PHASE II MUON UPGRADE SUMMARY

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CONTRIBUTIONS

- Simulation tools
  Vadim Khotilovich
- Muon chambers - Tracker association algorithms
  Ignazio Lazzizzera, Bobby Scurlock
- MTT development
  Alessandro Montanari, Oliver Pooth
- RPC Trigger Upgrade
  Archana Sharma

SIMULATION TOOLS (1)

Goal: to provide full simulation framework that realistically describes performance of the future CMS detector and muon trigger at SLHC luminosities

Why full simulation?

- studies of trigger primitives depend on realistic simulation of rather subtle effects in incredibly busy environment
- Simplifications in fast simulation make detailedmuon trigger simulations unreliable
- Understanding occupancy and BX related effects and backgrounds make Full Geant simulation the only viable option

Vadim Khotilovich

SIMULATION TOOLS (2)

High PU FullSim Machinery

- Custom SLHC FullSim framework by TAMU:
  - Needed in order to cope with memory hungry high PU FullSim
  - FullSim in fraction of detector, drop unnecessary data
  - Stable & reliable for efficiencies & single object rates estimates
  - Can simulate muon systems+long barrel tracker with PU400 in full DT or half of CSC
  - Twiki: SLHCFullSim
- It is still a short term fix
  - Can't study rates of global trigger or physics processes

Neutron Backgrounds

- Machinery for simulation of MB+neutrons is almost ready (Rick Wilkinson)
  - Will be included in CMSSW_3_4_0
  - Neutrons simulation takes ~30x longer /event than for regular MB
  - Waiting on MixingModule developers for a special "neutron" input

Vadim Khotilovich

SIMULATION TOOLS (3)

Samples

- Small samples available for Phase I emulator studies
  - PU hits digitized only for muon systems
  - Bigger samples would be necessary for rates estimation
- samples for Phase II (with new tracker)
  - PU (if present) is digitized in tracker and muon systems
  - No-PU samples for Florida's track-muon matching studies available

- Simulation of muon systems+long barrel tracker with PU400 in full DT or in half of CSC
  - Would require substantial amount of computing resources
  - Working framework exists: whoever needs it is welcome to use it
  - Plan to start some production before End of the year in LNL-Padova

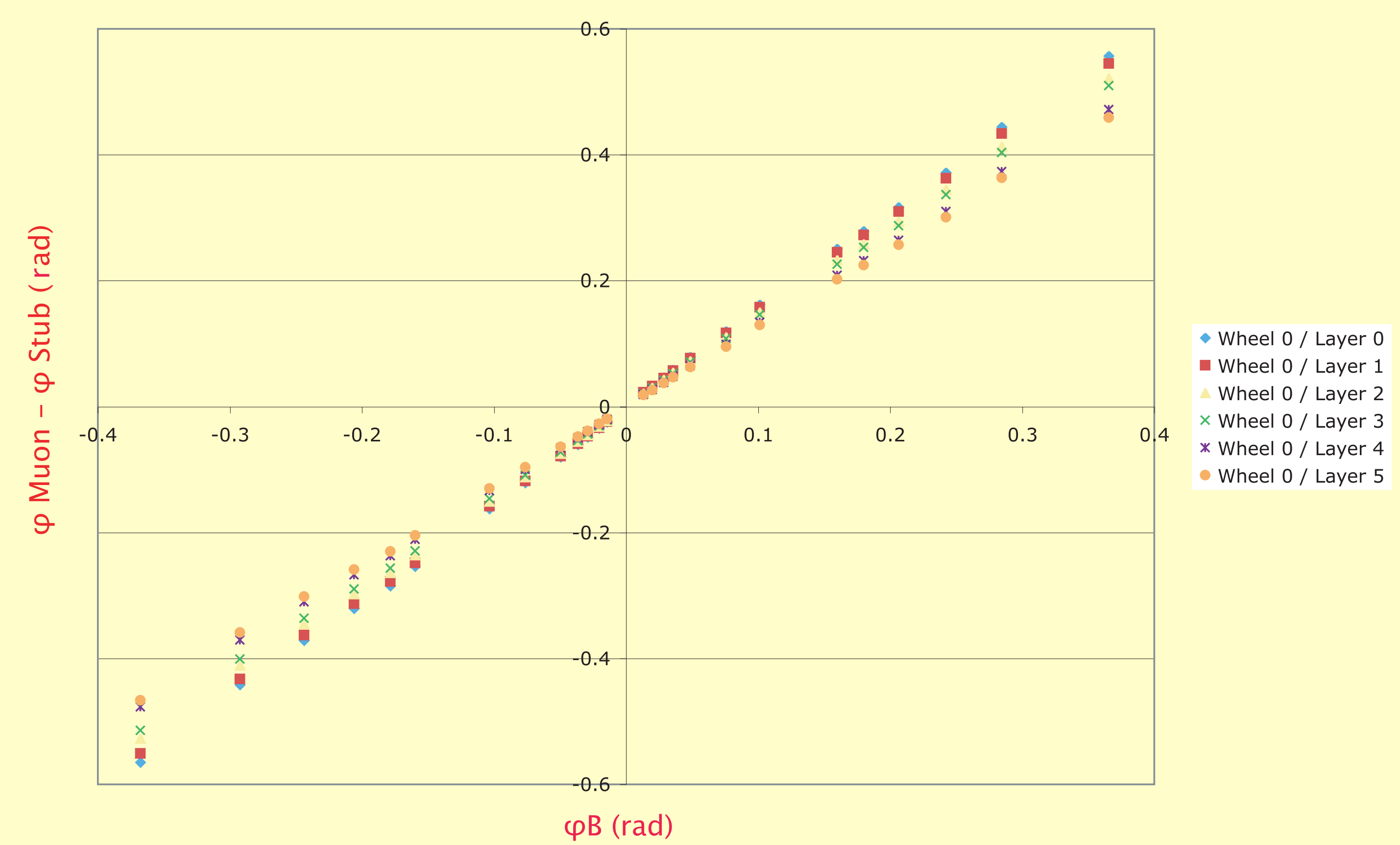
Vadim Khotilovich

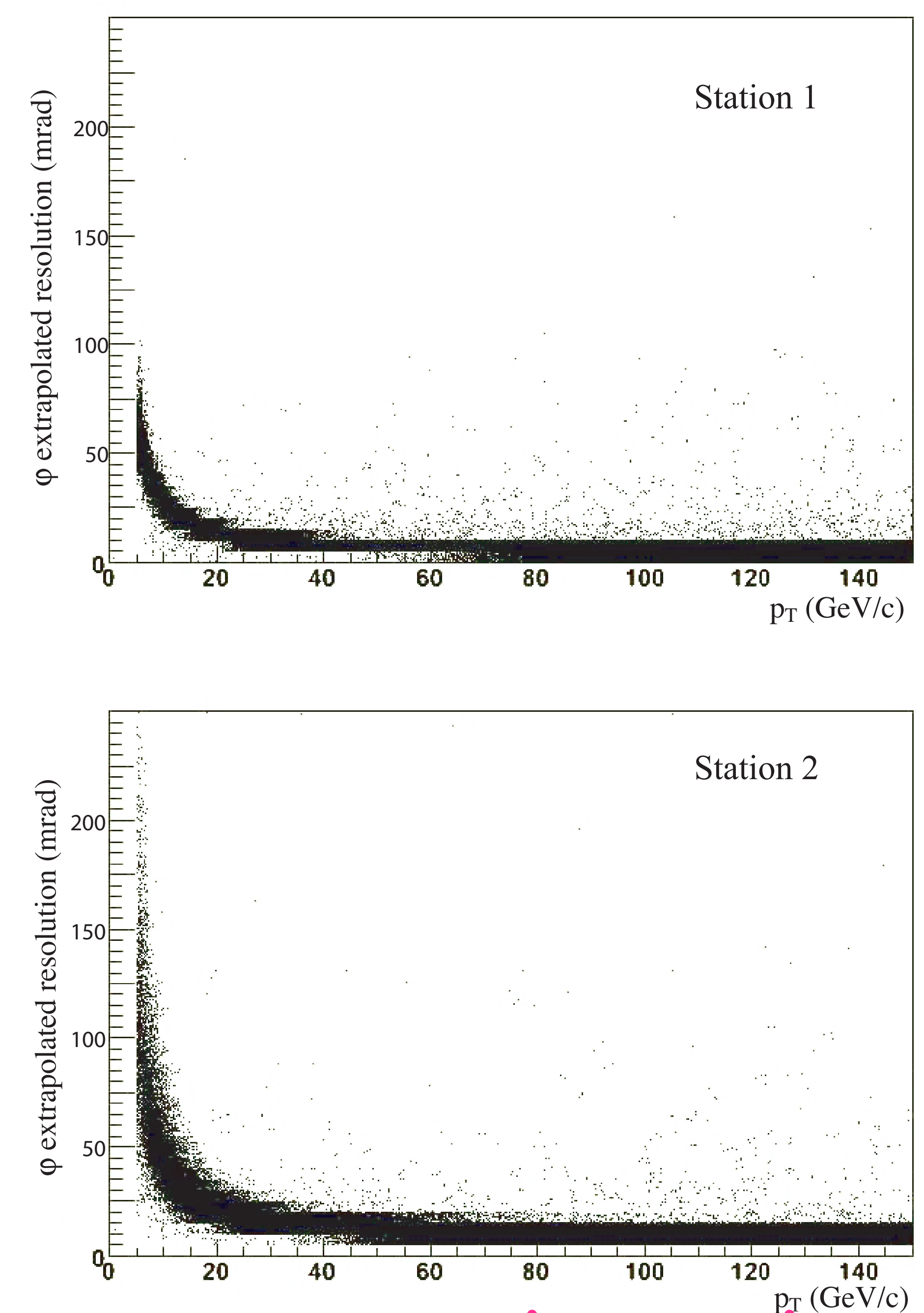
MUON-TRACKER ASSOCIATION STUDIES

Barrel and Forward groups are both working with a similar approach

- Extrapolate of the Trigger Primitives to the Tracker layers
  - linear extrapolation before track finding in the barrel
  - LUTs from CSC Track Finder estimation in the forward
- Define dinamically the size of the matching region depending on candidate PT and pseudorapidity
- Match with stubs of stacked layers
- Muon Trigger Primitive candidate confirmation
- Momentum re-computation using muon point and/or matched stubs

