EMCAL and jet triggers

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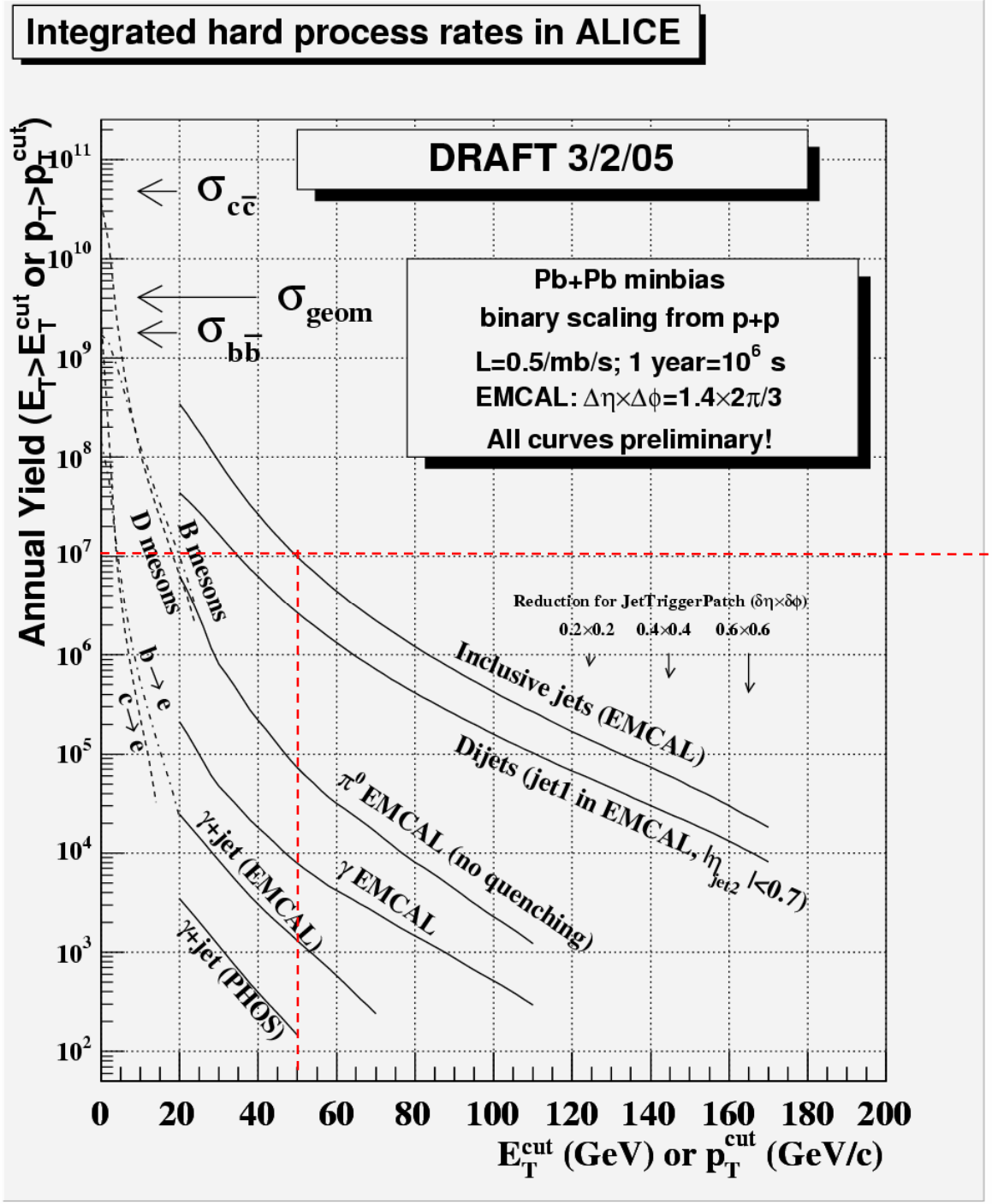
CERN/LBNL



inclusive jets
10 Hz @ 50 GeV

Jet trigger in Pb+Pb

- Goal: efficient, unbiased collection of jets with E_T>50 GeV

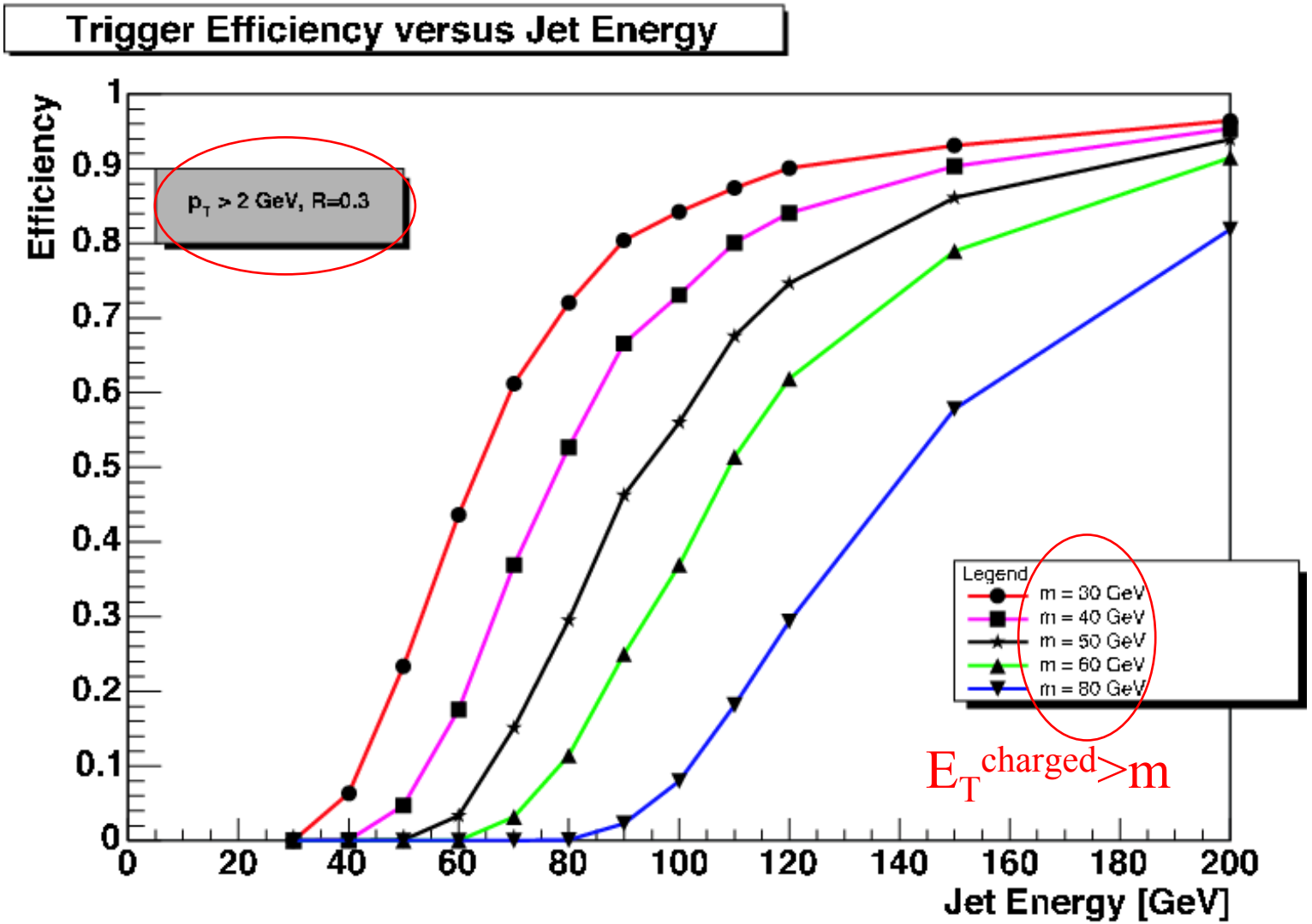
- Minbias Pb+Pb ~ 4 kHz
- minbias Pb+Pb + E_T^{jet}>50 GeV ~ 10 Hz

