High intensity beam studies of sparks in resistively-coated and standard Micromegas detectors

D. Attié, T. Alexopoulos, M. Boyer, P. Colas, J. Derré, F. Diblen, E. Ferrer Ribas, T. Geralis, A. Giganon, I. Giomataris, F. Jeanneau, K. Karakostas, S. Kirch, E. Ntomari, M. Titov, W.Wang

Within the MAMMA collaboration

Arizona, **Athens**(U, **NTU, Demokritos**), Brookhaven, CERN, Harvard, Istanbul, Naples, **CEA Saclay**, Seattle, USTC Hefei, South Carolina, St. Petersburg, Shandong, Stony Brook, Thessaloniki

Shuoxing Wu / CEA Saclay, USTC Hefei

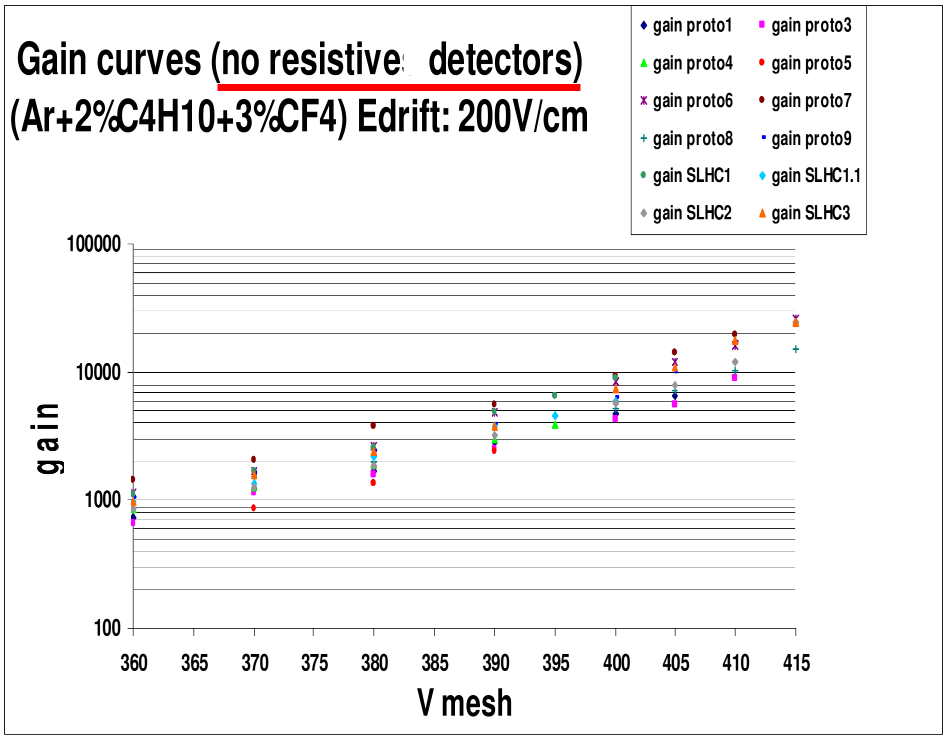
Outline:

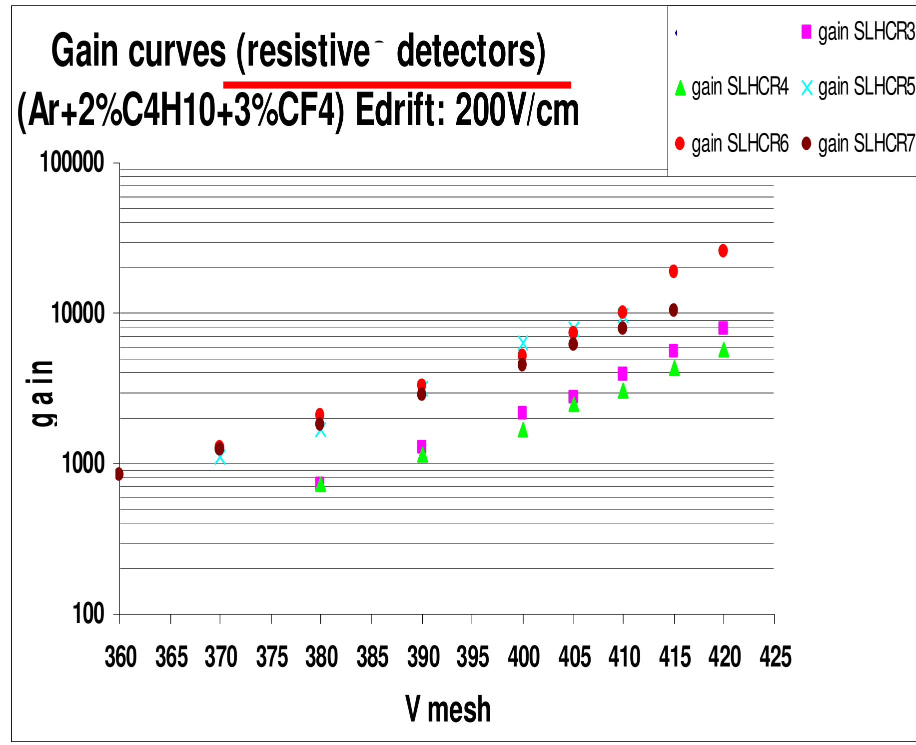
- Sparks will be a problem in SLHC conditions with today's Micromegas detectors

