Update on Chinese low resistive glass

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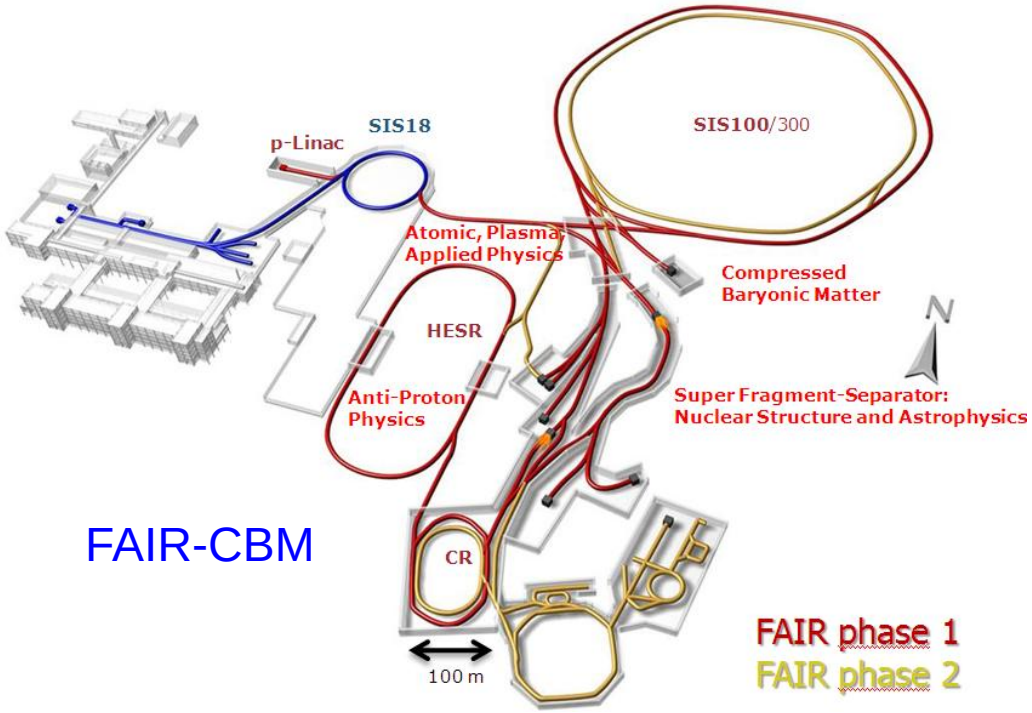
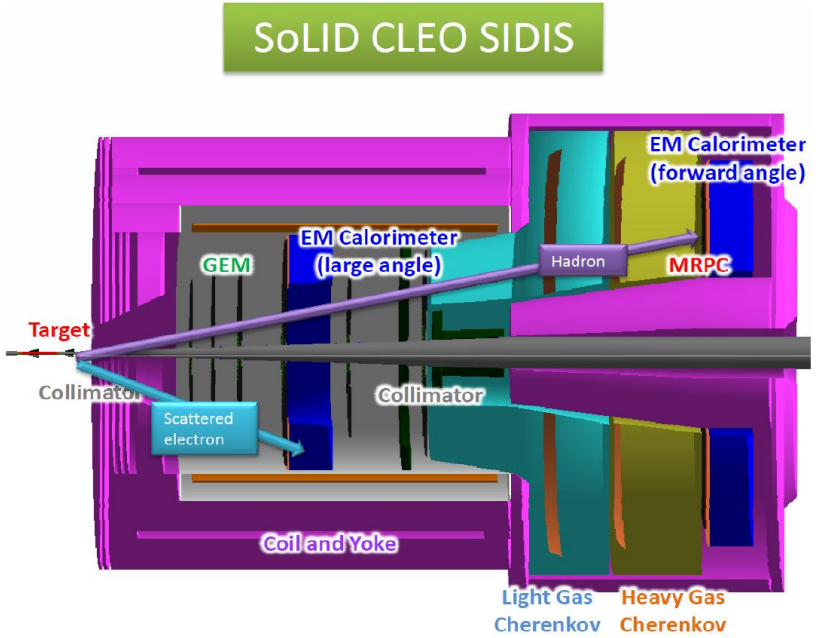
TOF requirement for high luminosity experiment



FAIR-CBM



JLab-SoLID

TOF requirements:

Time resolution: <80ps

Rate capability: >10~25kHz/cm^2

Glass resistivity: ~$10^{10}\Omega.\mathrm{cm}$ (low resitive glass)

Development of low resistivity glass

Components:

$SiO2$, Fe_2O_3 , Na_2O ,AL_2O_3 , MnO_2

Glass resistivity: ~10^{10} Ωcm

Process:

