Beam Test of Scintillation Tiles with MPPC Readout

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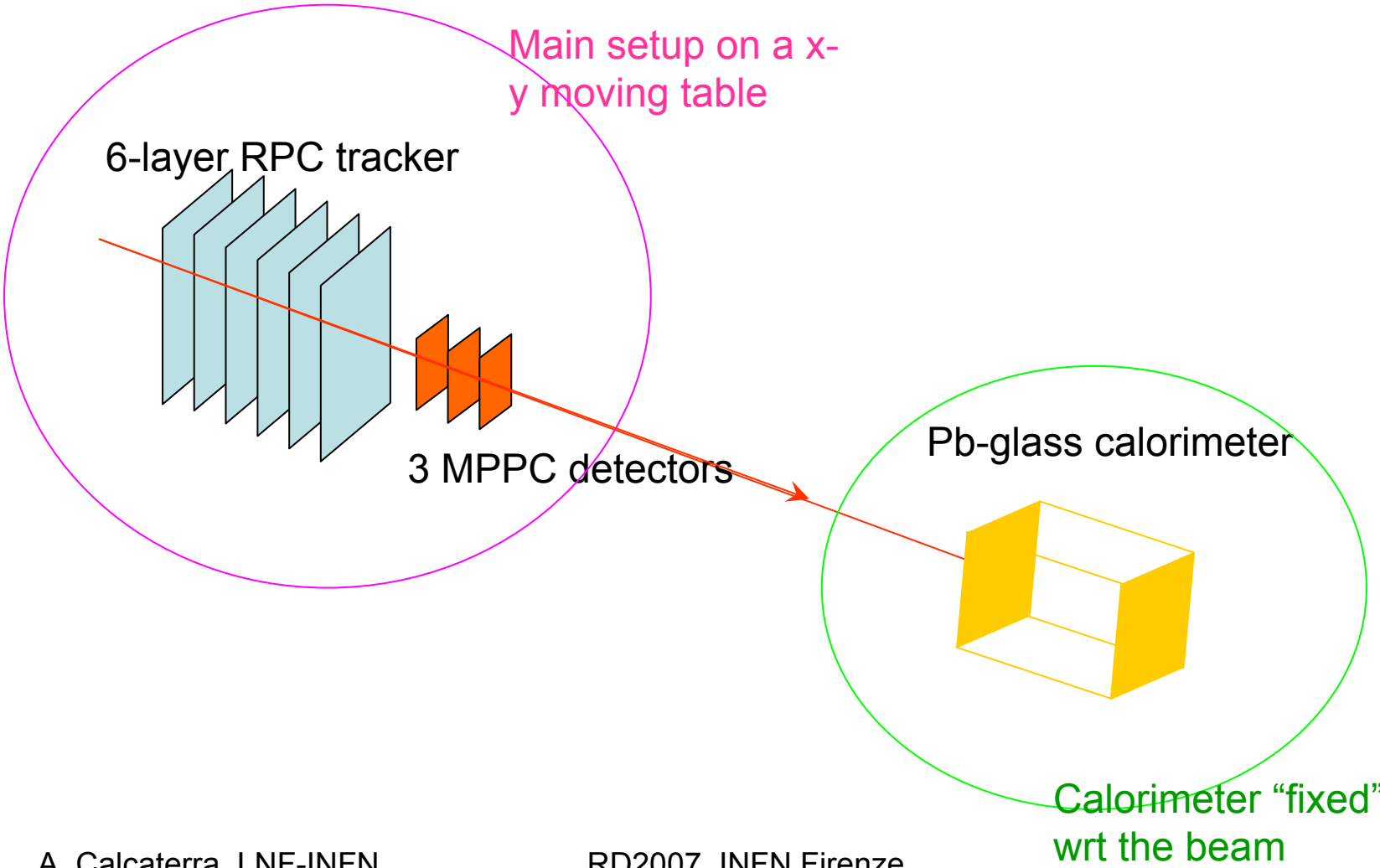
Test essentials

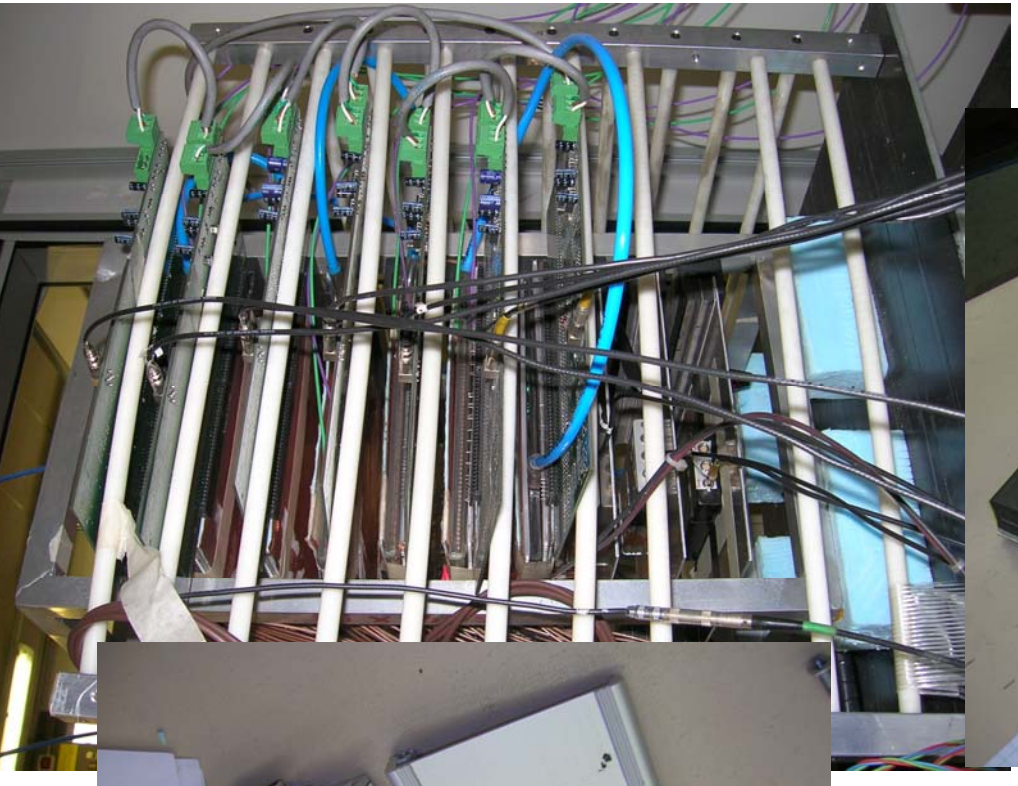
- Run in April at the Beam Test Facility in Frascati
- 3 detectors exposed: 3x3x0.5 cm scintillator tiles coupled to a Hamamatsu MPPC, readout via a preamp from CPTA (gain ≈15)
- Beam pulse-by-pulse information from a Pb-glass calorimeter and a tracker

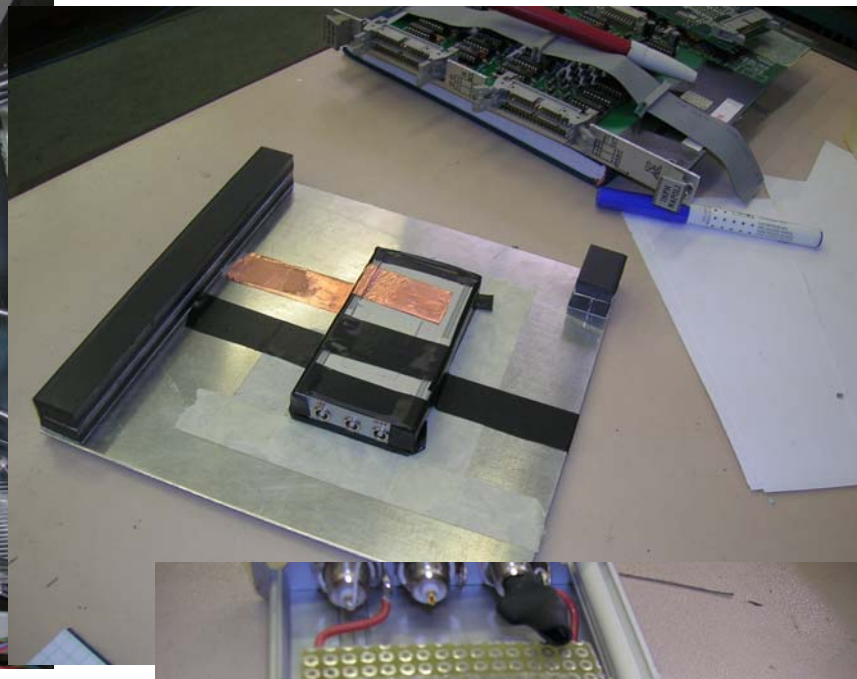
The Beam Test Facility

- Extraction line from the DAΦNE LINAC
- Variable energy, we used 477 MeV/c
- Pulse frequency 1 or 50 Hz; we trigger on every RF pulse: ***a 0-bias measurement***
- N.of e^-/pulse from 0 up to 20 (actual "policy-dictated" max: 10^3 /s)
- Beam spot dimensions (narrow core, some halo): ≈ 1-2 mm vert., ≈ 0.2-1.5 cm horiz.