- Sparks induce dead time and can damage the detector if persistent

- Possible solutions
  - Resistive films
  - Segmented mesh
  - Double amplification

Measurements done at the lab:





SLHC2 and SLHC3 are used as the reference detectors at the test beam

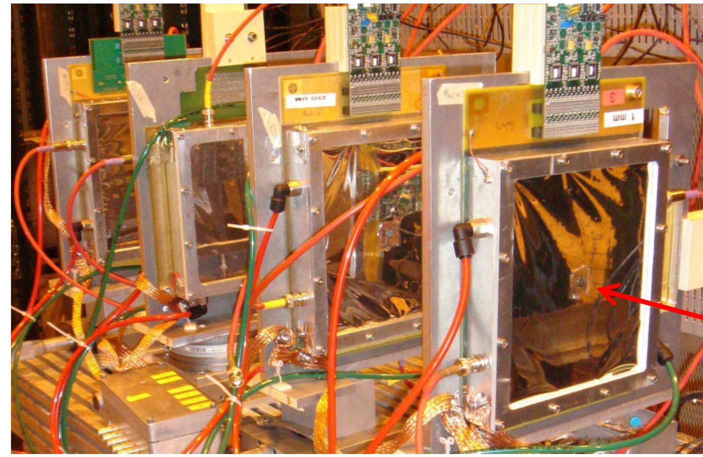
All the resistive detectors are tested at the test beam

Test beam set up:

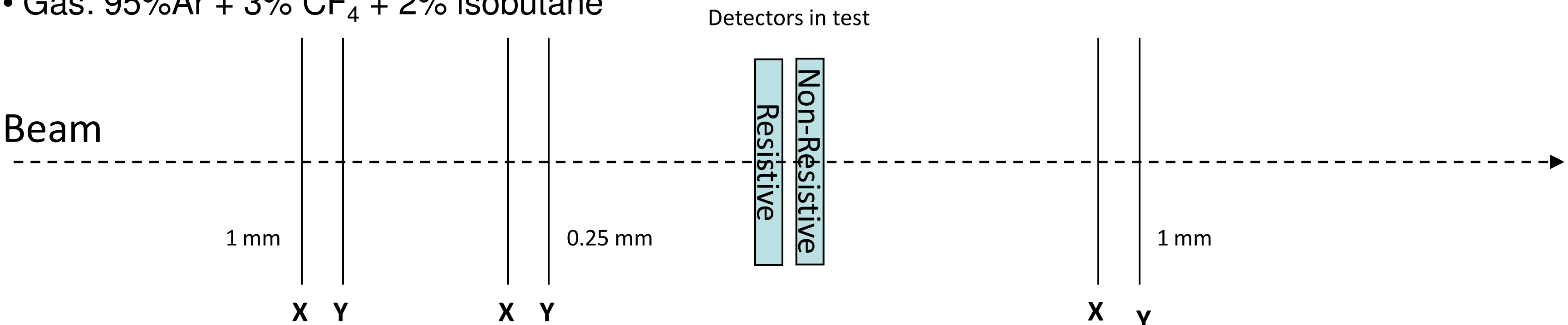
- Time: 13-19 Nov 2009
- Telescope:

3 X-Y detectors(10 x 10 cm[2]) manufactured at Saclay

- Aim: Test different resistive films detectors manufactured by Rui De Oliveira at CERN and compare behaviour to non-resistive detectors
- Electronics: GASSIPLEX
- DAQ: realised by Demokritos
- Gas: 95%Ar + 3% CF_4 + 2% isobutane



