Further developments of detectors with resistive electrodes:

Resistive Microdot Microhole detector

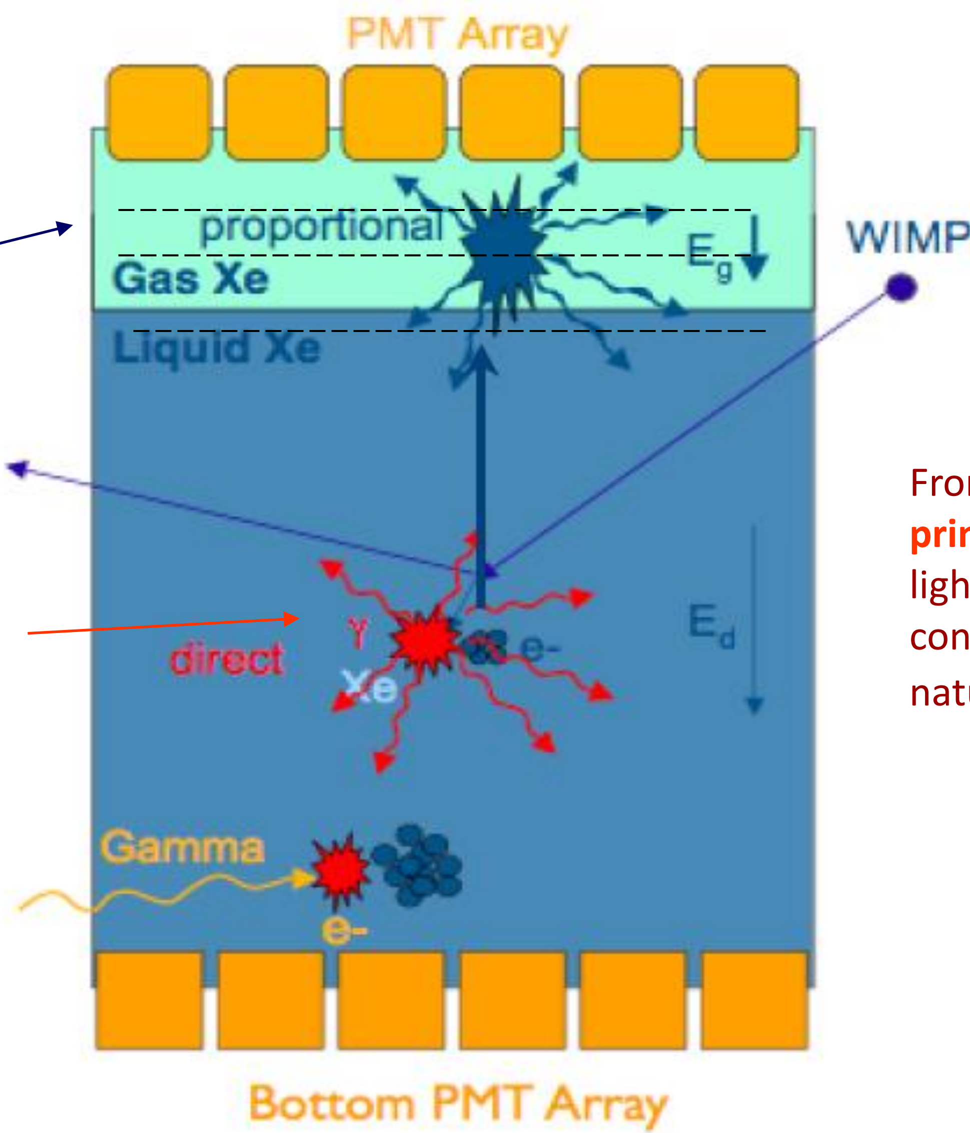
R. Oliveira[1], V. Peskov[1,2], F. Pietropaolo[3], P. Picchi[4]

[1]CERN, Geneva, Switzerland
[2]NAM, Mexico
[3]INFN Padova, Ialy
[4]INFN Fracati, Italy

Motivation of this development:

noble liquid dark-matter detectors

Double phase noble liquid dark matter detectors



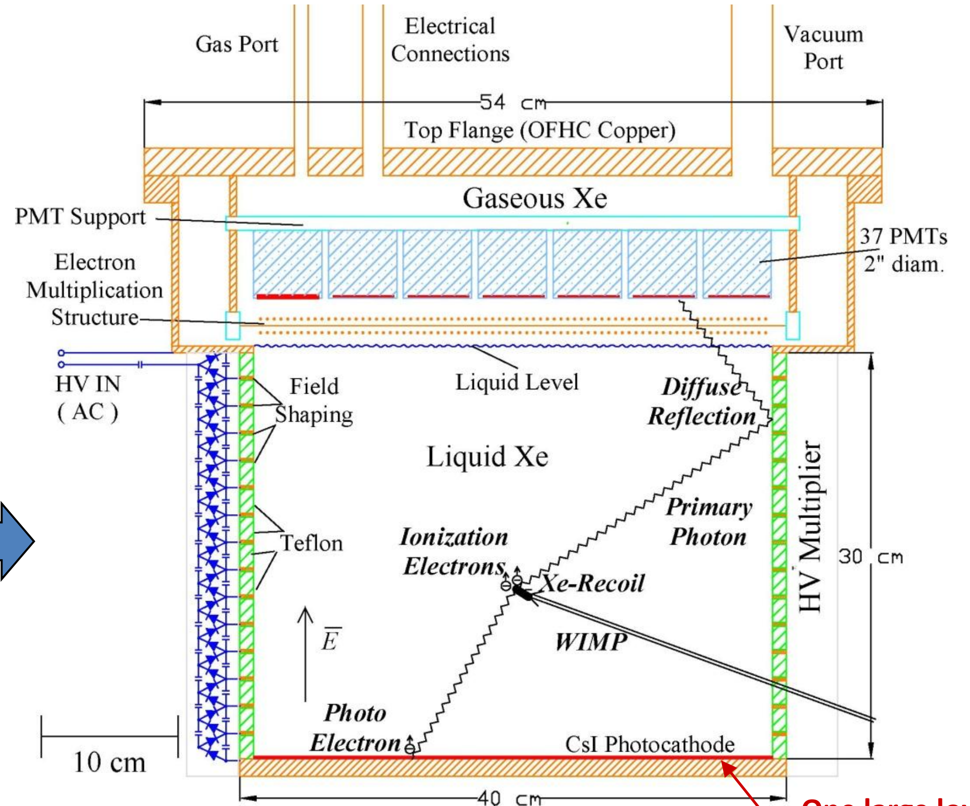
Two parallel meshes where the **secondary** scintillation light is produced

Primary scintillation light

From the ratio of **primary/secondary** lights one can conclude about the nature of the interaction

Several groups are trying to develop designs with reduced number of PMs

Large amount of PMs in the case of the large-volume detector **significantly increase its cost**