- Untriggered: 100 Hz minbias to tape = 100 Hz/4 kHz
  = 2.5% efficiency

Need a jet trigger!

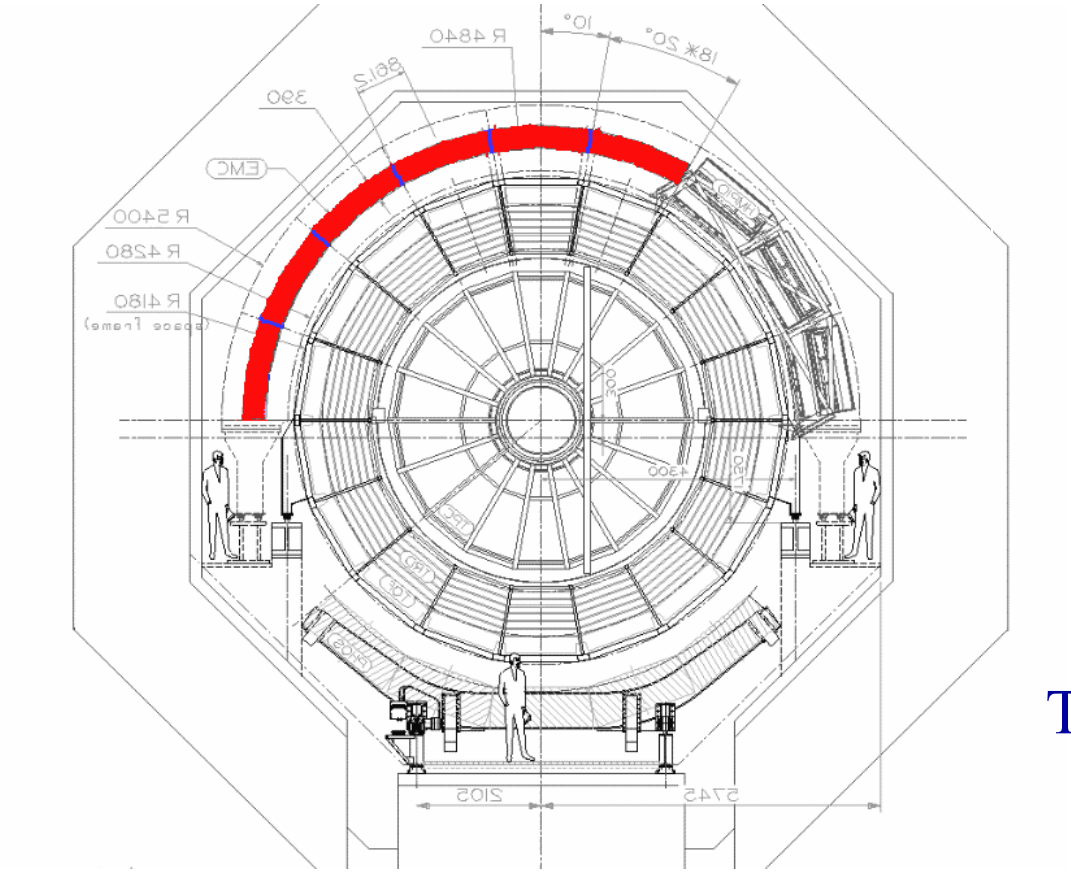
Measurement is modification of jet fragmentation in dense matter
⇒ trigger efficiency should be insensitive to fragmentation

HLT Charged Jets (C. Loizedes)



Charged jets: poor energy resolution, very slow turn-on above trigger threshold

Proposed ALICE EMCAL

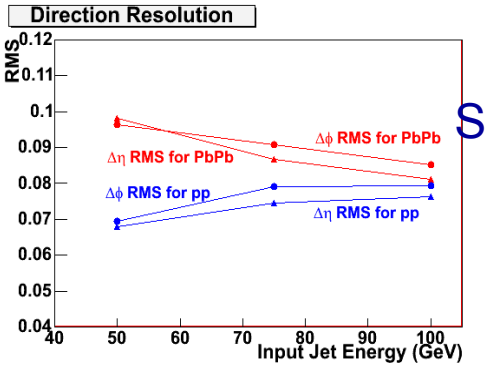


- *EM Sampling Calorimeter*
- *Pb-scintillator shashlik design*
  - $-0.7 < \eta < 0.7$
  - $\pi/3 < \Phi < \pi$
- *12 super-modules*
- ***~15K** towers*
- *Energy resolution ~15%/√E*

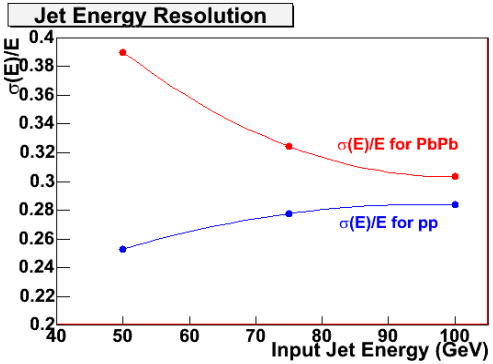
Tower $\delta\eta x \delta\phi \sim 0.014 x 0.014$