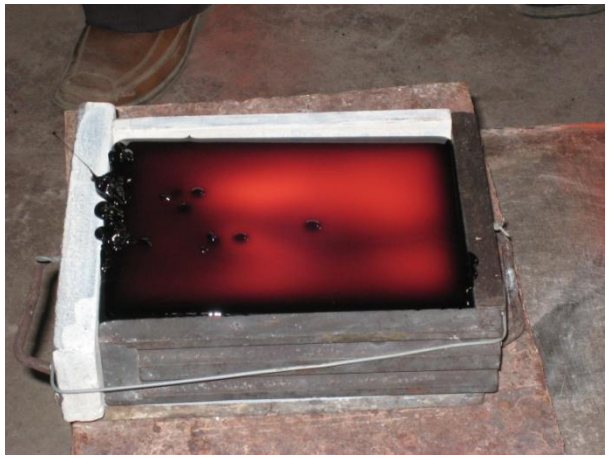
Melting

Cooling

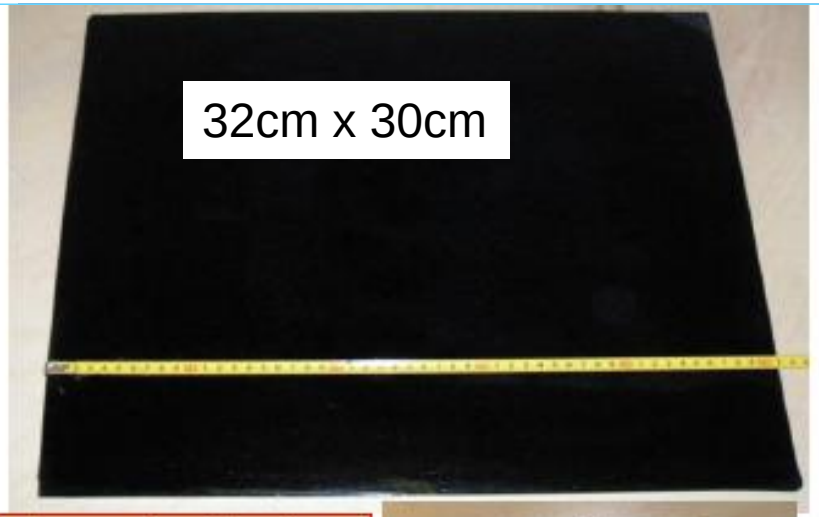
Cutting

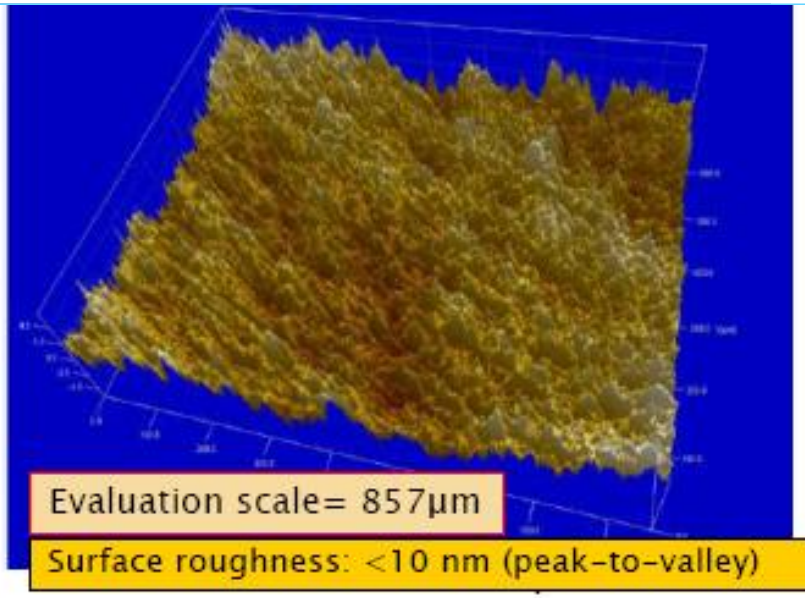
Polishing

- Different compositions and related production procedures have been studied, yielding a tunable bulk resistivity in the range of 10^{10}–10^{11} Ωcm.
- In the mass production, in order to produce reliable glasses with high quality, surface measurement has been taken as a key part of the quality control.
- This glass shows a large stability against electrical stress.

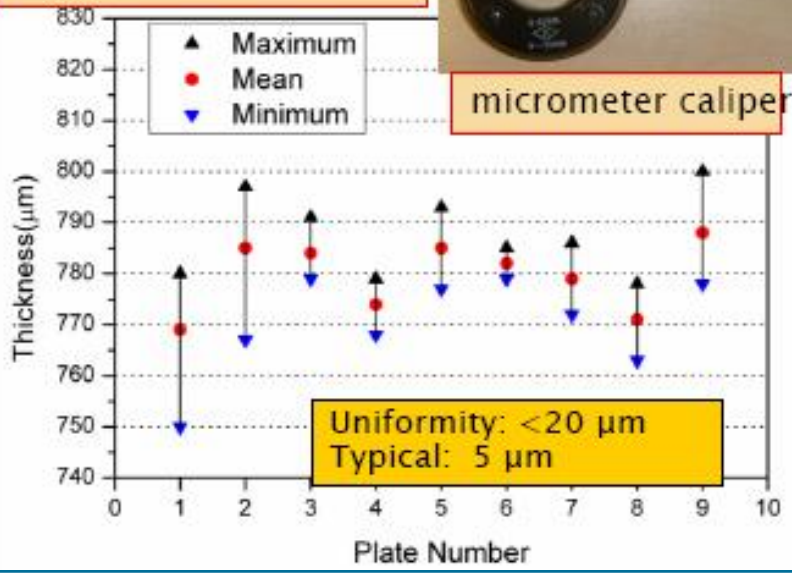


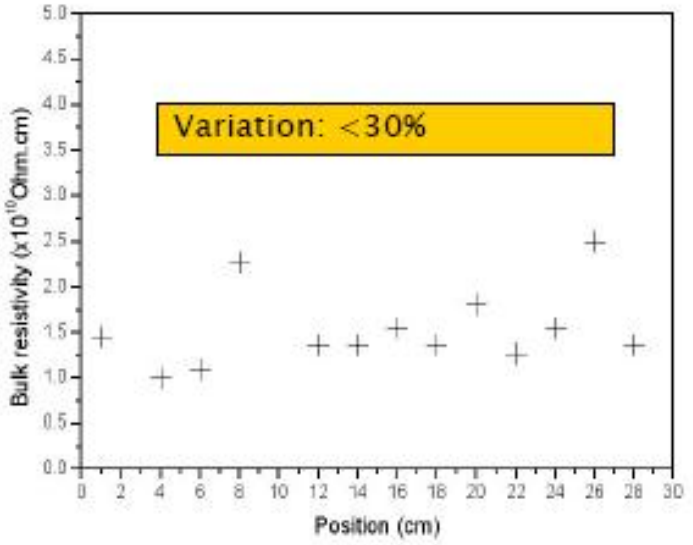
Performance of low resistivity glass



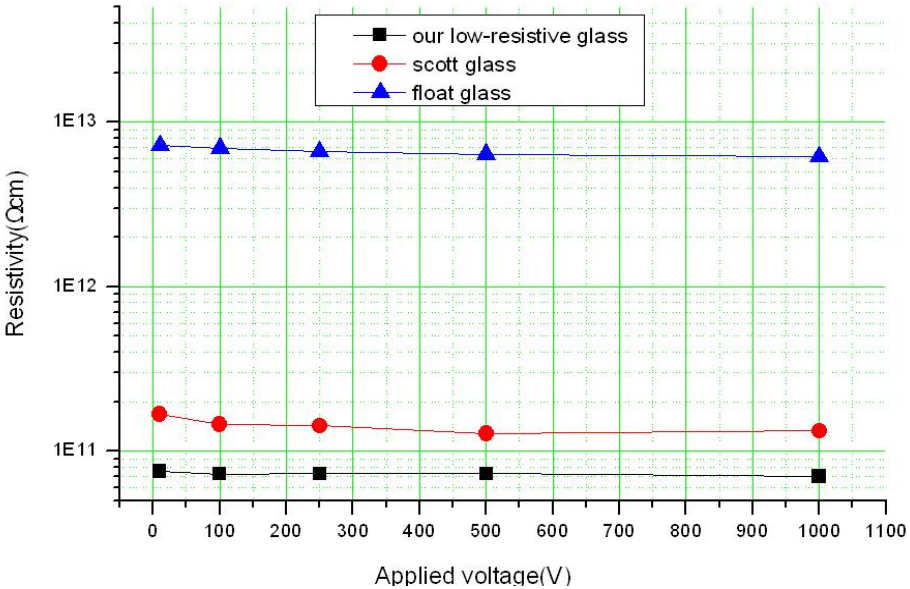


Thickness distribution
(Evaluation scale= 30cm)