See: E. Aprile [XENON: a 1-ton Liquid Xenon Experiment for Dark Matter](http://xenon.astro.columbia.edu/presentations.html)
http://xenon.astro.columbia.edu/presentations.html
and A. Aprile et al., NIM A338,1994,328; NIM A343,1994,129

Another option for the LXe TPC, which is currently under the study in our group, is to use LXe doped with low ionization potential substances (TMPD and cetera**).**

Nuclear Instruments and Methods in Physics Research A 338 (1994) 328–335
North-Holland

NUCLEAR
INSTRUMENTS
& METHODS
IN PHYSICS
RESEARCH
Section A

Performance of CsI photocathodes in liquid Xe, Kr, and Ar

E. Aprile [a,*], A. Bolotnikov [a], D. Chen [a], R. Mukherjee [a], F. Xu [a], D.F. Anderson [b], V. Peskov [b]

[a] *Physics Department, Columbia University, New York, NY 10027, USA*
[b] *Particle Detector Group, Fermi National Accelerator Laboratory, Batavia, IL 60510, USA*

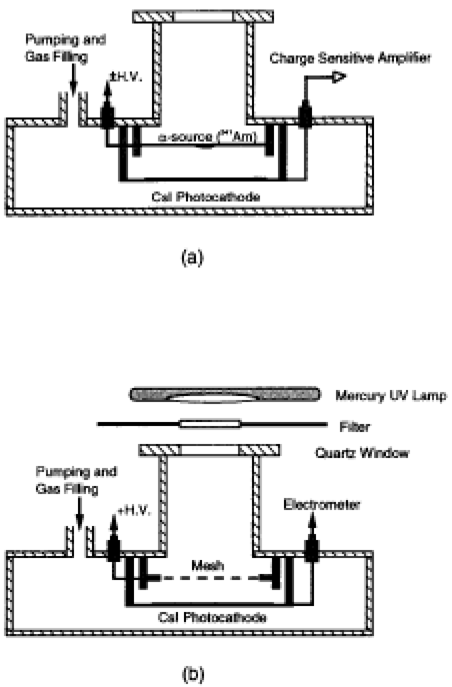


Fig. 1. Schematic of the experimental setup with (a) an ^{241}Am alpha-particle source and (b) filtered UV light from a mercury lamp.

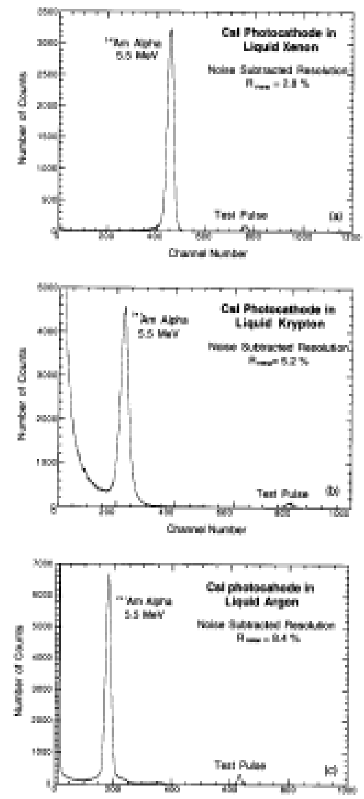


Fig. 2. Typical pulse height spectra of the scintillation light from ^{241}Am 5.5 MeV alpha particles in (a) LXe, (b) LKr, and (c) LAr. The resolutions quoted are with the noise subtracted.

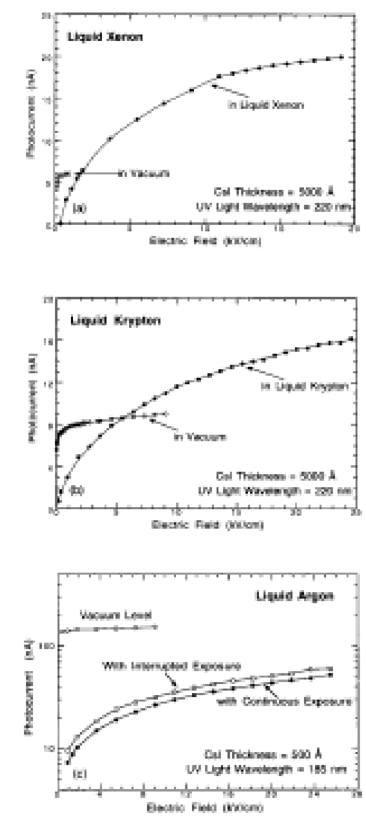


Fig. 4. Photocurrent induced by UV light as a function of electric field from the CsI photocathode in vacuum as well as in (a) LXe, (b) LKr and (c) LAr.

Nuclear Instruments and Methods in Physics Research A 343 (1994) 129–134
North-Holland

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH
Section A

Electron extraction from a CsI photocathode into condensed Xe, Kr, and Ar

E. Aprile [a,*], A. Bolotnikov [a], D. Chen [a], R. Mukherjee [a], F. Xu [a], D.F. Anderson [b], V. Peskov [b]

[a] *Physics Department, Columbia University, New York, NY 10027, USA*
[b] *Particle Detector Group, Fermi National Accelerator Laboratory, Batavia, IL 60510, USA*

N·H
ELSEVIER

Nuclear Instruments and Methods in Physics Research A 353 (1994) 55–58

NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH
Section A

First observation of the scintillation light from solid Xe, Kr and Ar with a CsI photocathode

E. Aprile [a,*], A. Bolotnikov [a], D. Chen [a], F. Xu [a], V. Peskov [b]

[a] *Physics Department, Columbia University, New York, NY 10027, USA*
[b] *Fermi National Accelerator Laboratory, Batavia, IL 60510, USA*

Performance of some Cs based photocathodes inside liquid and solid Ar

Gulaev, V.; Peskov, V.; Silin, E.