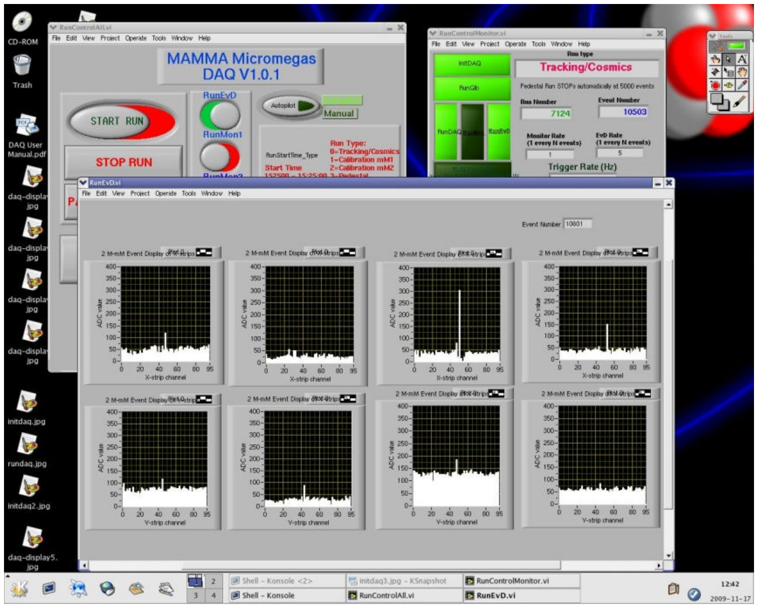
SPS-H6
120 Gev π+



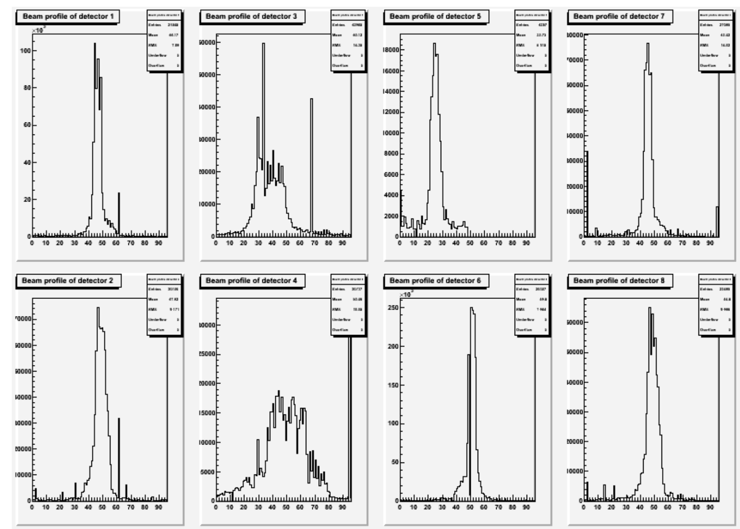
Tested detectors:
standard bulk detectors; 2 M Ω/□ Resistive kapton: R3&R4;
250 M Ω/□ Resistive paste: R5; 400K Ω/□ Resistive strips: R6;
Few tens of k Ω/□ resistive pads: R7; Segmented one: S1.

Readout and online monitoring:

Data acquistion based on Labview:



Monitoring through raw data
by C++/Root code:



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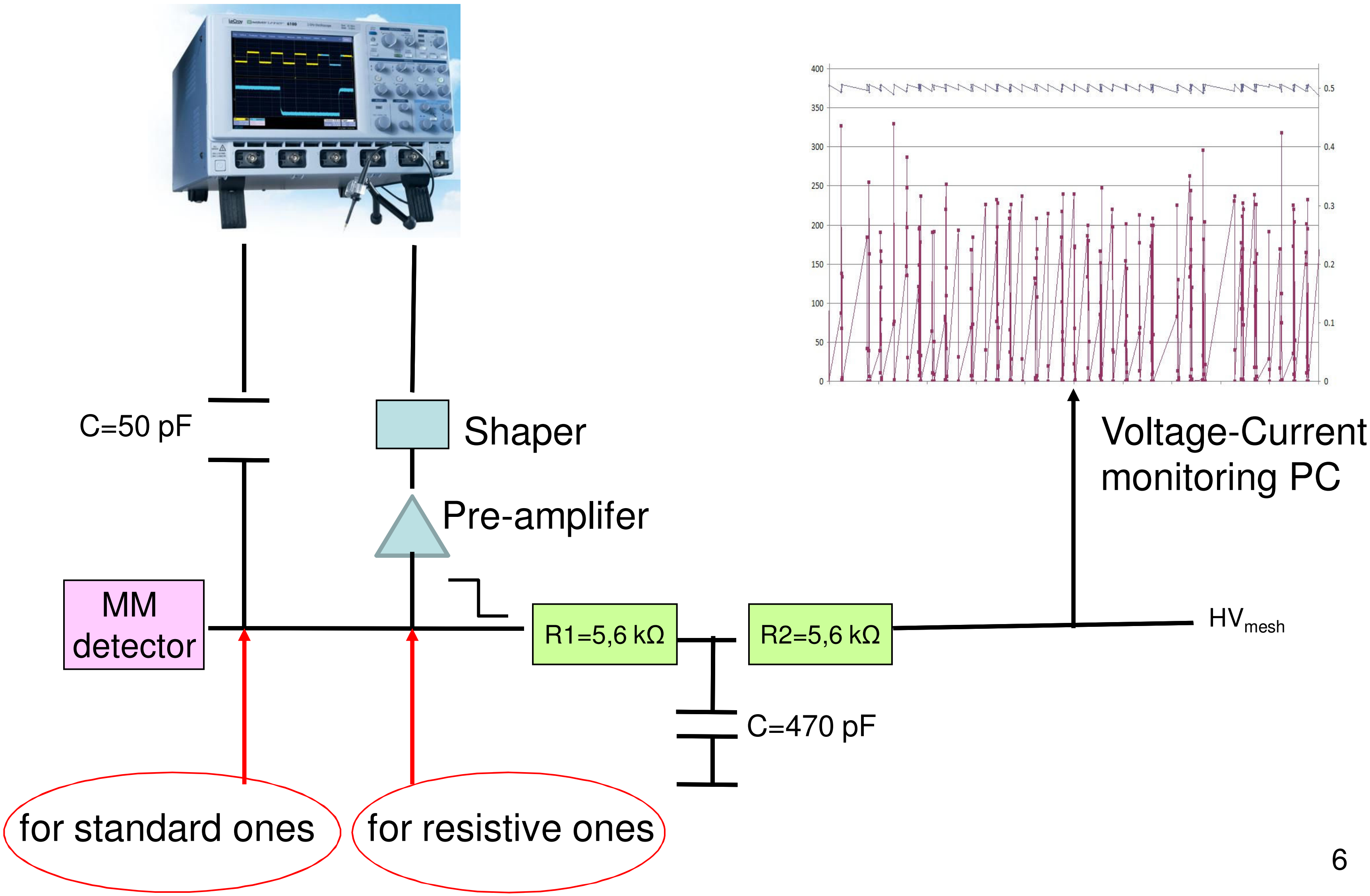
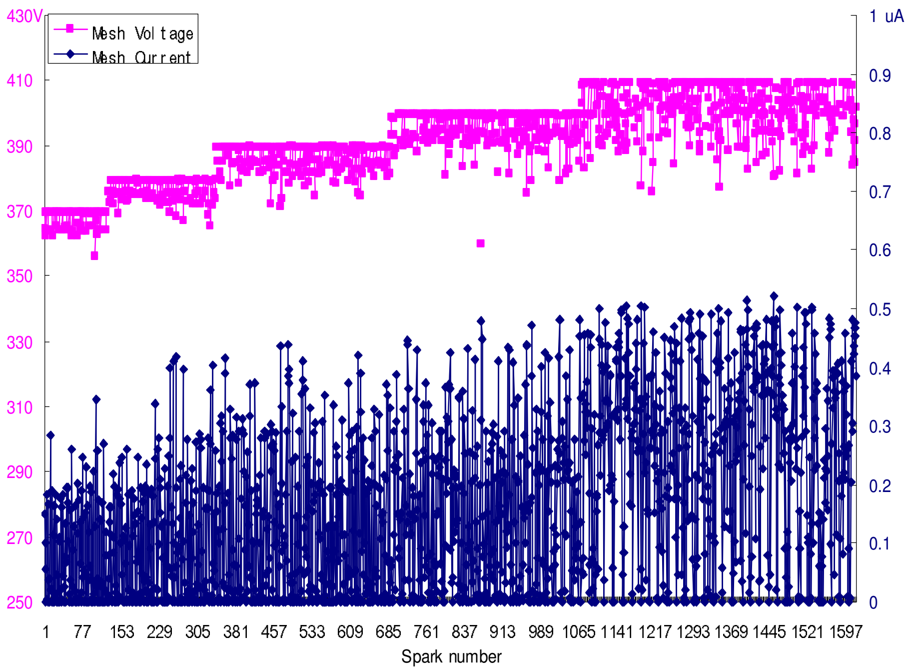
It’s easy to reconstruct the beam profile...