The setup


Main setup on a x-y moving table
6-layer RPC tracker
3 MPPC detectors
Pb-glass calorimeter
Calorimeter “fixed” wrt the beam





MPPC

More on the detectors

- MPPCs :
  - "1": 1600 25-μm pixels, St.Gobain BC-400, readout using green fiber 1mm thick
  - "2": 400 50-μm pixels, generic "green" scintillator, equivalent to EJ260 from Scionix, readout using green fiber 1mm thick
  - "3": 400 50-μm pixels, St.Gobain BC-400, direct readout (no fiber)
- V_{bias} from HP6614C, readout accuracy 0.03% $\oplus$ 12mV
- Q measured with 12-bit, 100 fC/ch CAEN V792

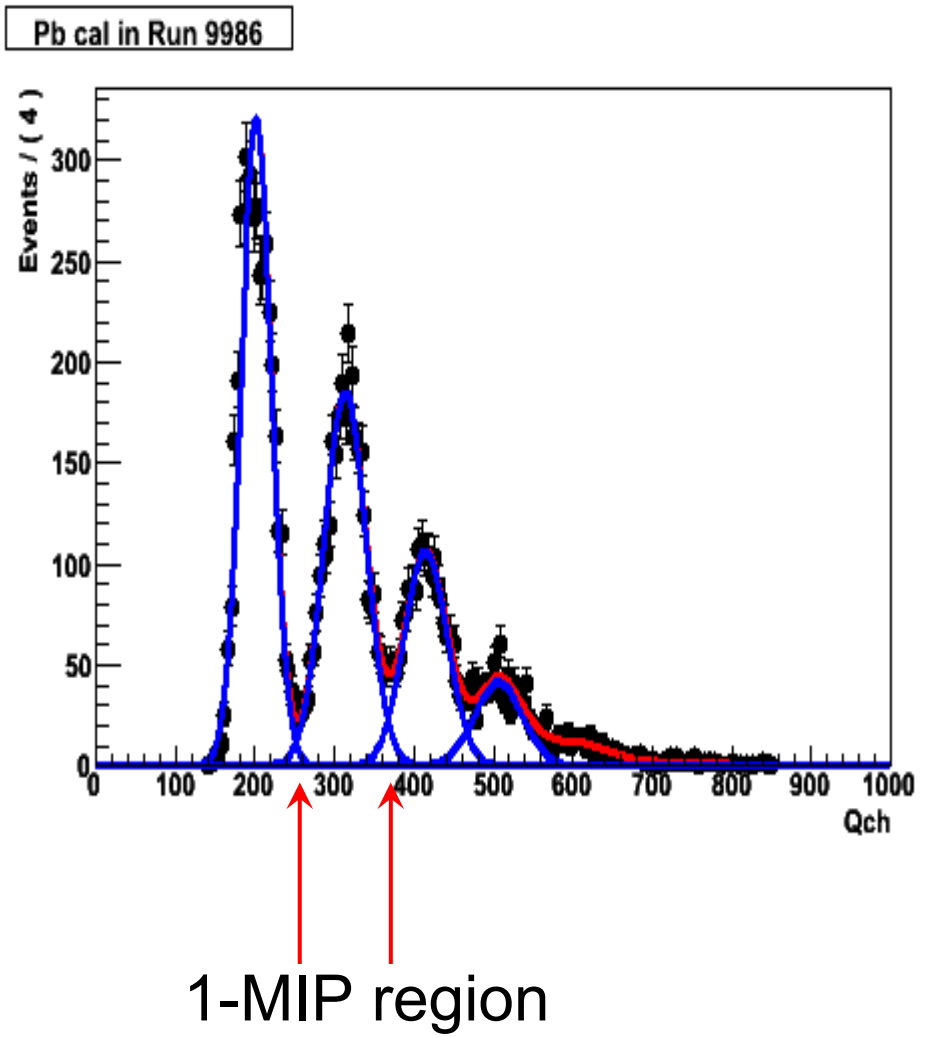
Aux equipment

- Lead glass calorimeter 10x10cm^2, 20 X_0 thick, measured the number of MIPs in every beam pulse
- X-Y tracker, 6 layers of mechanically-quenched$^{(*)}$ RPC's, measured the beam position with single layer resolution of 2 mm

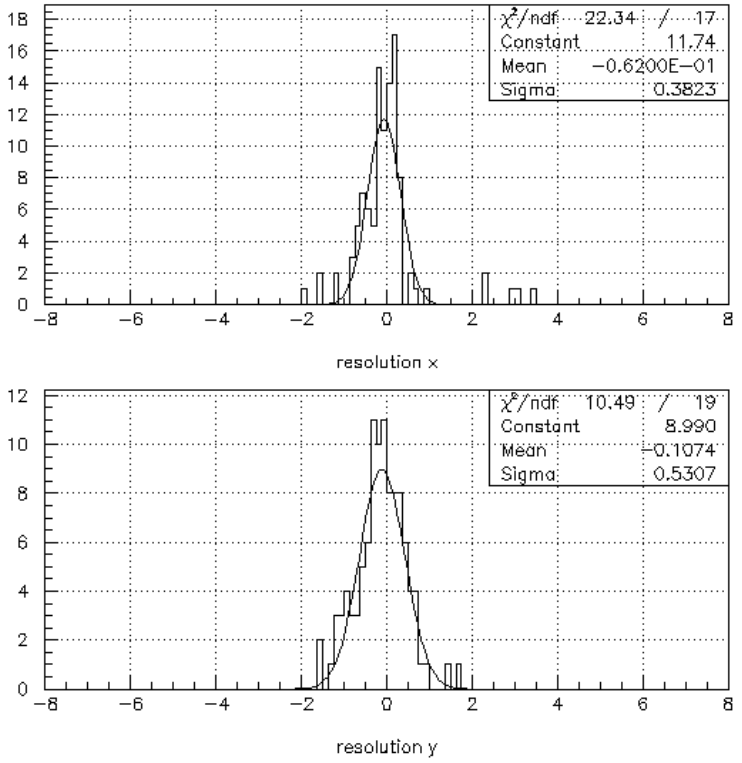
(*) Nucl.Instrum.Meth.A565:444-449,2006

The BTF calorimeter

- 0,1,2,3-MIP bands with few-% contamination
- Strategy: cut on the Pb-glass calo, and plot our detectors

