Sector Processor Design Status

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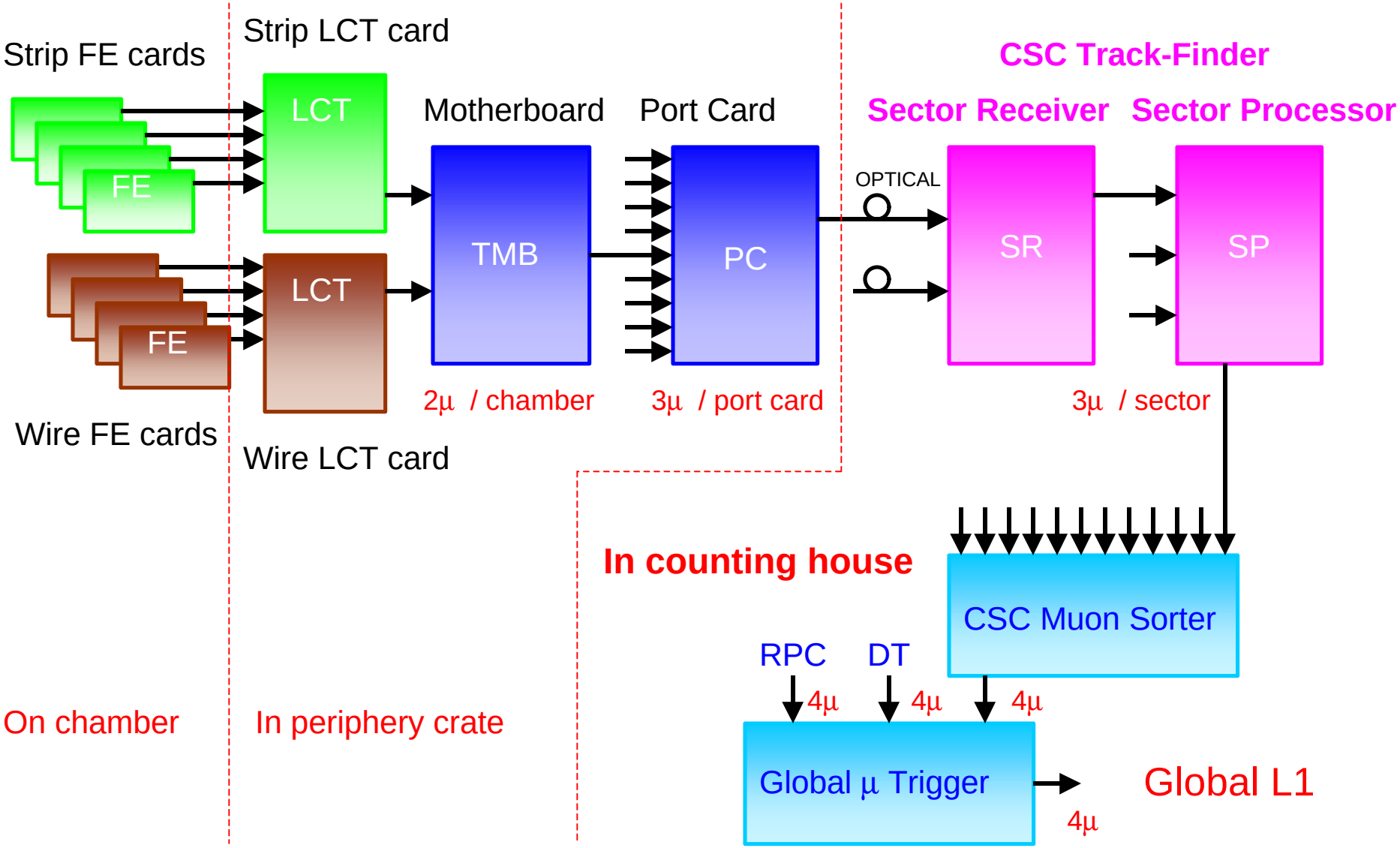
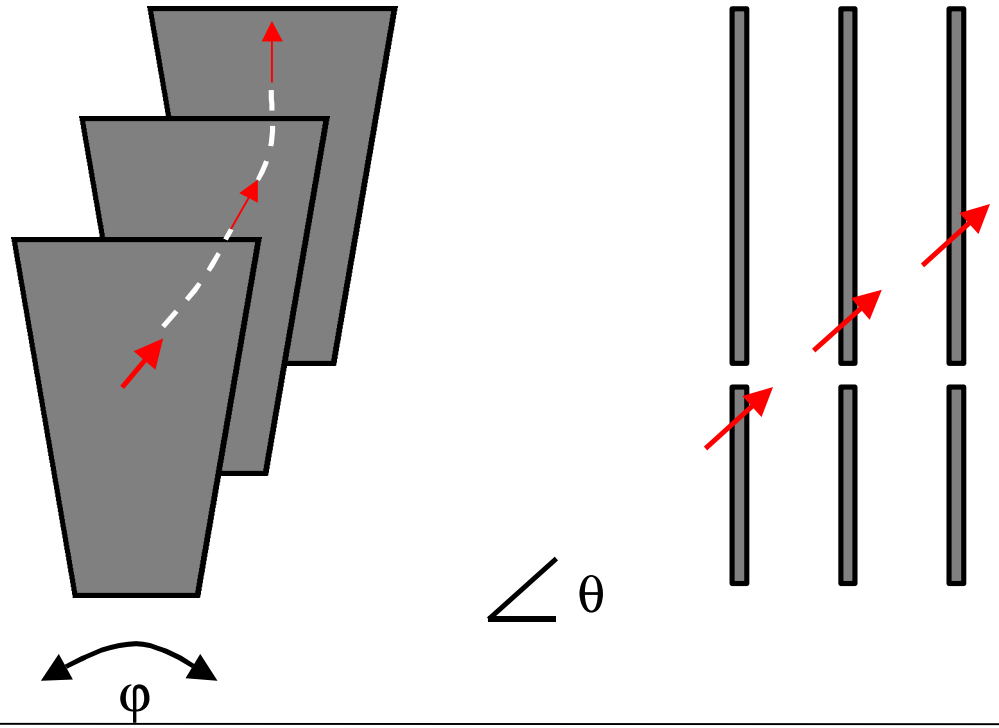
PNPI