BARREL WINDOWS



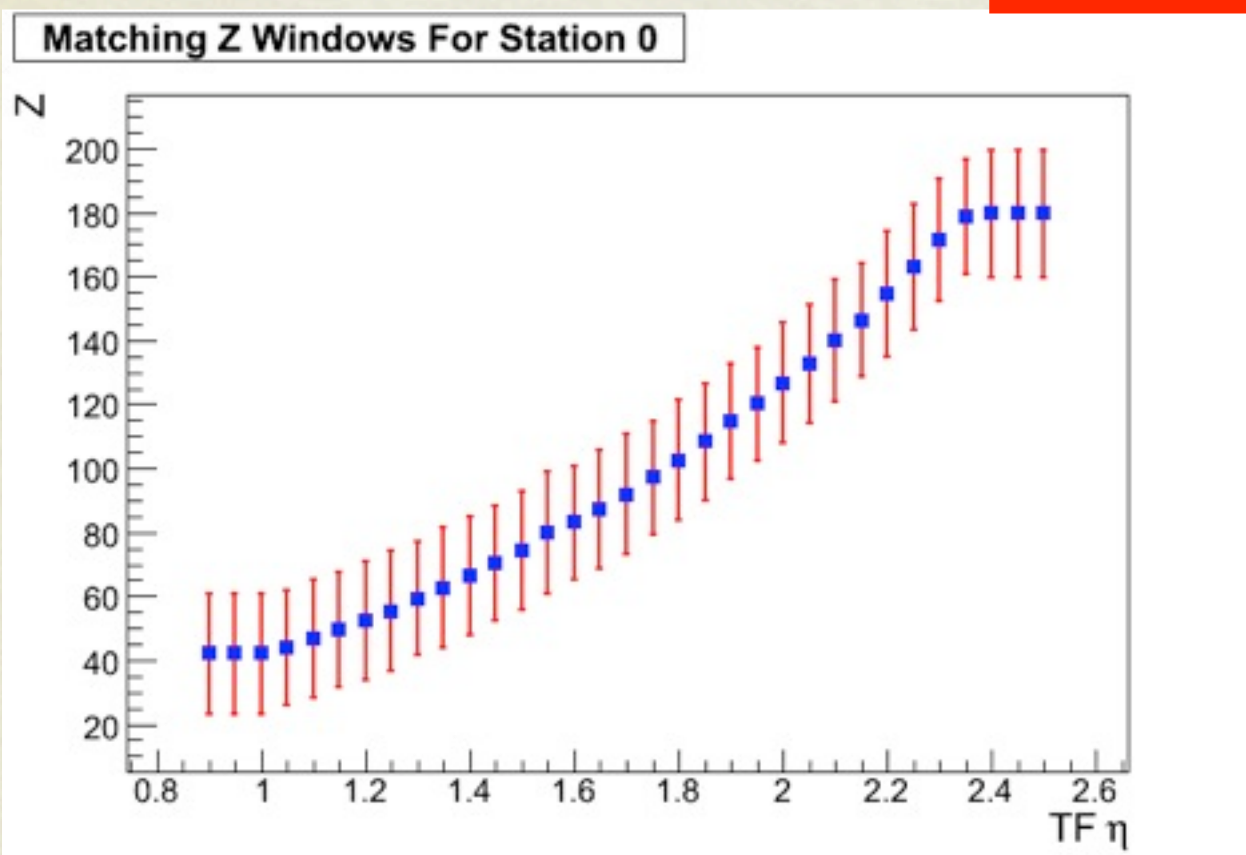


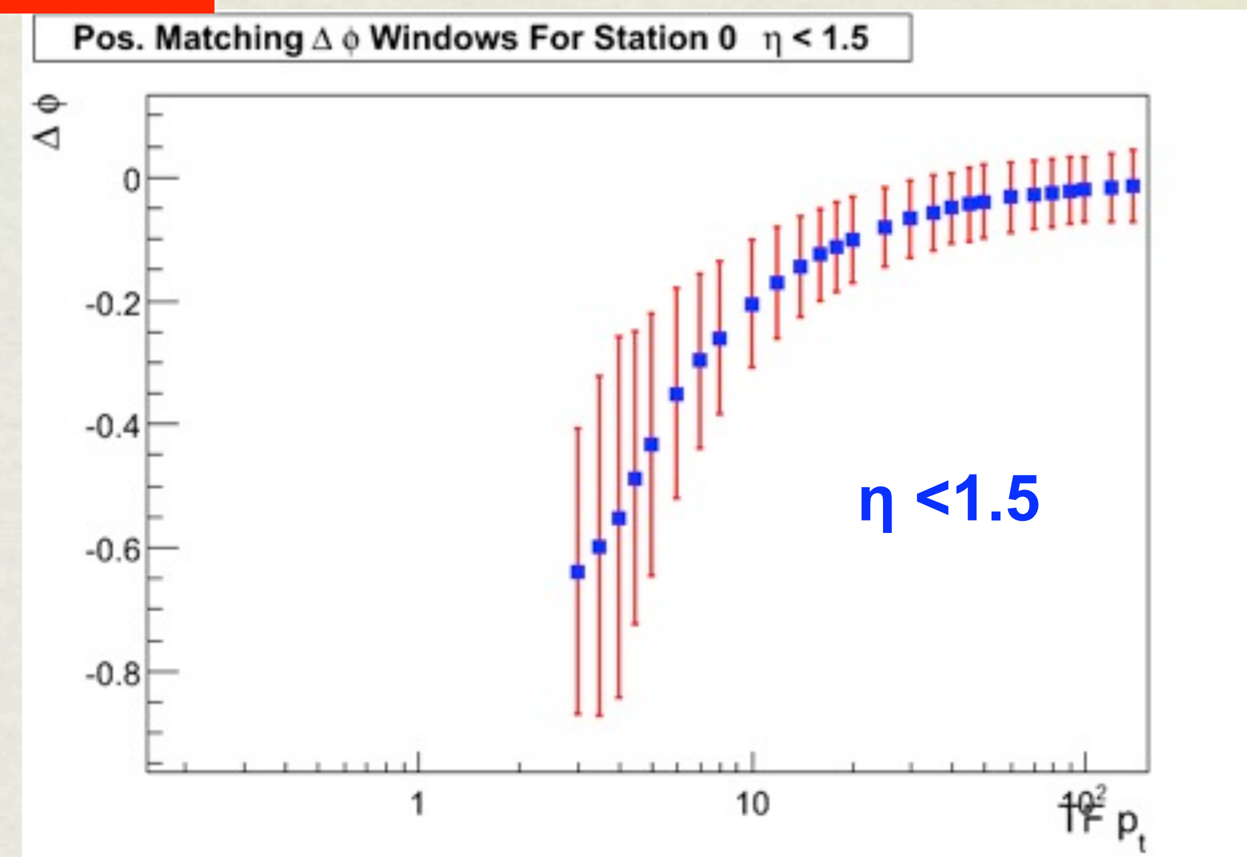
φ window (PT dependent)	at 100 GeV size is ±15 mrad at 10 GeV size is ±90 mrad
θ window (r dependent)	at 35 cm size is ± 300 mrad at 55 cm size is ± 180 mrad at 100 cm size is ± 90 mrad