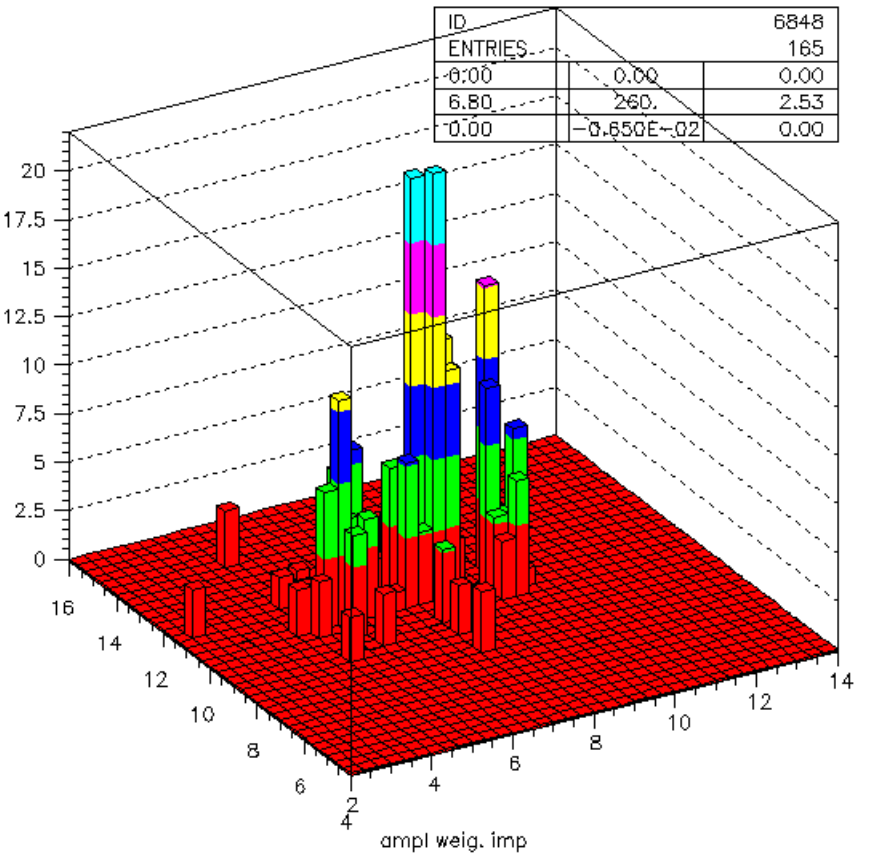


The RPC tracker

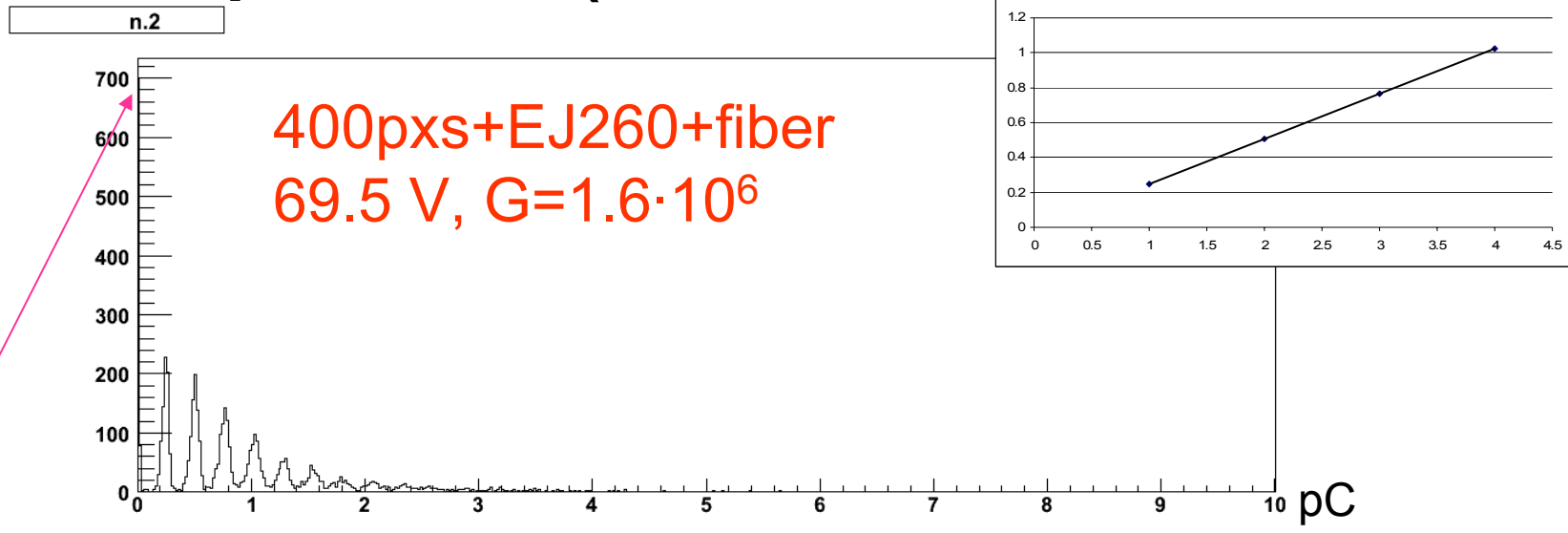


Fitted resolution (cm)

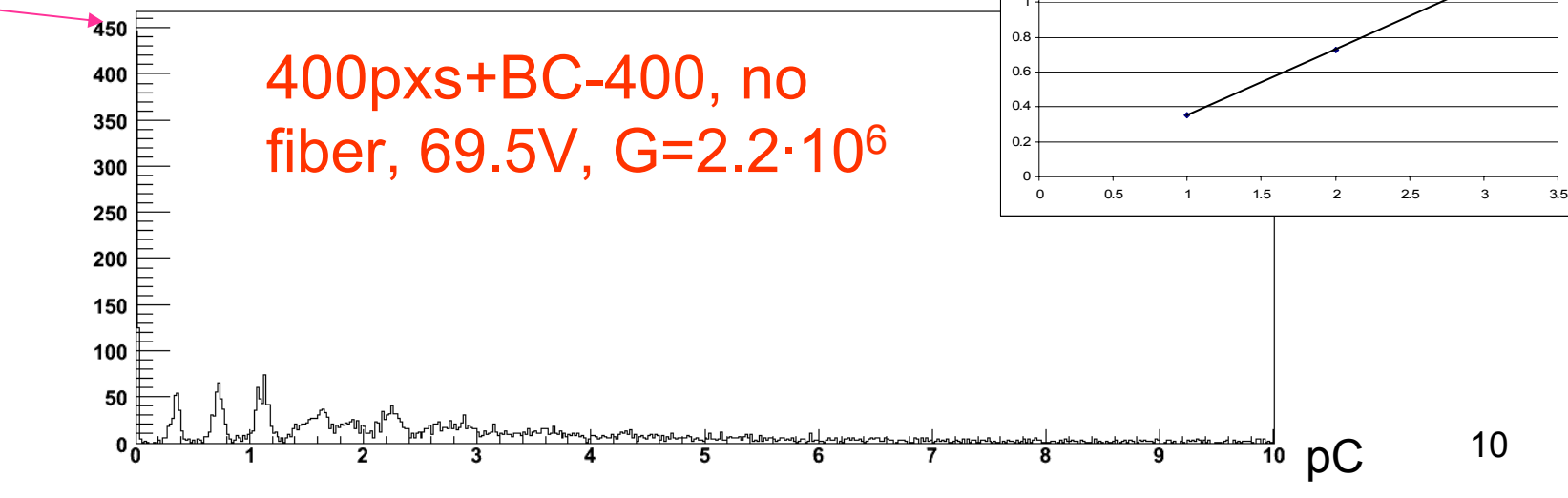
Beam profile on MPPC



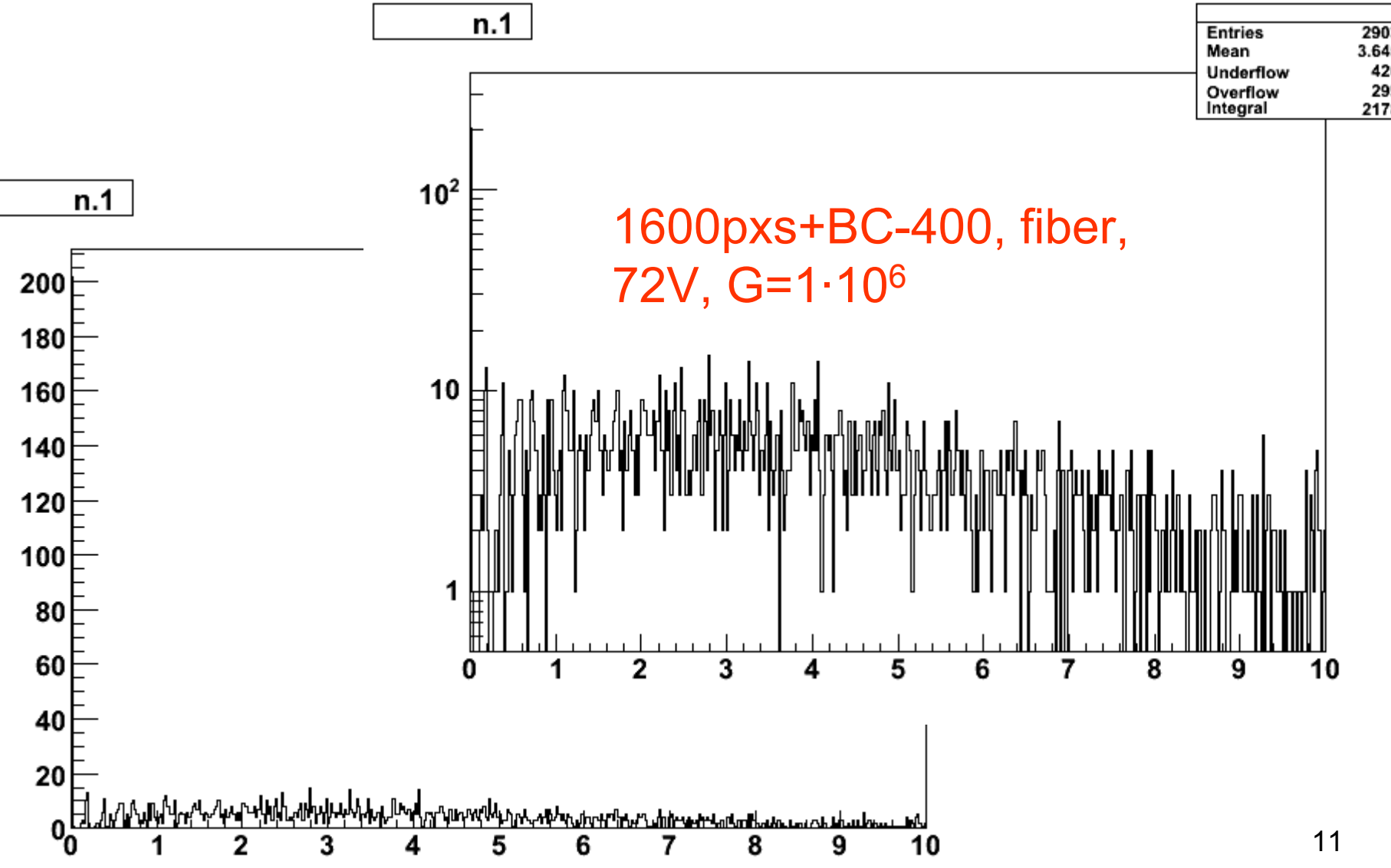
Q spectra (1 MIP in calor.)