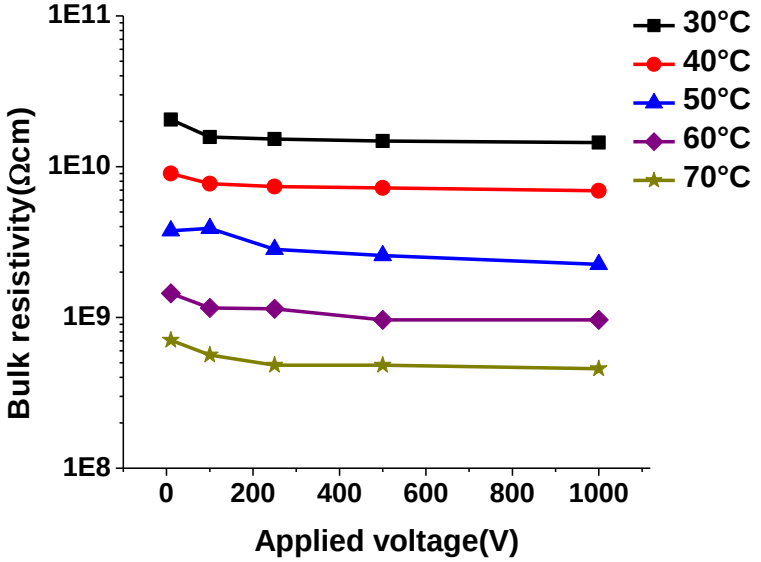




Performance of low resistivity glass

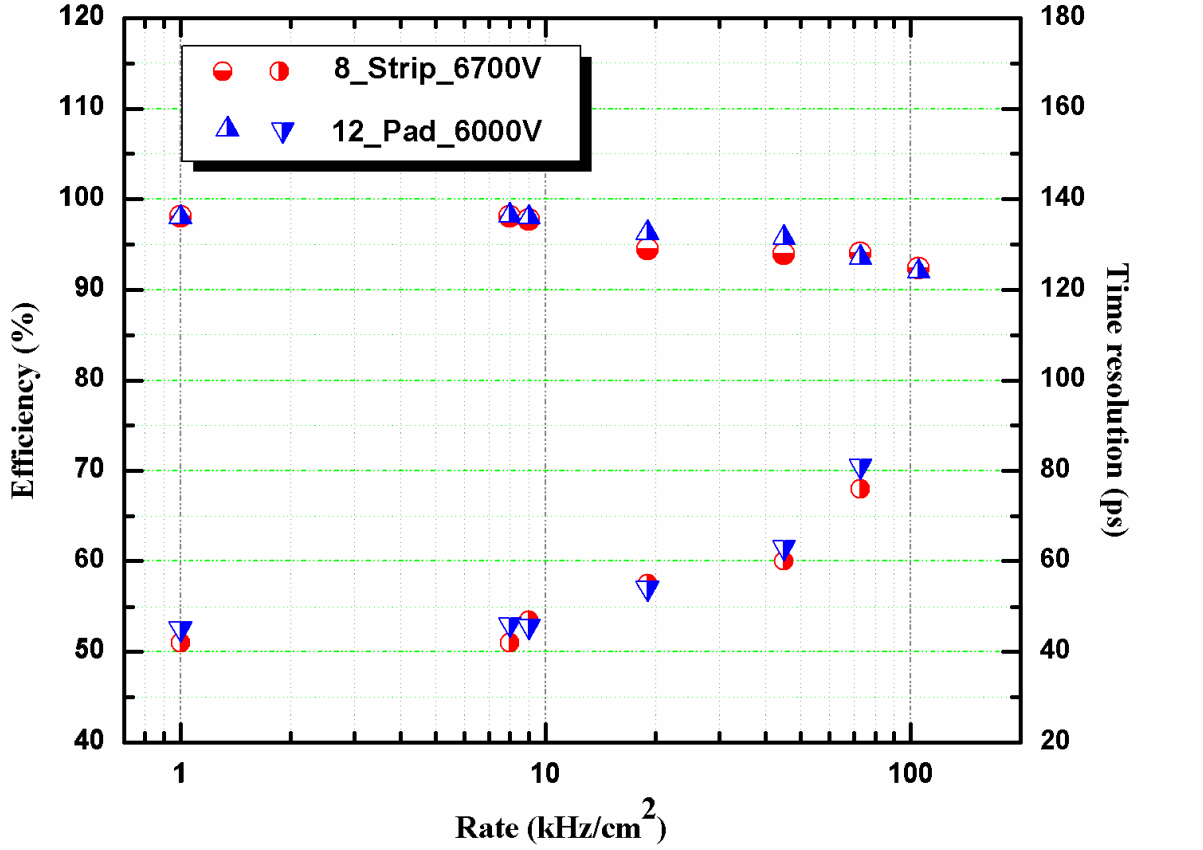


Resistivity vs. HV



Resistivity at different temperature

Time and rate performance of MRPC assembled with low resistive glass

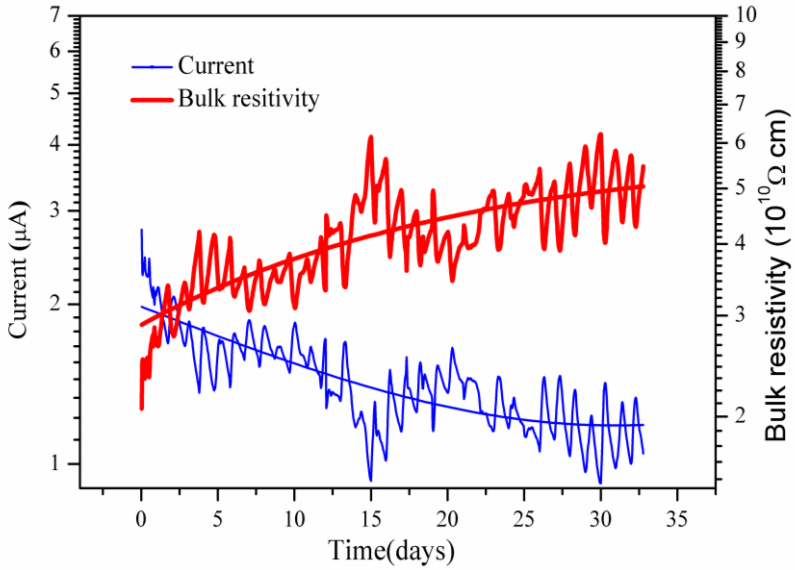


Even though the rate is 70kHz/cm^2, the efficiency is still higher than 90% and the time resolution is about 80ps.