Nuclear Science Symposium and Medical Imaging Conference, 1994., 1994 IEEE Conference Record

Physics behind this phenomena

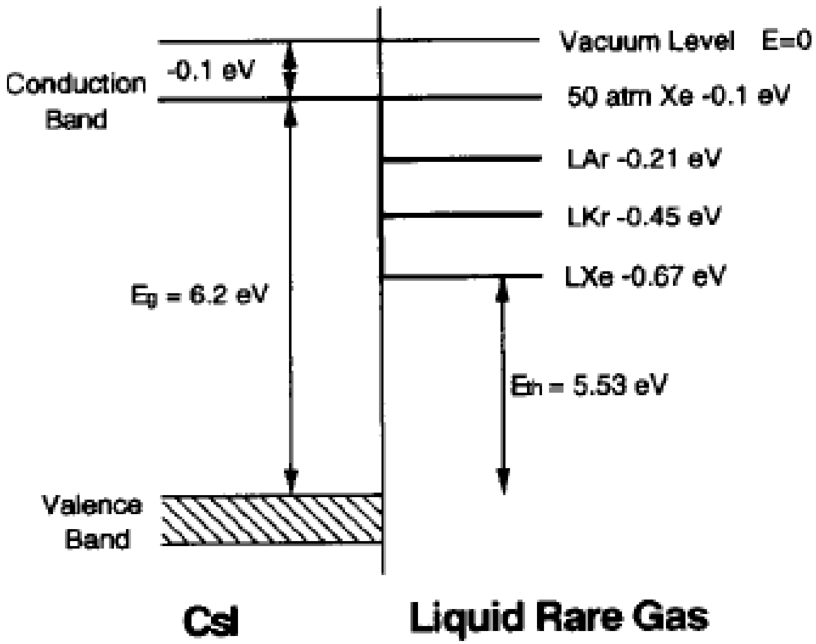
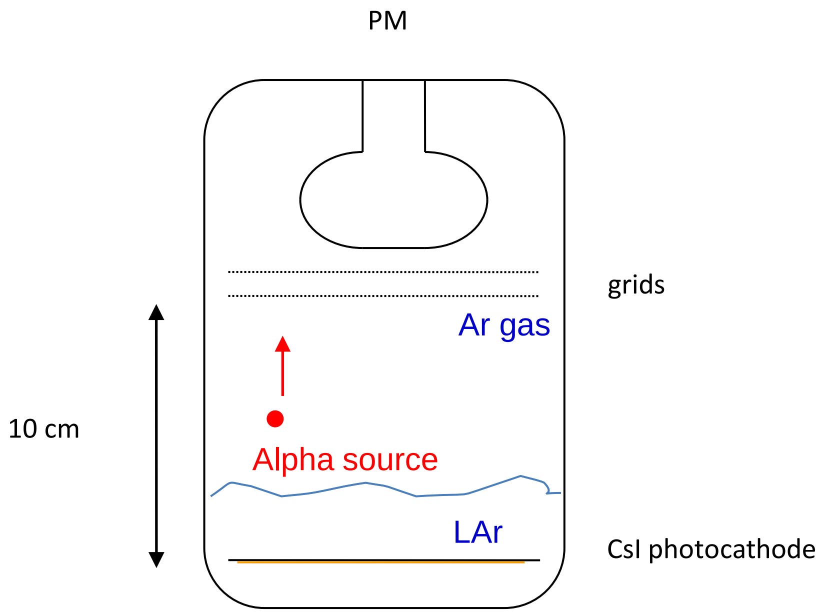
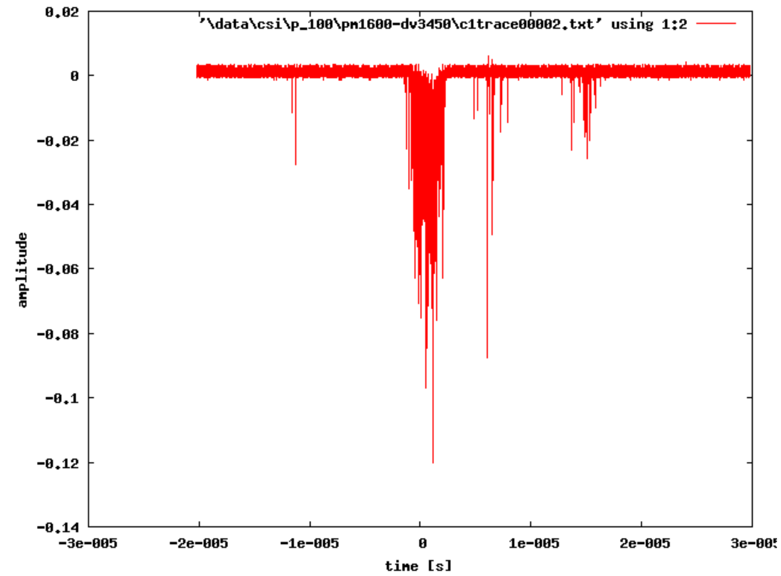


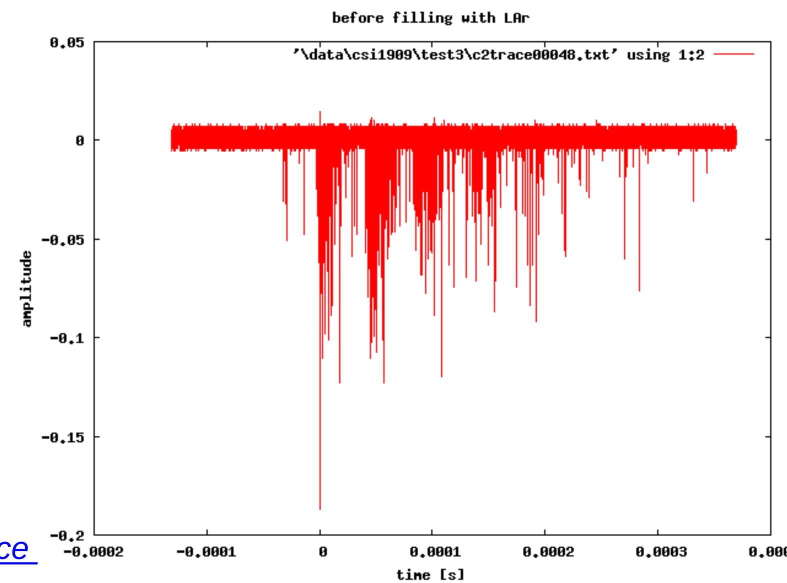
Fig. 8. Band structure at the CsI–liquid interface.