Ignazio Lazzizzera

FORWARD WINDOWS

Double Stack 0



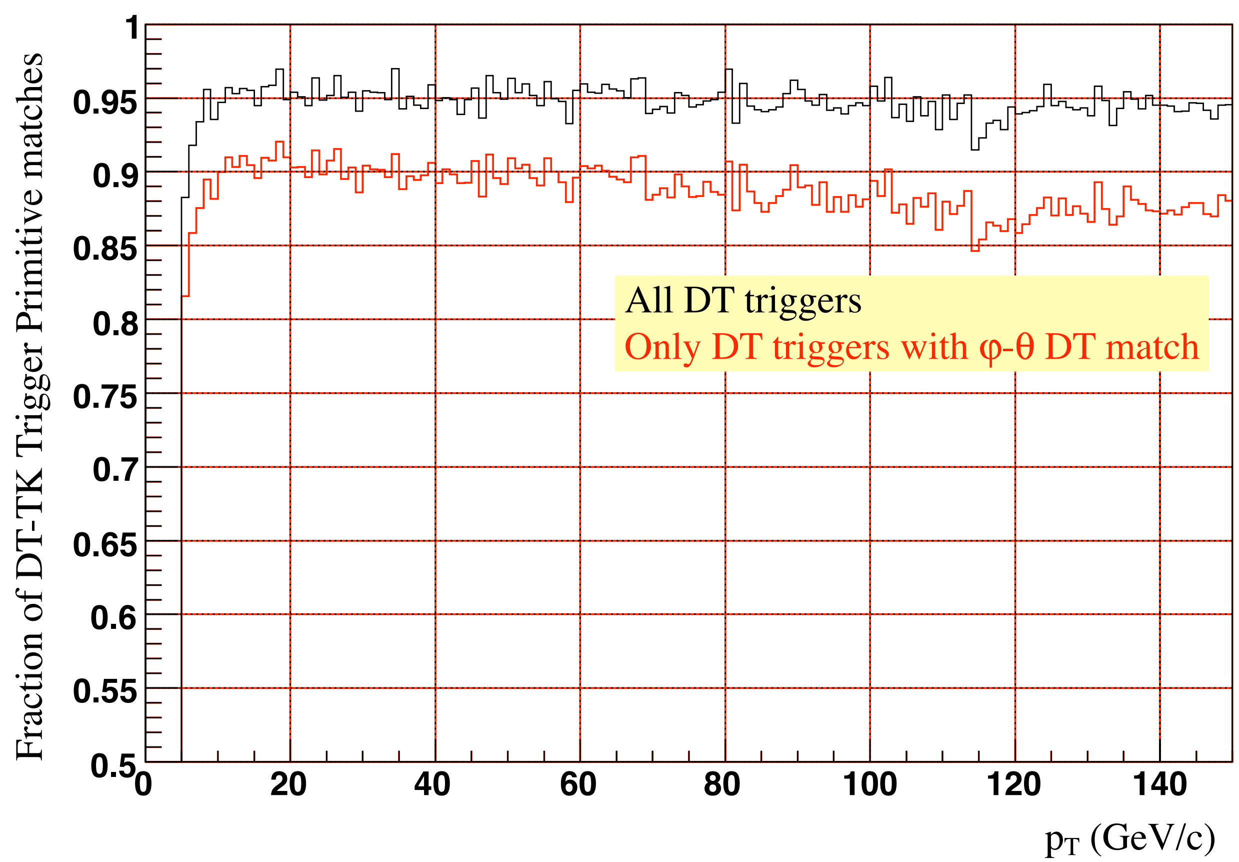


Matching Z_{TF}-$Z_{tracker}$ windows

Matching φ_{TF}-$\varphi_{tracker}$ windows

Bobby Scurlock

MUON -TRACKER MATCHING EFFICIENCIES

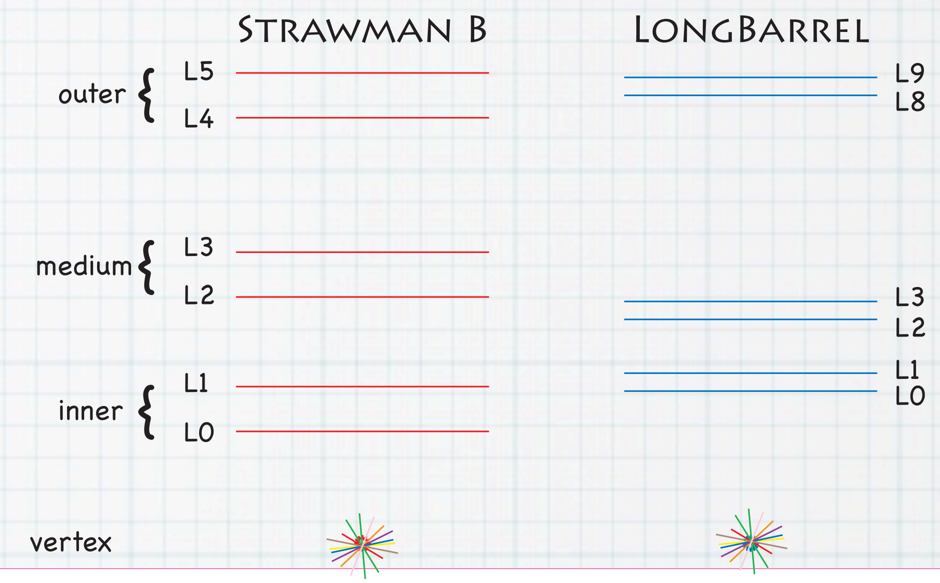


Barrel

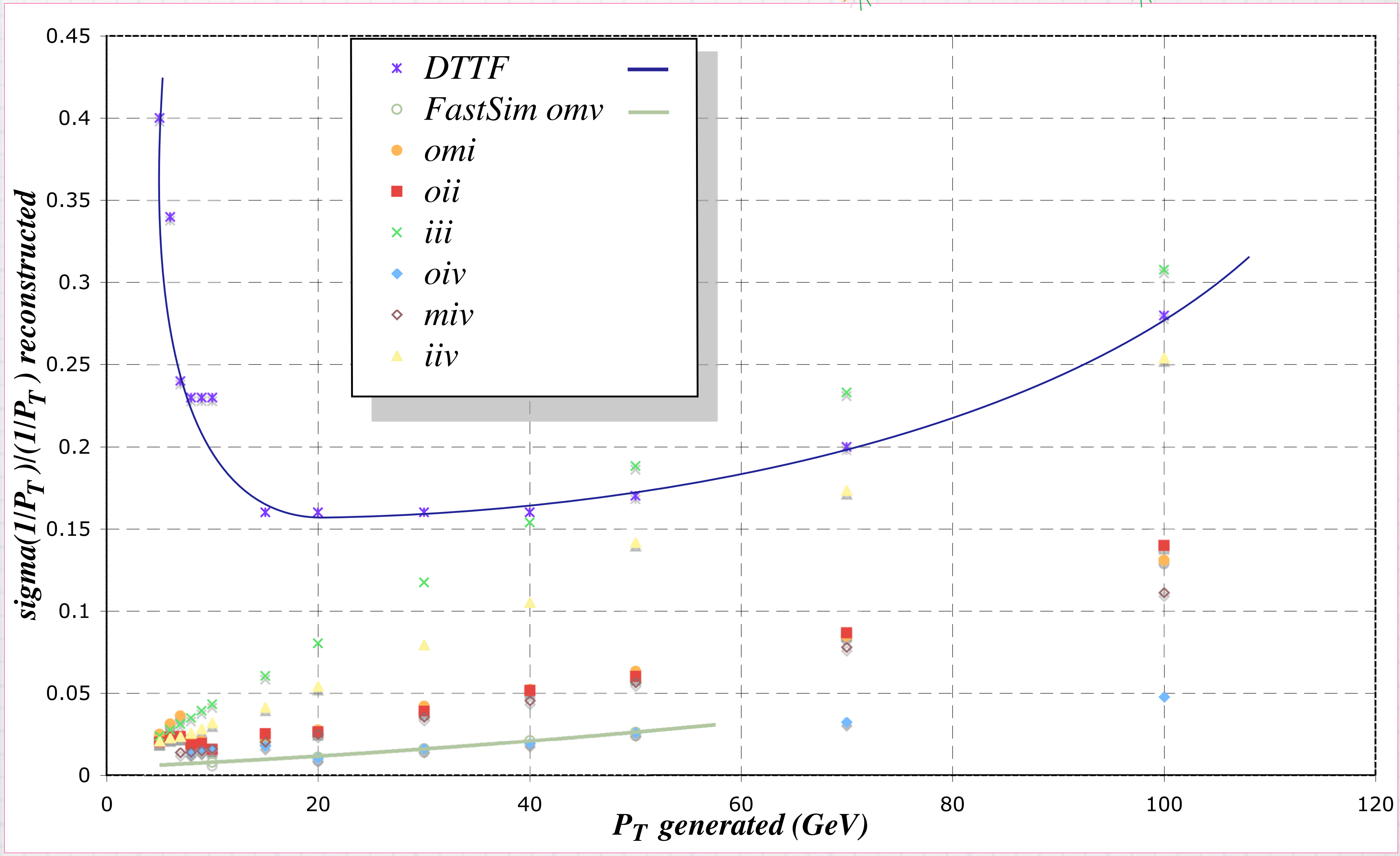
Forward

Ignazio Lazzizzera, Bobby Scurlock

Momentum fit resolution



- Large dependence on lever arm
  - innermost and outermost points position are driving result
  - middle point position almost negligible
- Vertex constraint really strong
  - should we dare to impose it? Caution needed with long lived particles ...
- Even small lever arm useful to improve resolution at low P_T
- Early FastSim results confirmed