Spark counting device:

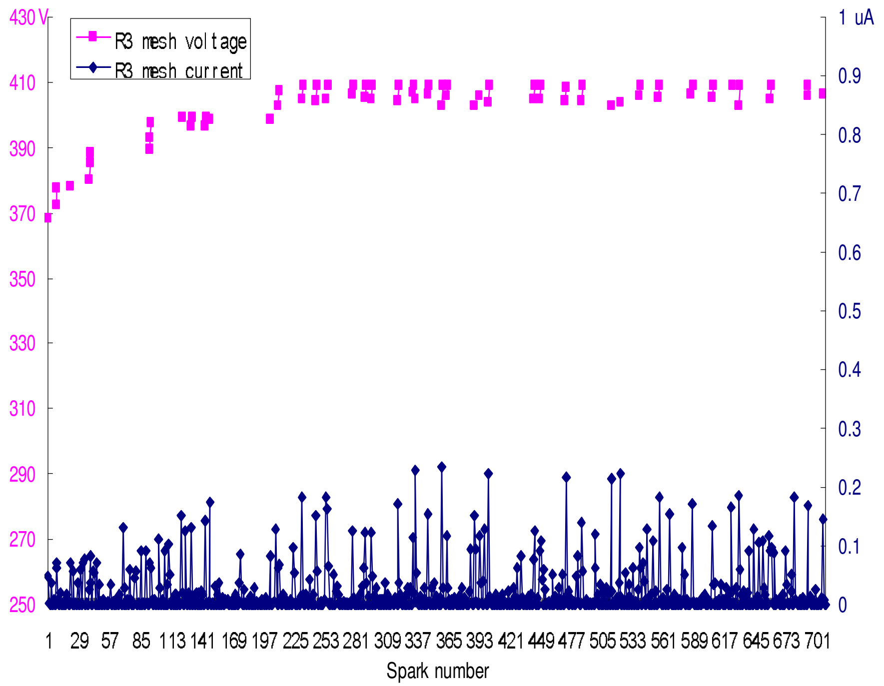


Different sparking behaviours of standard and resistive detector:

Standard SLHC2(@10KHz):



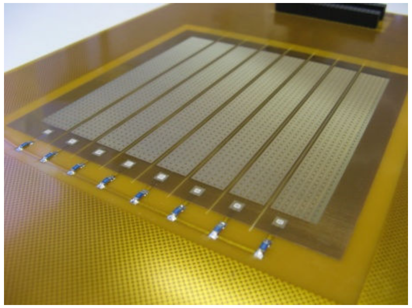
Resistive R3(@wide beam,15KHz):