CSC Muon Trigger Scheme



Muon Track-Finding

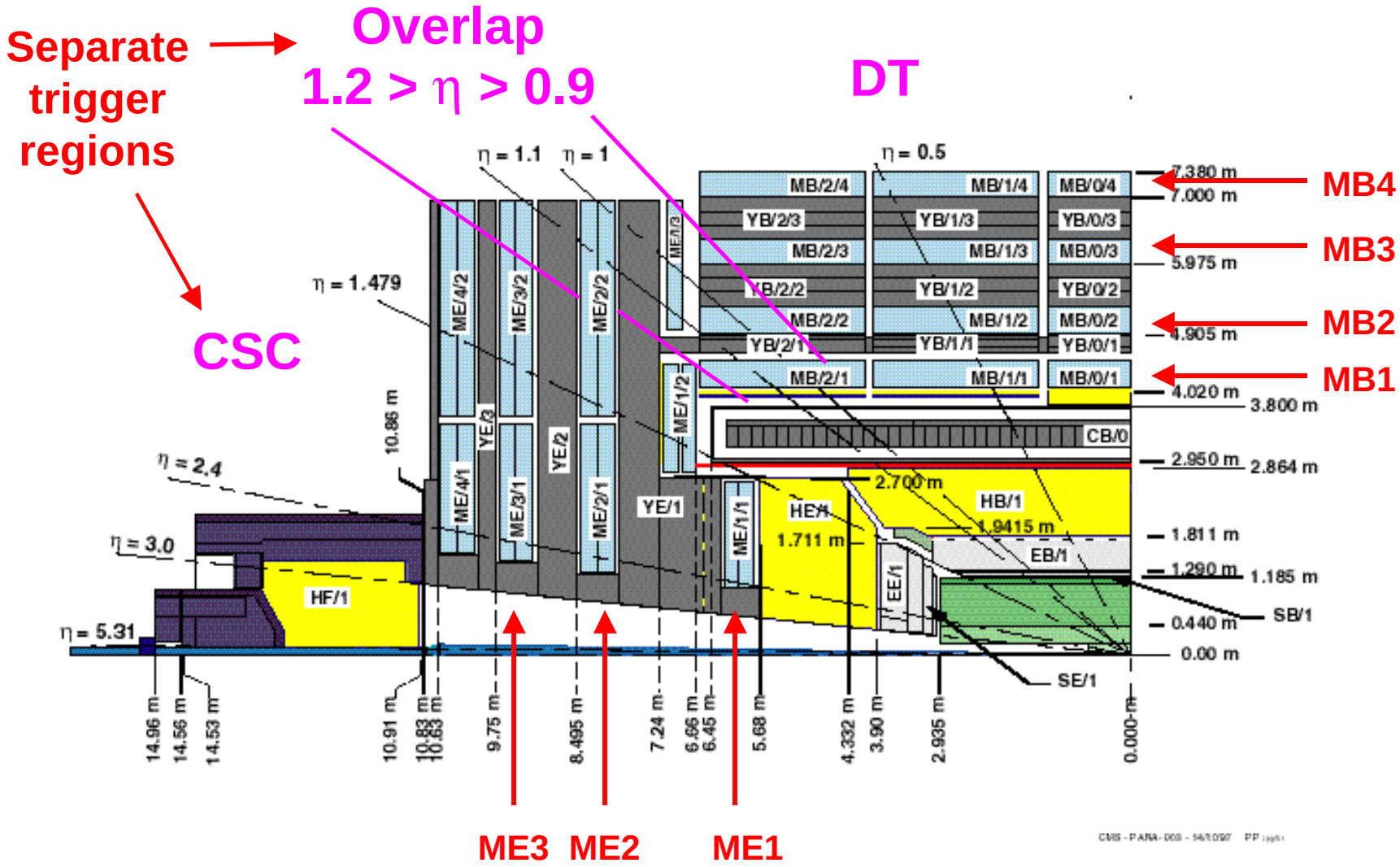
- Link trigger primitives into tracks
- Measure P_T, φ, and η
- Transmit highest P_T candidates to Global L1



CSC Track-Finder Requirements

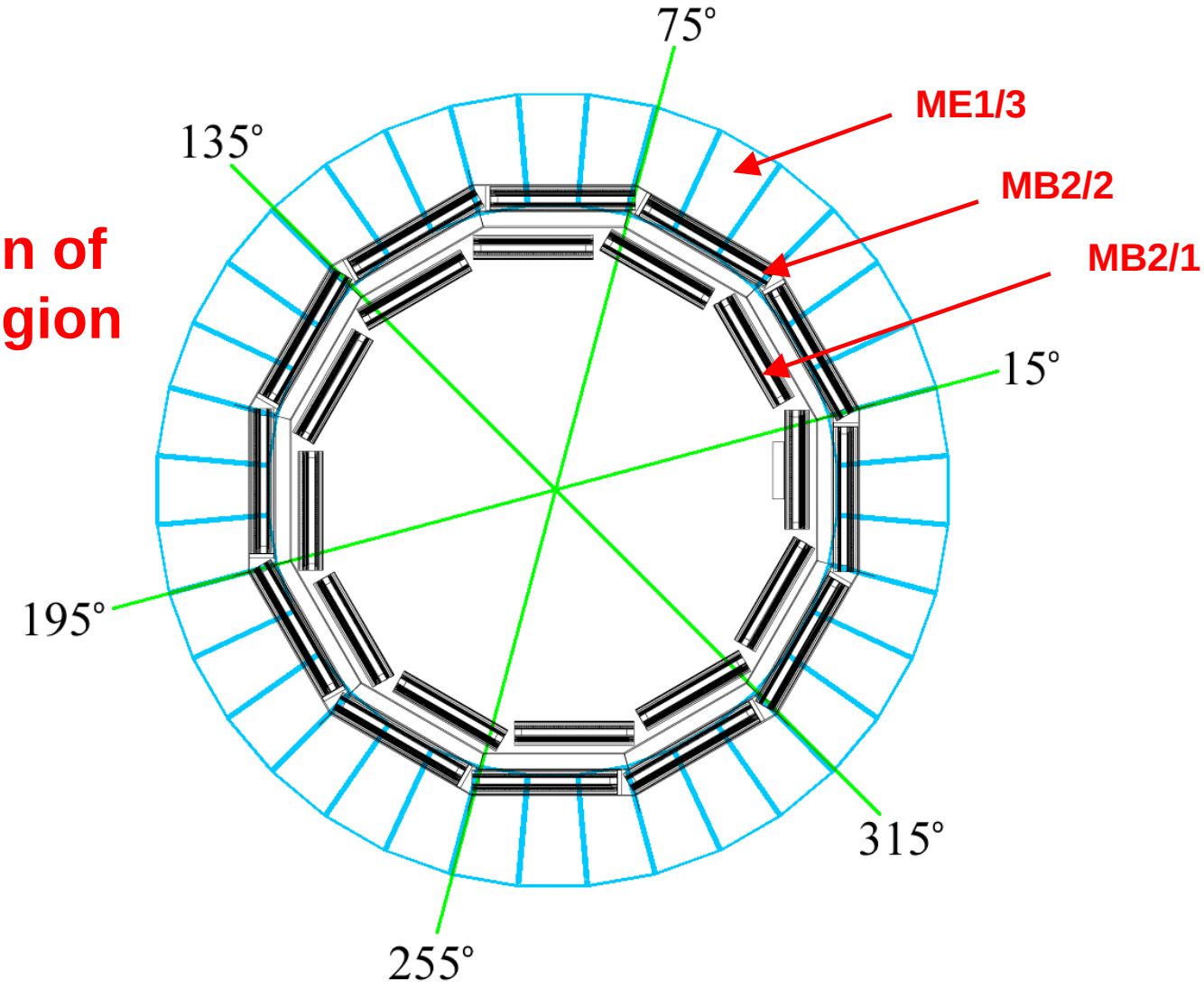
- High efficiency
- Trigger Rate:
  - Single muon rate < few kHz at $L = 10^{34} cm^{-2} s^{-1}$
- Resolution:
  - $\sigma_{Pt} / P_t \leq 30\%$ (*Requires* η *information*)
  - Ideally $\leq 20\% \Rightarrow$ 3-station sagitta measurement
- Selection:
  - ≤ 3 muons per 60° sector
- Redundancy
  - Require only 2 stations out of 3 (or 4)
- Minimal latency, pipelined, programmable