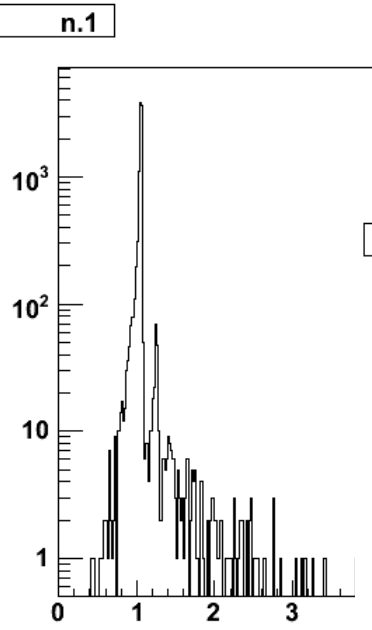
Noise ≈ 2-3 fC ≈ 2·10^4 e^-

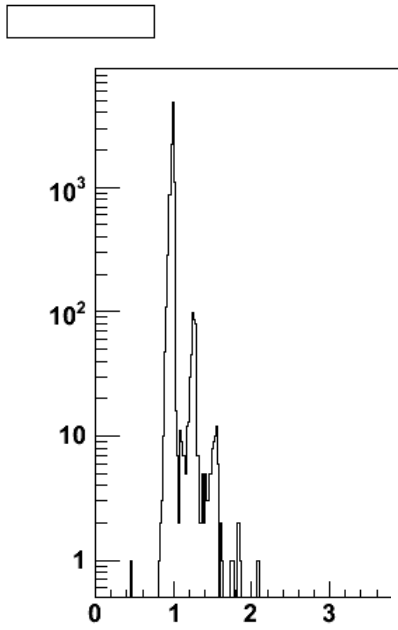


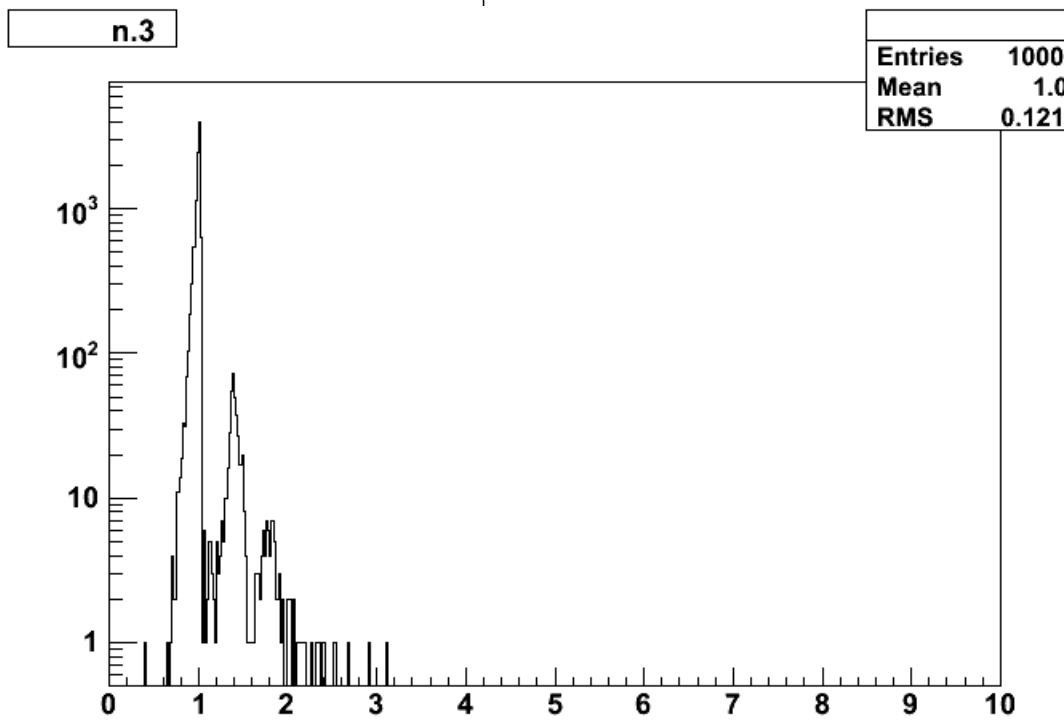
Q spectra (1 MIP in calor.)



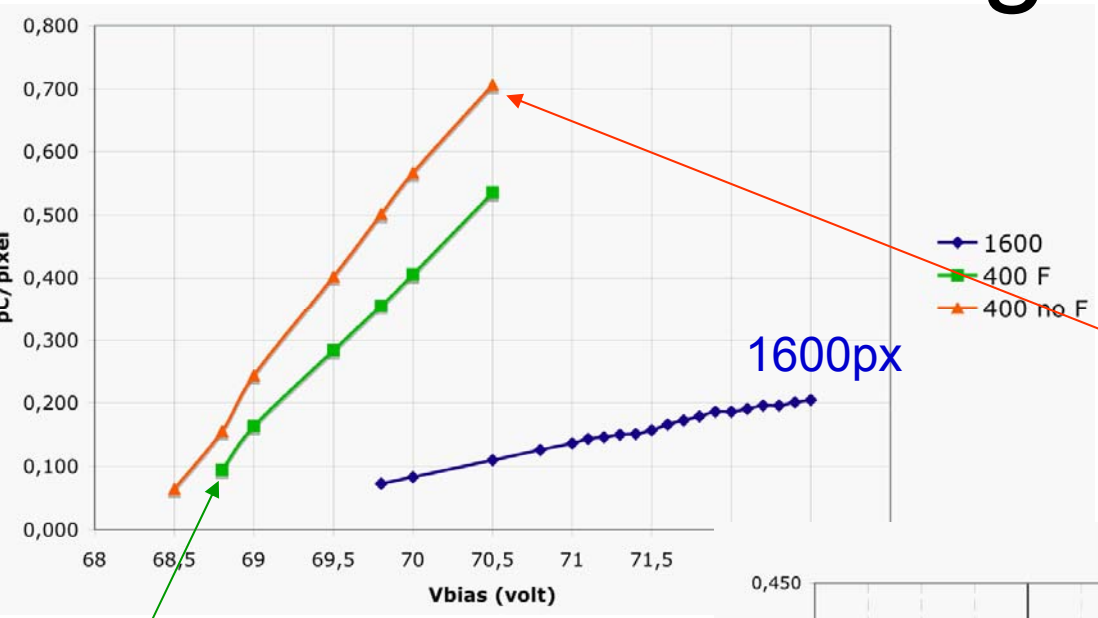
Q spectra (0 MIP in calor.)