Experimental setup





Ar gas, 1 atm



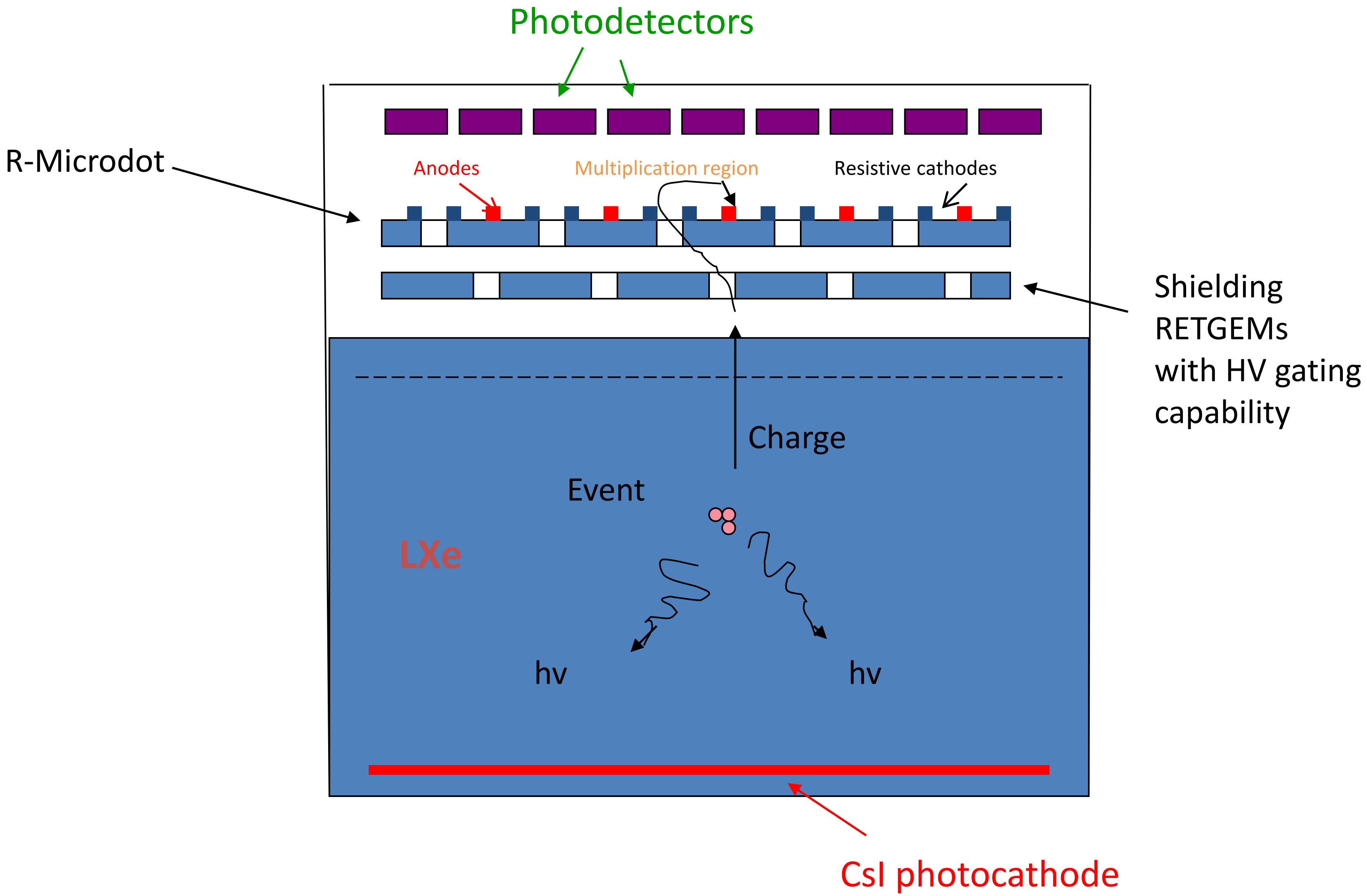
LAr+ gas phase

V. Peskov, P. Pietropaolo, P. Pchhi, H. Schindler

ICARUS group

Performance of dual phase XeTPC with CsI photocathode and PMTs readout for the scintillation light
Aprile, E.; Giboni, K.L.; Kamat, S.; Majewski, P.; Ni, K.; Singh, B.Ketal
Dielectric Liquids, 2005. ICDL 2005. 2005 IEEE International Conference
Publication Year: 2005 , Page(s): 345 - 348

The way to supress the feedback



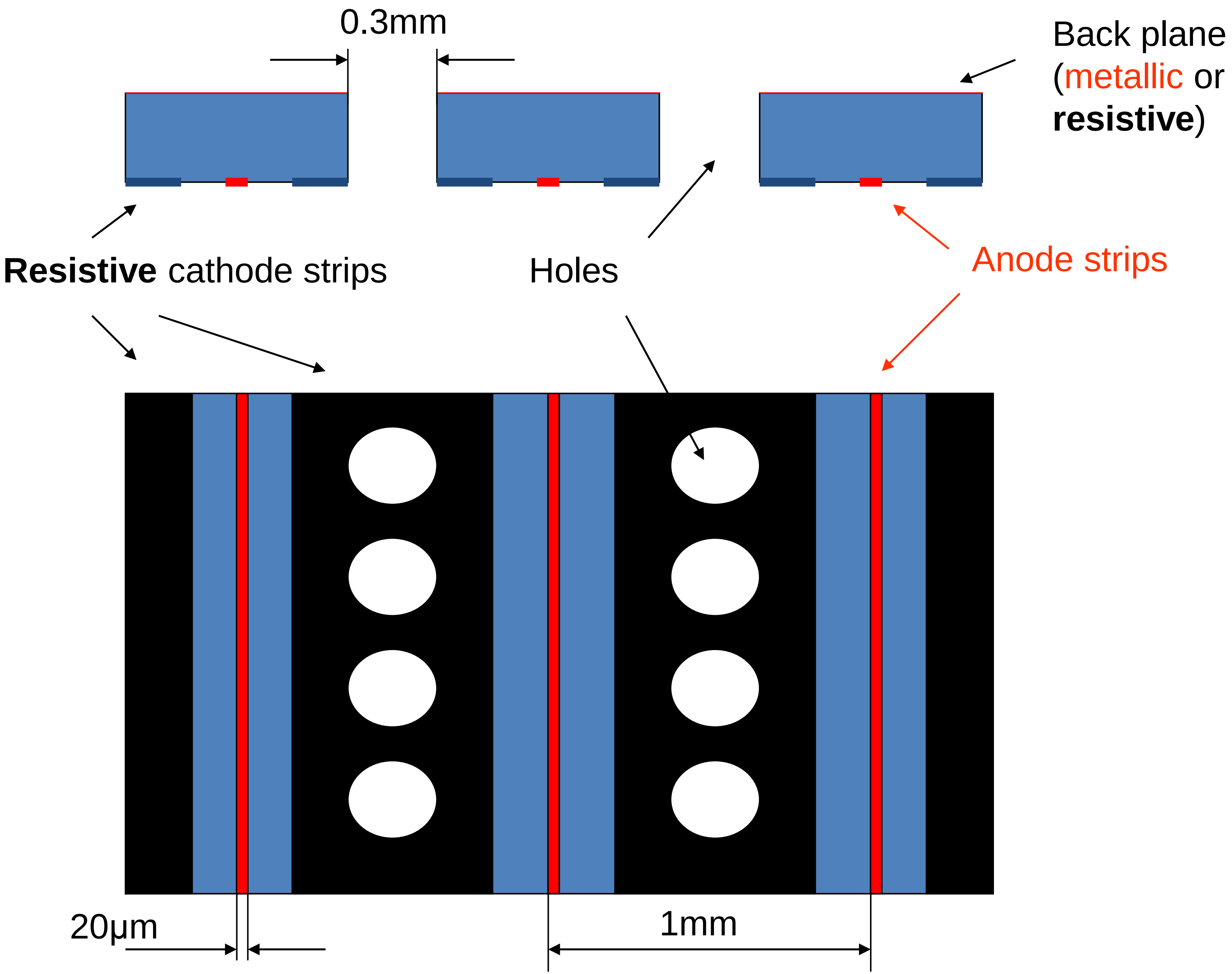
In hybrid R-MSGC, the amplification region will be geometrically shielded from the CsI photocathode (**or from the doped LXe**) and accordingly the feedback will be reduced