Trigger Regions in η



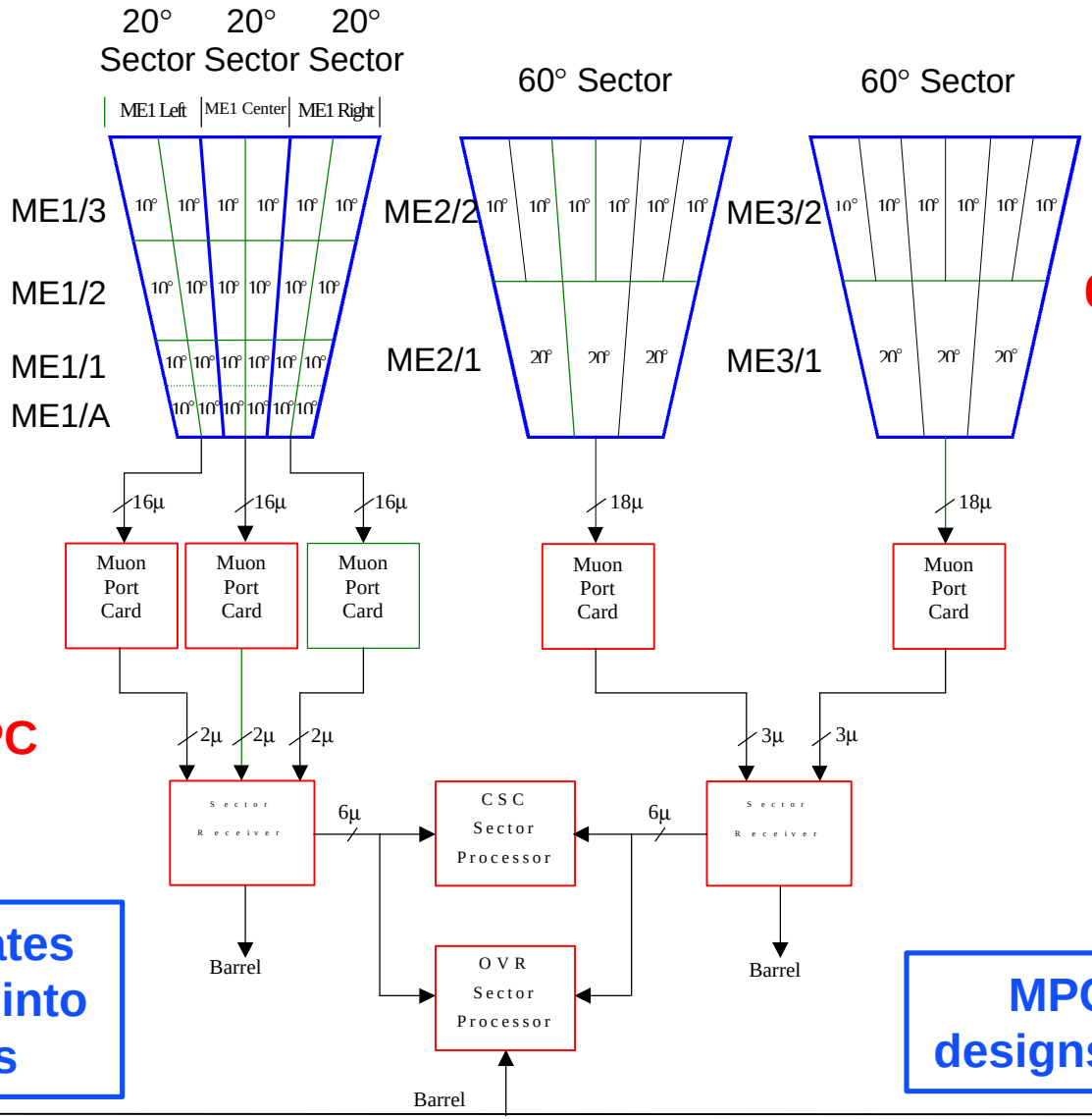
Trigger Regions in φ

Illustration of overlap region



Sector Partitioning

30° → 20° sectors



2 → 3 MPC

3 → 2 µ / MPC

ME2 and ME3 60° sectors are unchanged

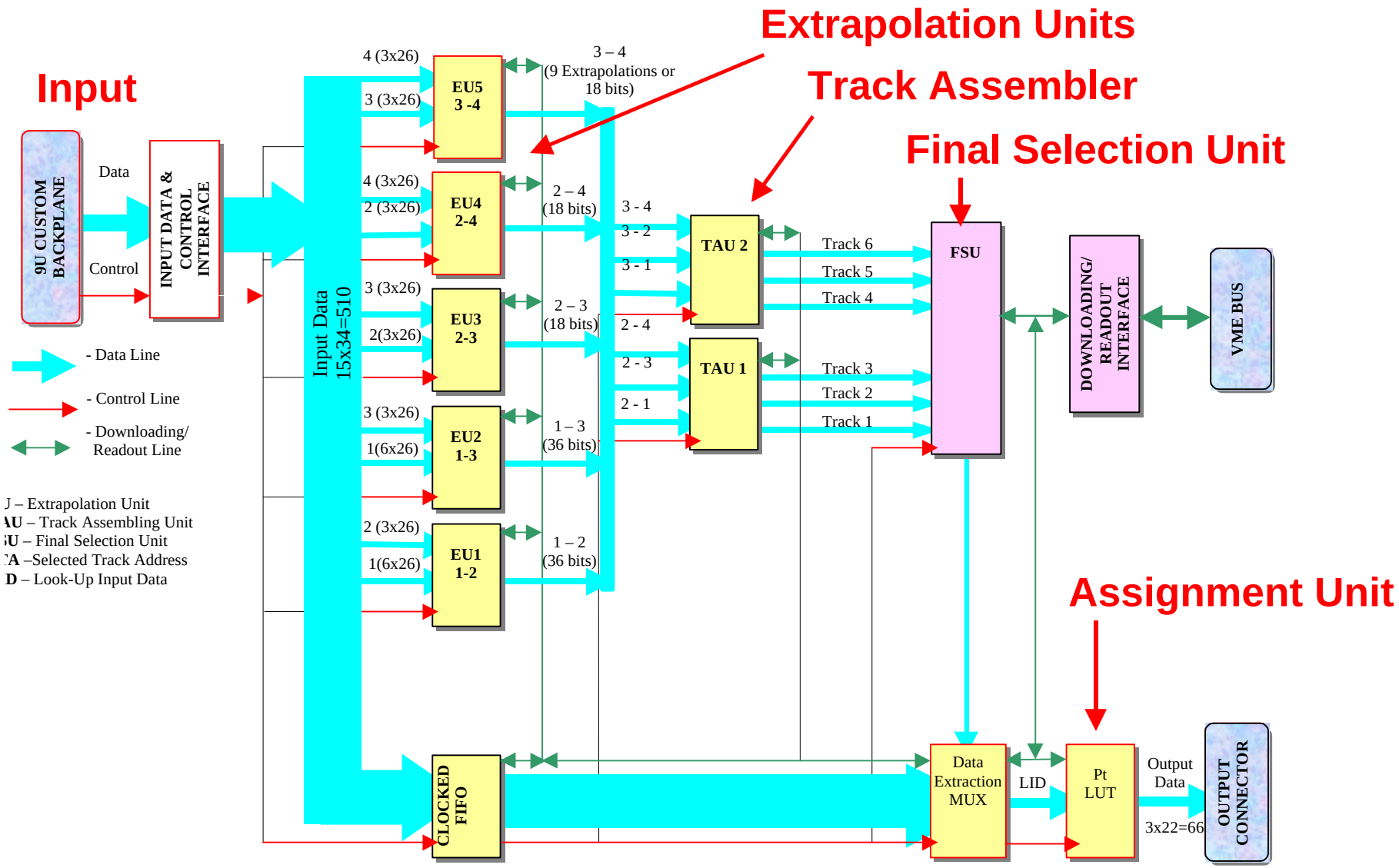
Accommodates split of ME1/1 into two regions

MPC and SR designs preserved

Sector Processor Functionality

- Perform all possible station-to-station extrapolations in parallel