Offline jet reconstruction: charged (TPC) + neutral (EMCAL)

- Modified UA1 cone algorithm
- Uses combination of tracking and calorimeter information
- Cone Radius: *R* = 0.3, Seed 4.6 GeV, Minimum Jet energy 14 GeV
- Background HIJING PbPb *b* = 0-5 fm

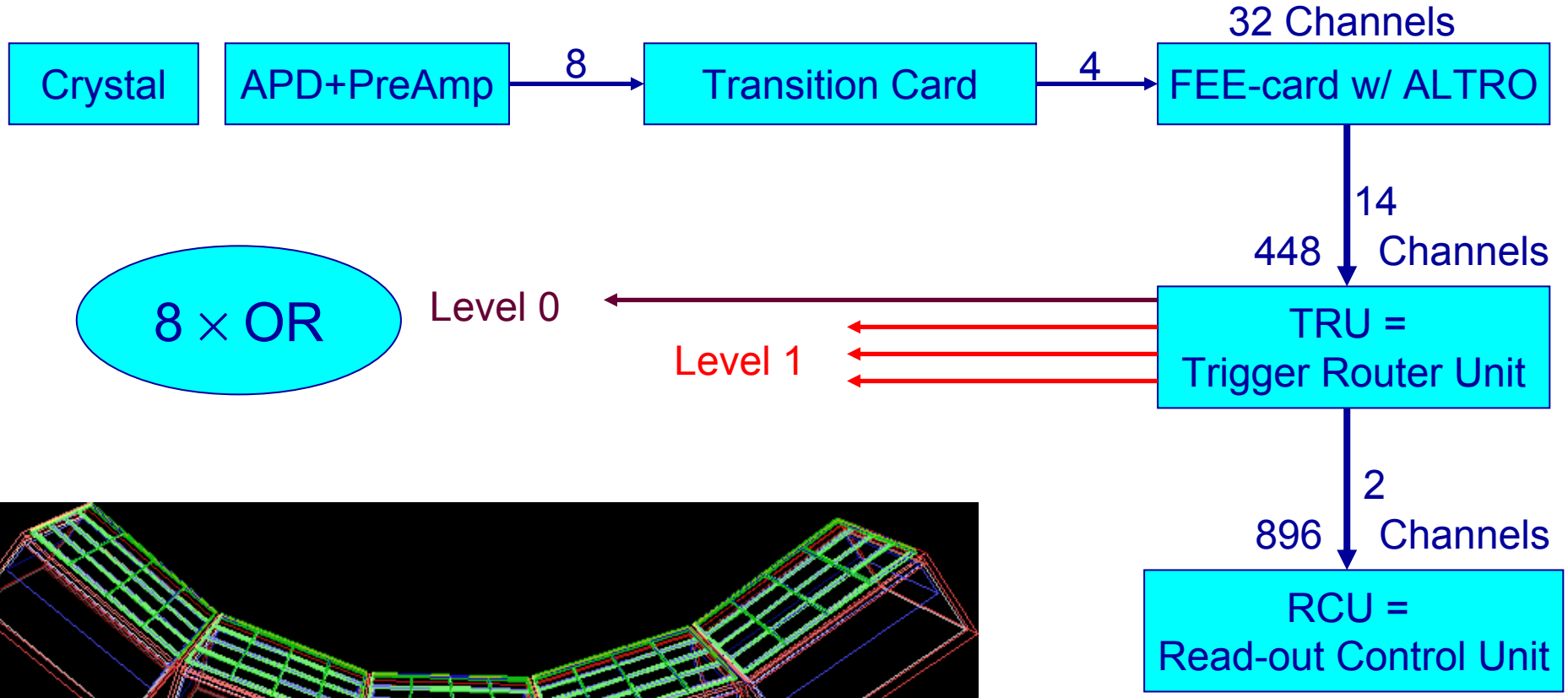


S. Blyth QM'04



S. Blyth QM'04

EMCAL: copy PHOS readout

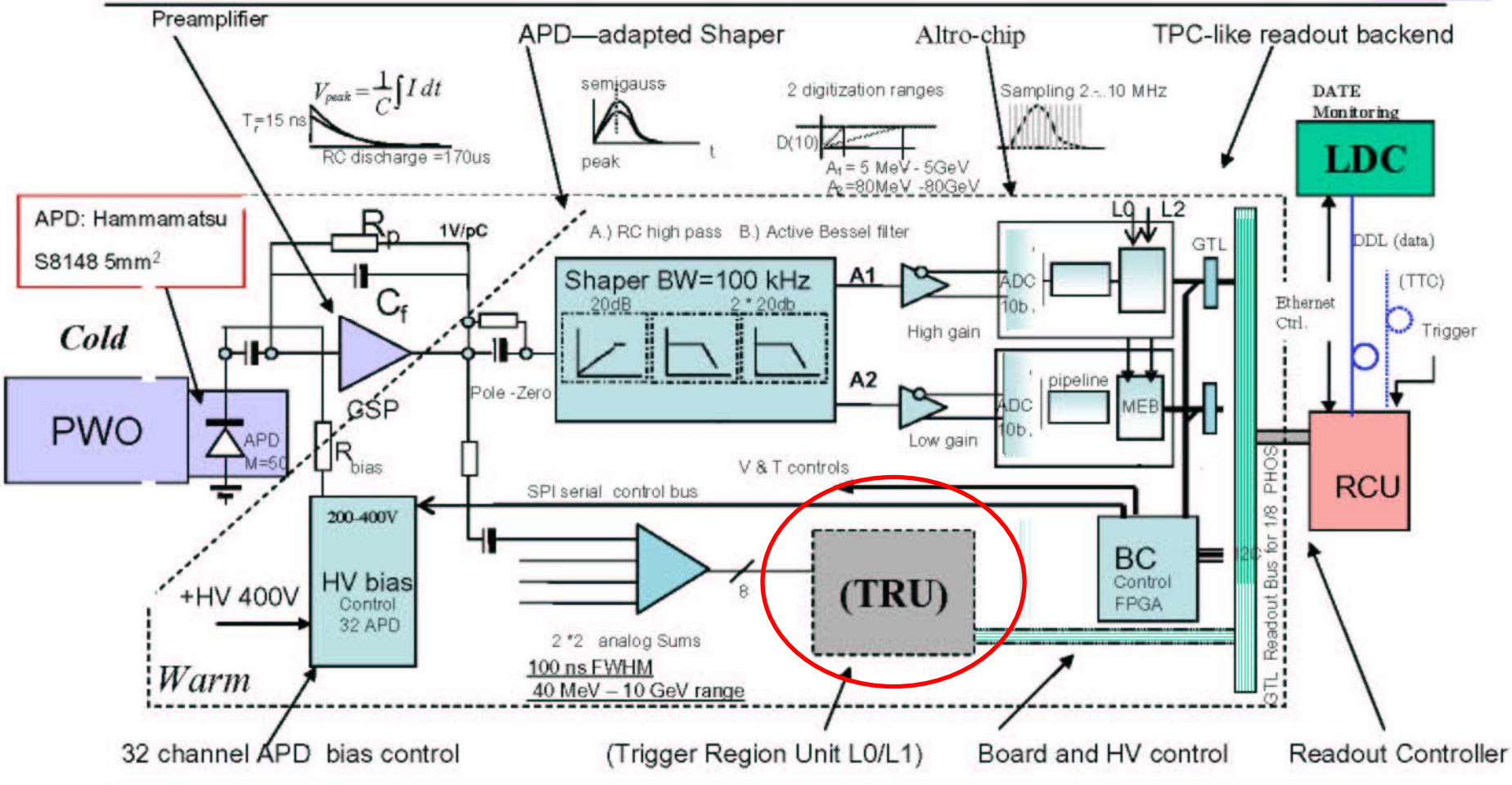


In total 5 PHOS Modules

4 RCU =
1 PHOS Module =
3584 Crystals

PHOS FEE electronics
Status @ CERN PHOSlab

H.Muller



