强脉冲辐射环境模拟与效应全国重点实验室

National Key Laboratory of Intense Pulsed Radiation Simulation and Effect

Energy Response of Aurum-Silicon Surface Barrier Detector to Kr and Xe ions

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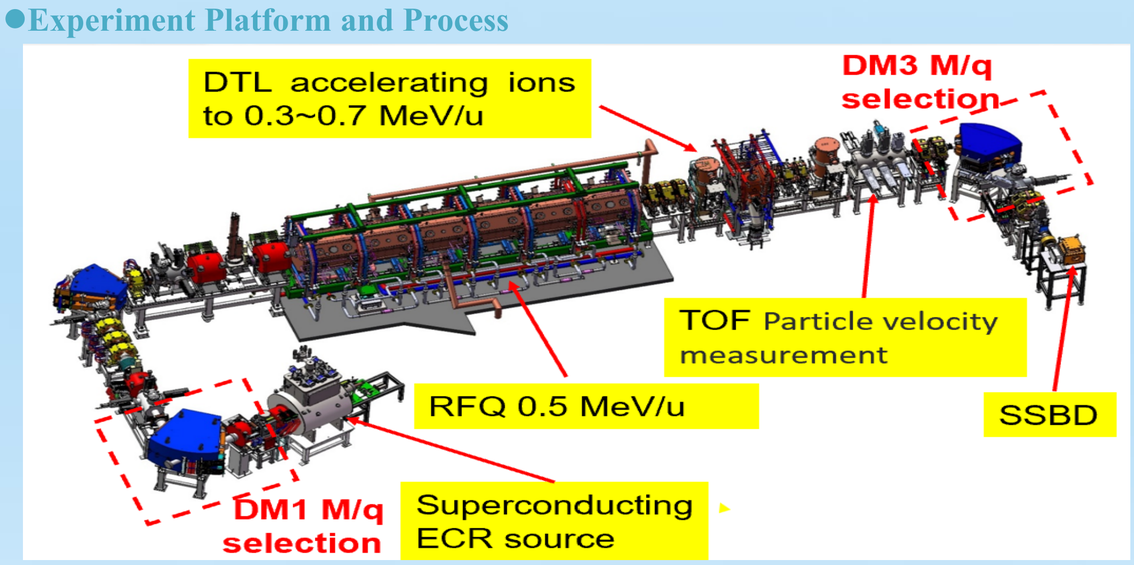
Introduction

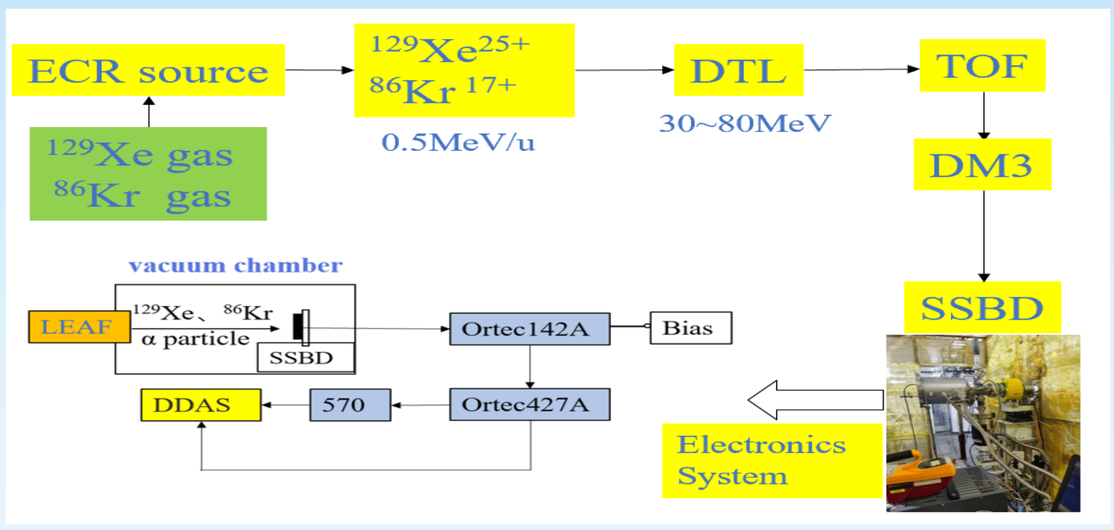
The use of aurum-silicon surface barrier detector (SSBD) for the measurement of the energy of fission fragments is inaccurate by the effects of significant pulse-height defect (PHD) phenomena. The comparison between the kinetic energy spectrum of fission fragments obtained by time-of-flight technique and that measured by semiconductor detector indicates that the latter has the defect of pulse height in the energy response of 5~10 MeV. Three contributions to the total PHD for the detectors, these are the window defect (E_w), due to the loss of energy in the front gold electrode, the non-ionization energy defect (E_n), due to the loss of energy by end of range non-ionizing atomic collisions, and the recombination defect (E_r), due to the recombination of nonequilibrium electron-hole pairs in the ionizing particle's track. A SSBD is used for the measurement of the energy of the Kr\Xe beams provided by Low Energy intense-highly-charged ion Accelerator Facility (LEAF) to study the energy response of heavy ions, and the three contributions are determinant by experiments and simulations.