  - Simultaneously search roads in φ and η
- Assemble 3- and 4-station tracks from 2-station extrapolations
- Cancel redundant short tracks if track is 3 or 4 stations in length
- Select the three best candidates
- Calculate P_T, φ, η and send to CSC muon sorter: 22 bits $\times$ 3 = 66 bits

Sector Processor Block Diagram



Extrapolation Unit Detail

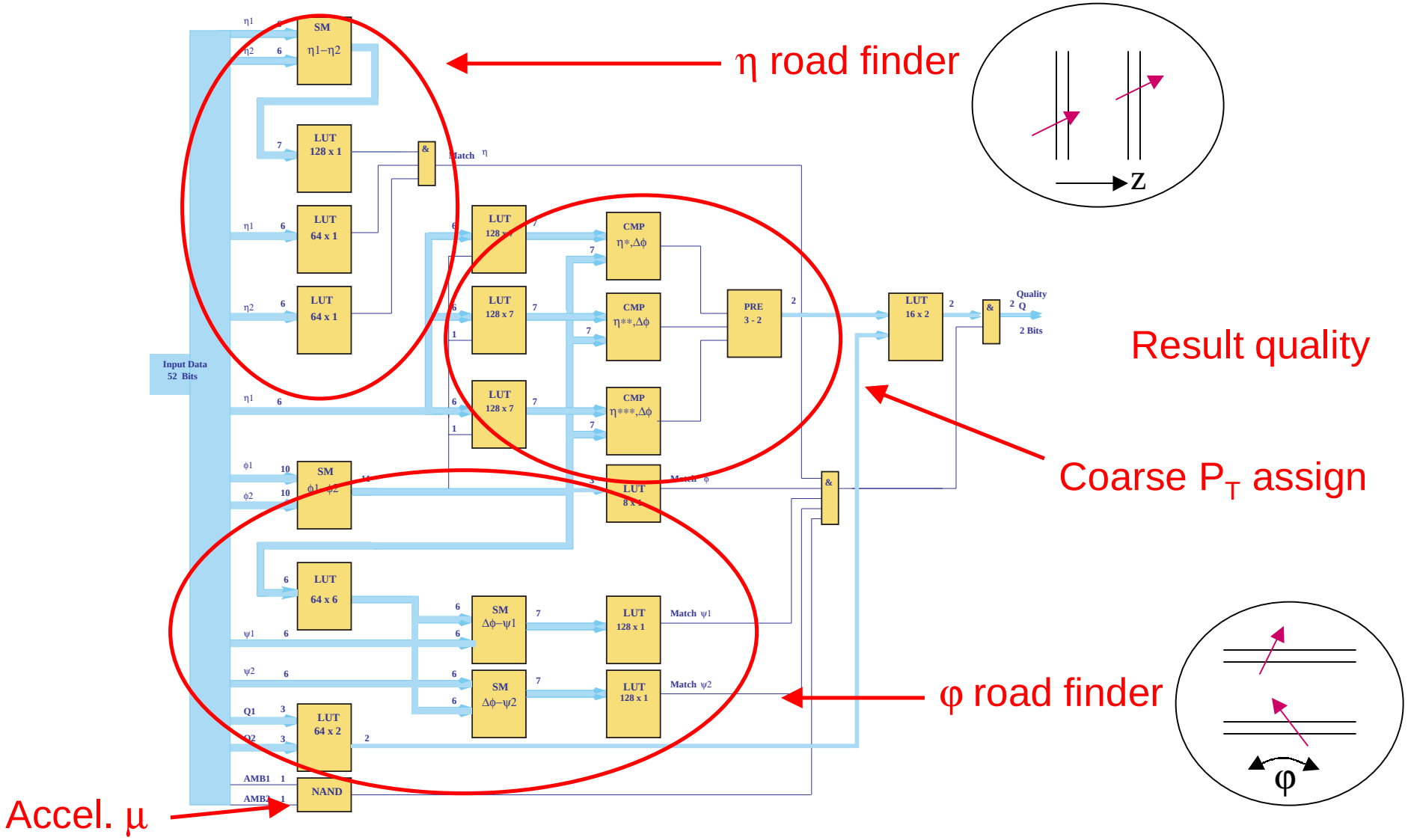
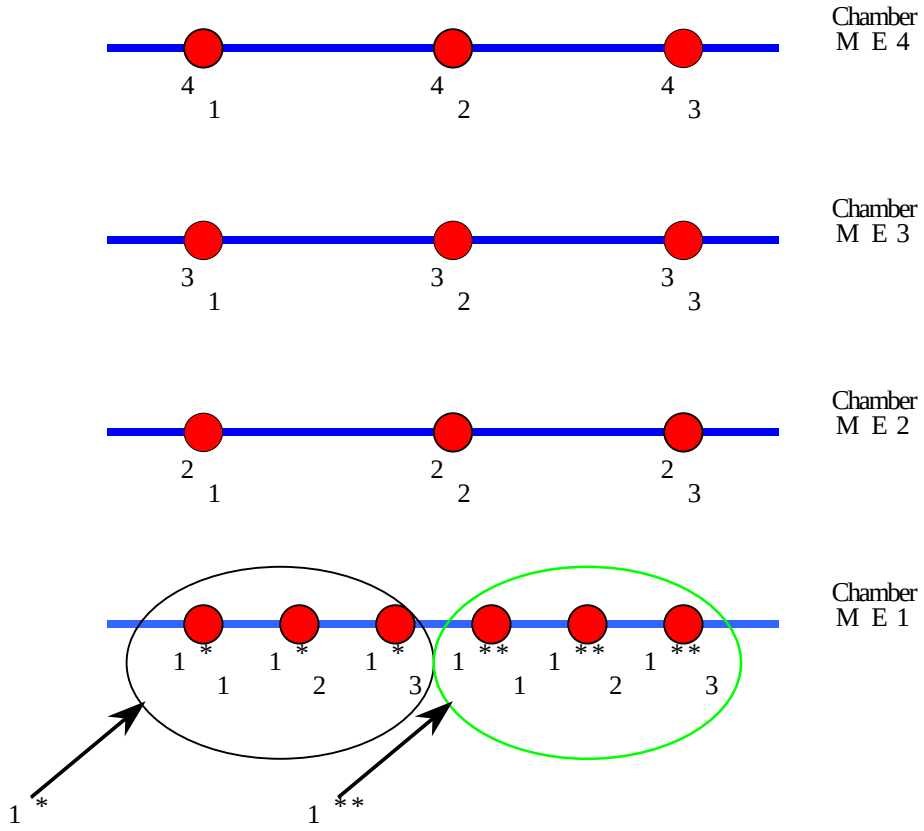