Better solution: EMCAL @ Level 1 + HLT

Some rough numbers:

Minbias data rate ~ 20 MB/evt*4 KHz ~ 80 GB/s
HLT input bandwidth ~ 15 GB/s

Least-biased efficient trigger algorithm:

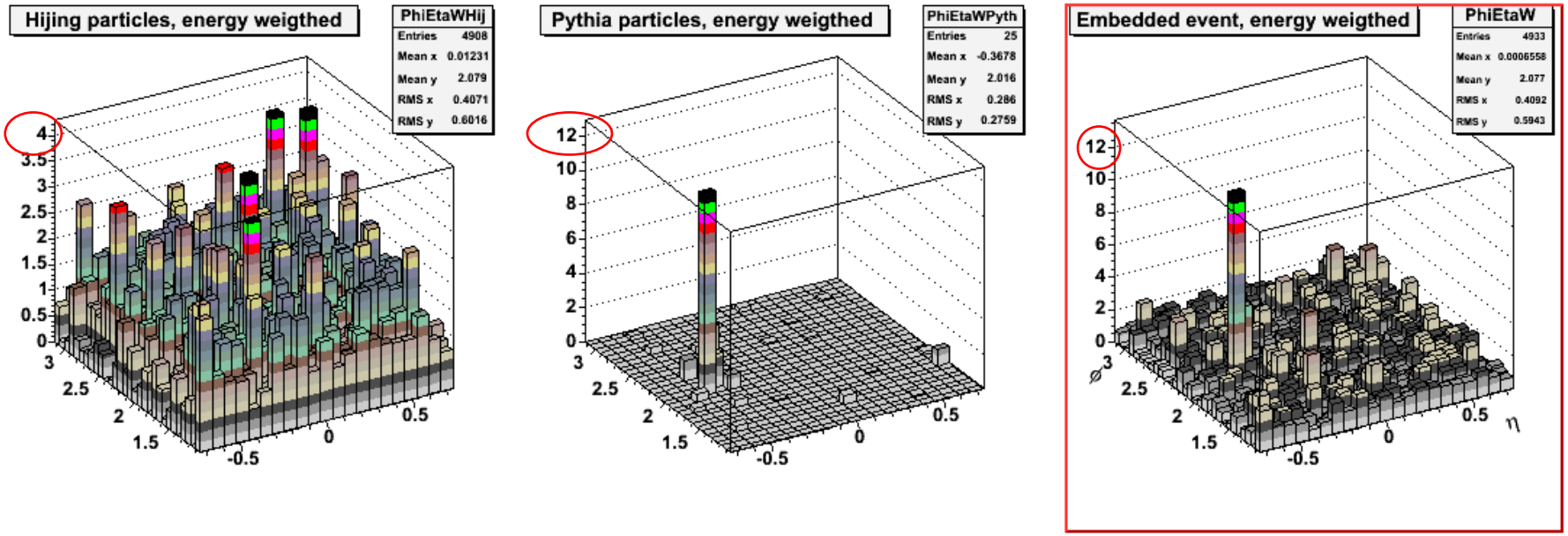
- EMCAL@L1: mildly biased jet patch trigger to cut **minbias** rate by factor 10 ~ 8 GB/s

- do the rest in HLT incorporating charged tracks, neutral energy from emcal, dijet topologies (?), etc

Jet Patch Trigger Simulations

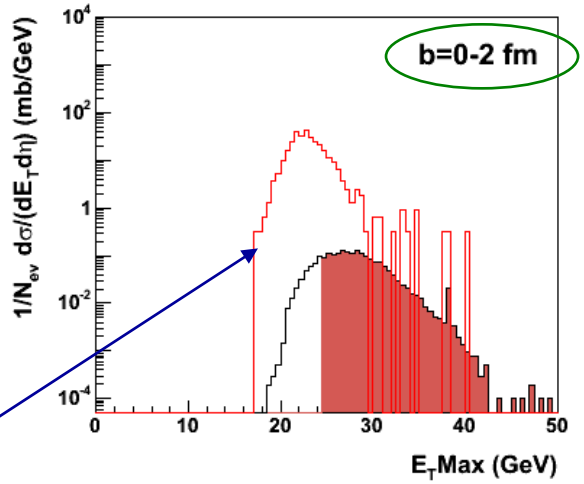
Andre Mischke (Utrecht)