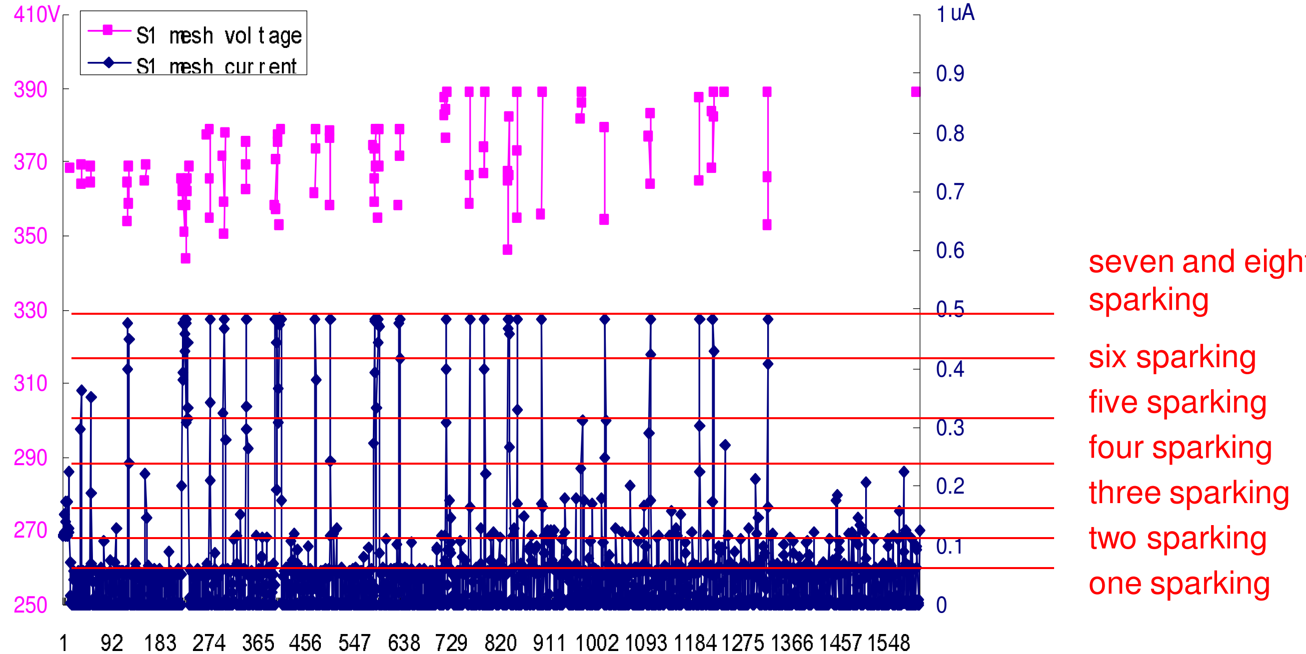


SLHC2: HV=400 V (Gain ~3000): current when sparking < 0.5 μA
voltage drop< 5%

R3: HV=410 V (Gain ~3000): current when sparking < 0.2 μA
voltage drop< 2%

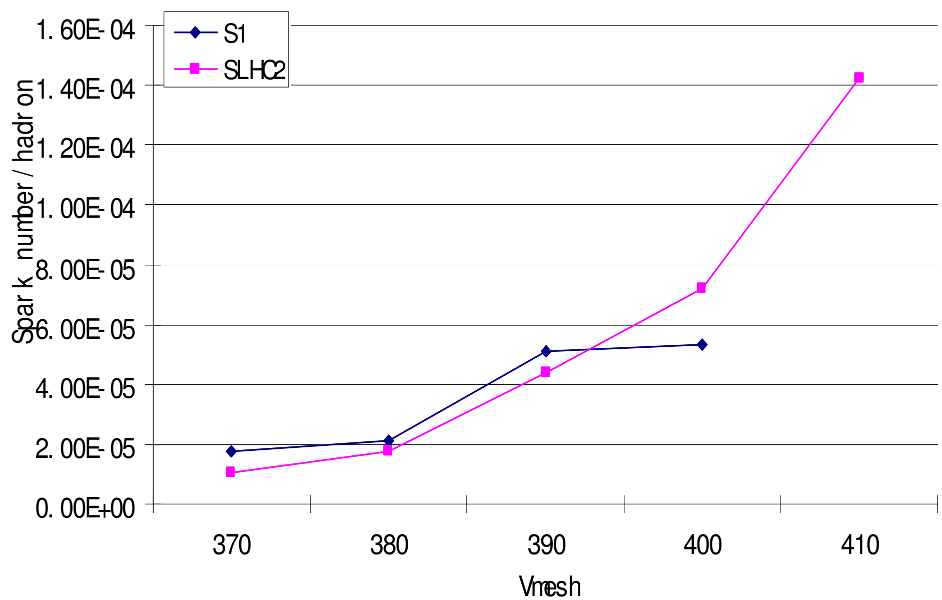