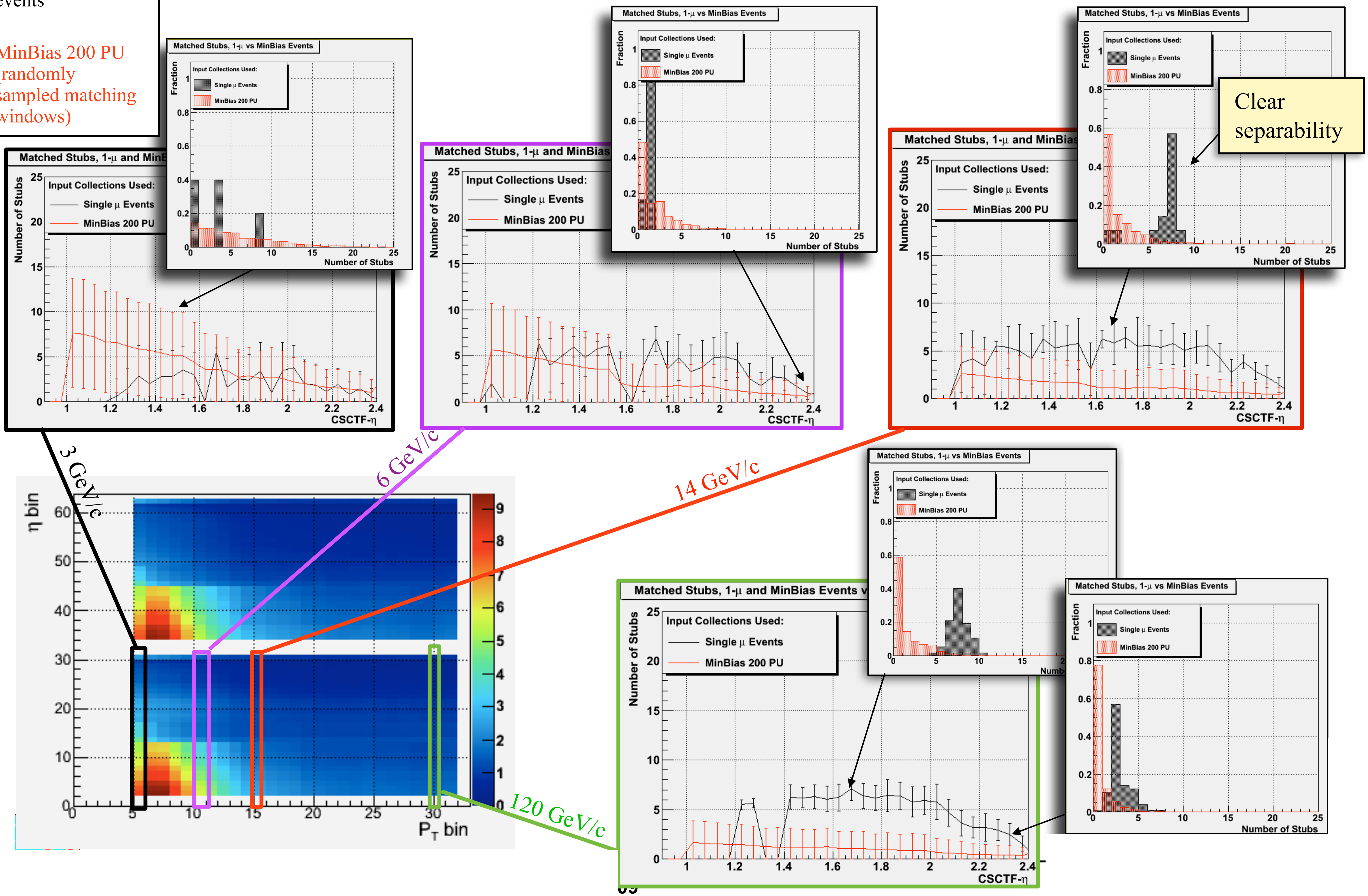


Ignazio Lazzizzera

Matching Windows: Signal versus Background

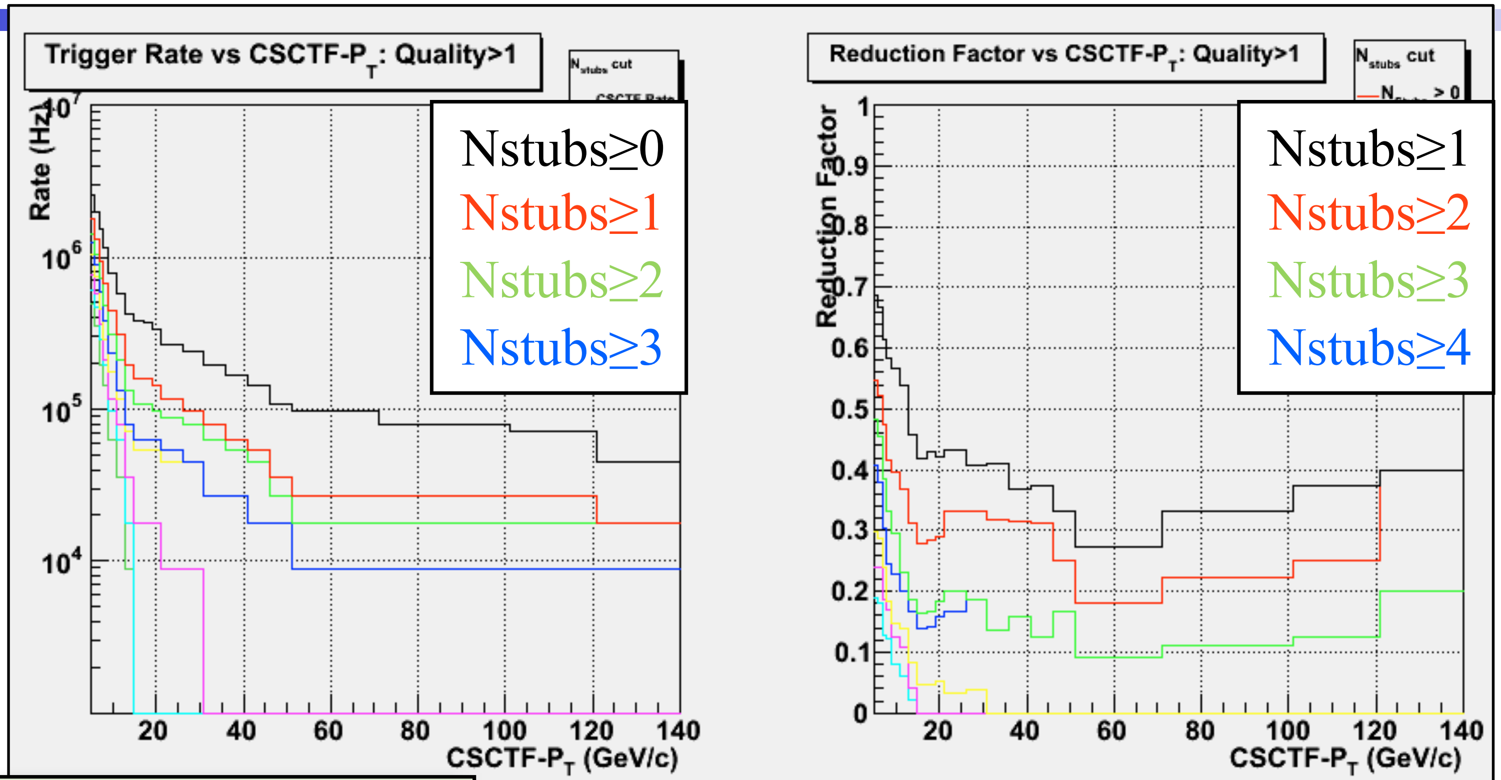
Single muon events

MinBias 200 PU (randomly sampled matching windows)



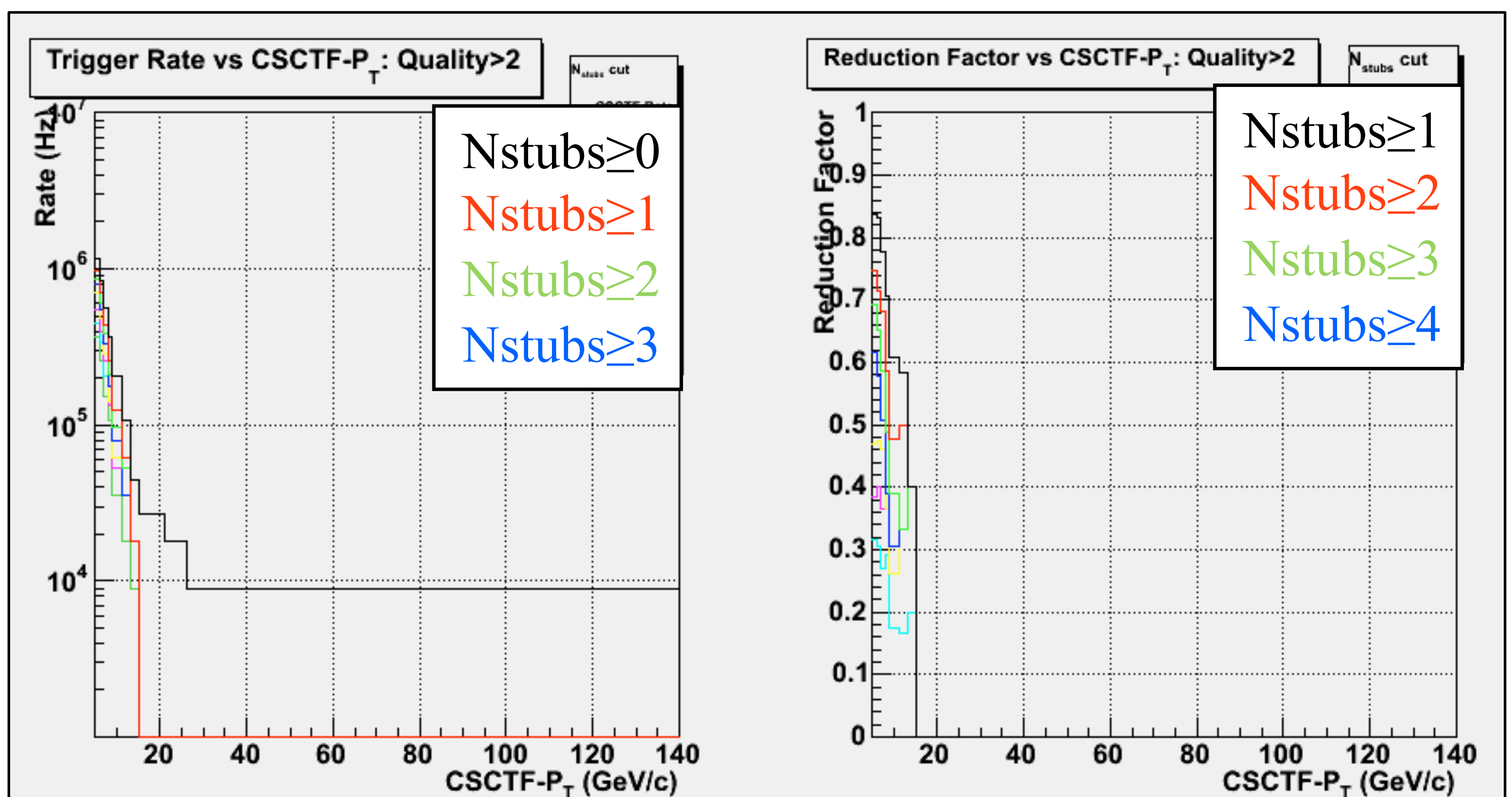
Bobby Scurlock

Rate Reduction from stubs in Matching Windows



Rate and relative reduction contours with Quality≥2 CSCTF Tracks (versus Nstubs matching window cuts)

Rate with Quality=3 CSCTF Tracks

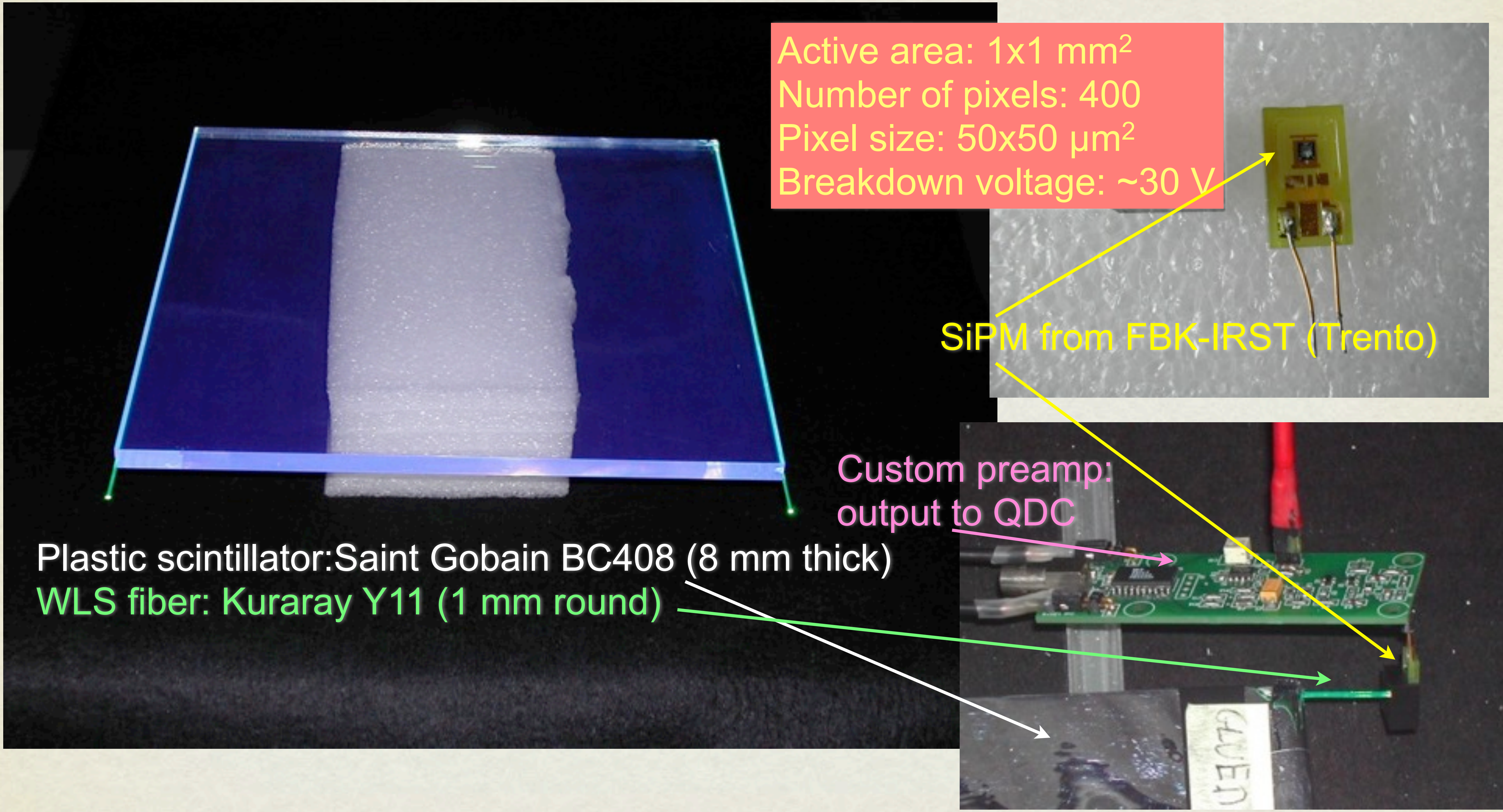


Rate reduction power is mostly related to CSCTF Quality. Improperly seeded windows miss underlying stubs. This can be a powerful weapon against CSCTF mis-measurement!