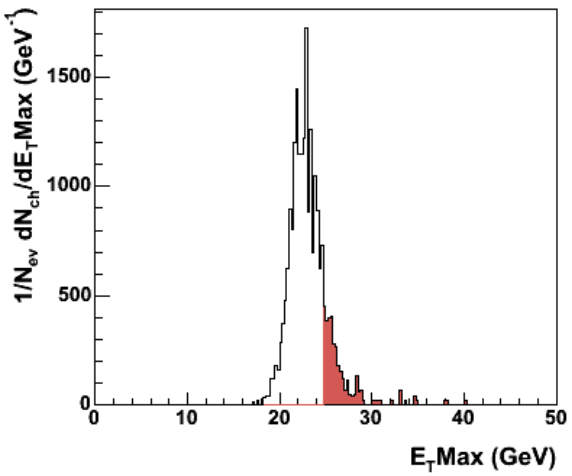
- Pythia jet (E_T~50 GeV) + HIJING background
- candidate jet patches ($\delta\eta$ x $\delta\phi$) ~ (0.2 x 0.2), (0.3 x 0.3)
- slide patch quasi-continuously over detector, find maximum

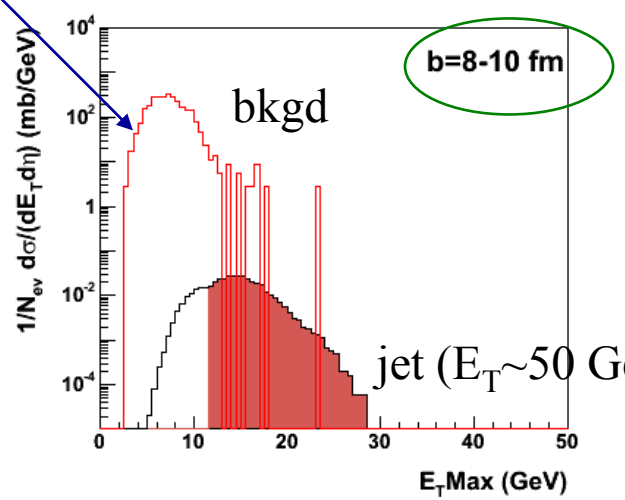


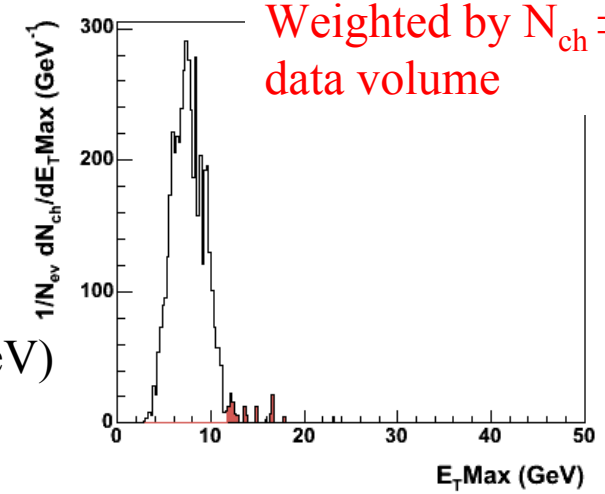
E_T cut for 80% trigger efficiency @ 50 GeV