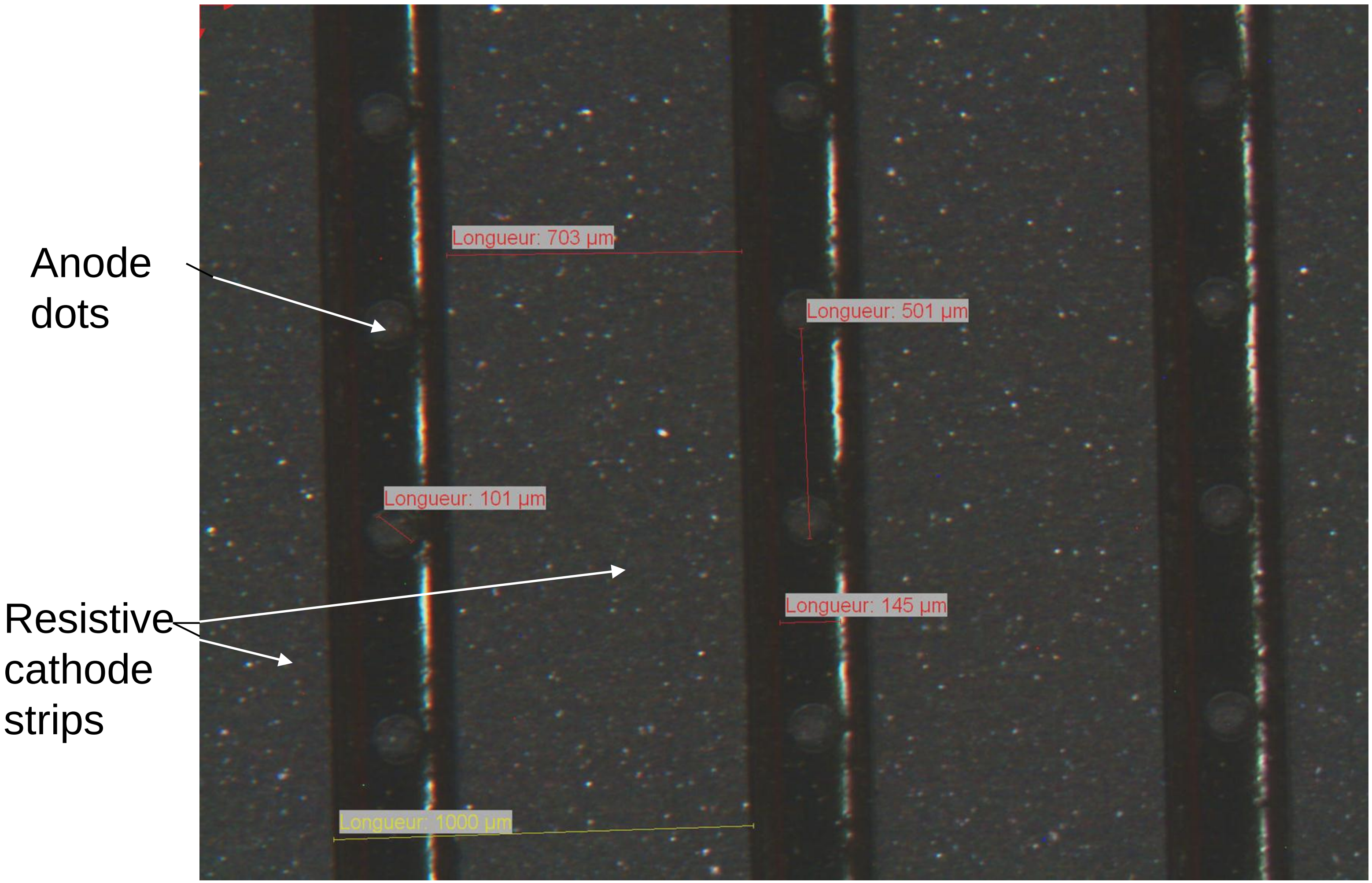
In our previous presentaion

RD51 mini week (21-23 November 2011)

"New developments in spark-protected micropattern detectors"

Microhole-microstrip detector and Microdot detectors were introduced


0.3mm
Back plane
(metallic or
resistive)
Resistive cathode strips
Holes
Anode strips
20μm
1mm



