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High/Low Preshower Thresholds

- Design of Preshower triggers to date has been based on assumption that all channels can have charge splitting at input to SIFT/SVXII

- Basic motivation : enable separate trigger terms for high E_T (*W*,*Z*, top …) and for low E_T terms (ψ(*ee*), *b* to *e*, trileptons, …)

- Need for calibration of PS response

High E_T Electrons

- Expect max L1 trigger rate = 6 - 7 kHz
- For 2 E32: 5000 Hz (*W*,*Z* to *e*,*m*, top,jets,MET, diμ)

  Electron triggers (*e*, *ee*, *e*jet) are about 2000 Hz of this without Preshower terms (old Blazey et al. Estimate) .

>> Preshower (5MIP w/ quadrant match) gives x2.5 reduction in electron rates for CAL triggers > 5,10 GeV.

Adding PS (5 MIP threshold) saves about 1 kHz of L1 bandwidth.

Dropping the PS threshold to 2 MIP doubles the rate, making PS trigger ineffective.

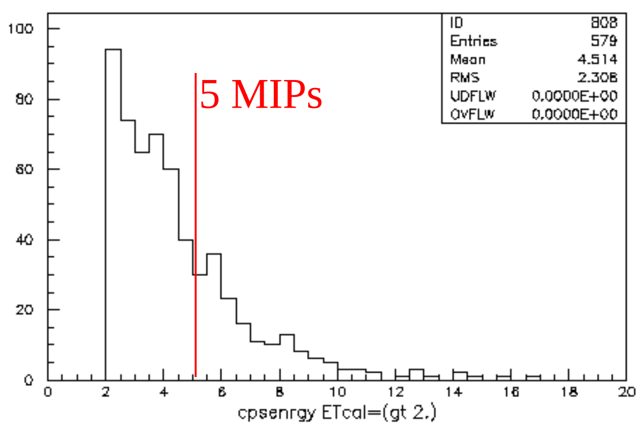
We should keep PS thresholds of ~ 5MIP to control the high E_T Level 1 trigger rates

Low PS threshold : J/Ψ

- Utility of J/Ψ:
  - > Large calibration sample for CALEM energy;
  - > CP violation via B $\rightarrow \Psi K_S \rightarrow ee K_S$, ; (current indication is that dielectron channel gives at least 50% added sensitivity to sin(2β) (Lucotte) addition of like sign capability in L1 will help more).
  - > B_S mixing; B_C …

- Efficiency for $\Psi \rightarrow ee$ depends strongly on PS threshold for Central Preshower.

CPS efficiency for Ψ vs. thresh.



Inclusive distribution of CPS strip energies for Ψ(*ee*) and backing CCEM tower over 2 GeV.

Clear gain in lowering CPS threshold from 5 to 2-3 MIPs

L1 Ψ rates increase x2.5 when CPS axial threshold lowered from 4 to 2 MIPs.

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FPS L1 Ψ rates plateau for threshold < 5 MIPs but lower threshold may help forward Ψ too.

Central J/Ψ Trigger Rates

Central dijet J/Ψ rates

CPS thrsh	Rate (L1/L2) (Hz) for CAL thresh. 2.0	2.25	2.5 GeV
2 MIPs	**5950** / **45**	**2930** / **19**	**1530** / **8** Hz
3 MIPs	**1480** / **59**	**970** / **34**	**640** / **19**
4 MIPs	**830** / **37**	**580** / **24**	**410** / **16**

Forward dijet J/Ψ rates

FPS thrsh	Rate (L1/L2) (Hz) . CAL = 2.5	3.0 GeV
5MIPs	**1760** / **40**	**695** / **30**
10 MIPs	**970** / **20**	**360** / **15**

Quadrant matching CPS/CAL or FPS/CAL in ϕ was imposed.

Did not impose opposite sign requirement; should give another factor of 2.

Other needs for low E_T *e* triggers

- $b \rightarrow e \nu X$ capability adds to DØ *b* tagging efficiency, crucial for top to all jets, single top, Higgs searches etc. Ability to find $b \rightarrow e \nu X$ improves J/Ψ triggering by picking up tagged *b* .