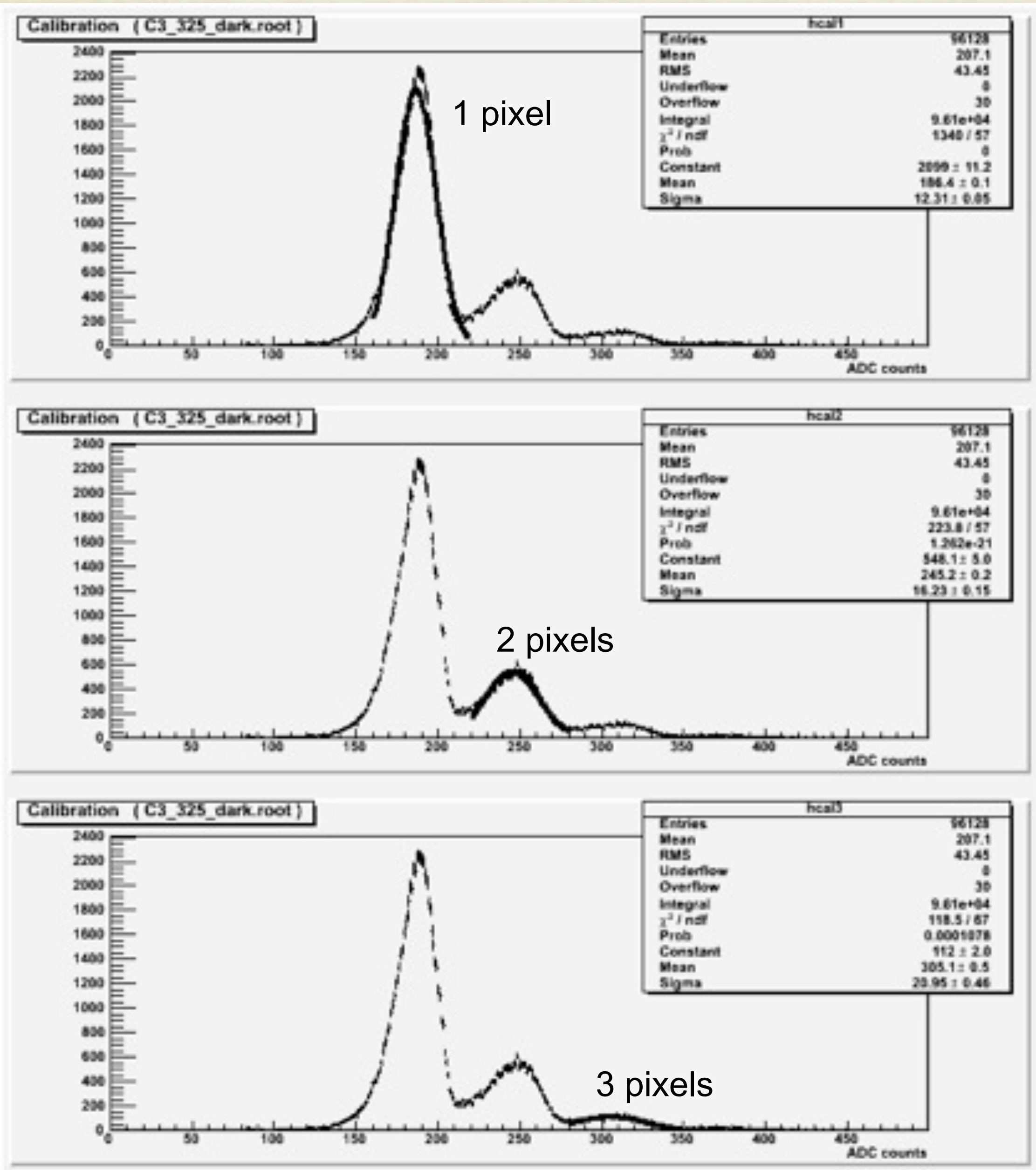
HARDWARE - MTT

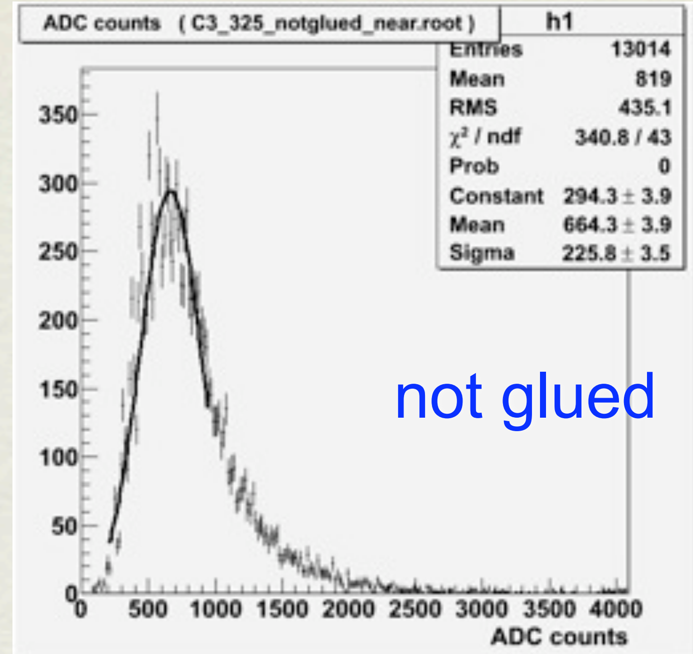
- Muon Track fast Tag
  - initially (2007) proposed as a possible device for
    - fast selective readout of Tracker (Static Mapping)
    - improvement of RPC trigger
    - ghost/fakes suppression in MB1
  - now, in the new Tracker scenarios
    - it is still possible to send fast muon tag (L0 trigger) to some stage
    - it allows ghost/fake suppression in MB1 for Dynamic Mapping
  - various hardware implementation are under study
    - new RPC with 2D readout (Bari)
    - scintillator tiles (Aachen, Bologna)

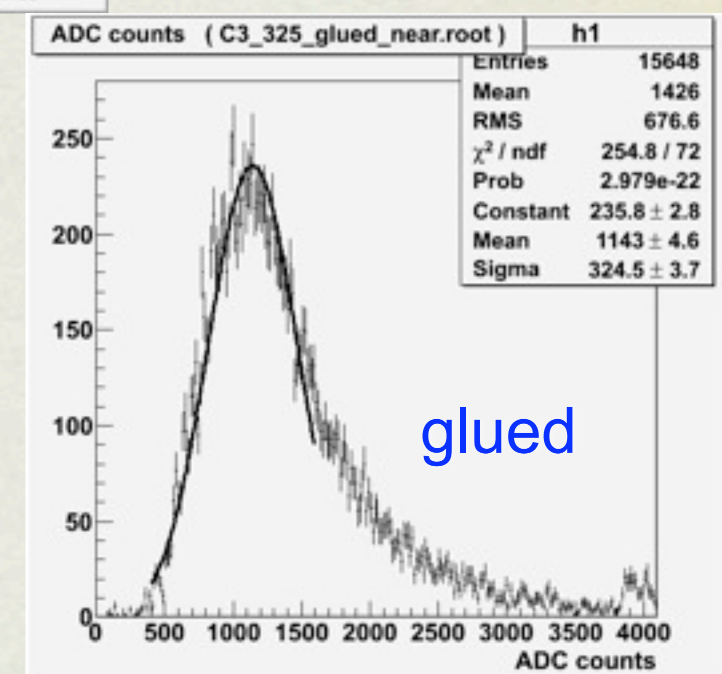
Alessandro Montanari



Prototype built and tested in Bologna







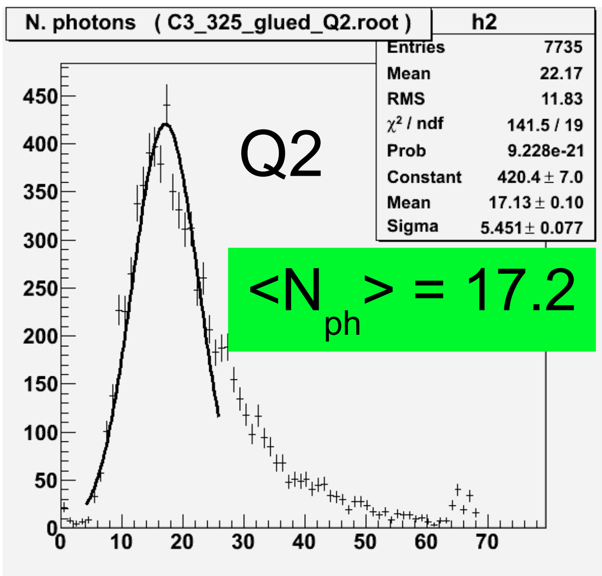
Measured # of photoelectrons collected

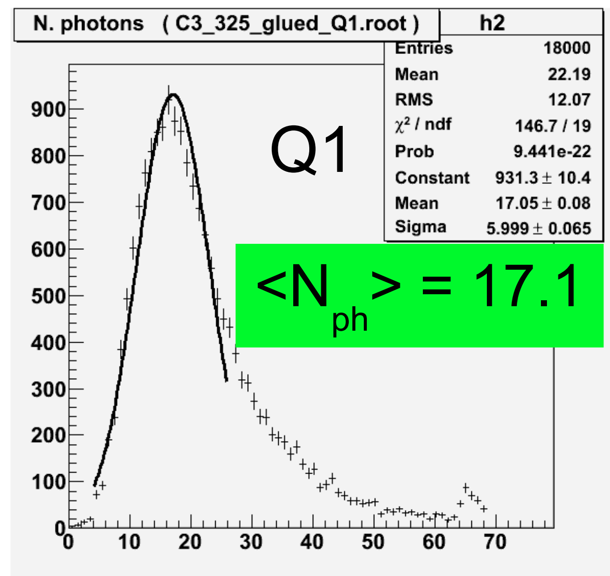
$\langle N_{ph} \rangle$(not glued) = 9.0
$\langle N_{ph} \rangle$(glued) = 17.1