S1: Segmented mesh



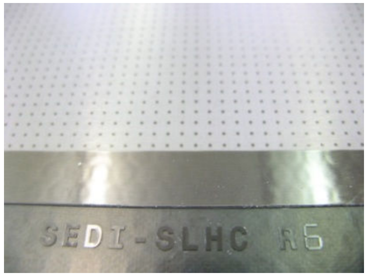


Spark rate= #Sparks/#incident hadron

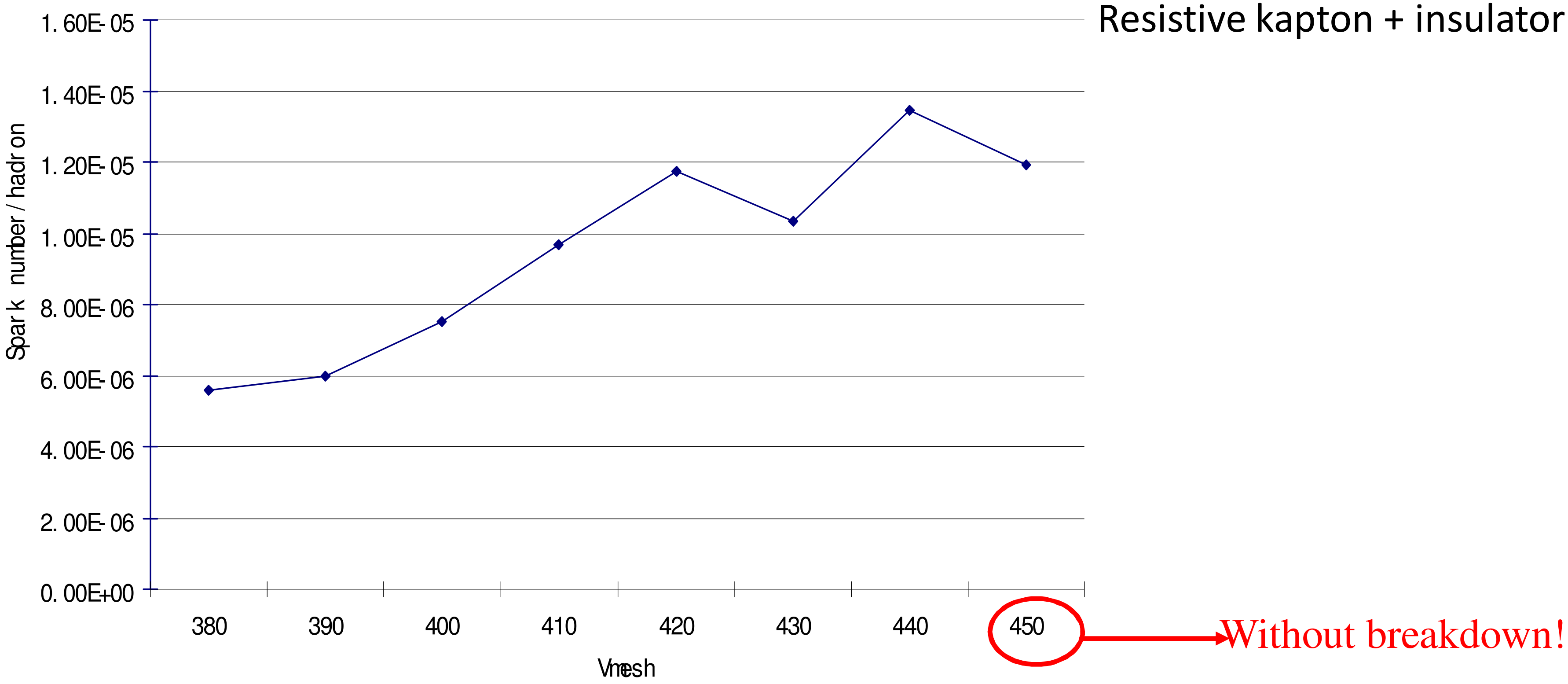
Spark rate@10KHz:



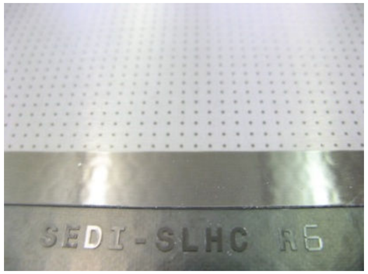
R3 spark rate(@10KHz):