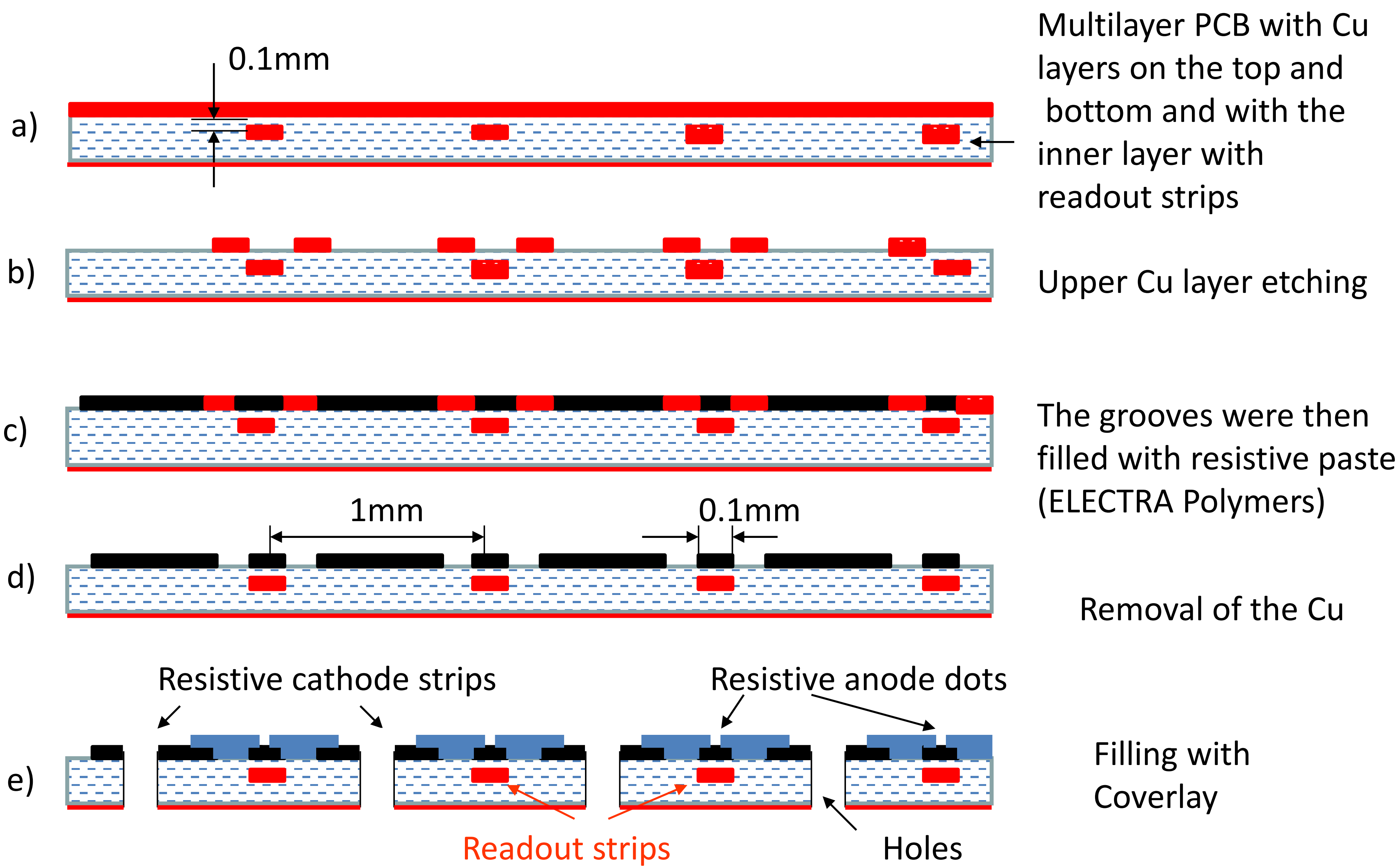
A magnified photo of Microdot detector

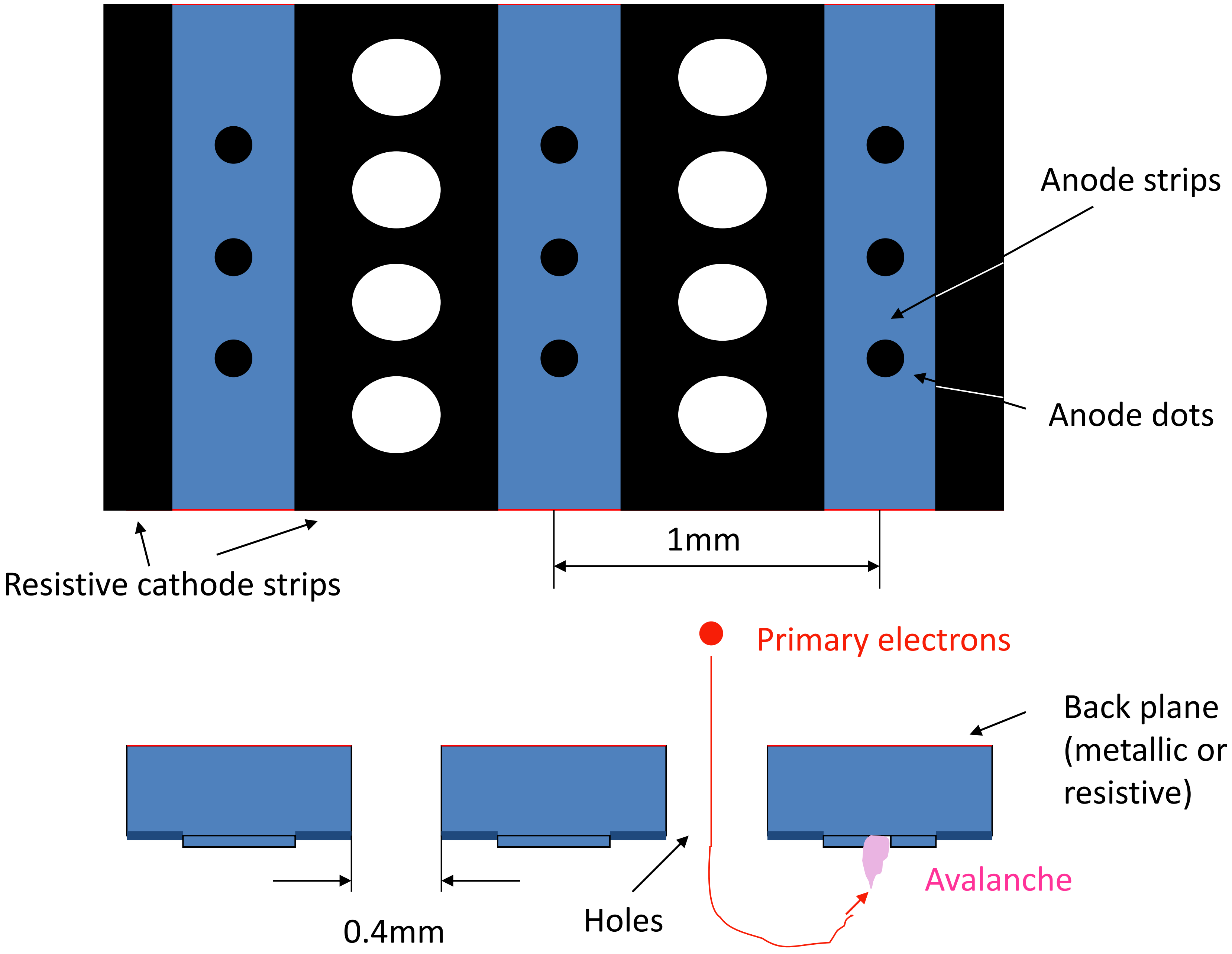
Today we will present further developments:

Microdot microhole detector

This detector allows <u>10 timed higher</u> gas gains to achieve at cryogenic temperatures then with microstrip-microhole detector