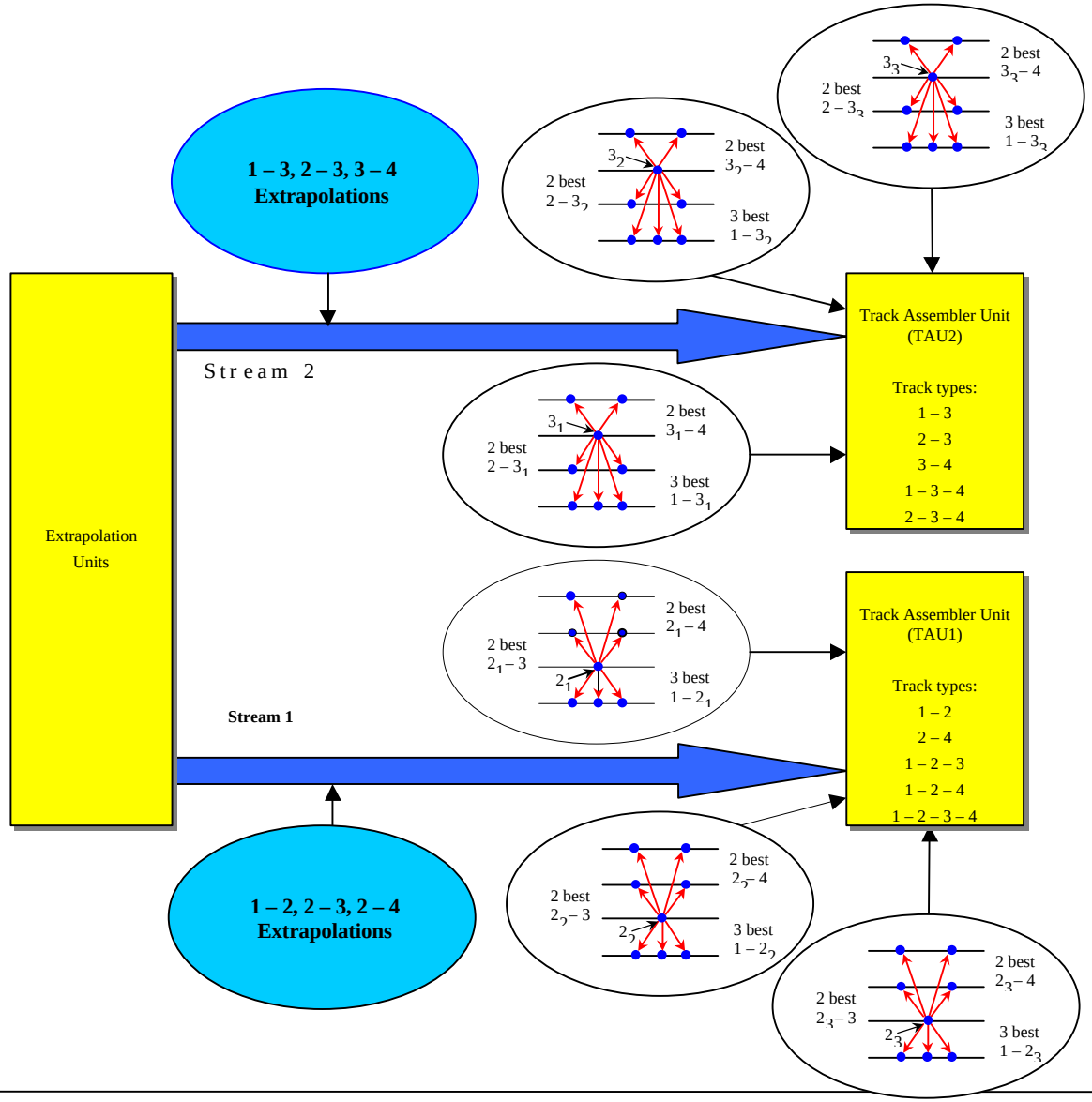
FIG.2. EXTRAPOLATION UNIT. BLOCK DIAGRAM.