Experimental method

●Experiment Platform and Process



The schematic diagram of LEAF



The experiment process

Results and discussion

●Energy of the charged particle beam

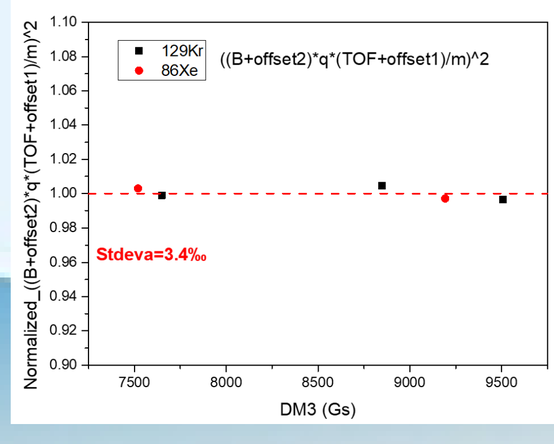
1、Time of flight TOF

$$TOF = \frac{L}{v} + offset1$$

2、Deflecting magnetic DM3

$$B = \frac{mv}{qR} + offset2$$

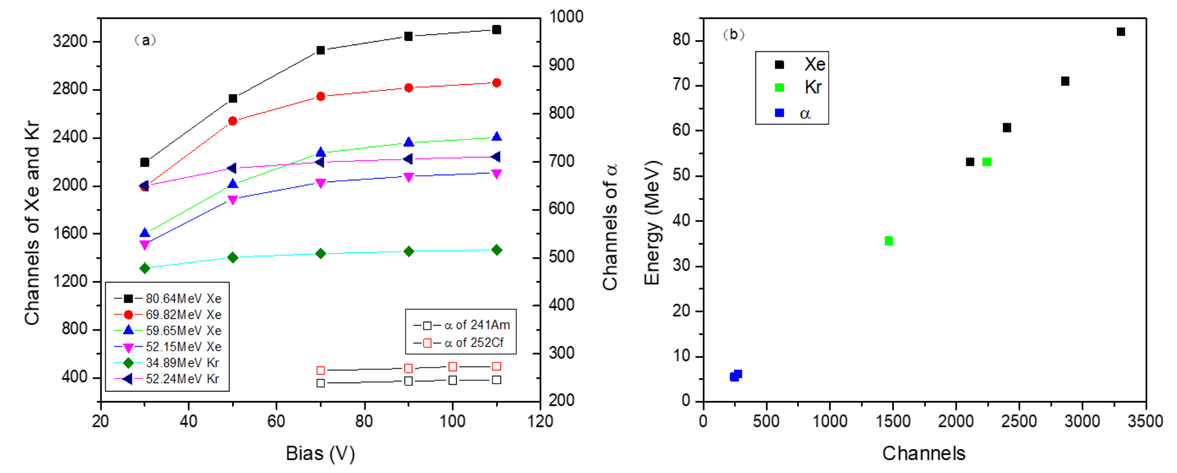
$offset1$=-0.45 ns， $offset2$=-37 GS



●The correction of energy defect

- E_w and E_n

The window defect (E_w) the non-ionization energy defect (E_n) are determinant by the experiment of alpha source and SRIM program.