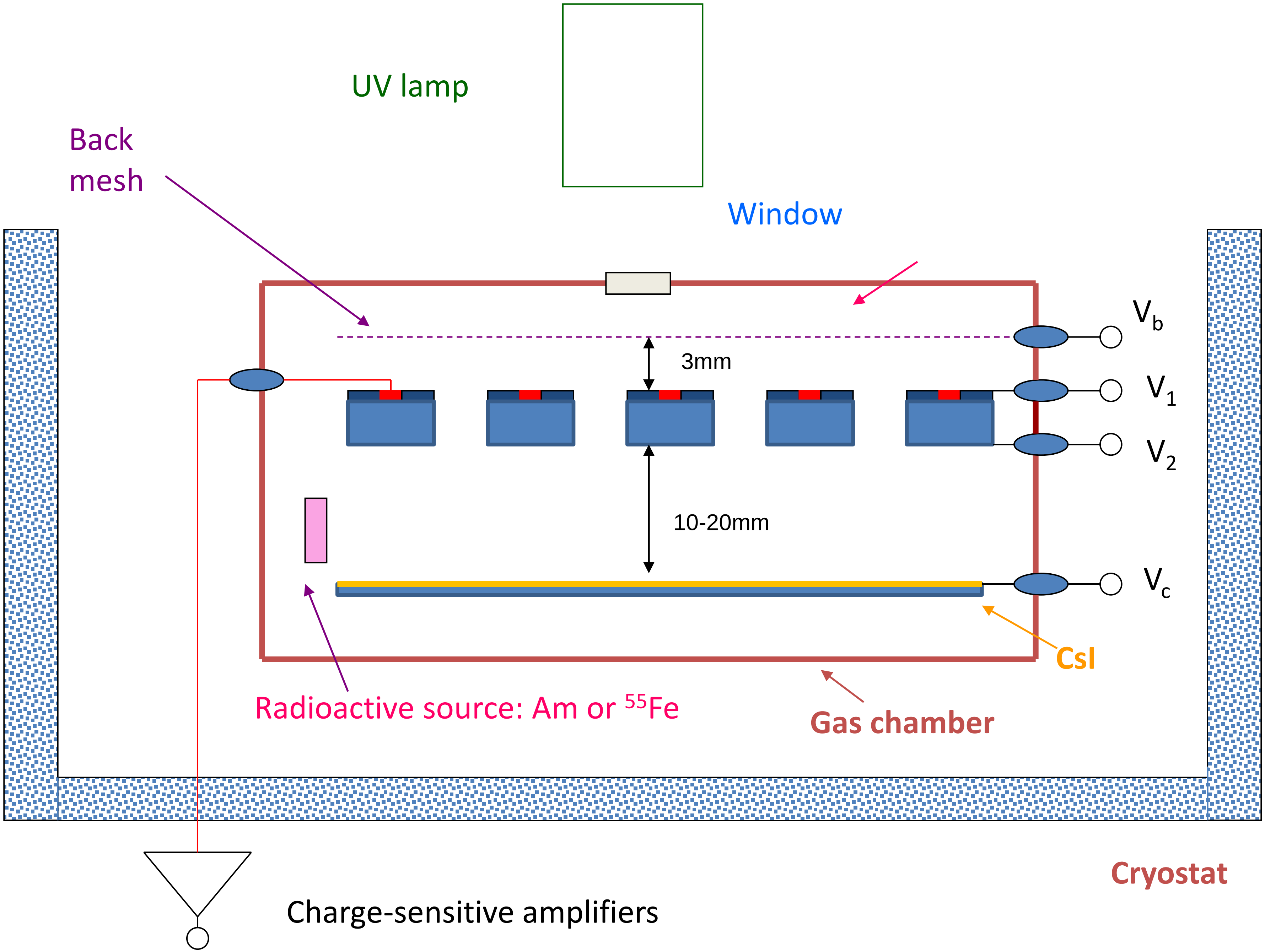
Manufacturing technique


0.1mm
a)
Multilayer PCB with Cu layers on the top and bottom and with the inner layer with readout strips
b)
Upper Cu layer etching
c)
The grooves were then filled with resistive paste (ELECTRA Polymers)
1mm
0.1mm
d)
Removal of the Cu
Resistive cathode strips
Resistive anode dots
e)
Filling with Coverlay
Readout strips
Holes



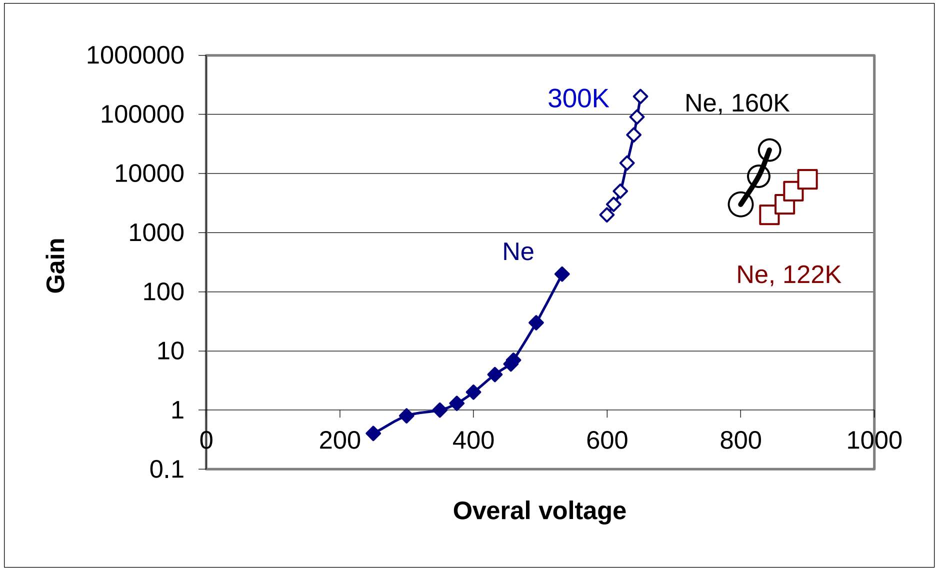
Anode strips
Anode dots
Resistive cathode strips
1mm
Primary electrons
Back plane (metallic or resistive)
Avalanche
0.4mm
Holes

Experimental setup


UV lamp
Back mesh
Window
V_b
3mm
V_1
V_2
10-20mm
V_c
CsI
Radioactive source: Am or ^{55}Fe
Gas chamber
Cryostat
Charge-sensitive amplifiers