Sector Processor Logic



- Perform all combinations of extrapolations in parallel:
  - $1_i \leftrightarrow 2_k$, $1_i \leftrightarrow 3_k$, $2_i \leftrightarrow 3_k$, $2_i \leftrightarrow 4_k$
  - But not $1_i \leftrightarrow 4_k$
- Track Assembler takes best 2 or 3 extrapolations per reference segment

Data Stream Paths



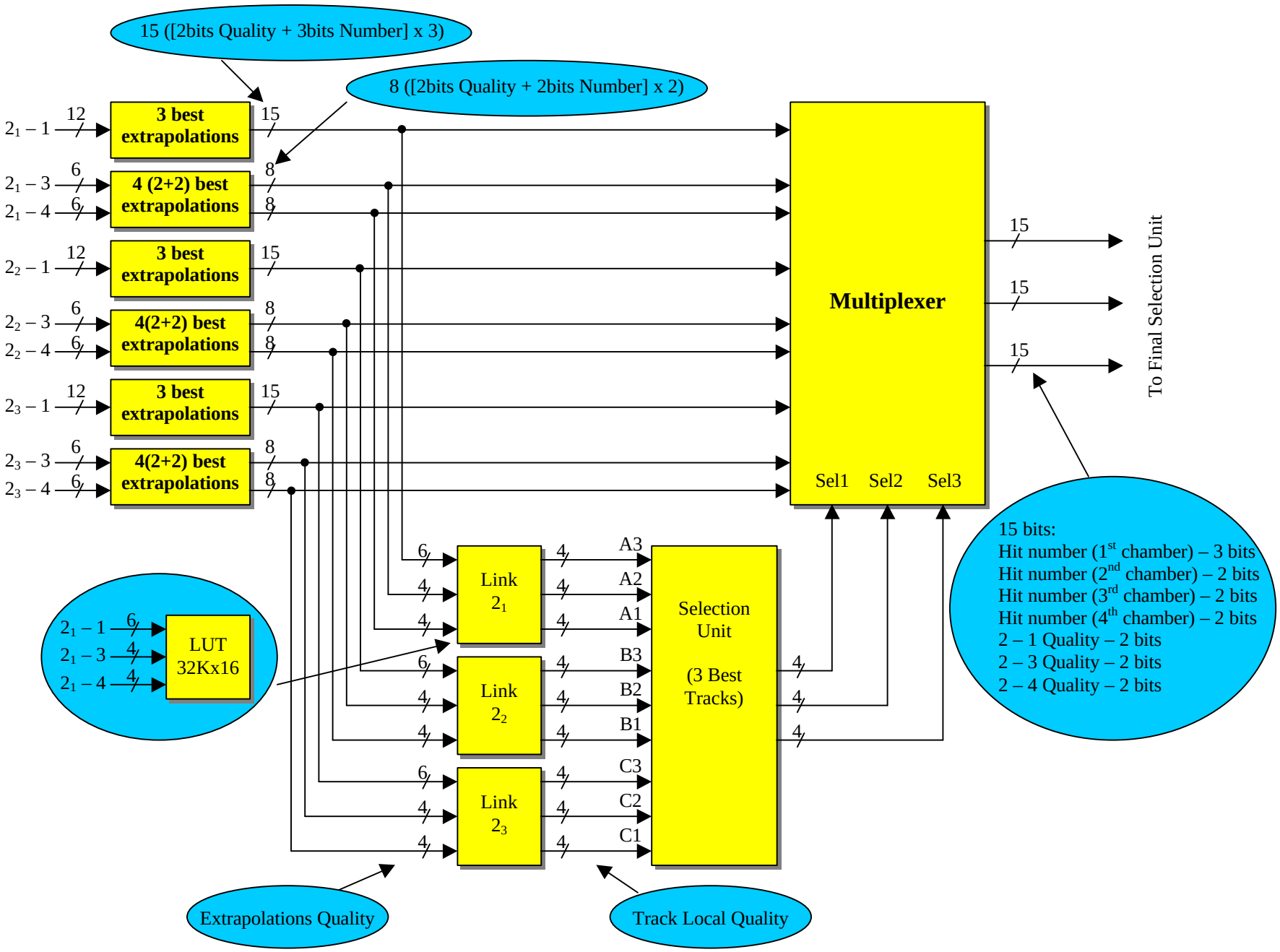


Fig.2.Track Assembling Unit (TAU1)