- Trileptons: these are the most promising triggers for finding Susy signatures (χ_1^+ , χ_2^0 production; *eee*, *eeμ, eμμ, μμμ* final states). The third lepton is low E_T.

- Low energy photons are the chief signature for gauge mediated Susy. Low E_T γ's in conjunction with jets and missing E_T would form the trigger.

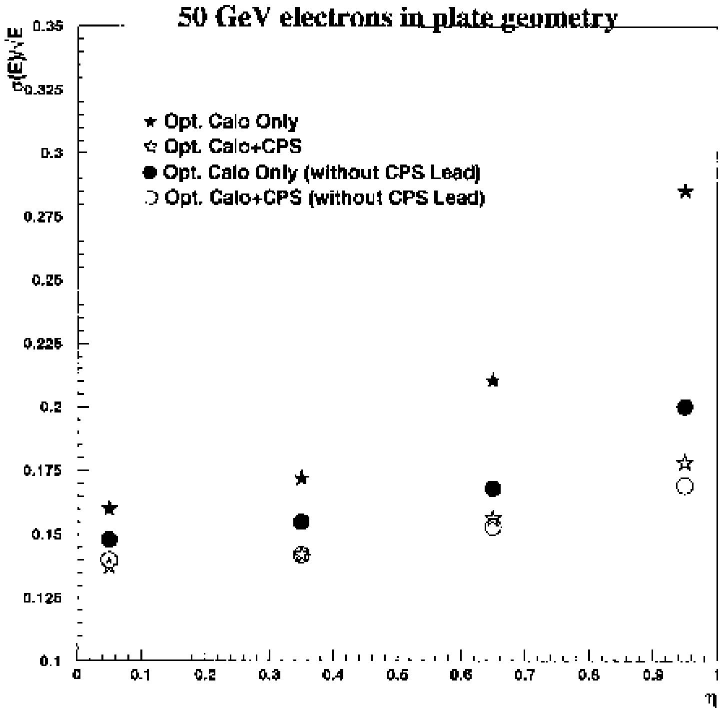
Calibration of Preshowers

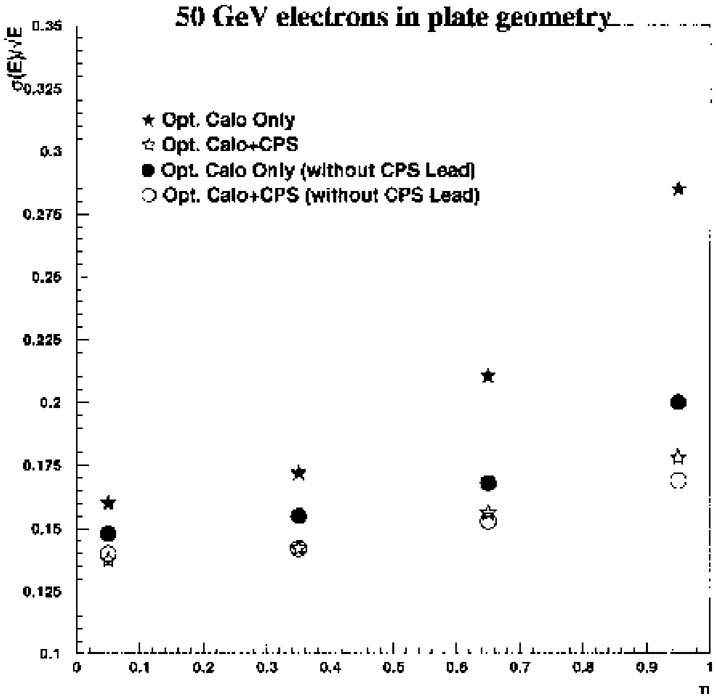
- The response calibration of preshowers is not *a priori* known and must be determined from data. (variations in VLPC gain, clear fiber/connector differences, electronics gains …).

- The CPS response needs to be known absolutely in MeV to better than 10% to prevent degradation in EM energy resolution -- particularly for *e*'s near the CPS ends where the Pb thickness is large. FPS response needs to be known to better than 15% (Zutshi/Zielinski).