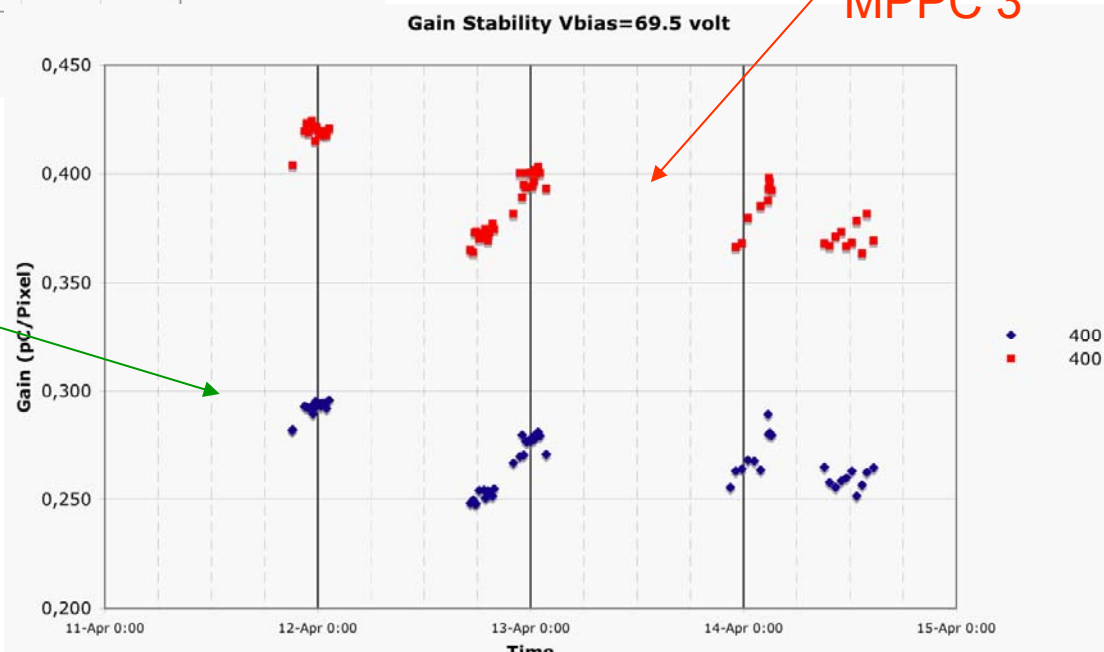
MPPC gain



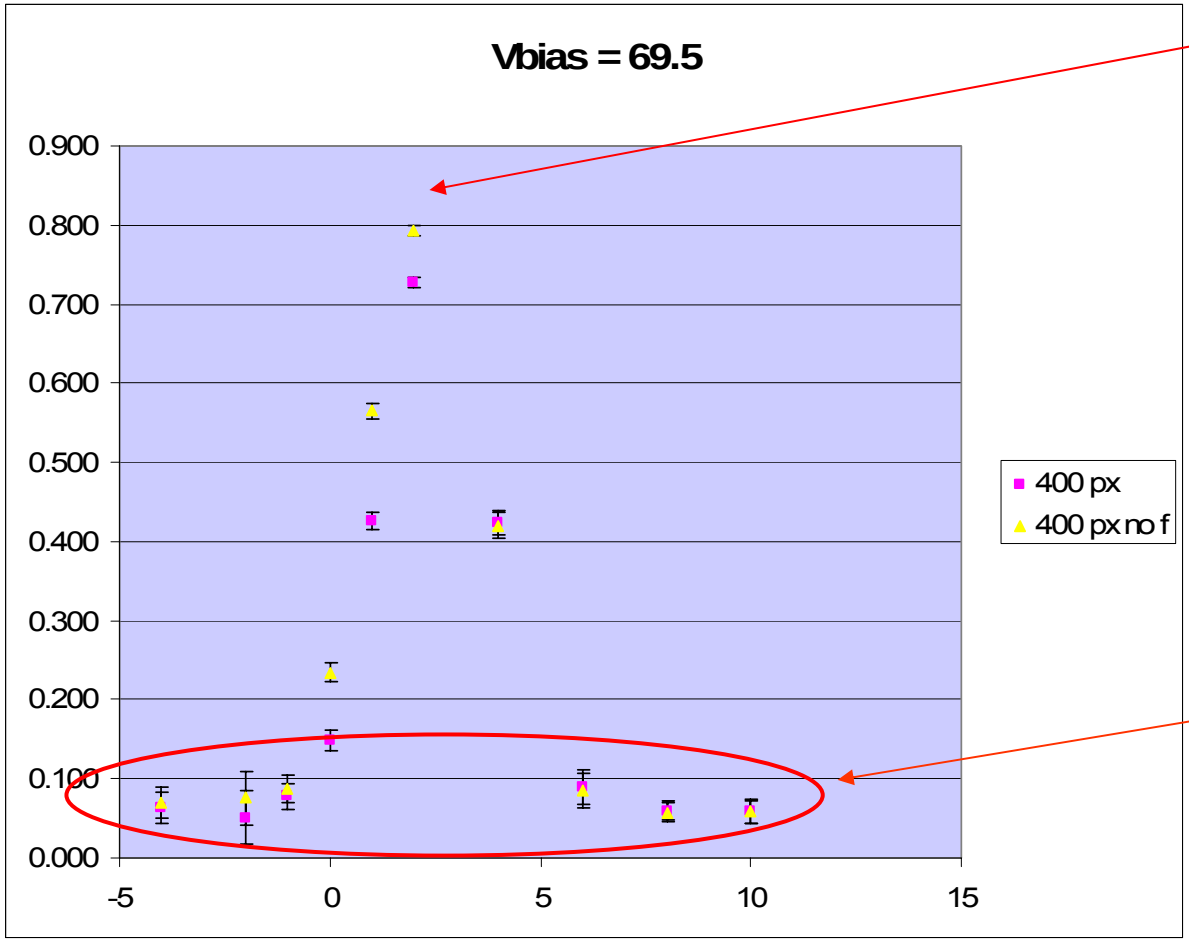
1600px

MPPC 3

MPPC 2



Efficiency in a Y-scan (requesting 1 MIP in calo)

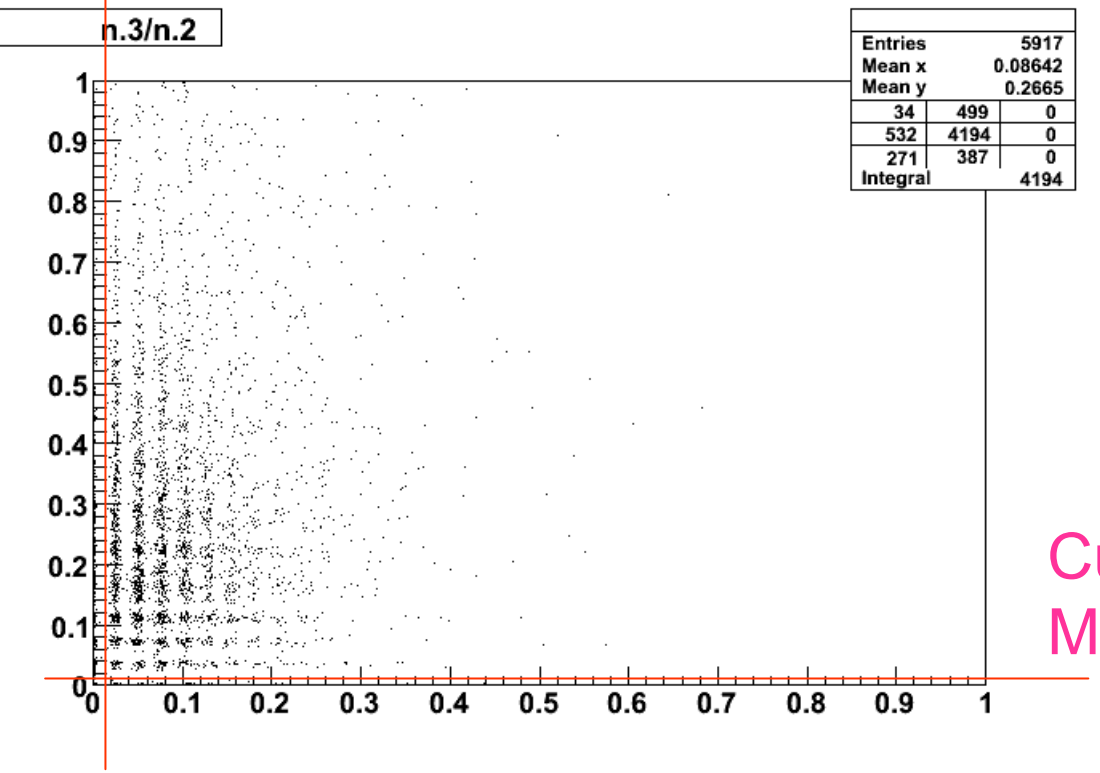


Most favorable impact point in MPPCs 2 and 3

Bkg level at 7% is MPPC dark noise

Efficiency from nearest MPPC (requesting 1 MIP in calo)

