 4 per board

Each FPS FE crate has:

- 8 Right Hand FPS FE Trigger Boards
- 8 Left Hand FPS FE Trigger Boards
- 16 BP Connectors for 50-Conductor Cables
- 8 BP Connectors for Cryo I/O

Each CPS FE crate has:

- 3(2) Right Hand FE CPS Trigger Boards
- 3(2) Left Hand FE CPS Trigger Boards
- 6 BP Connectors for 50-Conductor Cables
- 3 BP Connectors for Cryo I/O

Each FE board has:

- 1 Serial link to broadcaster crate
- 1 1553 Node to receive down load
- 2 SVX Strings
- 1 50-Conductor Cable from Sequencer
- 2 Analog and Serial Clock generator
- 16 MCM, each with 1 SVX and 4 SIFT chips
- 1 Set of L1 trigger hardware on FPS boards

Each Broadcaster crate has:

- Controller board
- L1 Concentrator Board
- L2 Concentrator Boards
- Receiver Boards
- Copper Serial link receivers (from FE)

## **Data Transfer - L1 Transfer**

### **- From FE to Concentrator to TM**

The L1 Trigger looks at counts of the number of matched clusters in 32 categories.

(North/South[2]) by (quadrant[4]) by (e/gamma[2]) by (U/V[2])

From FE to Concentrator – 4 Numbers

Each link - (e/gamma) by (U/V)

From Concentrator to Trigger Manager, TM, - 32 Numbers

Link 1 - (quadrant[1,2,3,4]) by (e/gamma) by (U/V) for North

Link 2 - (quadrant[1,2,3,4]) by (e/gamma) by (U/V) for South

The count of clusters tagged as an electron or gamma candidate for each of the U and V stereo views is made in the FE and sent to the concentrator board.

The Concentrator Board sums the sectors into quadrants and sends the sums to the TM

Each number is 6 bits for a total data size of

24 bits from FE to Concentrator – 4 numbers X 6 bits

96 bits from Concentrator to TM (each link) – 8 numbers X 6 bits

The transfer from FE to Concentrator is 132ns

The transfer from Concentrator to TM is 132ns.

## L2 Transfer

From FE to Concentrator to Preprocessors – two words per cluster

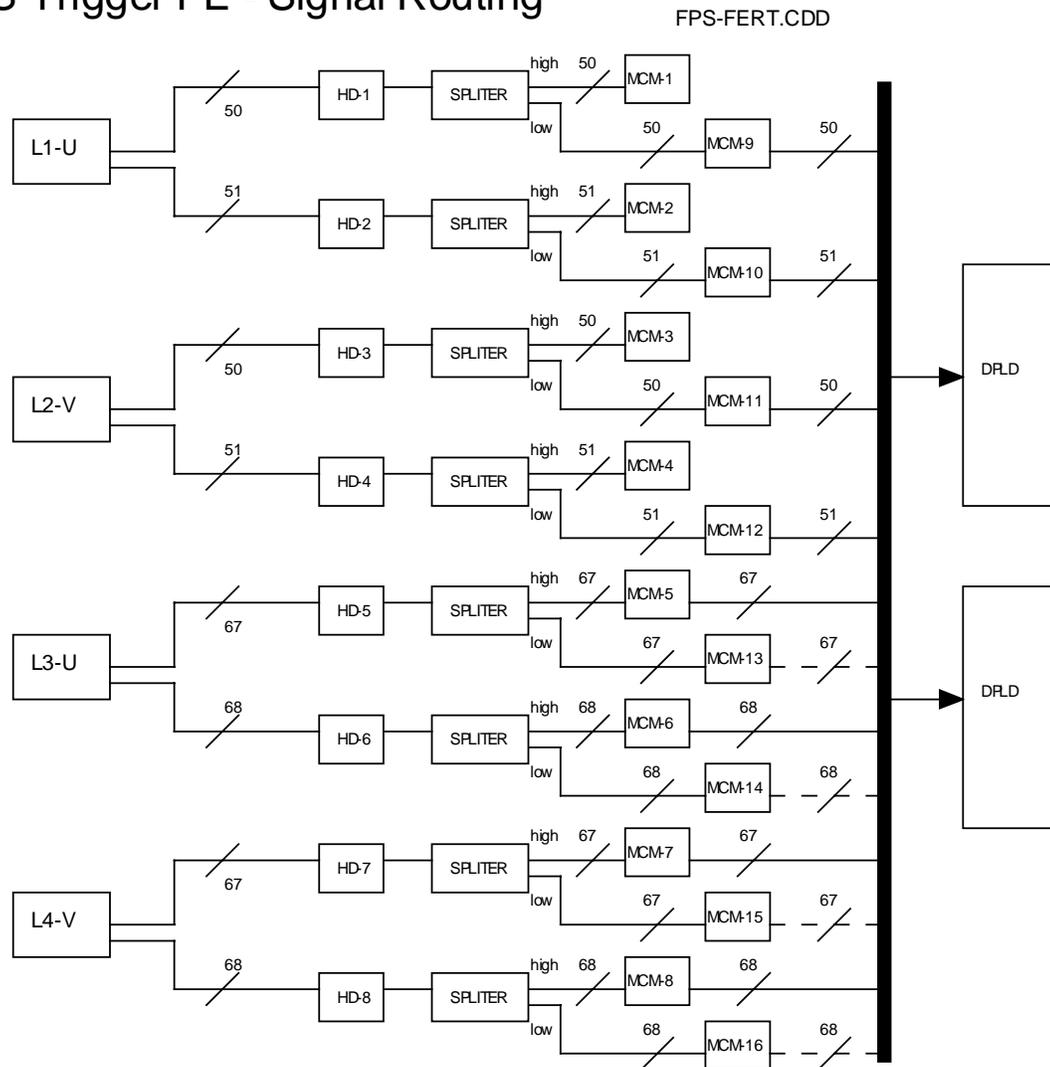
<u>size in bits</u>	<u>Objects</u>
1	North / South
1	Type of cluster (e/gamma)
1	Orientations of cluster (U/V)
12	Spare (Upstream bit mask)
1	word marker – always off
4	Sector number
8	address of lowest strip in cluster
3	width of cluster
1	word marker – always on

From each FE to the Concentrator – Maximum of 32 clusters – 1.28 us  
 $32 \text{ clusters} \times 2 \text{ words/cluster} \times 20\text{ns/word} = 1.28 \text{ us}$

From Concentrator to PSpp – Maximum of  
 North\_1 ->  $64 \text{ clusters} \times 2 \text{ words/cluster} \times 20\text{ns/word} = 2.56 \text{ us}$   
 North\_2 ->  $64 \text{ clusters} \times 2 \text{ words/cluster} \times 20\text{ns/word} = 2.56 \text{ us}$   
 South\_1 ->  $64 \text{ clusters} \times 2 \text{ words/cluster} \times 20\text{ns/word} = 2.56 \text{ us}$   
 South\_2 ->  $64 \text{ clusters} \times 2 \text{ words/cluster} \times 20\text{ns/word} = 2.56 \text{ us}$

Also each transmission will contain Header and Trailer words.

# FPS Trigger FE - Signal Routing



Drawing of the data from from the PS detector through the FE board.

L1 & L2 are the forward or MIP PS layers, L3 & L4 the back or shower layers.

HD-1 through -7 are the high density connectors at the bottom of the board.

The splitters divide the signals into 'high' range and 'low' range.

For the forward layers the 'low' range contains the MIP level.

For the back layers the 'high' range contains the shower max.

Trigger outputs from both the 'low' and 'high' splits are sent to the PLDs for added flexibility.