(a)The relationship between bias and channels of Xe、Kr and α (b) The Energy response of the SSBD to different particles at operating bias

①The channels of Kr、Xe particles is not saturated at maximum bias;

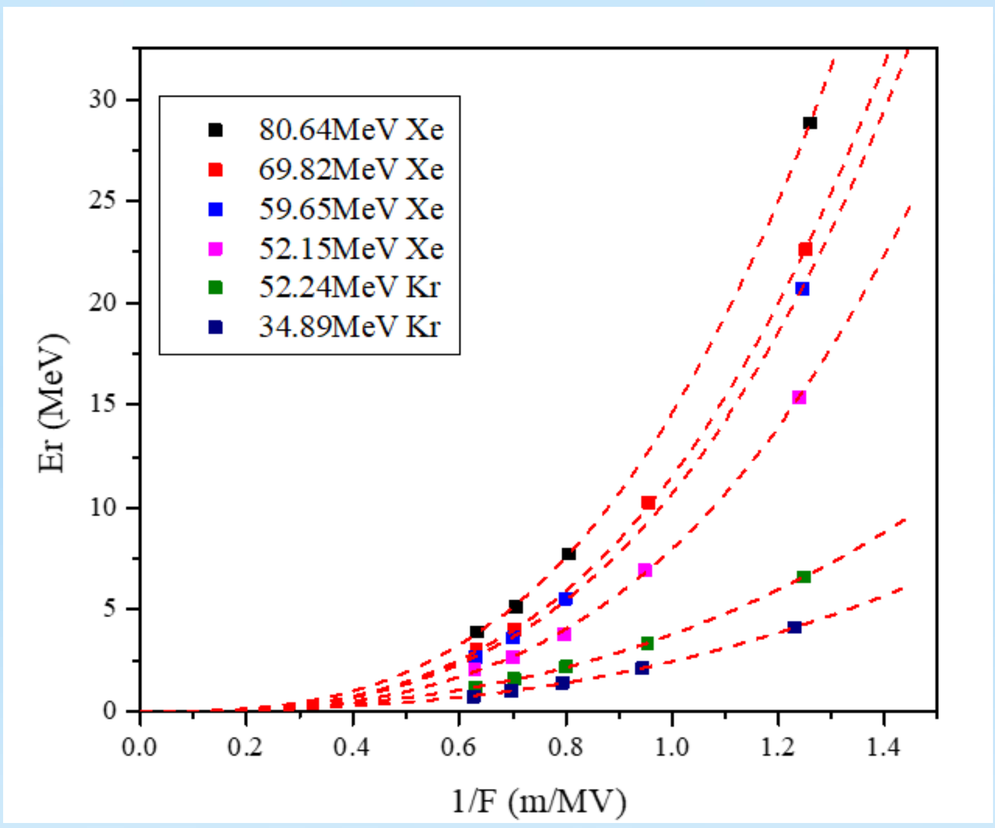
②The channels of α is saturated before maximum bias;

③The linear relationship of Kr、Xe and α particles is poor.

- E_r

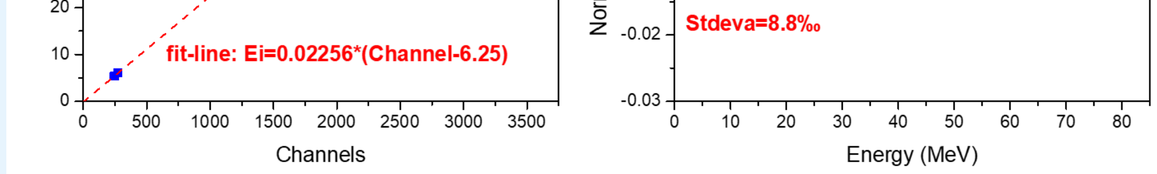
The relationship between channels and electric field：

$$Channels = c\text{-}b(\frac{1}{F_e})^a$$



●The correction of energy response

After the correction, the linear relationship of Kr/Xe and α particles is good.



Conclusion

The energy response of SSBD is studied by measuring the different energy of different particles(Kr、Xe beams and α particles), the three contributions to the PHD are determinant by experiments and SRIM program. The results indicate that the recombination defect increases with the higher energy for the same particles, and the larger number of charges lead to the more recombination defect for the particles with similar energy. The linear relationship of the energy response between the 5.486 MeV of α particle and the 80 MeV of Xe ions ultimately is good after the correction of the three contributions. The recombination defect is the largest and most complex correction term of PHD, and further work will focus more on the recombination defect in detectors.