Pedestal: strong centrality dependence





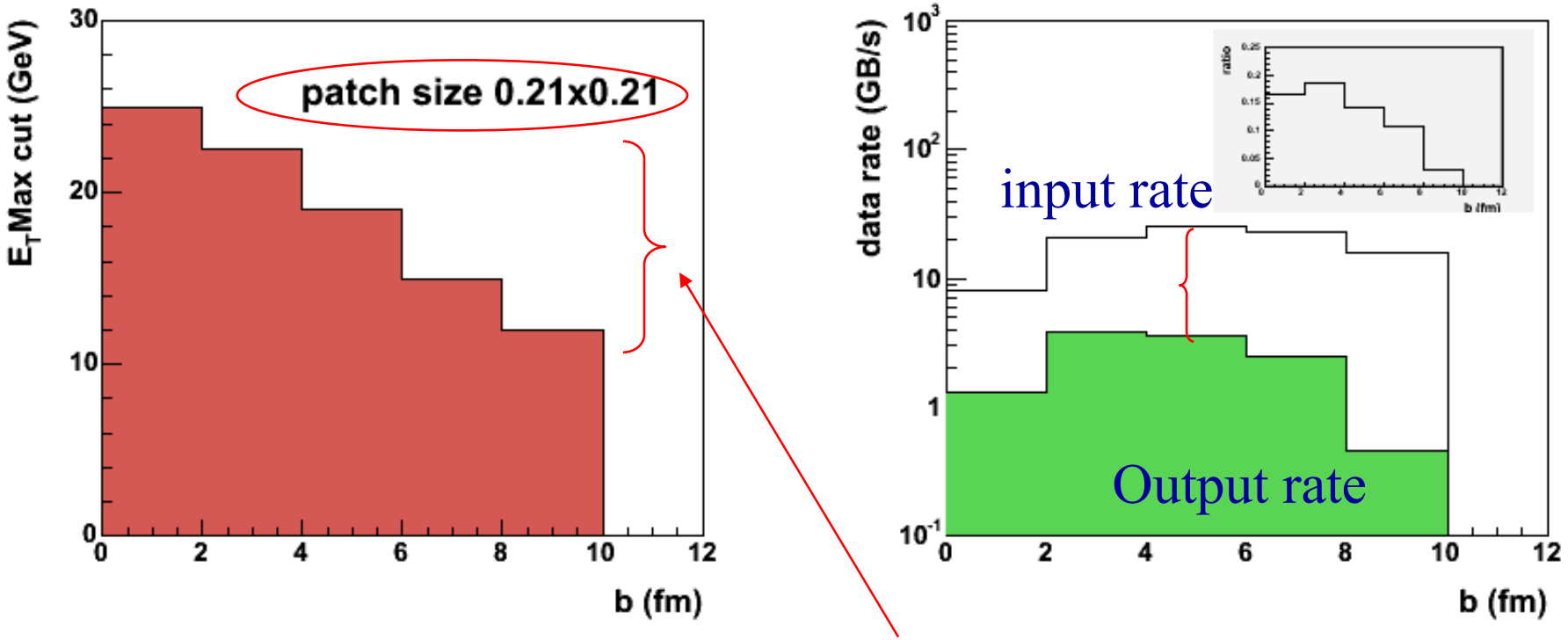




Weighted by N_{ch} ⇒ data volume

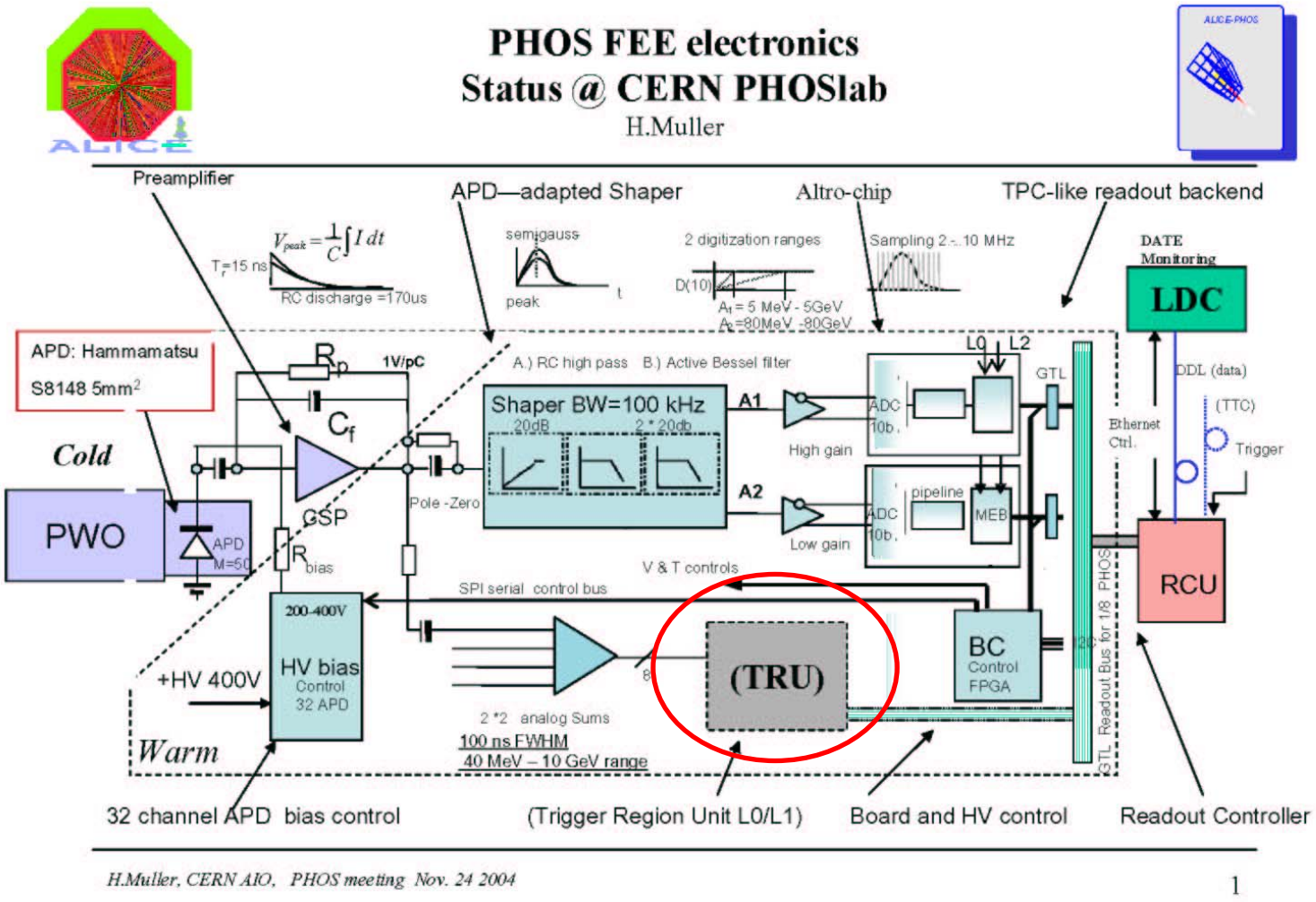
Obvious, unavoidable problem: jet is extended object ⇒ patch trigger integrates large background ⇒ need centrality dependent threshold

L1 output data rate for 80% jet efficiency @ 50 GeV



- factor ~2 centrality variation in threshold
- factor ~8 reduction in data rate
- rejection depends on patch size
- rejection vs efficiency is tunable, depends on backgrounds