- MIP deposits by tracks passing near to center of strips give adequate (3%) determination of gain if the response is at least 10 SVX counts/MIP.

PS use for Cal EM calibration





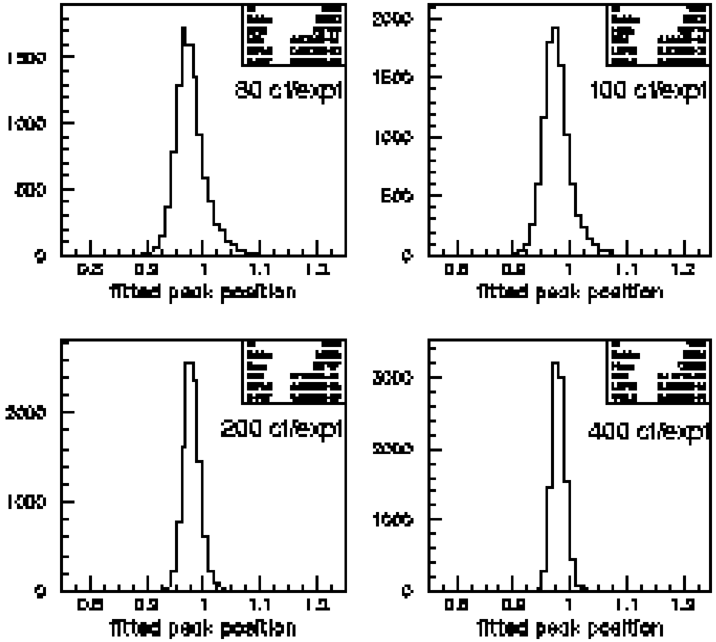
Need CPS energy to regain CCEM resolution, particularly at high η

At η = 0.95, need CPS energy deposit calibration to < 10%

Want PS energy digitized up to ~ 60 MIPs to avoid saturation (low gain)

Need for FPS calibration not as severe, but still needed

MIP Calibration



Ensemble of 10,000 expts.
Binning is 10 counts/MIP

With 80 hits per strip, rms < 3%. No special selection other than requiring that neighbor strip be < 0.1 MeV

Need ≥ 10 counts/MIP (in high gain channel)

Sample SIFT parameters - 40K VLPC gain

	CPS	center		CPS	45 deg	Units
Gain =	**High**	**Low**		**High**	**Low**	
Charge fraction	**16.0%**	**4.0%**		16.0%	4.0%	
Lower desired thresh	**2.0**	**5.0**		0.7	1.7	MIP
Higher desired thresh	**5.0**	**10.0**		3.5	3.3	MIP
Input charge low thrsh	41.0	25.6		41.0	25.6	fC
Input charge high thrsh	102.4	51.2		102.4	51.2	fC
SIFT output gain	**0.388**	**0.194**		0.388	0.194	
SVX full scale	18.9	151.0		6.3	50.3	MIP
SVX resolution (cnt / MIP)	13.6	1.7		40.7	5.1	ct / MIP

	FPS	Dnstrm		FPS	Upstrm	Units
Gain =	**High**	**Low**		**High**	**Low**	
Charge fraction	**13.0%**	**4.5%**		**70.0%**	**15.0%**	
Lower desired thresh	**2.0**	**5.0**		**0.2**	**2.0**	MIP
Higher desired thresh	**5.0**	**10.0**		**0.5**	**5.0**	MIP
Input charge low thrsh	46.9	40.6		25.3	54.1	fC
Input charge high thrsh	117.3	81.2		63.2	135.4	fC
SIFT output gain	**0.388**	**0.194**		**0.194**	**0.194**	
SVX full scale	16.5	95.2		6.1	28.6	MIP
SVX res.(cnt / MIP)	15.5	2.7		41.8	9.0	ct / MIP

Charge needs for Calibration

- With nominal VLPC, electronics gains and setting charge divisions to give comfortable SIFT threshold settings for high E_T electrons (5 - 10 MIPs corresponding to 40 - 120 fC), we only get 1.7 counts/MIP (CPS 90^o) to 2.7 counts/MIP (FPS).