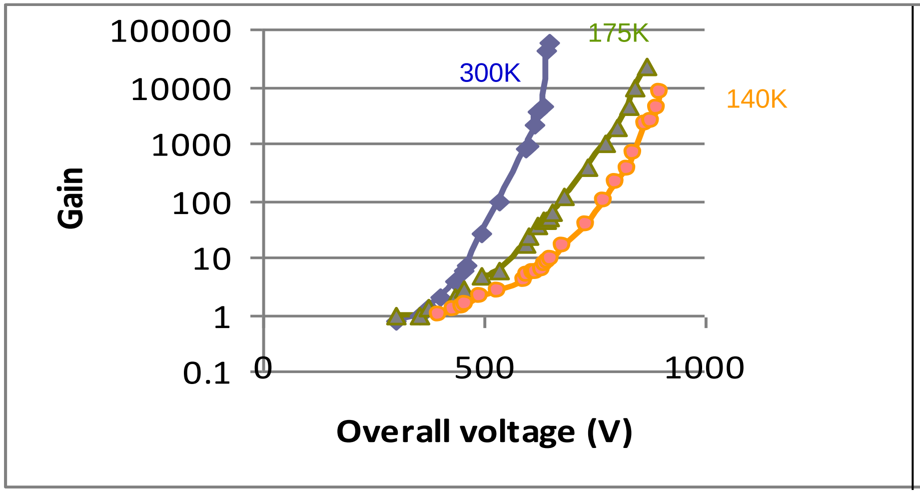
Preliminary results

Measurements in Ne

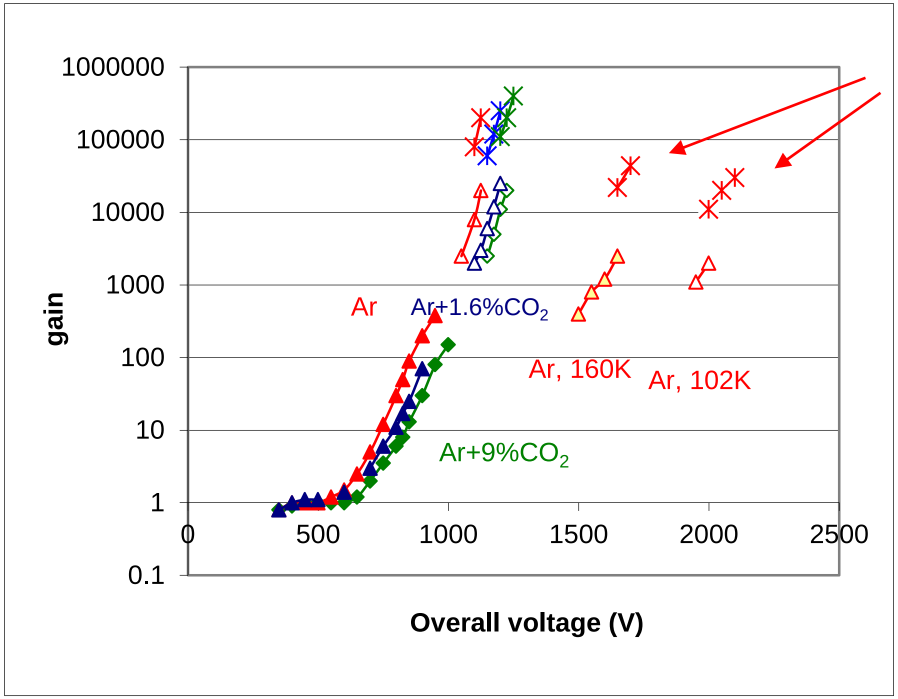


Results obtained with alphas and ^{55}Fe

Results obtained with UV lamp



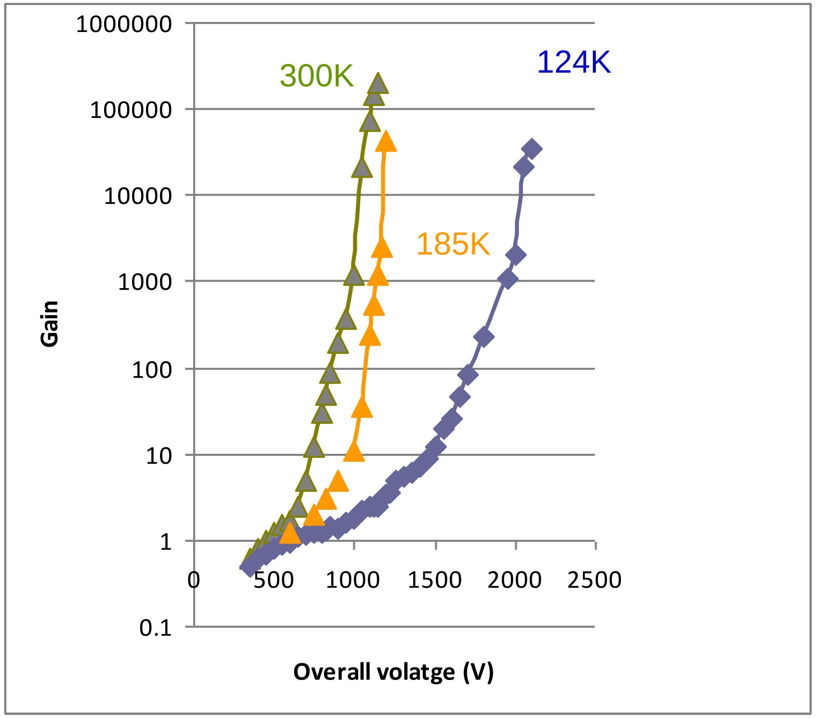
Measurements in Ar



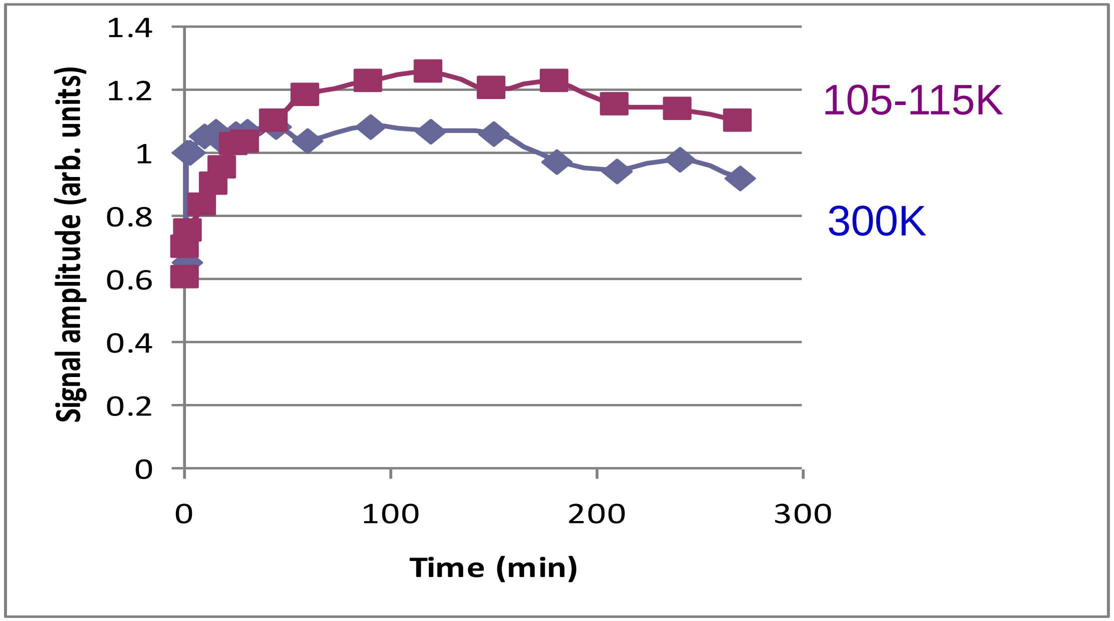
“streamer” mode

Results obtained with alphas and ^{55}Fe

Results obtained with UV lamp



Stability tests (preliminary)



Conclusions:

- Preliminary studies indicate that Microdot-microhole detector can be very promising for cryogenic dark matter detectors with CsI photocathodes or with dopands
- It offers almost <u>10 time higher</u> gain than microhol-microstrip detectors
- Certainly more studies are needed to demonstrate the stability, long-term operation and vitality of this approach