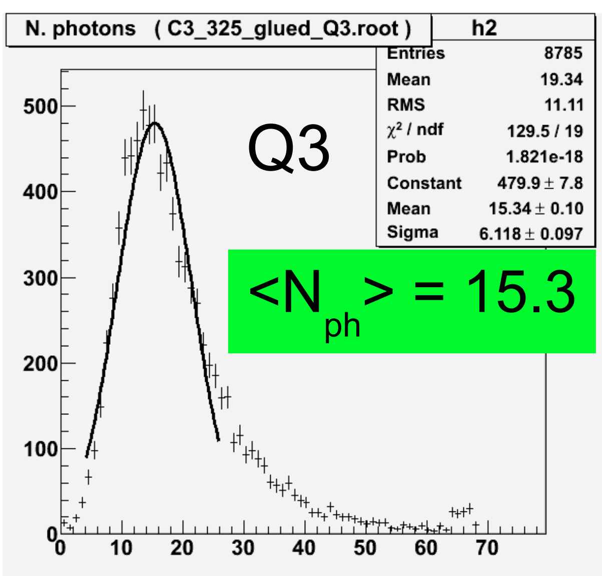
Clearly distinguish number of fired pixels

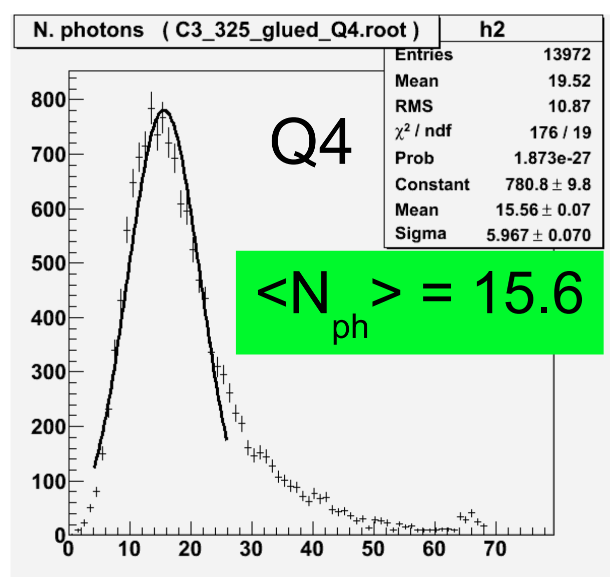
Alessandro Montanari

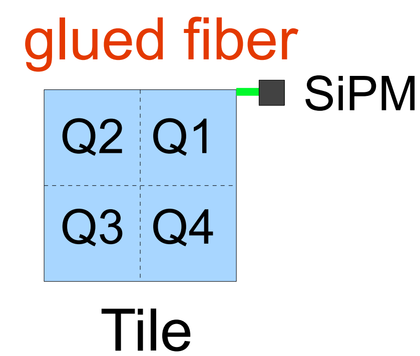
Light collection uniformity











Q2	
Thr (#ph)	Eff.
≥ 4	99.5
≥ 5	99.5
≥ 6	99.3
≥ 7	98.9

Q1	
Thr (#ph)	Eff.
≥ 4	99.9
≥ 5	99.7
≥ 6	99.3
≥ 7	98.8

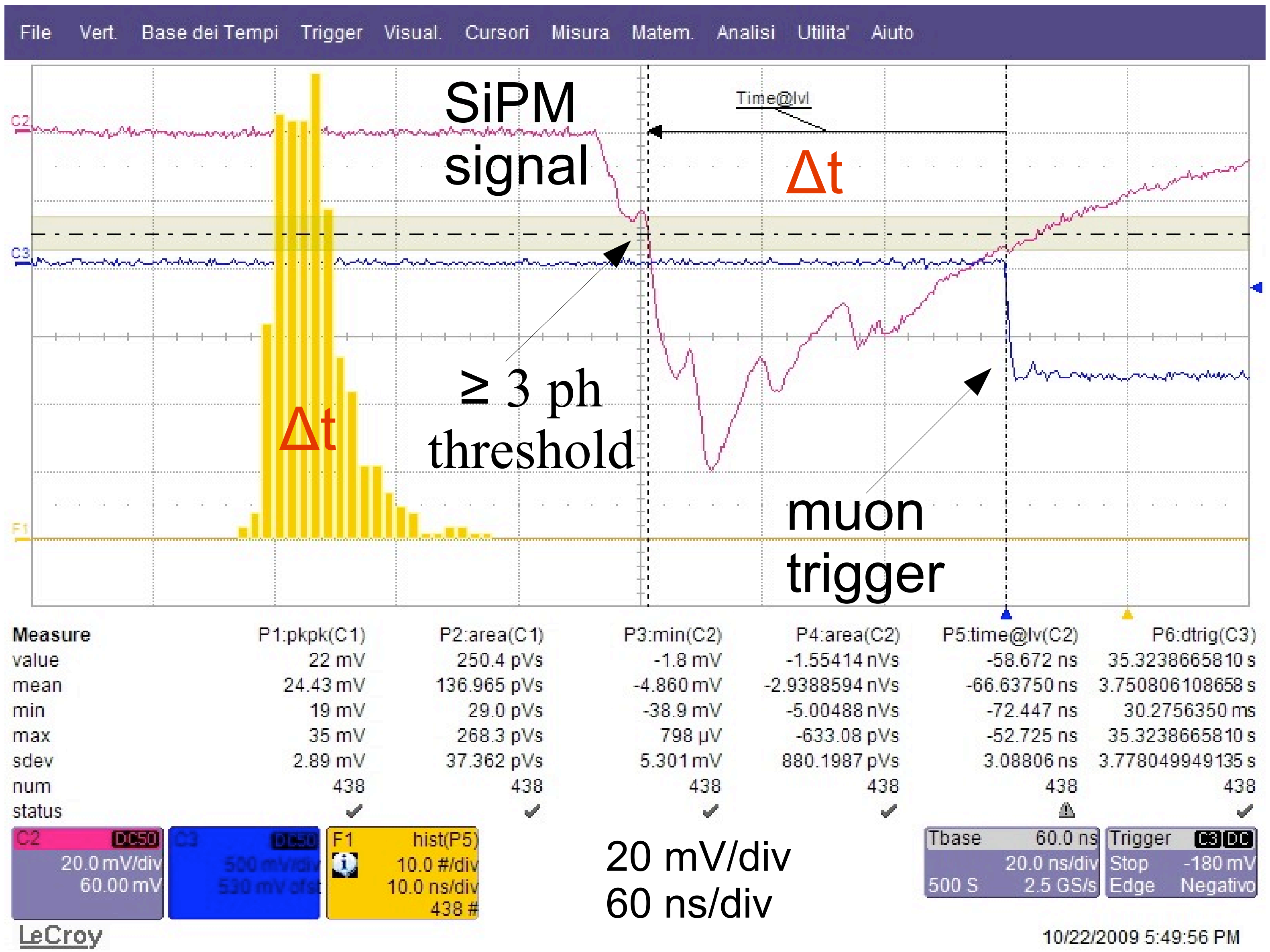
Q3	
Thr (# ph)	Eff.
≥ 4	99.5
≥ 5	99.1
≥ 6	98.4
≥ 7	97.2

Q4	
Thr (#ph)	Eff.
≥ 4	99.8
≥ 5	99.4
≥ 6	98.8
≥ 7	97.8

10% more light closer to fiber

Time walk

Timing resolution is dominated by the the spread in arrival times of the collected photons: it can be improved with more efficient light collection

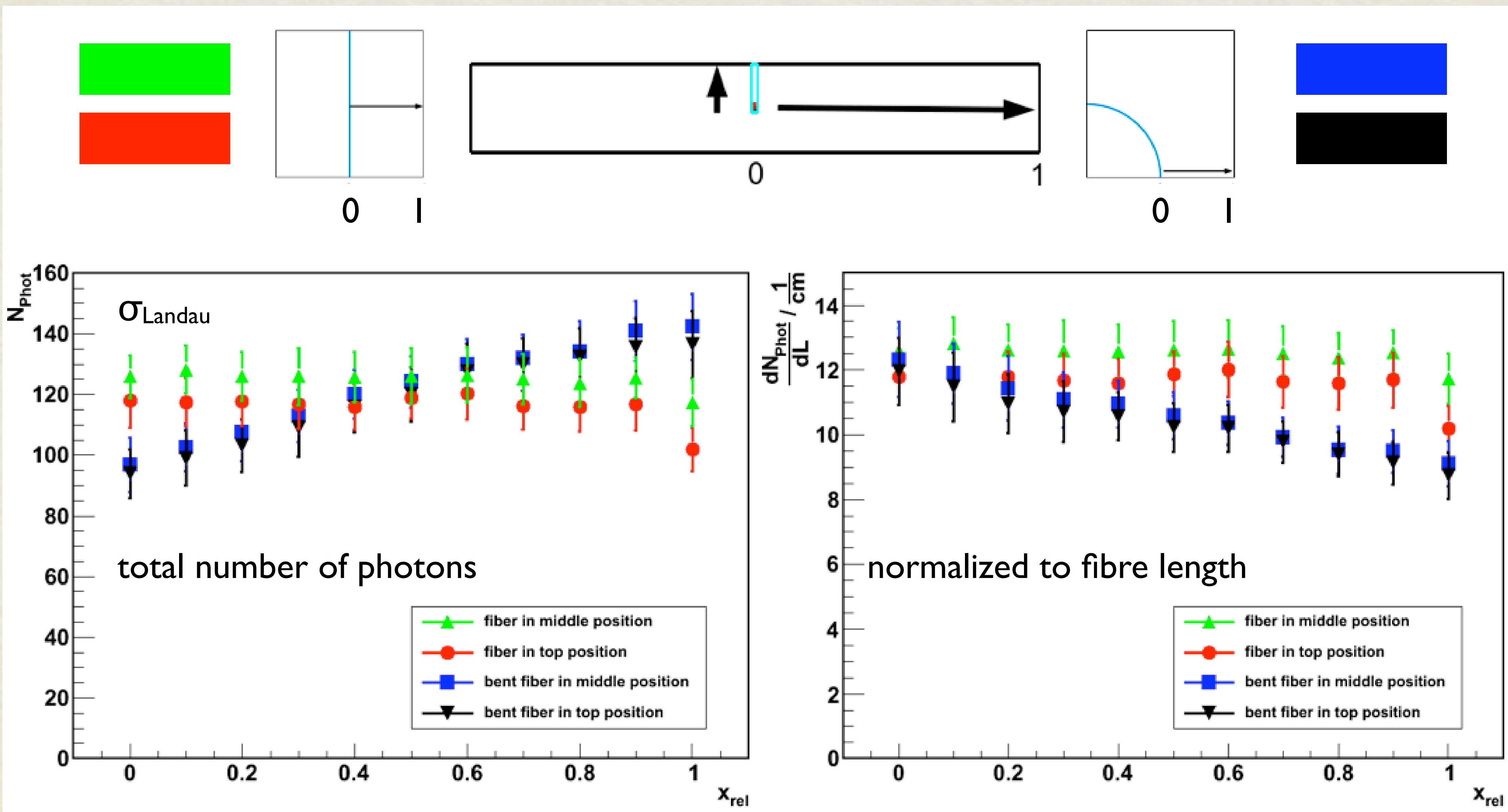


Threshold (# photons)	RMS of arrival time (ns)
≥ 2	2.7
≥ 3	3.0
≥ 4	3.4
≥ 5	3.6
≥ 6	3.7