→ **High gain channel crucial for good energy calibration of the PS's**

- Desire dynamic range > 60 MIPs to avoid saturation in showers for calibration of EM energy resolution .

→ **need Low gain threshold to get energy calibration of EM Calorimeter including Pb, SC coil.**

Constraints (CTT Group)

- Cannot make arbitrary charge splits due to crosstalk; maximum 3:1:3 (Hi:Lo:Drain) thus requested FPS upstream split seems untenable. -- OK by PS group (FPS upstream split was to allow possible trigger on conversions in tracker)

- Difficulty fitting two channels per strip for FPS downstream and CPS stereo on existing MCMs; solutions involve extending size of FE bds/ cryostats. (CPS axial will have 2 channels)

CTT Front End Bd constraints

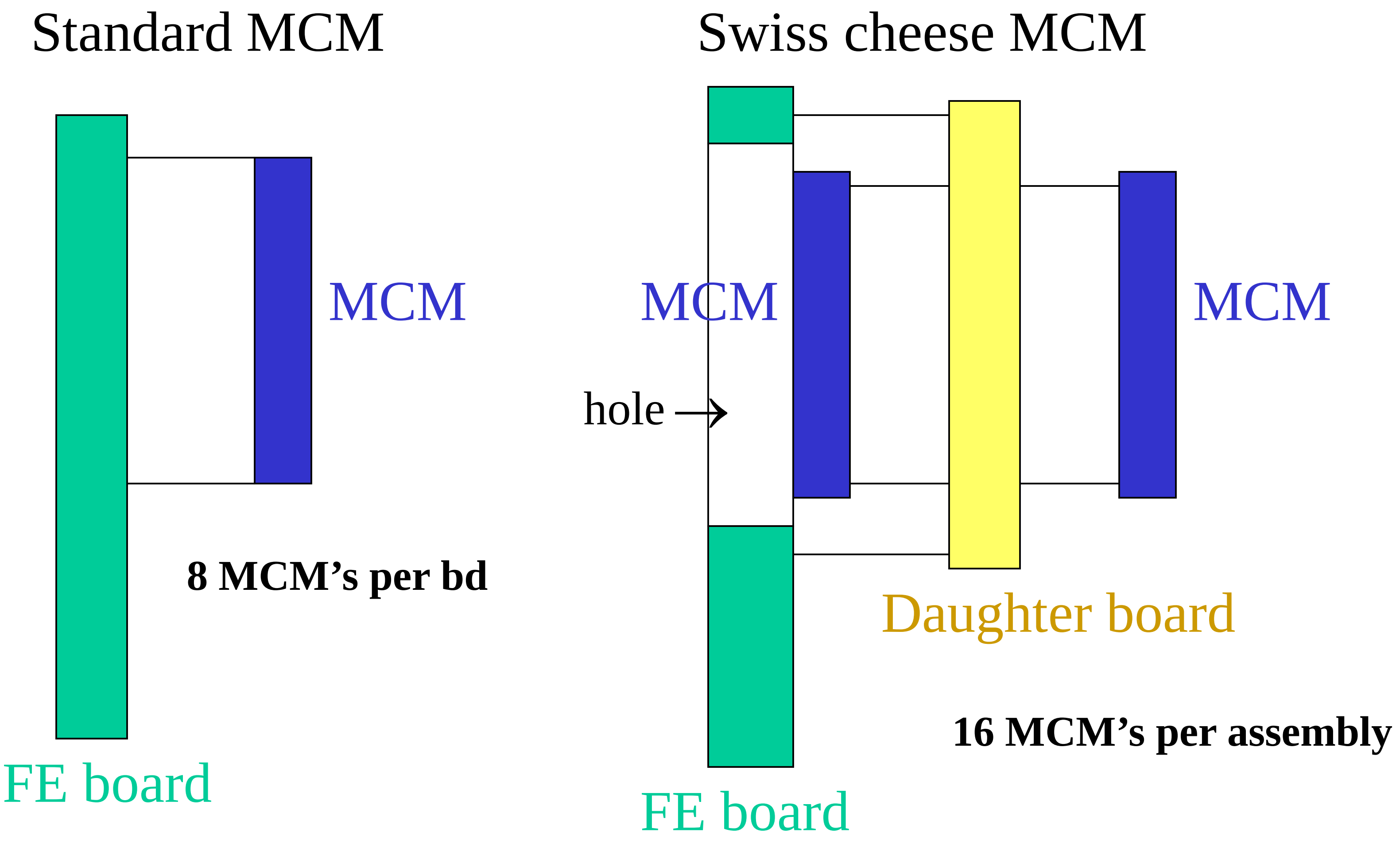
- Flex cable problems may force FE Bd to be shorter -- can only fit 8 MCM's (SIFTs/SVX) on board in std. layout.