HV test of glass

This glass was applied with 1000V for about 32days, integrated charge: 1 C/cm^2

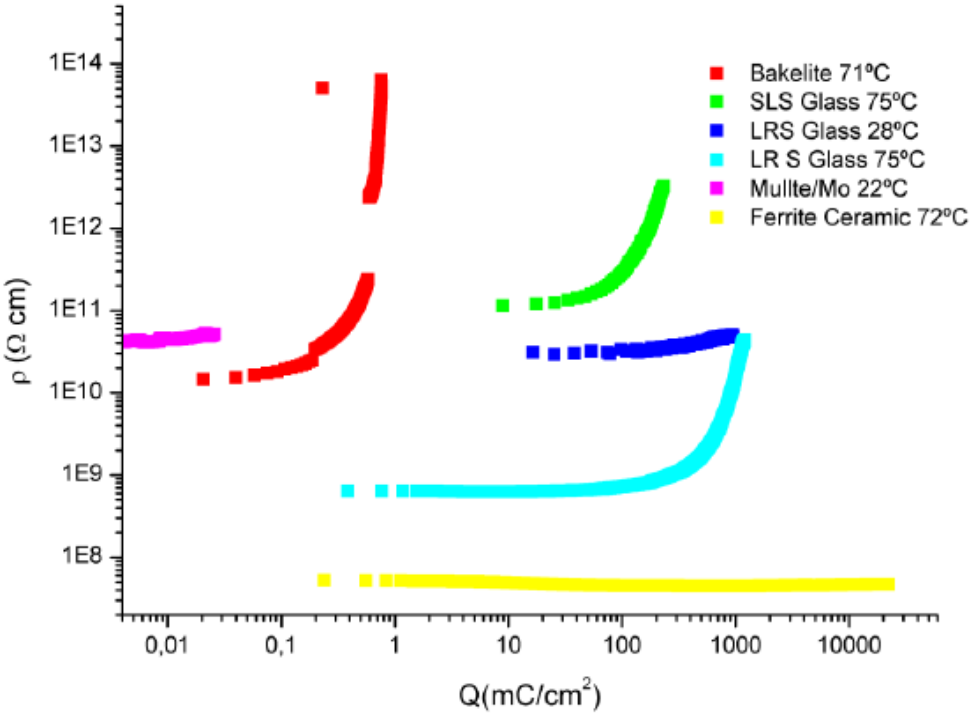
--roughly corresponding to the CBM life-time over 5 years operation at the maximum particle rate.



Glass specifications:

Maximal dimension	32cm × 30cm
Bulk resistivity	10^{10} Ωcm
Standard thickness	0.7, 1.1mm
Thickness uniformity	20 μm
Surface roughness	< 10nm
Dielectric constant	7.5 - 9.5
DC measurement	Ohmic bebavior stable up to 1 C/cm^2

Comparasion with other material



Drifted charge		
Material	T(°C)	Q(mC/cm²)
SLS Glass	75	230
LR S Glass	28	900
	75	1190
Bakelite	72	0.8
Mullite/Mo	22	0.025
Ferrite Ceramic	72	22 000

Note: Expected Charge transfered by the CBM RPCs

$Q/A = 5y \times 0.5 \times 20\ KHz/cm^2 \times 1.5pC/gap = 2C/cm^2$

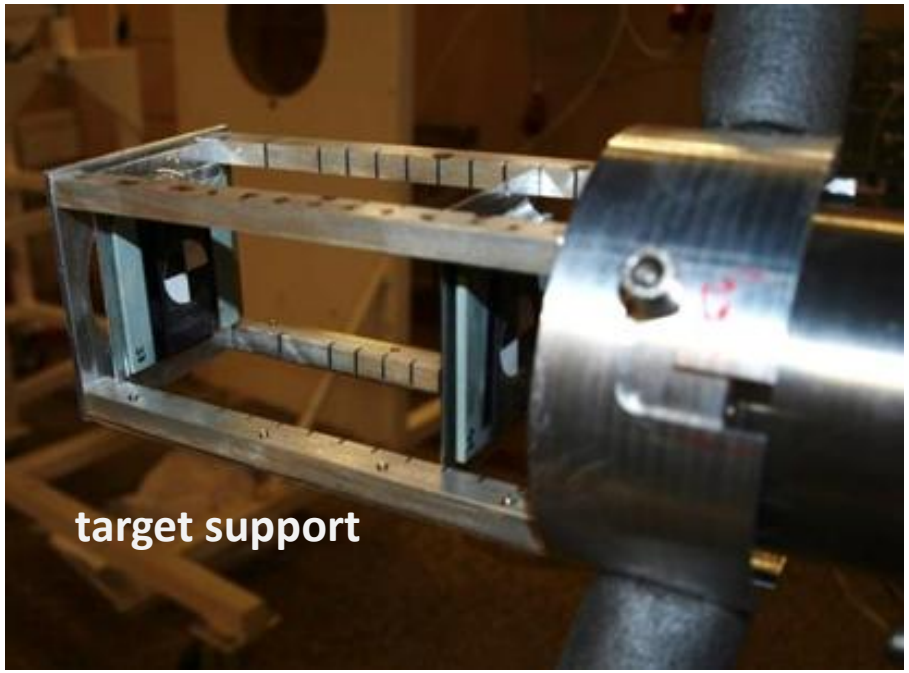
Morales talk @RPC2012

Electrode Material Samples for neutron test

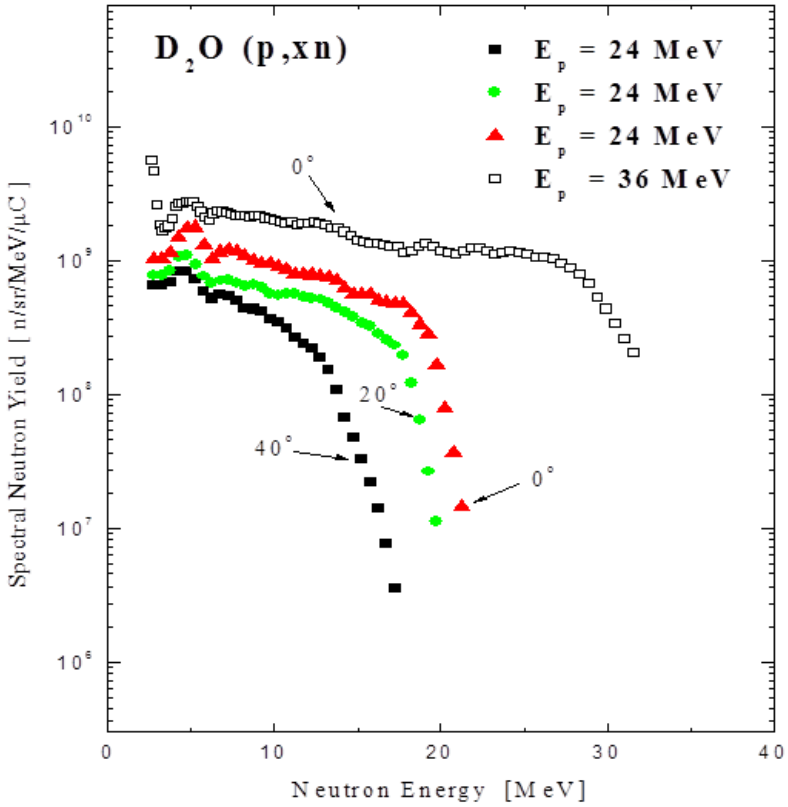
sample	material	length [cm]	width [cm]	area [cm^2]	thickness [cm]	volume [cm^3]	weigth [g]	density [g/cm^3]
layer-1	soda-lime glass	4	4	16	0.05	0.8	2.0	**2.5**
layer-2	Si_3N_4 / SiC ceramics	5	5	25	0.20	5.0	16.0	**3.2**
layer-3	semicond. glass	3	3	9	0.07	0.6	1.6	**2.5**

Experimental Facility

- Cyclotron U-120M (Řež)
- Proton energy 36 MeV
- Neutron production target Be
- Neutron flux 10^8 - 10^{10} n/cm^2/s
- Neutron energy spectra 1 – 36 MeV