Alessandro Montanari

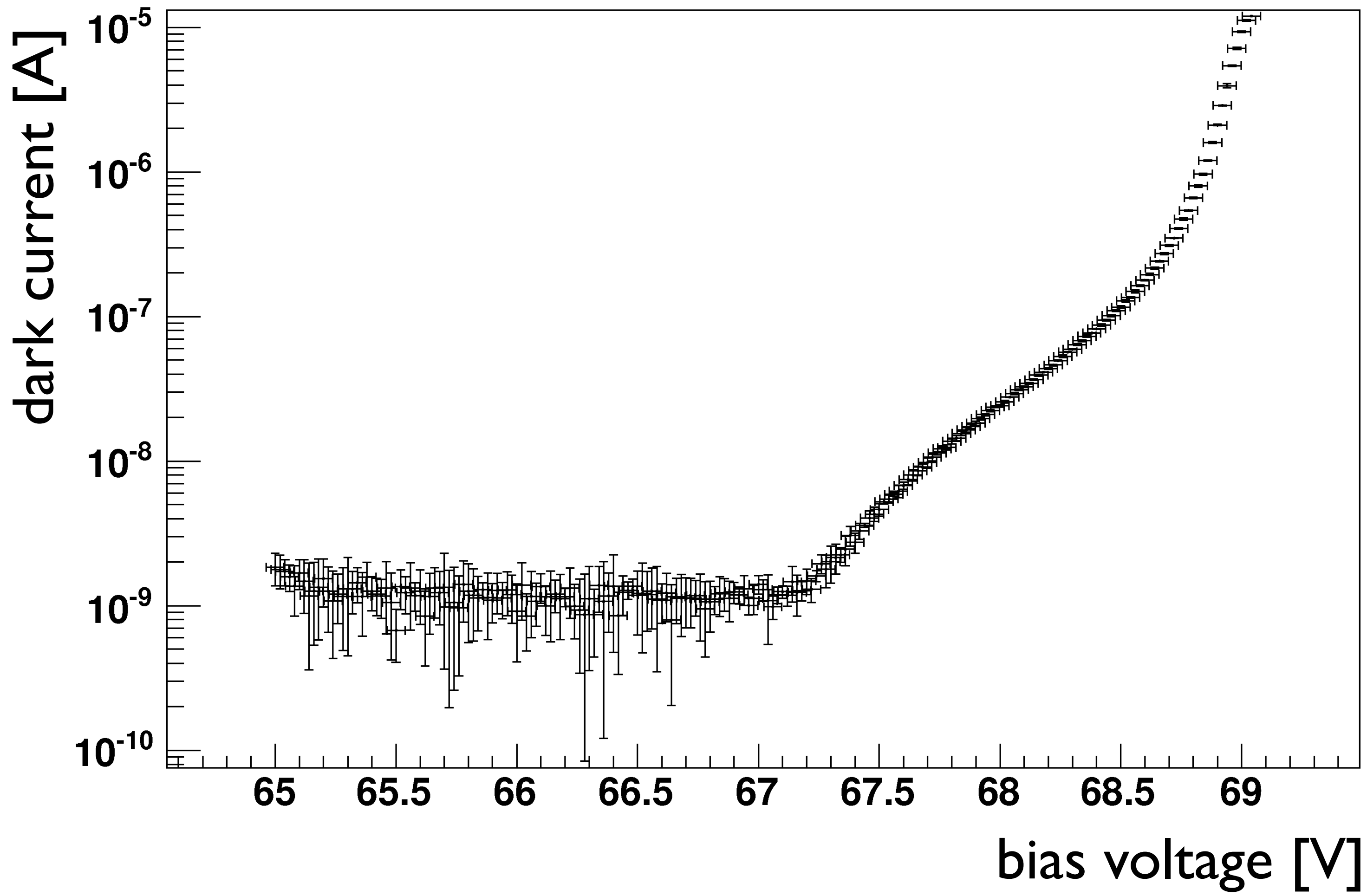
MTT ACTIVITIES IN AACHEN

Developing a MC simulation of light collection for MTT scintillator option



Oliver Pooth

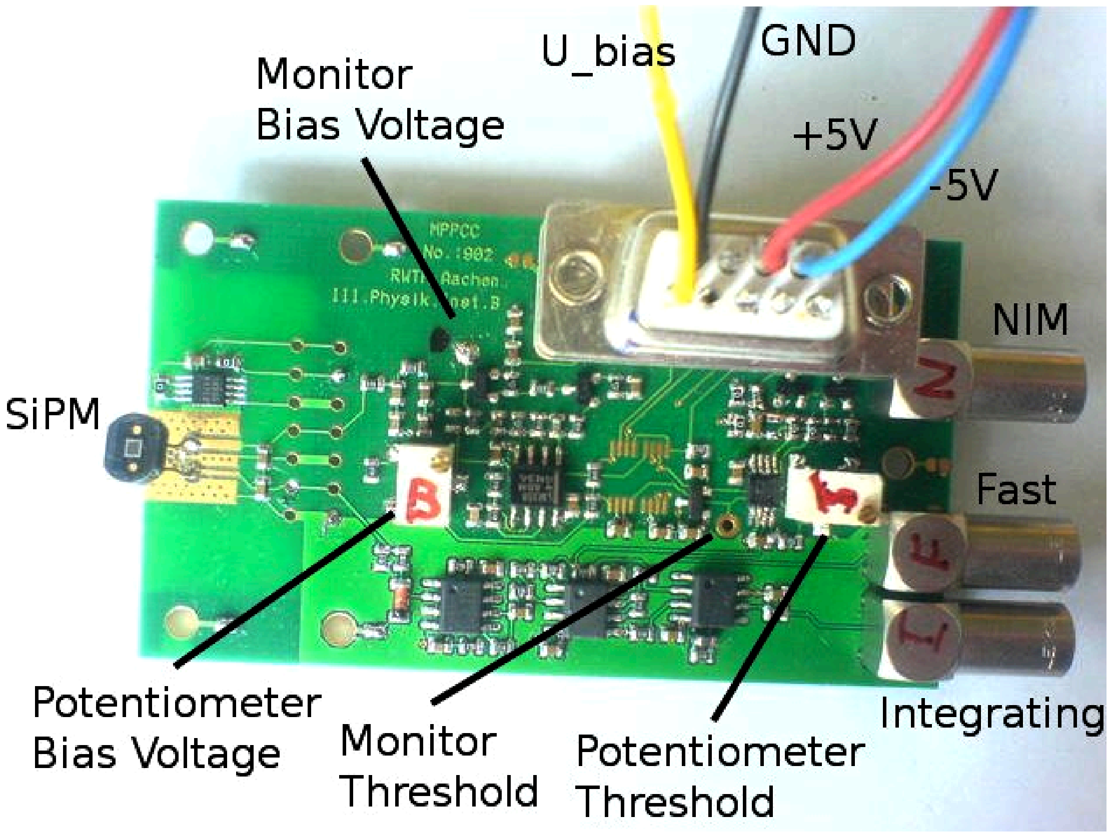
Other projects



Fine characterization of SiPM

Development of FE electronics

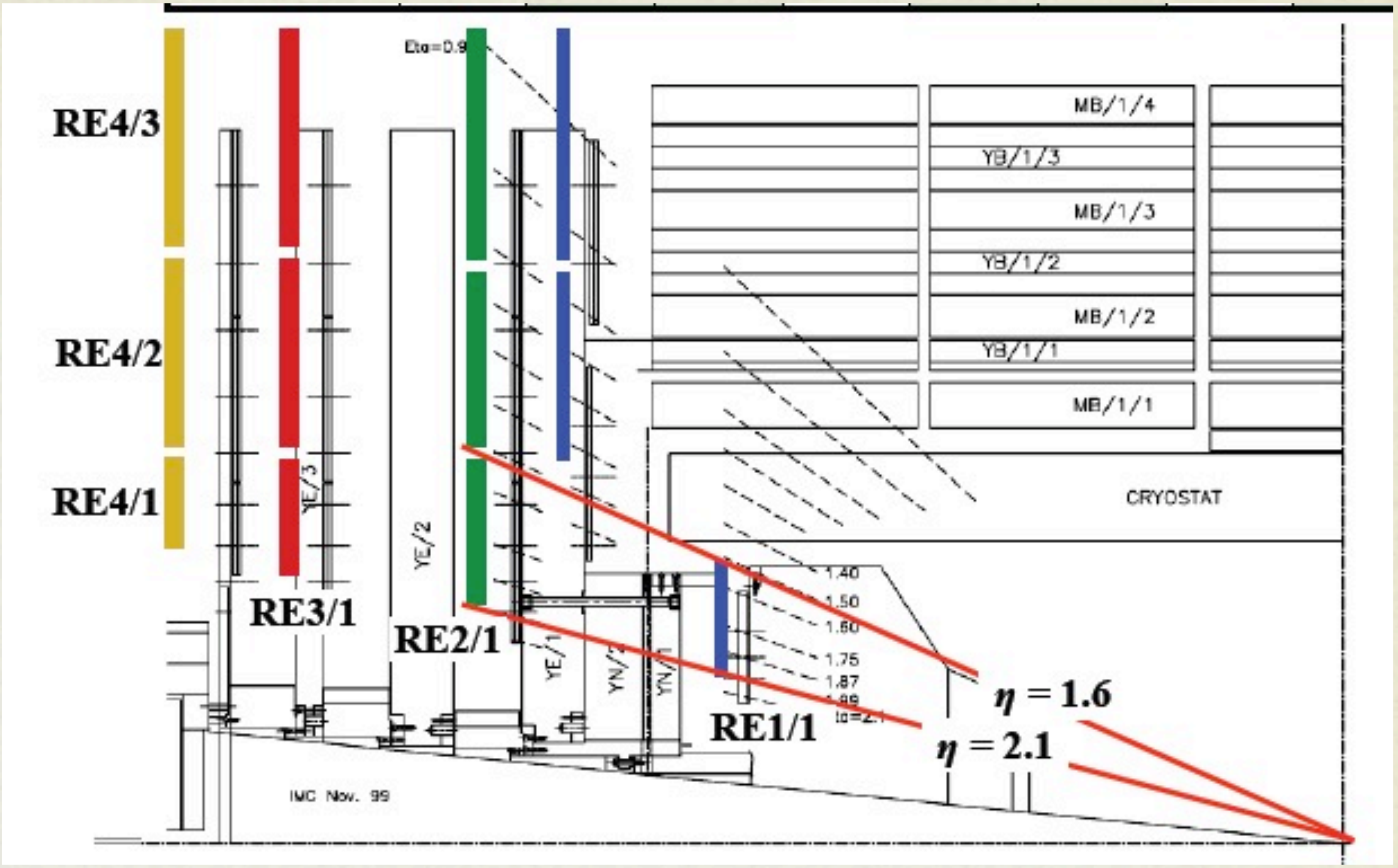
new front end prototype

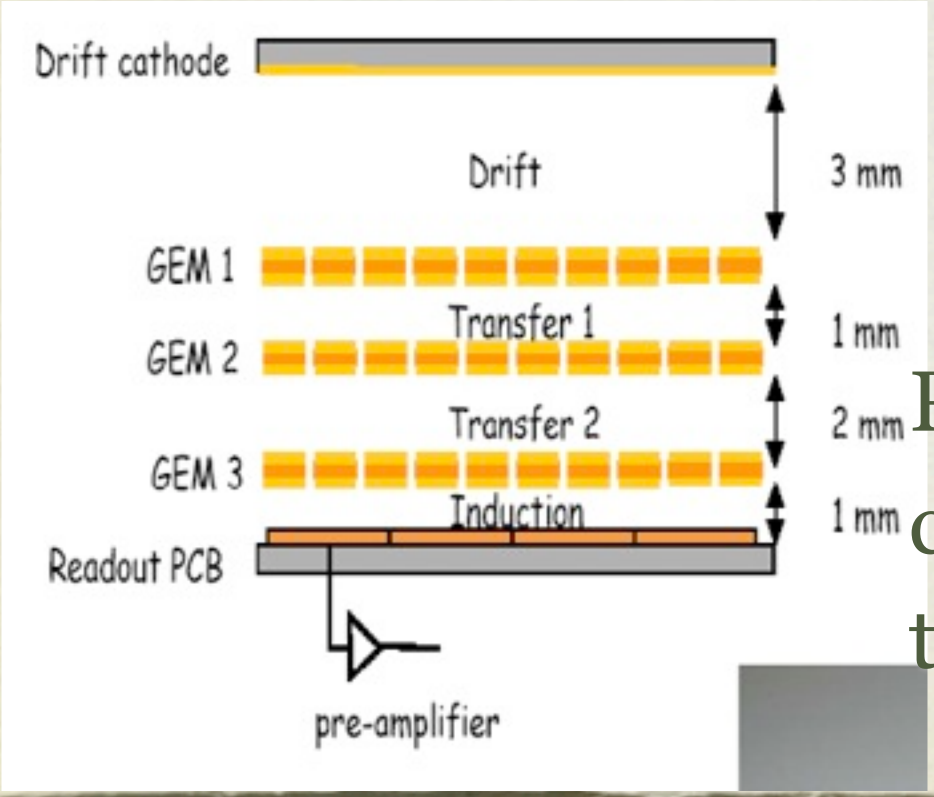


Oliver Pooth

A MPGD FOR UPGRADE

Proposal to instrument region at 1.6≤ η ≤ 2.4





Proposed detector is GEM: combination of triggering and tracking in a single detector

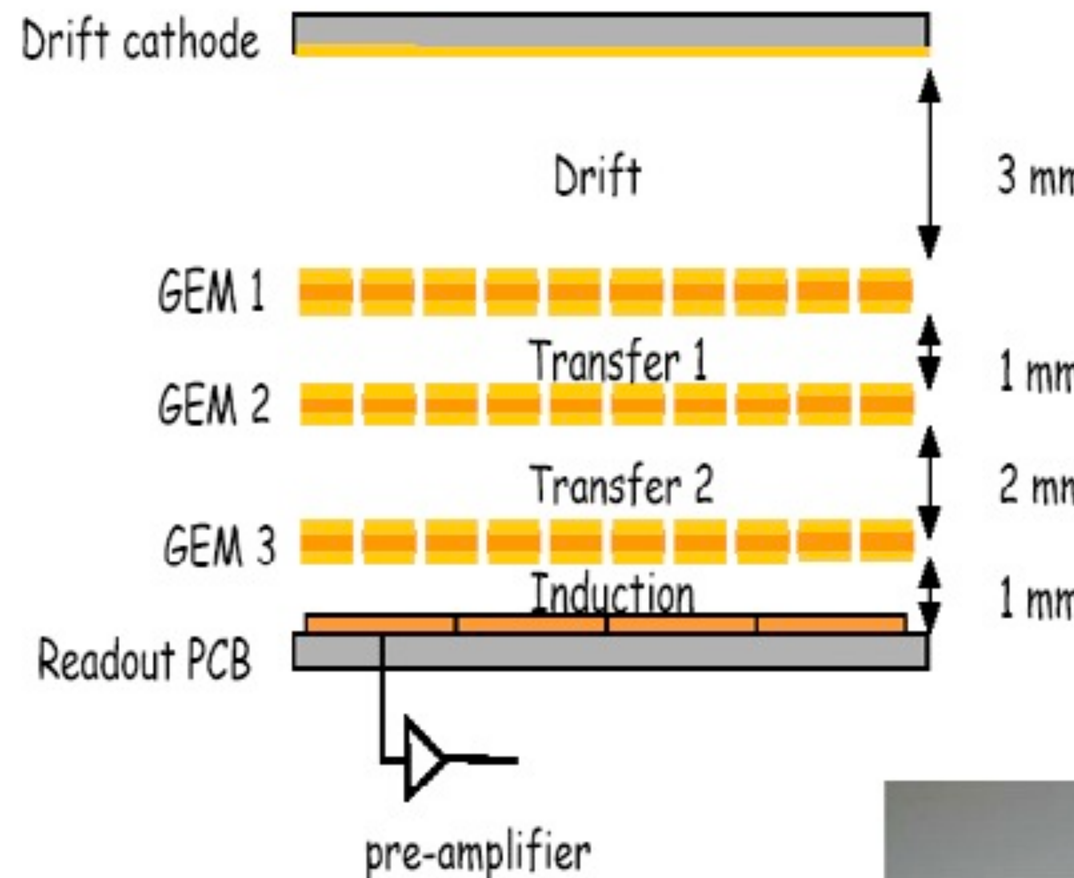
Archana Sharma