- Adding MCM's on both sides of FEB or introducing daughter board lengthens cryostat row by too much for access.   Also forces new layout of FE boards.

- Swiss cheese boards … equivalent to 12 channels possible for FPS downstream and CPS stereo.

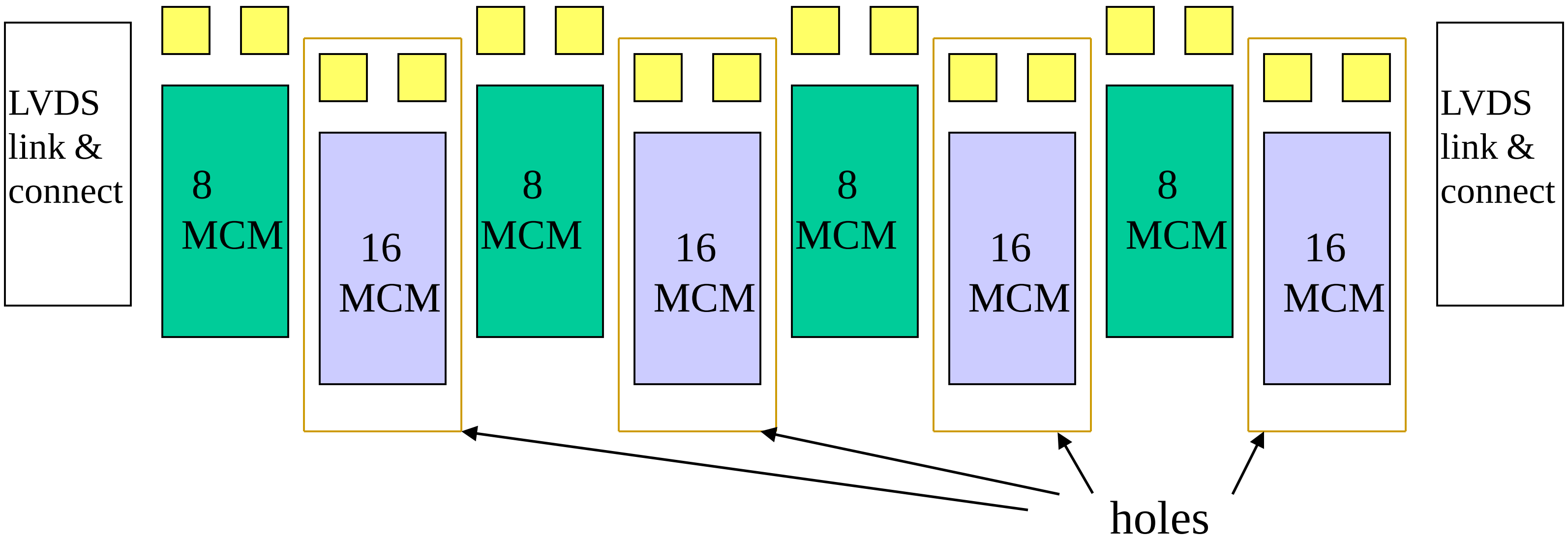
- If 12 channels/MCM (CPS stereo & FPS dnstrm, all but one spare FE board cassettes are used.