PHOS trigger: Trigger Regional Unit

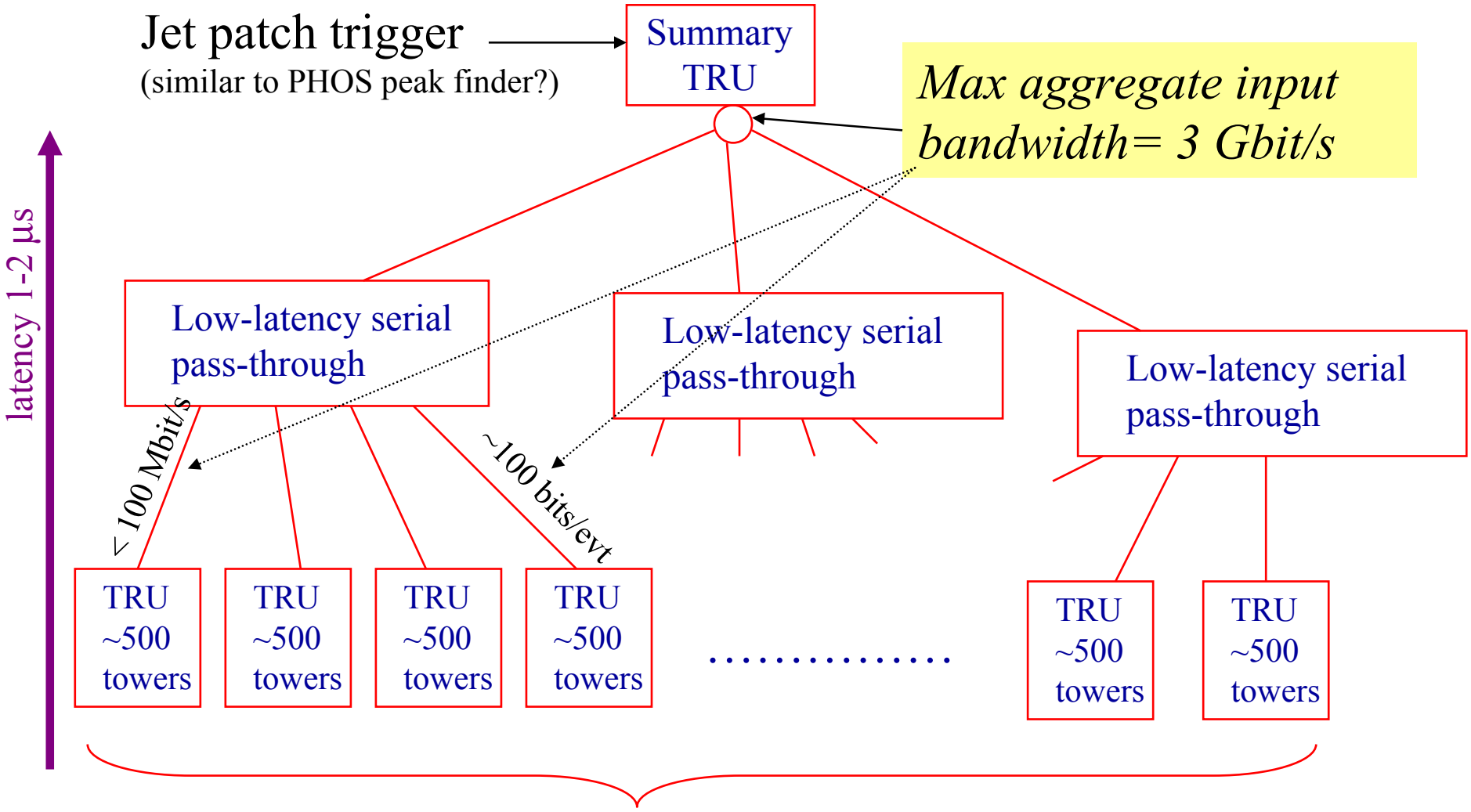


1 TRU ~ 500 towers $\Rightarrow \delta\eta \times \delta\phi \sim 0.2 \times 0.2$

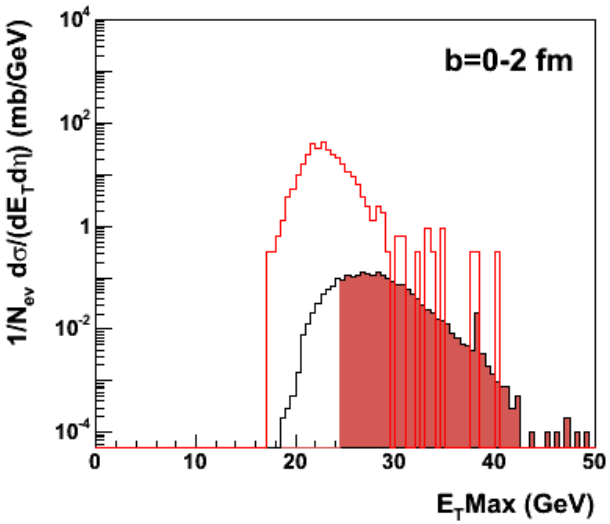
no inter-TRU communication

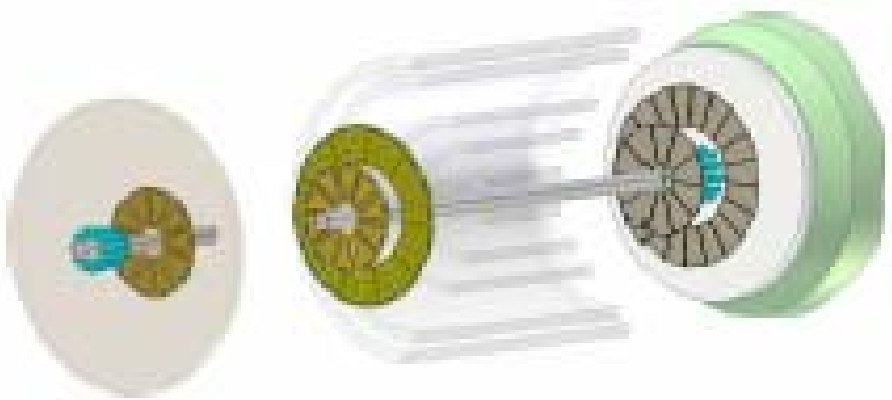
jet patch $\delta\eta \times \delta\phi \sim 0.2 \times 0.2 \Rightarrow$ strong boundary effects

Candidate implementation: TRU hierarchy



Centrality-dependent trigger threshold? V0





Uniform jet trigger efficiency across centralities: need to account for centrality-correlated pedestal fluctuations

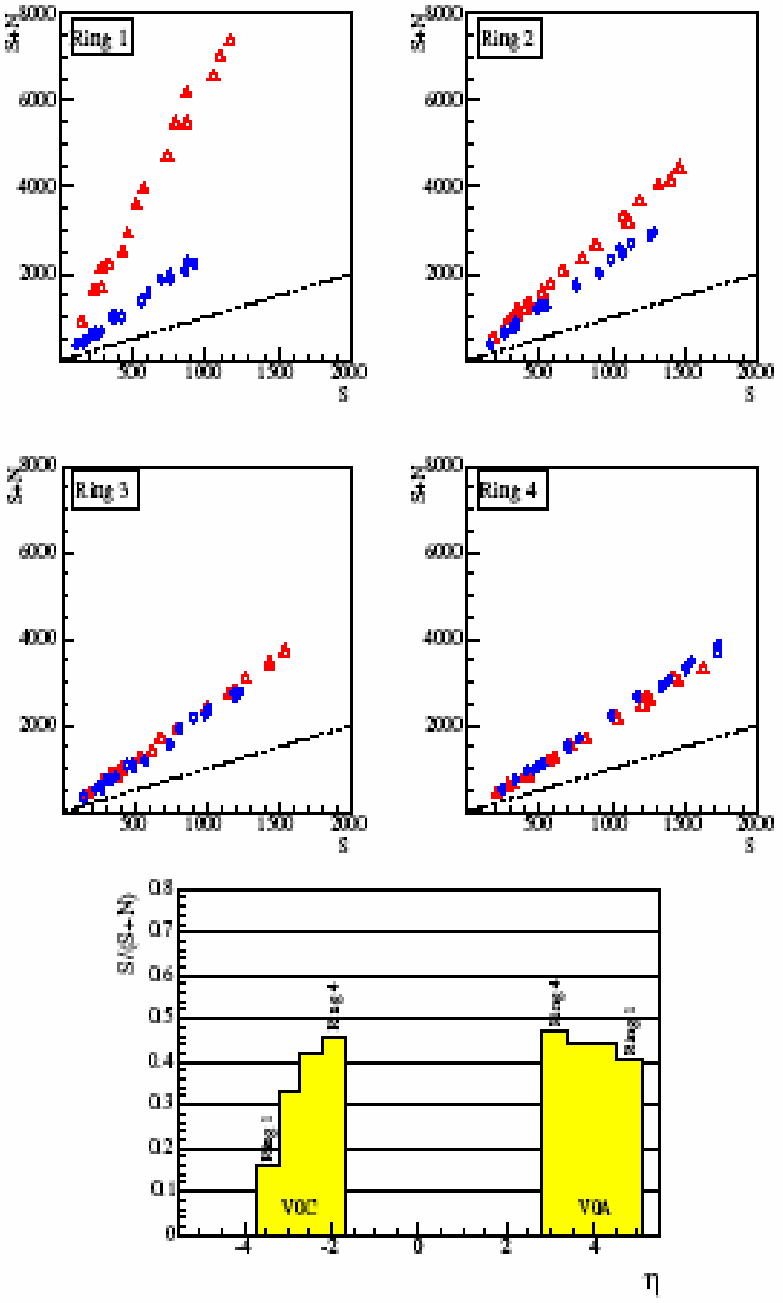
V0 is only fast (L1) detector with sufficient coverage