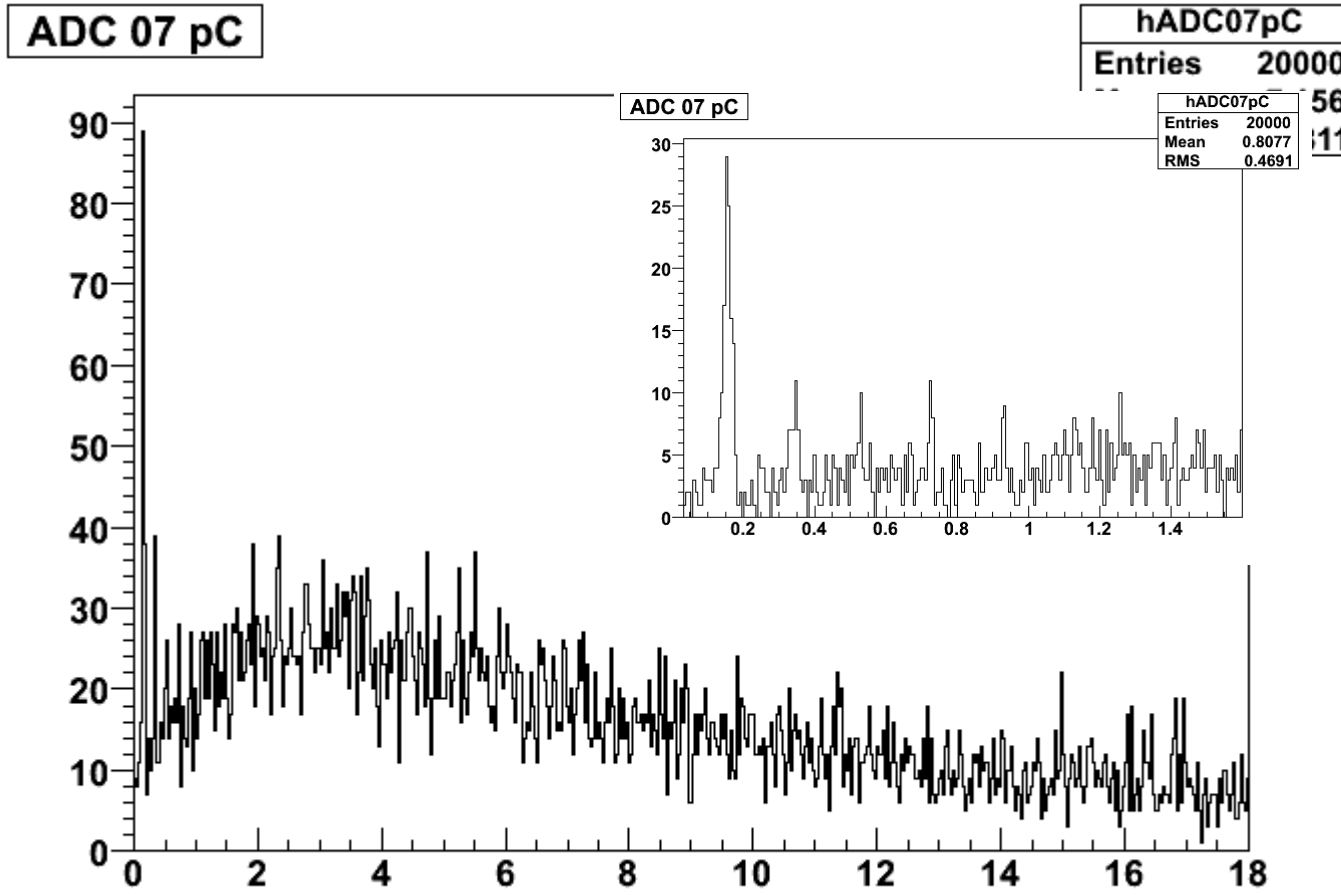
Cutting on MPPC 2, ε in MPPC 3 is (84±1)%



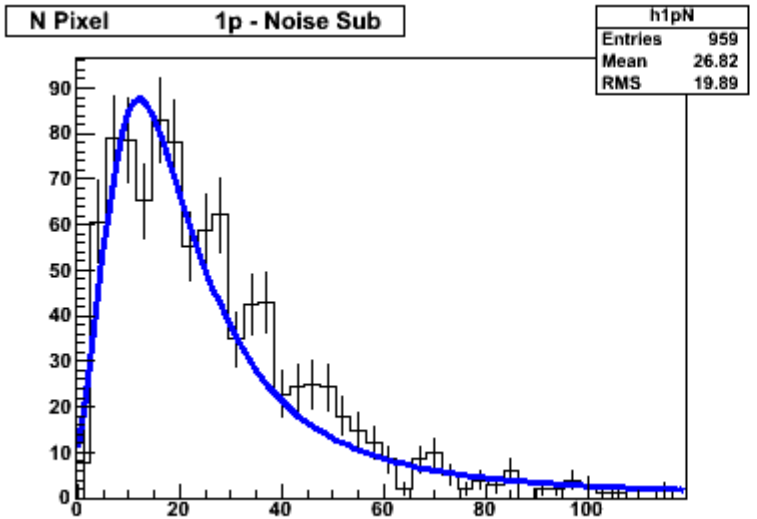
Cutting on MPPC 3, ε in MPPC 2 is (91±1)%

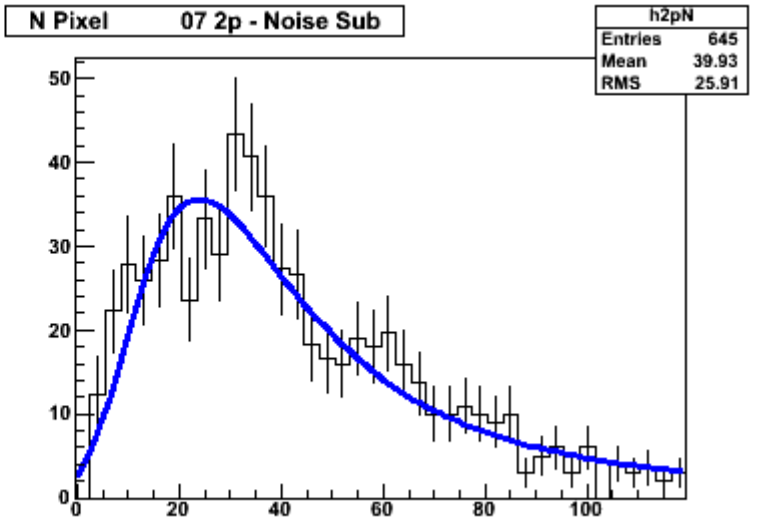
MPPC 1600 pixels

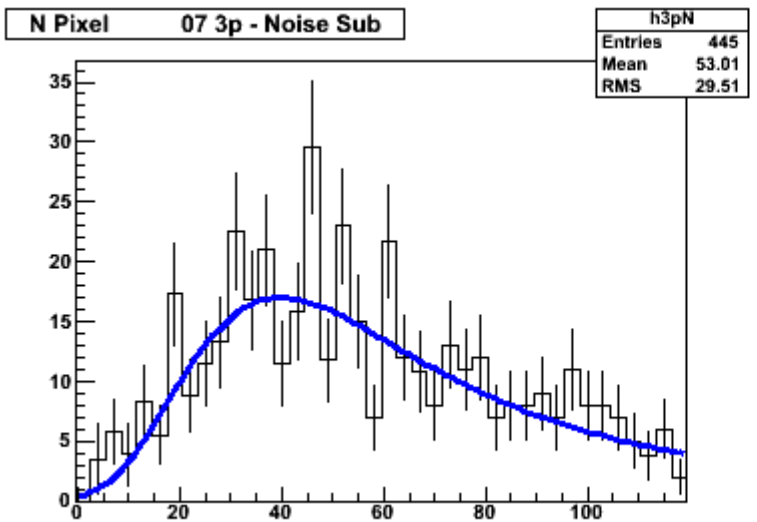
- Step 1: find gain & peak posn's
- Step 2: rebin around peaks