Possible solution to increase number of MCM's/FE board



Alternate these two types on FE board

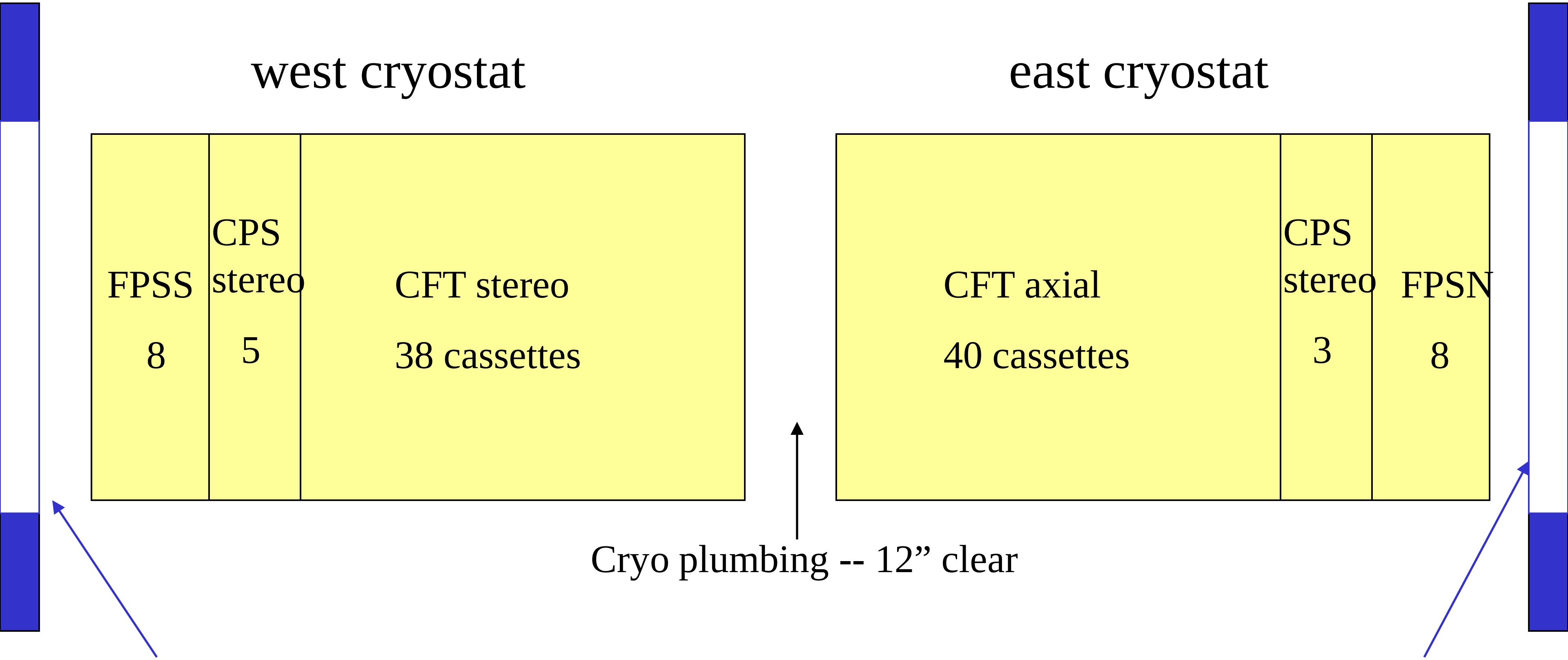
Swiss cheese front end board arrangement



(average number of MCM's per slot = 12)

Each such Swiss cheese bd. adds ~ 0.25" to cryostat length

J. Anderson claims can do FE board if 14 inches height; if 12", it gets very hard



Platform cross beam -- personnel access
27” clear space for standard FE boards.
Reduce by 3.25” with Swiss cheese soln.

Reduce by 2.75” with
Swiss cheese soln

Can squeeze cryo plumbing between cryostats ?

Can drop cryostat location (by 8” - Bross) to help regain FE board height.

Conclusions

- J/Ψ samples critical for many high p_T physics studies, for CP violation, etc. Susy signatures benefit from low E_T leptons. CPS thresholds in 2-5 MIP range are needed to collect useful samples.
- Preshower terms with 5-10 MIPs will help the Level 1 bandwidth crunch.
- PS/CAL calibration needs **low and high** threshold

We advocate dual thresholds for CPS (axial, stereo) and FPS downstream layers. Ask Trigger Group to press dual range solution with upgrade management.