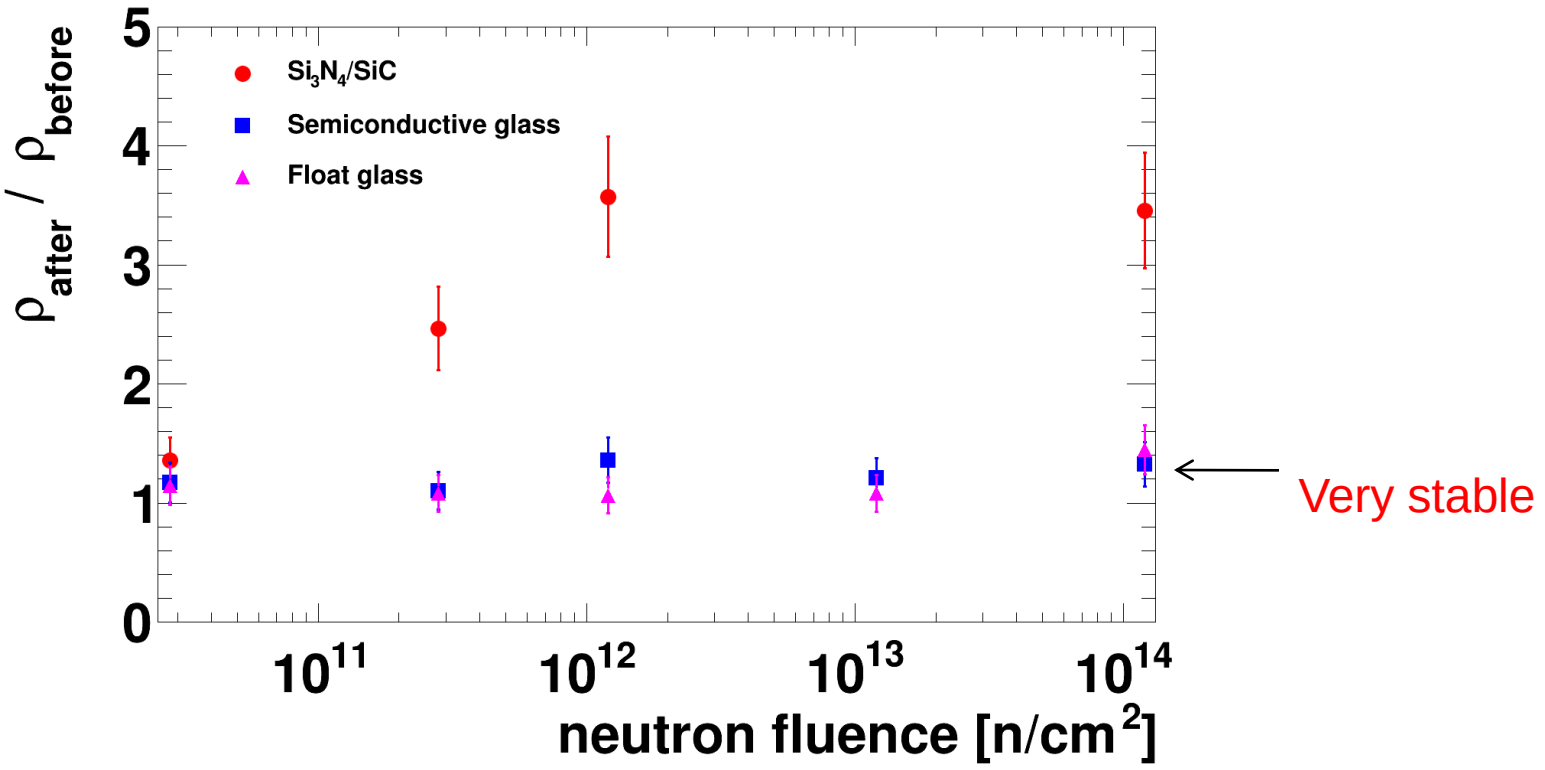


Neutron energy spectrum

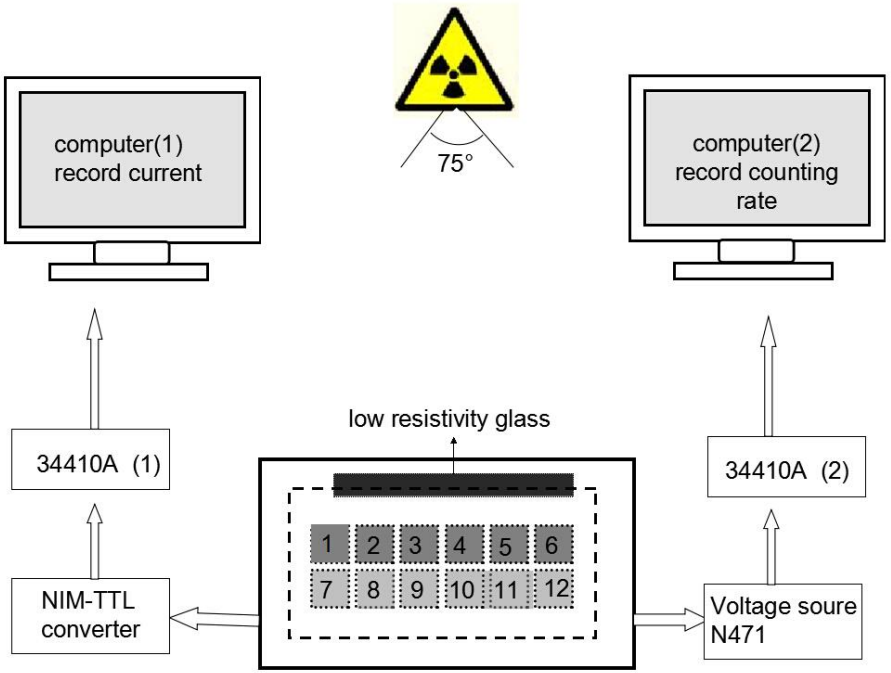


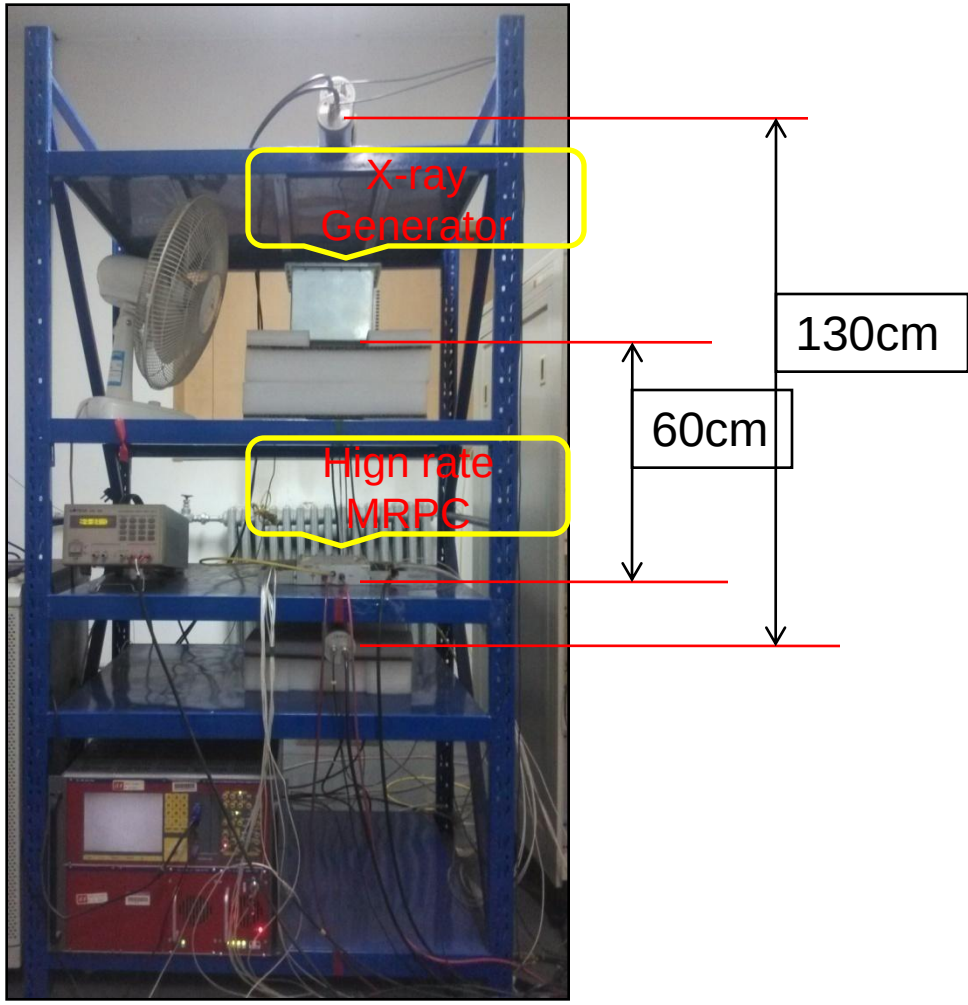
Special thanks to A. Kugler and O. Svoboda for their strong support.

Neutron test result