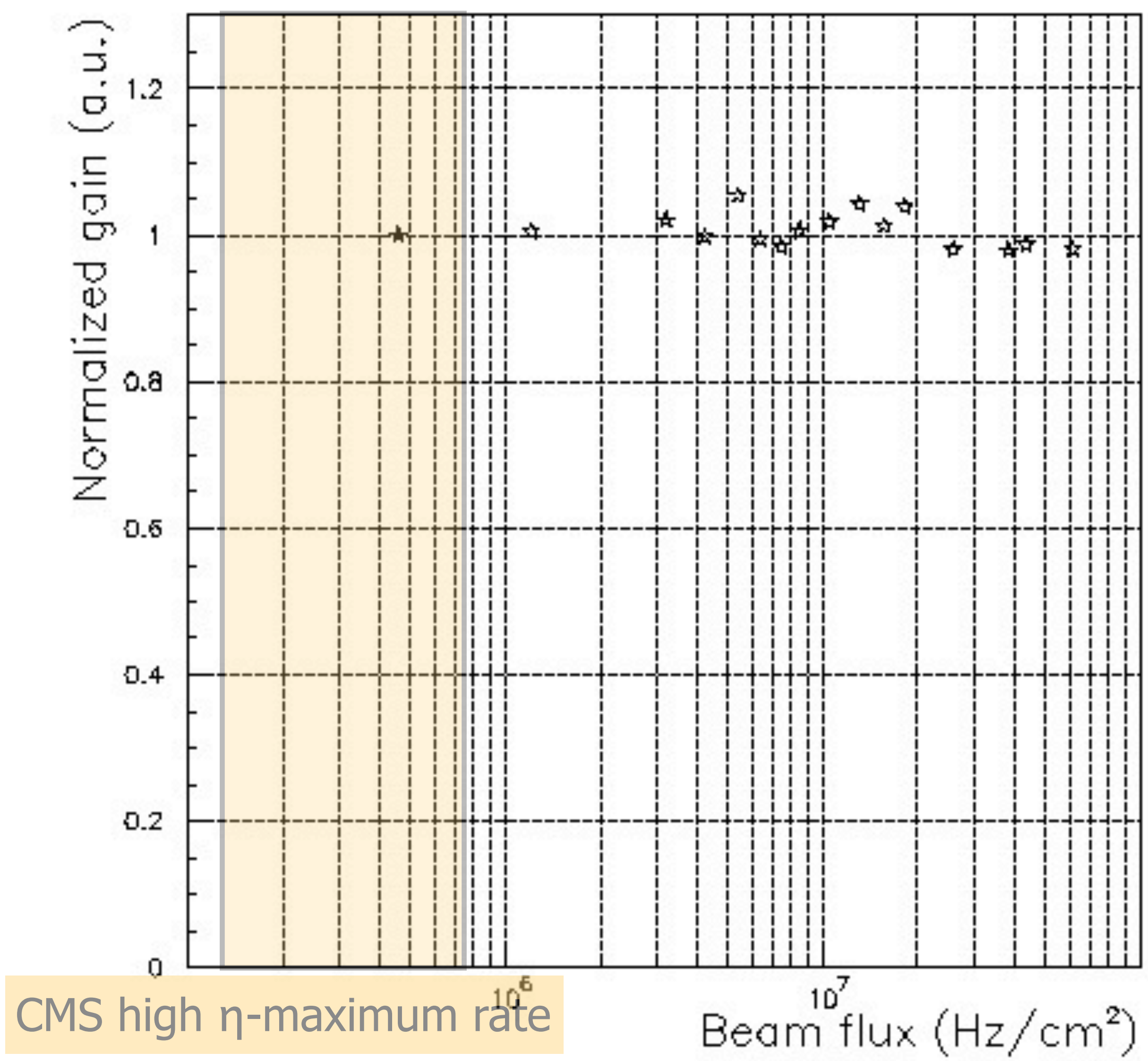
Enhance and optimize the readout (η−ϕ) granularity by improved rate capability

Rate capability –$10^4/mm^2$

- Spatial resolution ~ 100 μm (Θ_{track}< 45°)
- Time resolution ~ 1-3 ns (Gas!)
- Efficiency > 98%
- Rate capability > 5 kHz/cm^2

-Argon CO_2 (non flammable mixture -big plus)





GEM tests show they are adequate in terms of rate capability and ageing

CONCLUSIONS

- Lot of progress showing convergence of designs
- Transition to 2.2.6 + longbarrel finished and code being released soon
- Ready to start full simulation studies with high PU
- First results on a MTT real size prototype.