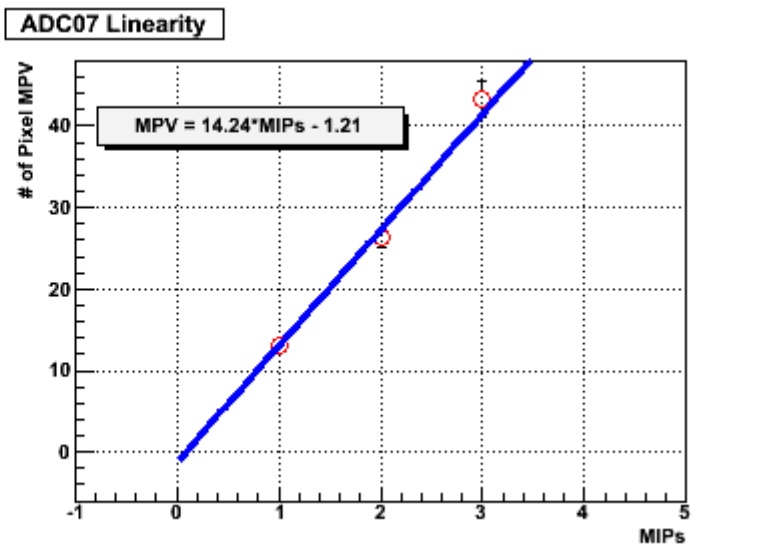


MPPC 1600 pixels









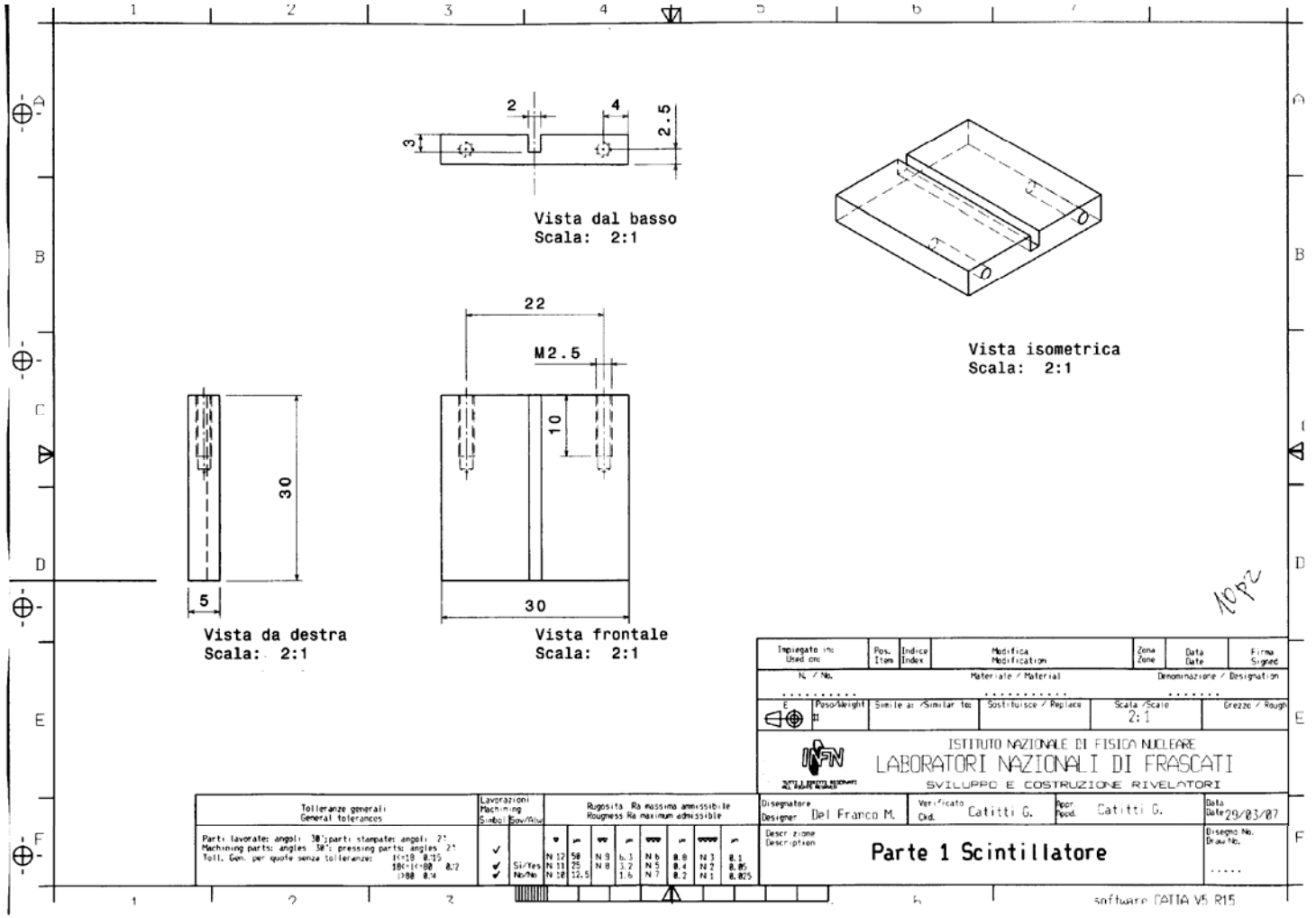
Conclusions

- This is our first shot at the MPPC characteristics in a tile-scintillator detector
- Efficiencies for MIPs are in the ballpark ~80-90% with the geometry we used
- Gains of ~10^6 with noise rate ~300 kHz have been obtained
- Preliminary analyses show that the device is linear within the tested range

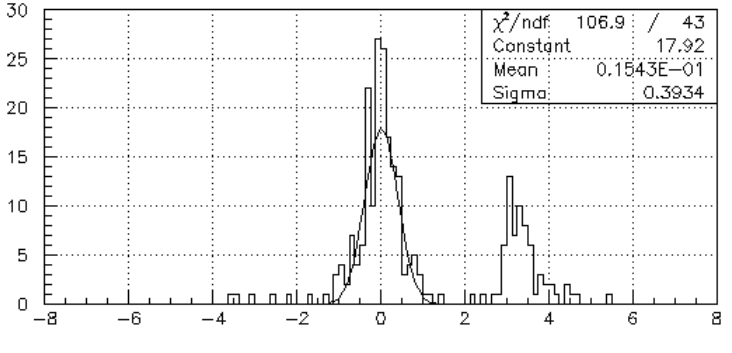
Outlook

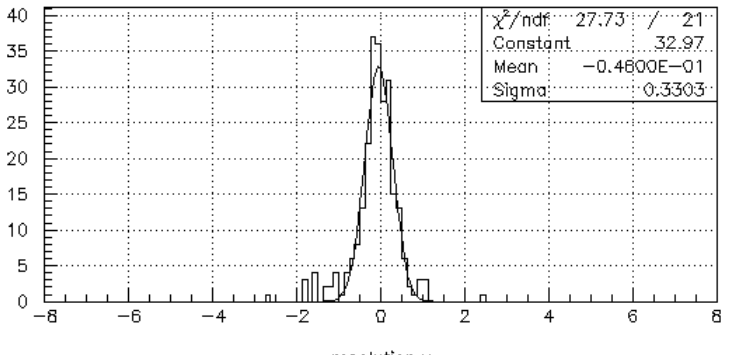
- We need to complete the present analysis, and draw all potential from our data
- A new beam-test is coming up in the fall
- We plan to repeat all measurements, with many improvements
  - T monitoring
  - wider dynamic range (more particles/pulse)
  - different scintillators/photon detectors

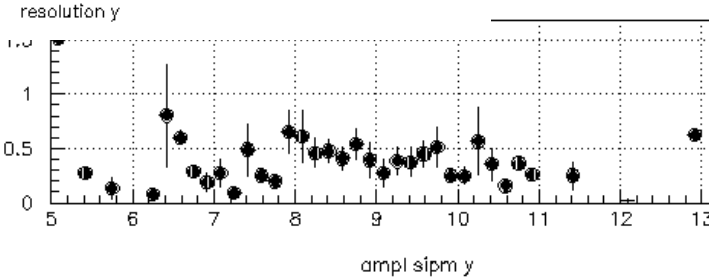
Backup Slides

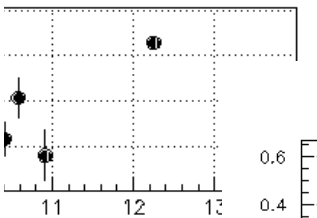


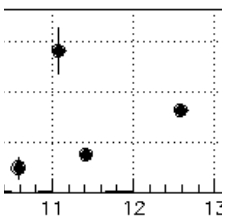
RPC tracker (figs. of merit)