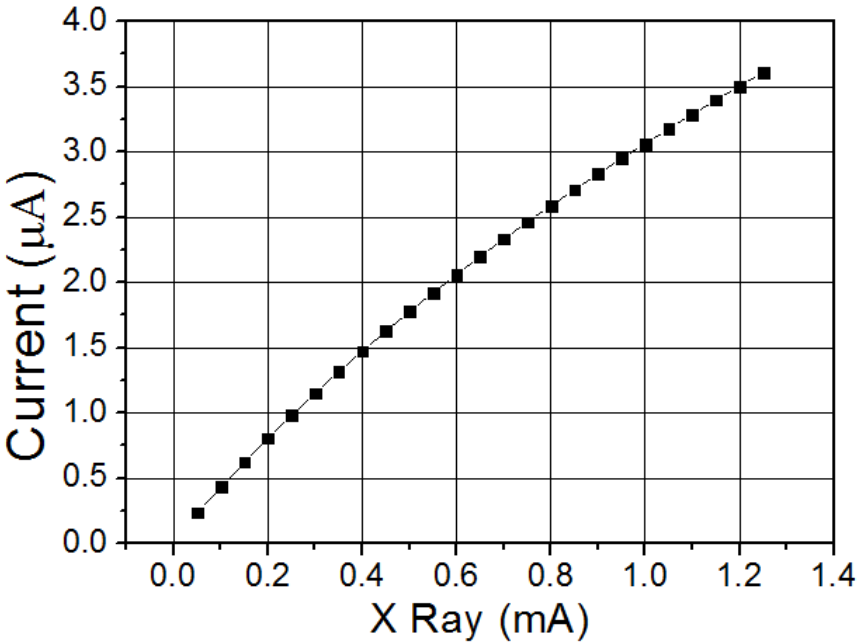


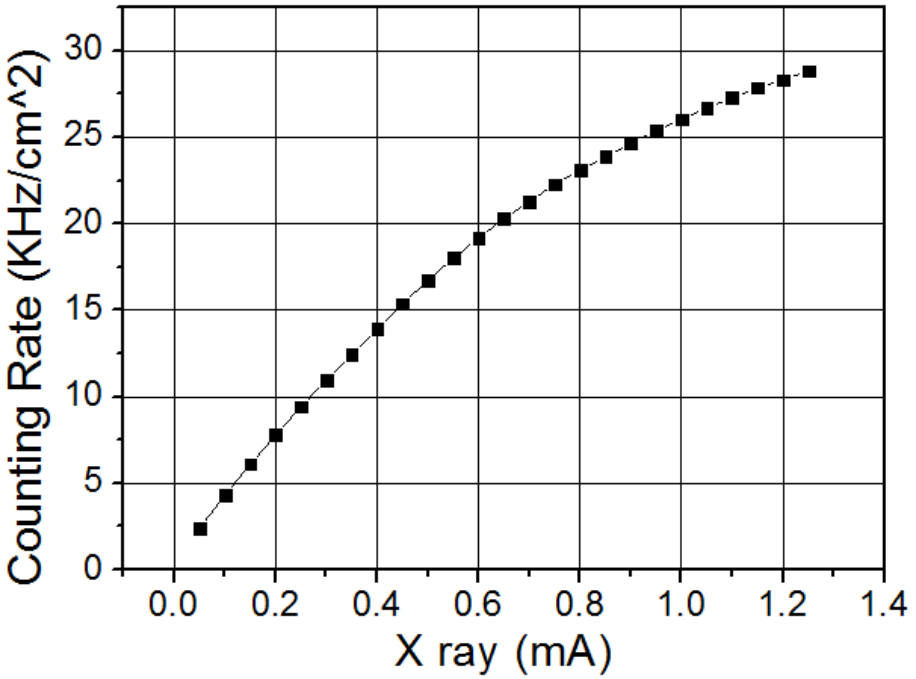
Setup of irradiation test





This is online test system. The efficiency and time resolution can be obtained by cosmic ray while irradiated by X-rays. 0.1C/cm^2 charge is accumulated in 35 days.