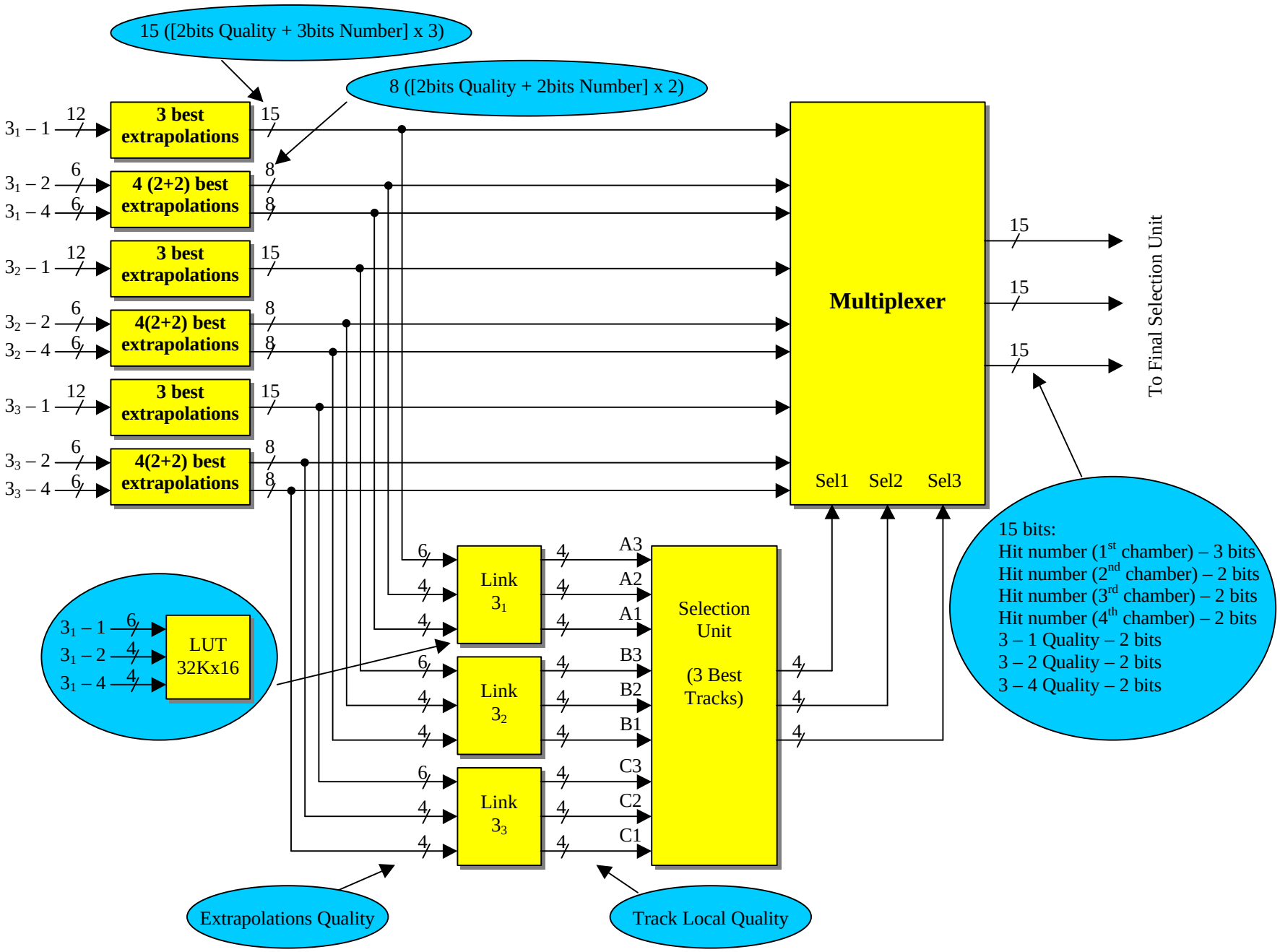
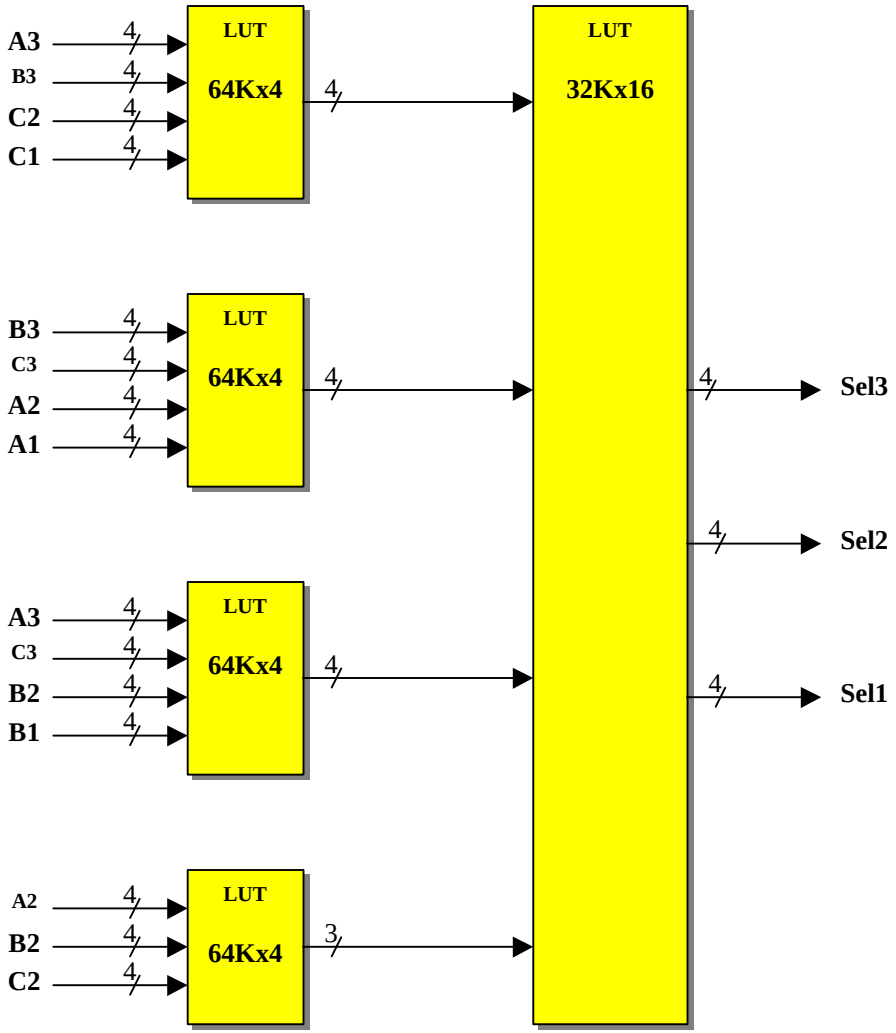


Fig.2a.Track Assembling Unit (TAU2)

Selection Unit Implementation in TAU



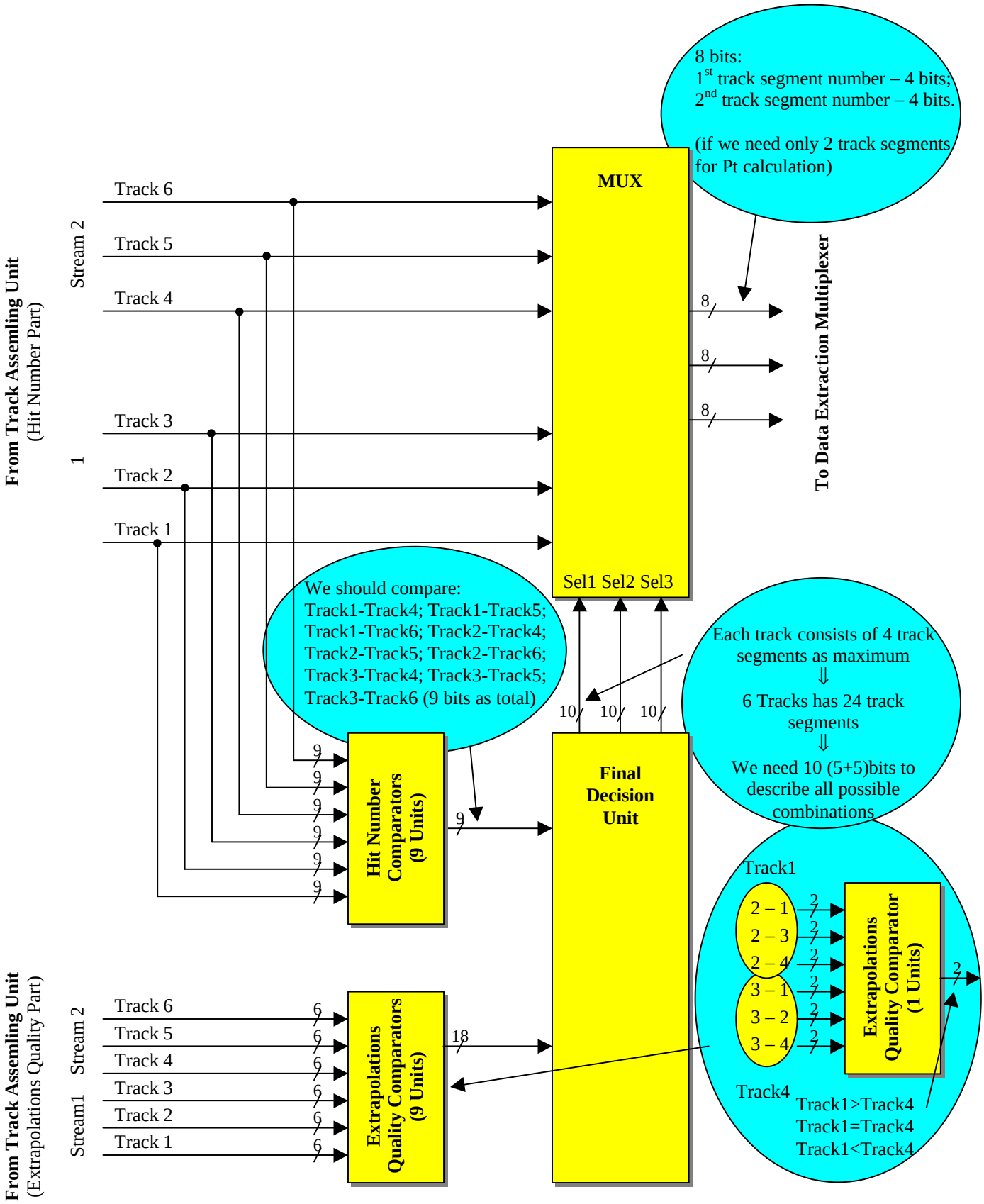
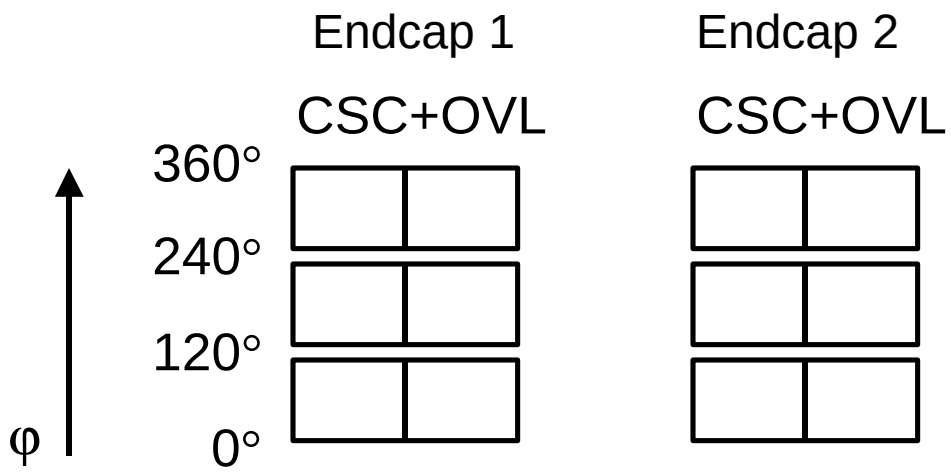