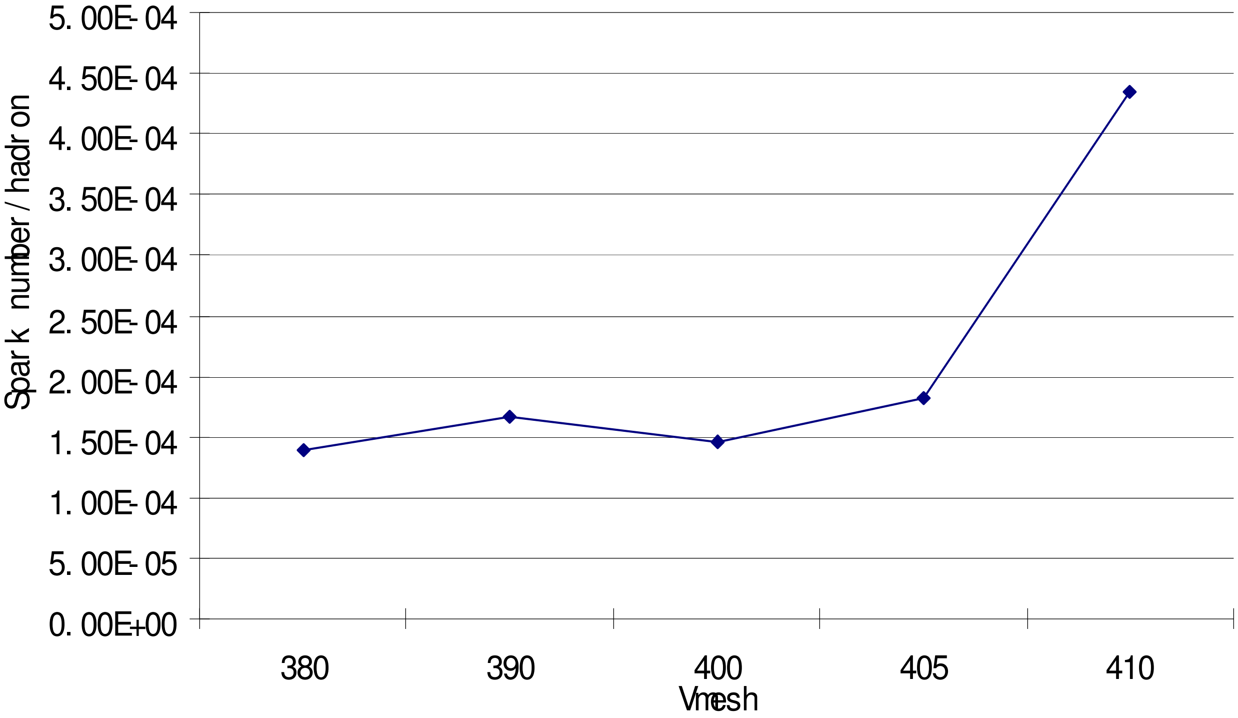
R3 /R4: 2 M Ω/□
Resistive kapton + insulator



R5 spark rate(@10KHz):



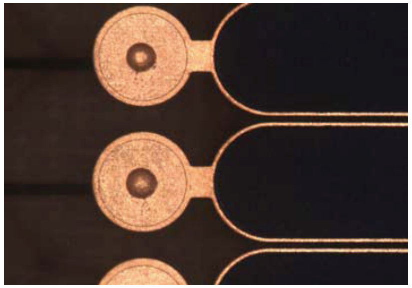
250 M Ω/□
Resistive paste + insulator



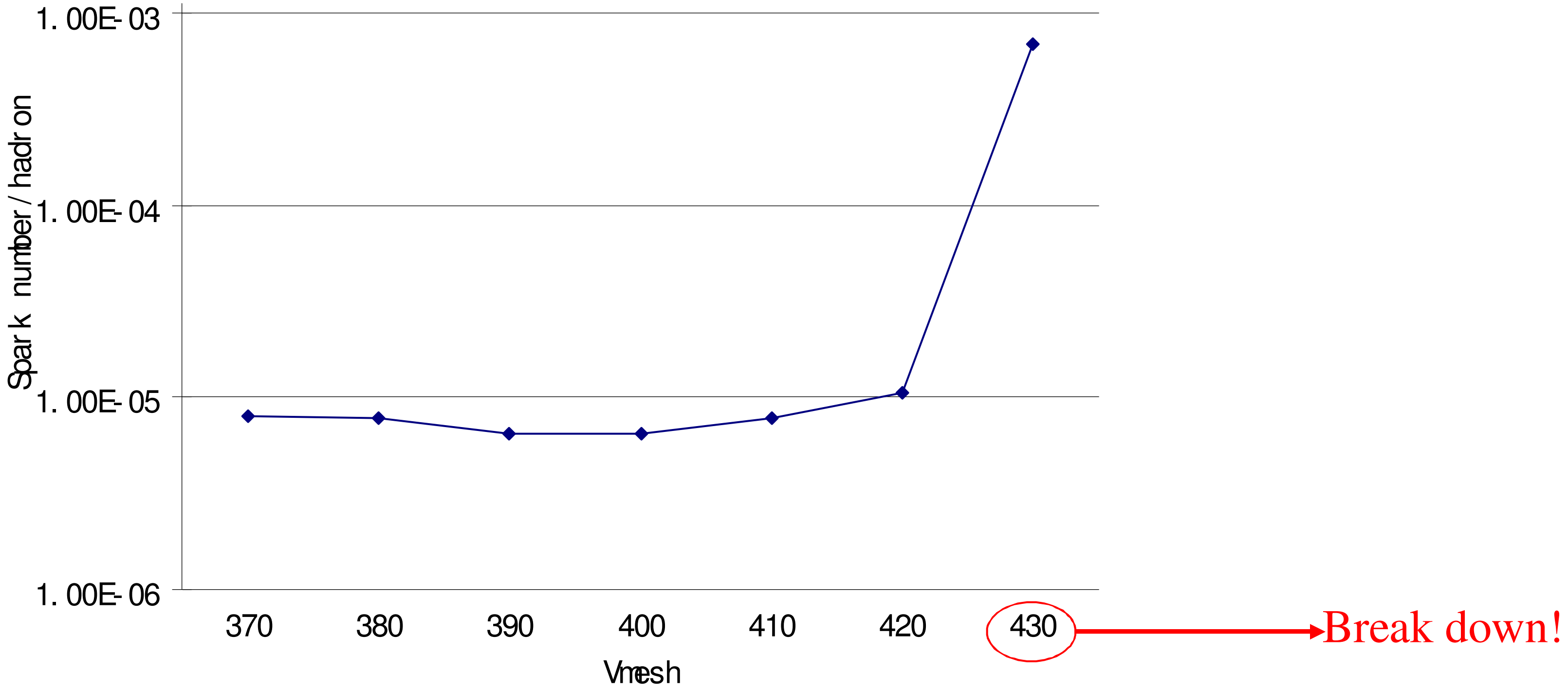
HV=390 V (gain~3000): current when sparking<0.1 μA

voltage drop<1.5%

Spark rate R6(@10KHz):