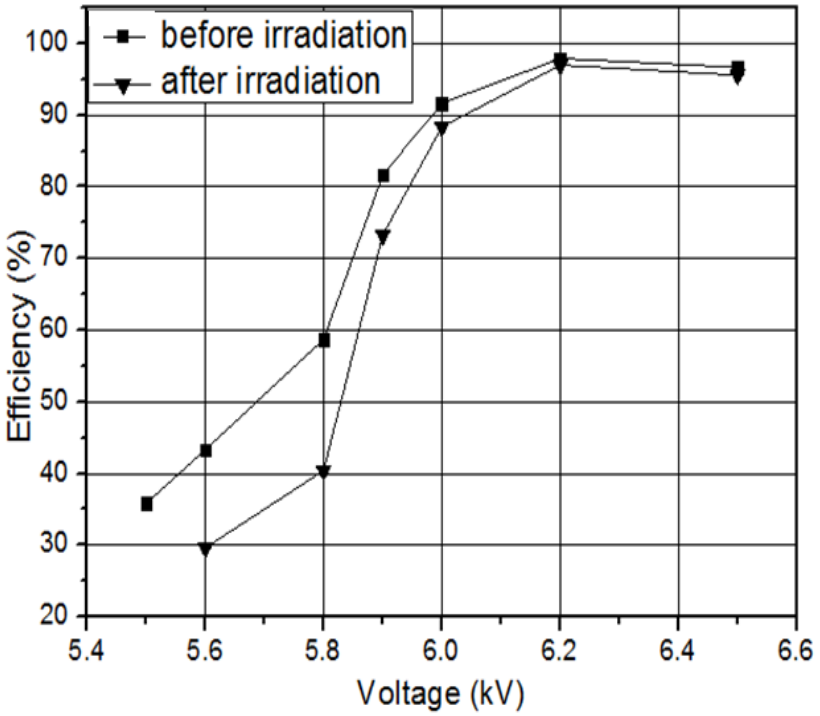


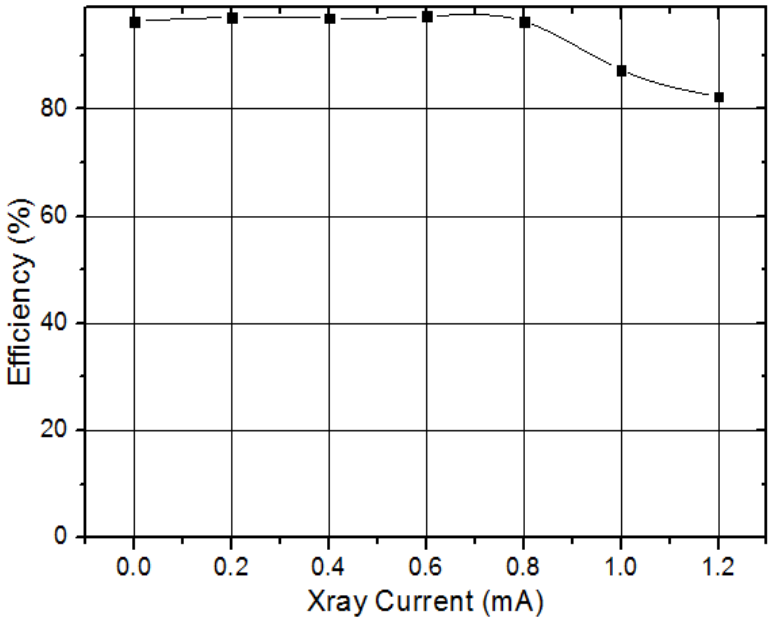


Current VS. X ray strength

Counting rate VS. X ray strength

Efficiency

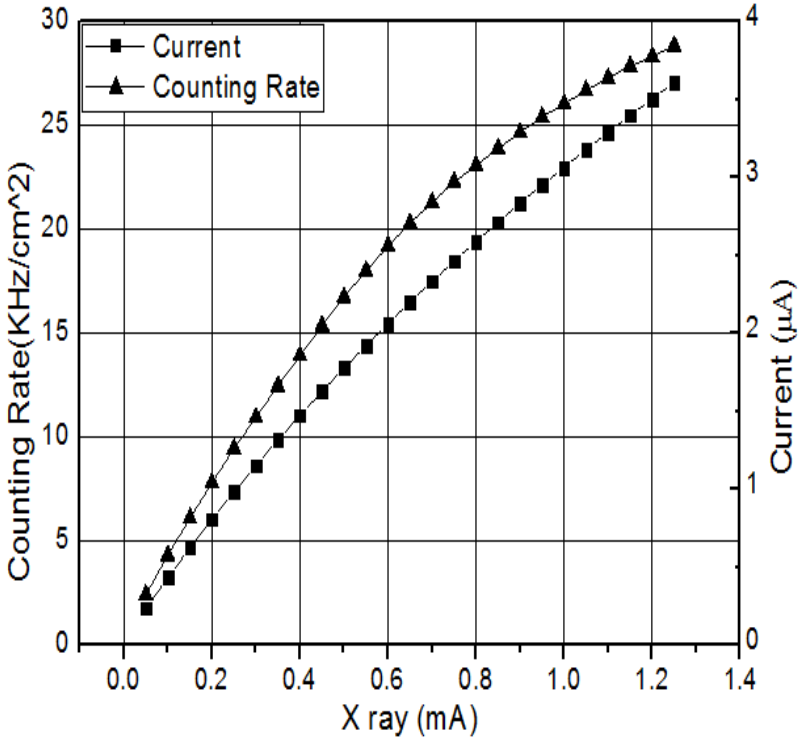




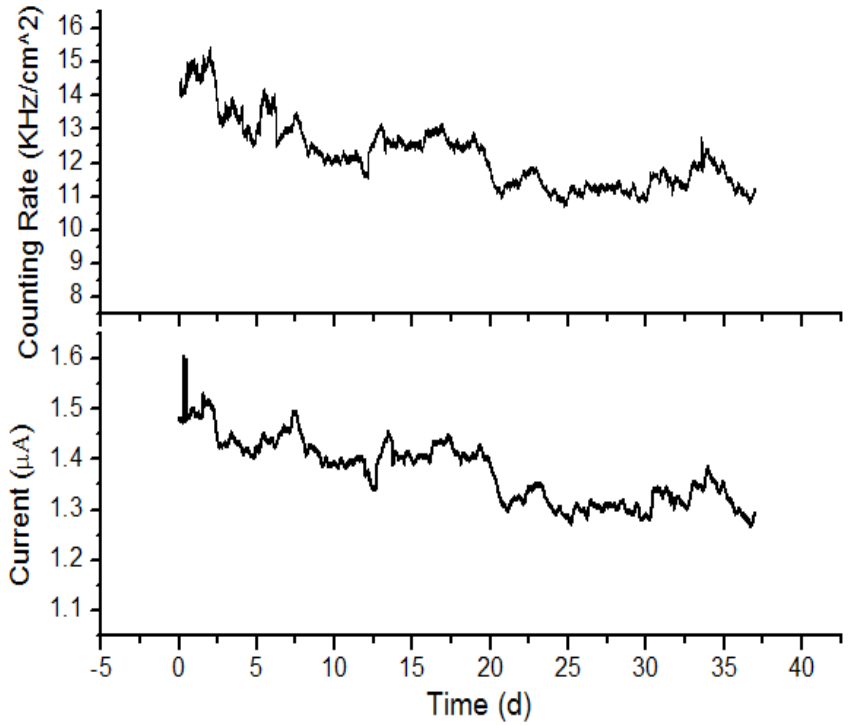
Efficiency plateau before and after irradiation