Fig.5. Final Selection Unit

New CSC Track-Finder Crate Organization



CSC and overlap regions now handled in same crate

CSC Counting House electronics:

Racks: 3 (was 4)

Crates: 6 (was 8)

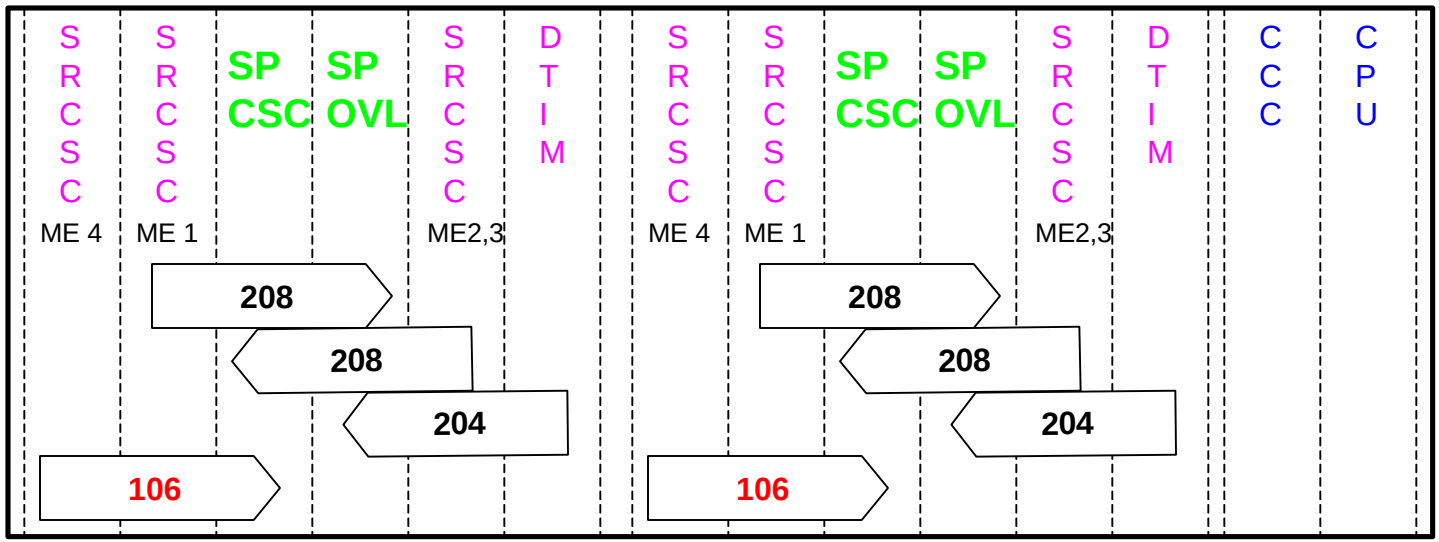
Sector Receivers: 24 (was 48)

Sector Processors: 24

Muon Sorter: 1 (new)

Two 60° sectors per crate

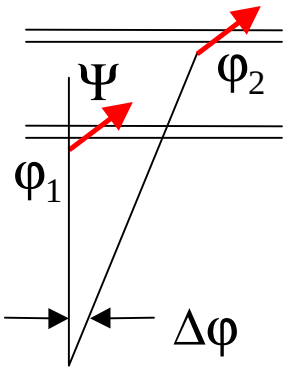
New Layout for CSC Track-Finder Crate



- Two 60° sectors housed in one 9U VME crate with custom backplane
- Each SR-CSC sends 6 CSC muon stubs × 34 bits and 4 bits BXN = 208 bits (3 stubs for ME4)
- Each DT-IM sends 8 DT muon stubs × 25 bits and 4 bits BXN = 204 bits

Required Precision of Data

- Azimuthal angle φ:
  - 12 bits / 60° ⇒ 1 bit / 0.26 mrad (0.1 strip)
- Bend angle Ψ:
  - 6 bits / ±45° ⇒ 1 bit / 60 mrad
- Polar angle η:
  - 6 bits / 1.5 units ⇒ 1 bit / 0.025
- Quality:
  - 3 bits
- Chamber i.d.:
  - 6 bits
- Accelerator μ flag: 1 bit



34 bits per CSC segment to Sector Processor

Track Segments per 60° Sector

Region	Station	Chamber	Segments per sector	No. of φ sectors	No. of segments	Extrap-olations
CSC	1	ME1	2	3	6	81
	2	ME2	3	1	3	
	3	ME3	3	1	3	
	*4**	*ME4**	*3**	*1**	*3**	
					12, 15*	
OVL	1	MB1	2	2	4	106
	2	MB2	2	2	4	
	3	ME1	2	3	6	
	4	ME2	3	1	3	
					17	

- Segments sent by Muon Port Cards to Sector Receivers via optical links.
- Processed by Sector Processor

2- or 3-station P_T Assignment