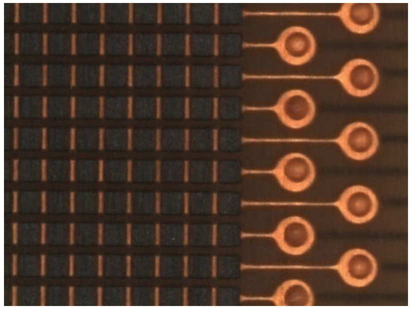
400K Ω/□
Resistive strips (paste)



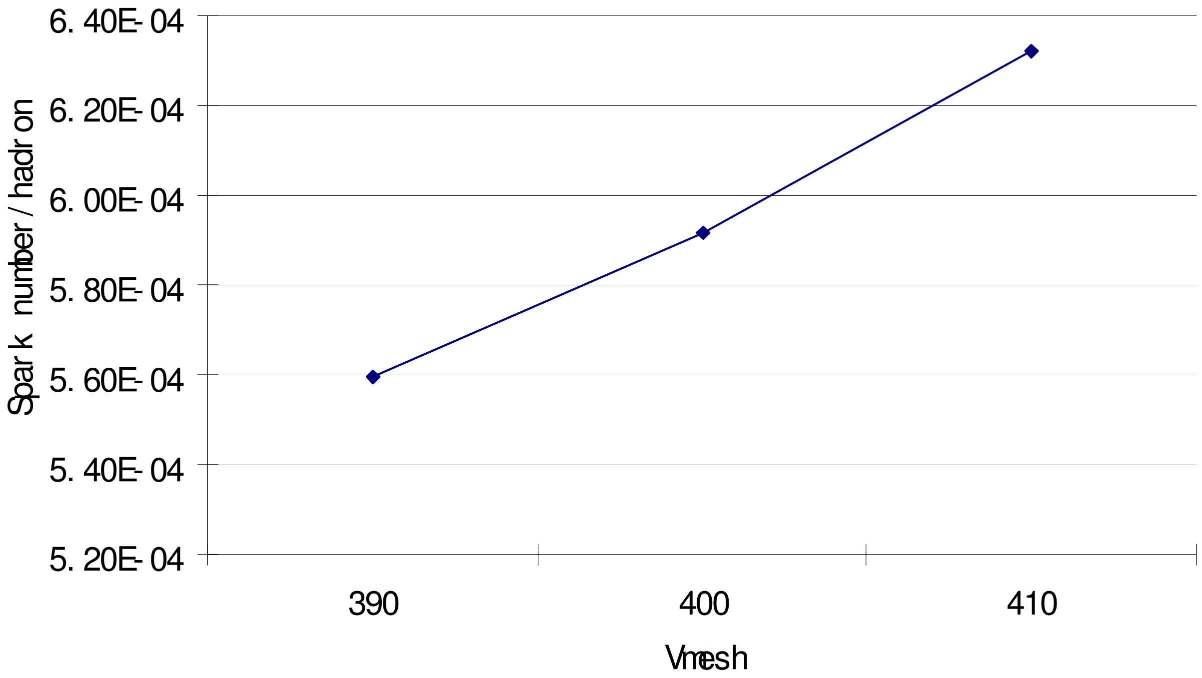
HV = 390 (gain~3000): current when sparking < 0.08 μA

voltage drop < 0.5%

R7 spark rate(@10KHz):



a few tens of kΩ/ □
Resistive pads (paste)



HV = 400V (gain~3000): current when sparking< 0.35 μA

voltage drop< 4.5%

Detector performance at same gas gain (~3000):

Detector	type	Spark rate	Spark current /μA	Voltage drop
SLHC2	standard	7*E-5	0.4	5%
R3	2 M Ω/ □ resistive kapton	9.6*E-6	0.2	2%
R5	250 M Ω/ □ resistive paste	1.6*E-4	0.1	1.5%
R6	400K Ω/ □ resistive strip	6.4*E-6	0.08	0.5%
R7	tens of K Ω/ □ resistive pad	5.9*E-4	0.35	4.5%

Conclusions and outlook:

1. Resistive detectors R3 and R6 can reduce the spark rate by one magnitude, R5 and R7 increase the spark rate, they are not successful ones.

2. All the resistive detectors can reduce the spark current and voltage drop by a factor of 2-10, thus provide a better working performance for high luminosity SLHC period.

3. Performance such as efficiency and spatial resolution need to be done later to compare between the resistive one and standard one, at least we had a very successful data taking…