Efficiency changes with X-ray current

Current and counting rate

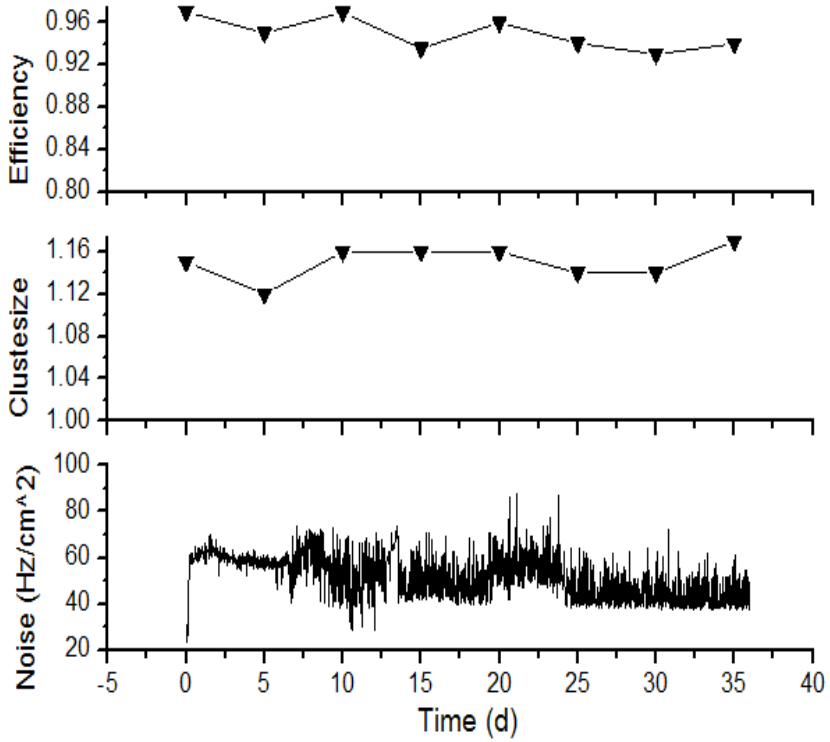


Variation of current and counting rate with X-ray strength

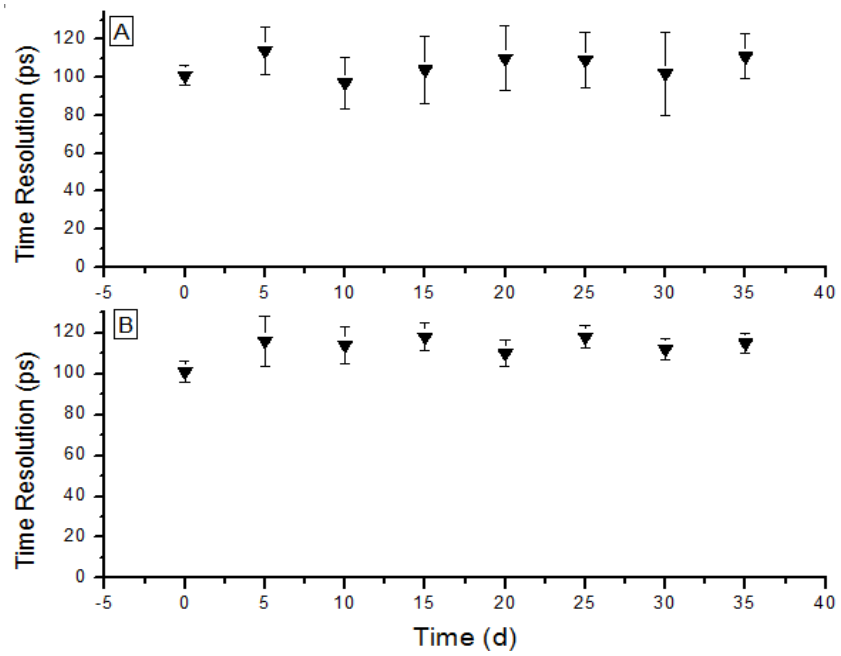


Variation of current and counting rate with irradiation time

Time resolution, cluster size and noise

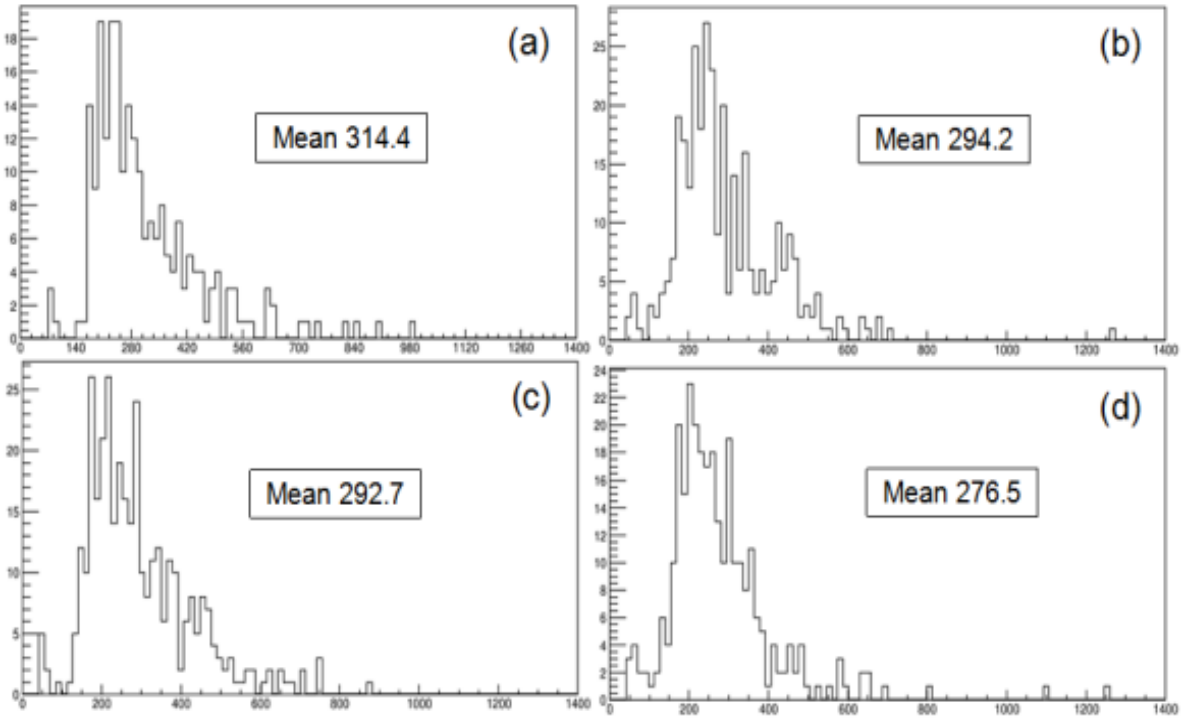


Variation of efficiency, cluster size and noise with irradiation time



Variation of time resolution with irradiation time

Charge spectrum



The charge spectrum at different stages: (a) before irradiation, (b) after ten days' irradiation, (c) after twenty days' irradiation and (d) after thirty days' irradiation

Summary

- The resistivity of low resistive glass is ~10^{10}Ωcm, it has excellent resistivity uniformity, surface roughness and behaves very stable.
- Pad and strip MRPC have excellent performance, its time resolution can reach 40ps, rate capability reach 70kHz/cm^2.
- The glass behaves very stable in Neutron test and online X-ray aging test.

Thanks for your attention!