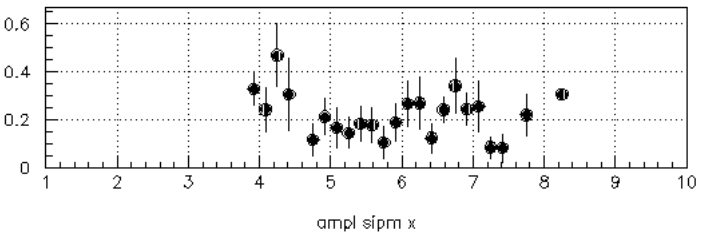


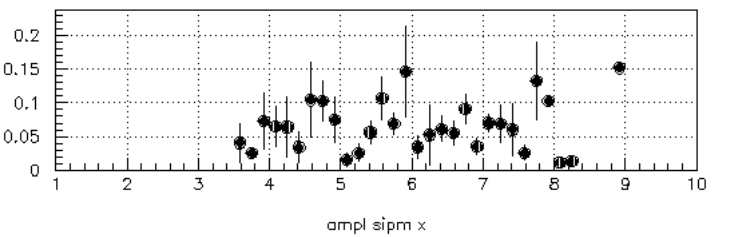


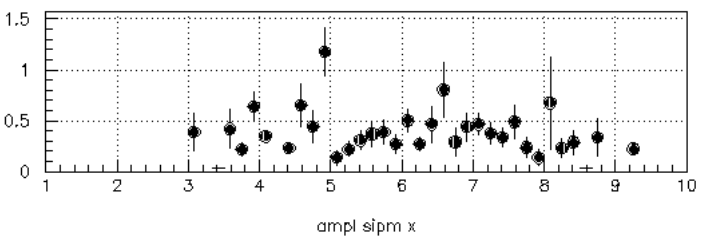




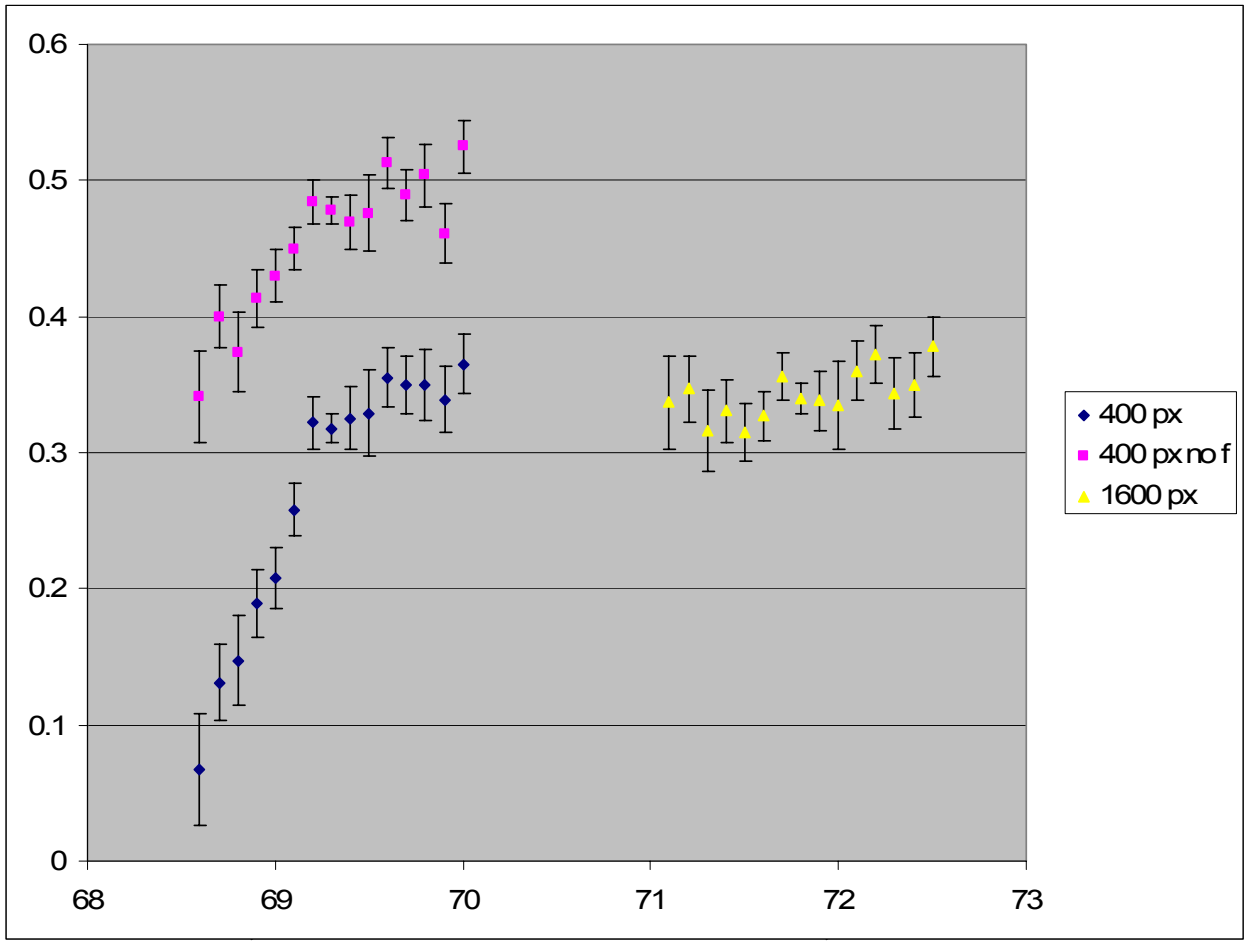




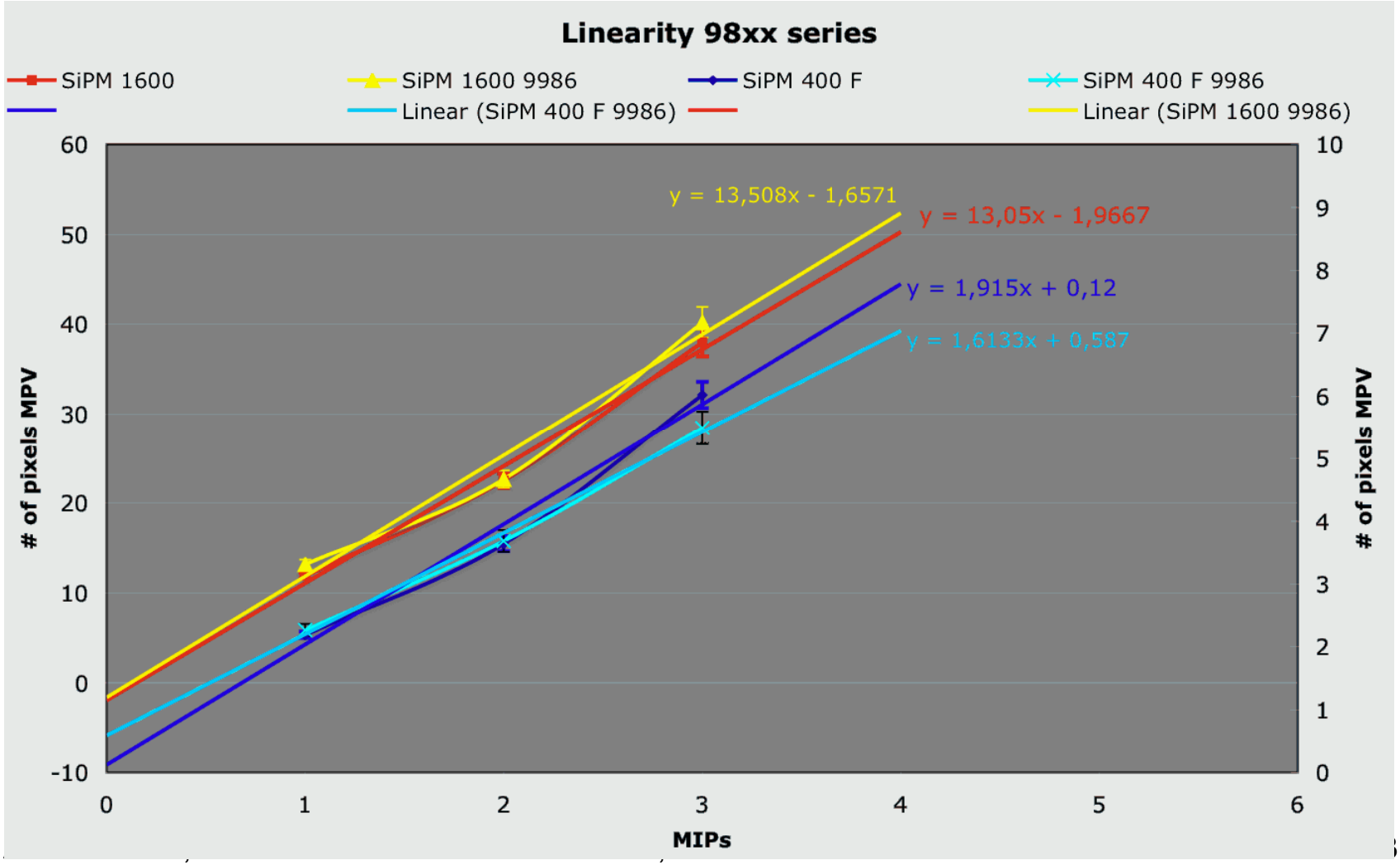




Scanning V_{bias}



Quota “nom+1.5”


Linearity 98xx series
SiPM 1600
SiPM 1600 9986
SiPM 400 F
SiPM 400 F 9986
Linear (SiPM 400 F 9986)
Linear (SiPM 1600 9986)
y = 13,508x - 1,6571
y = 13,05x - 1,9667
y = 1,915x + 0,12
y = 1,6133x + 0,587
# of pixels MPV
# of pixels MPV
MIPs
60
50
40
30
20
10
0
-10
10
9
8
7
6
5
4
3
2
1
0
0
1
2
3
4
5
6