Detector	η_{min}/η_{max} A side (RB24)	C side (RB26)
T0	4.5 / 5.0	−3.3 / −2.9
V0	2.8 / 5.1	−3.7 / −1.7
FMD	1.7 / 5.0	−3.4 / −1.7

V0 response to Pb+Pb

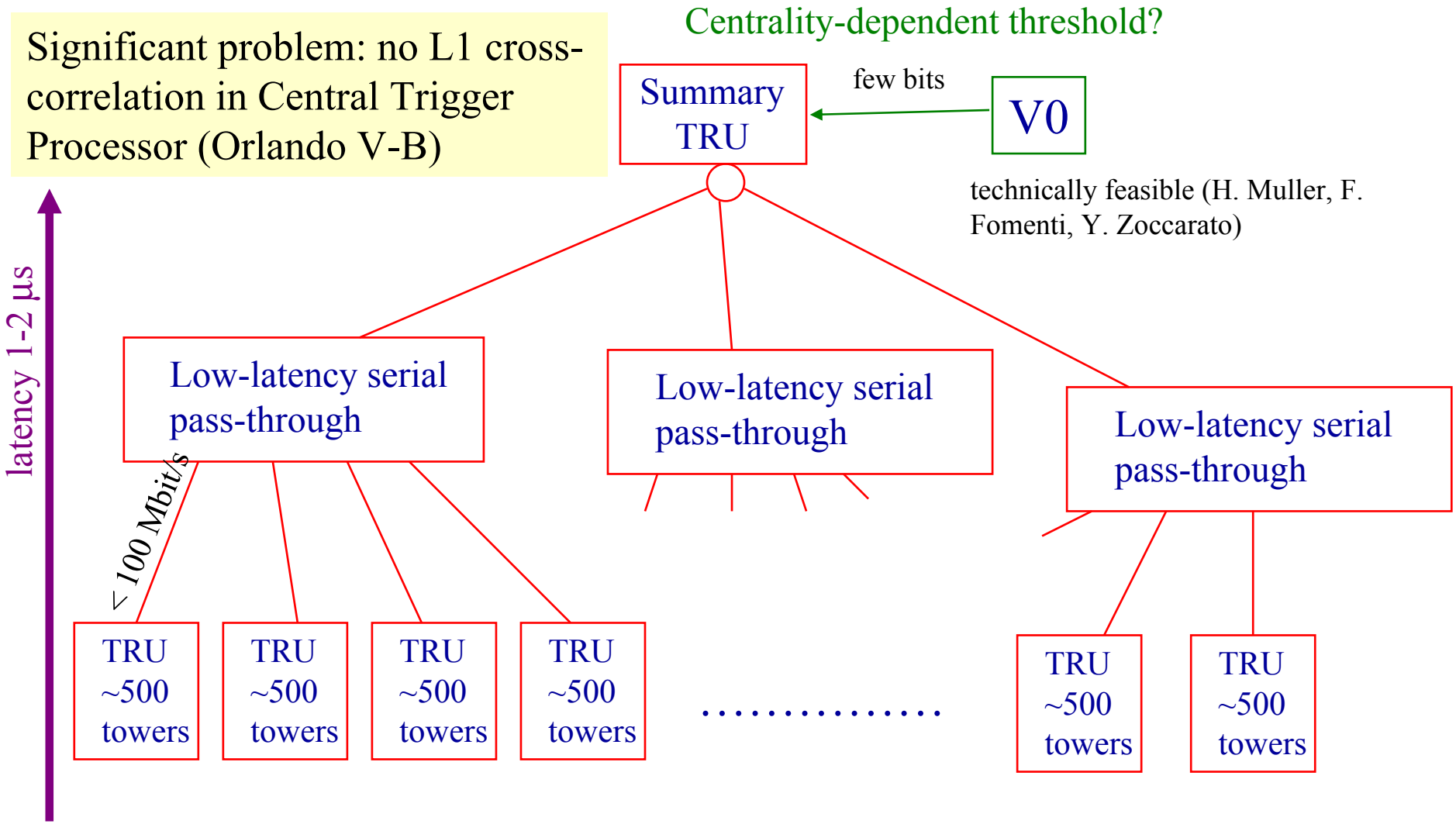
Large generation of secondaries in beampipe but response is nicely linear

Forward detector TRD fig 3.6



V0 bits in jet patch summary TRU?

Significant problem: no L1 cross-correlation in Central Trigger Processor (Orlando V-B)



System design issues: non-locality of trigger logic (i.e. not in CTP), scalars,… ⇒ needs more discussion

L0 triggers for p+p?

In principle: EMCAL can supply effective L0 jet trigger in p+p

Simple guess: total E_T in EMCAL provides efficient jet acceptance and good background rejection

Other p+p L0/L1 triggers: π^0/γ, electrons

Some talking but no actual progress yet in this direction…

EMCAL and jet triggers: task list

- simulation of jet patch algorithms including digitization effects

- Centrality fluctuations: understand V0 and CTP issues, other ways to do correction?

- High level trigger: continue from where Constantin left off, incorporate EMCAL $\Rightarrow$ what are ultimate efficiency and rejection?

- TRU heirarchy FPGA resources issues, pass-through latency, etc

- p+p L0 jet trigger?

- EMCAL pi0, gamma triggers
- …..