Analysis of beam contamination along the beam path by isotopes of ^{12}C beam and their role in charge changing cross section measurement by PHITS

Dr. Quazi Muhammad Rashed Nizam

Department of Physics, University of Chittagong, Chittagong-4331, Bangladesh

Introduction

➢In particle accelerator, from the beam of projectile, secondary particles including various isotopes can be produced (Fig 1) by the interactions with scatterer, monitor, range shifter etc. as shown in (Fig 2) on the way to the target.

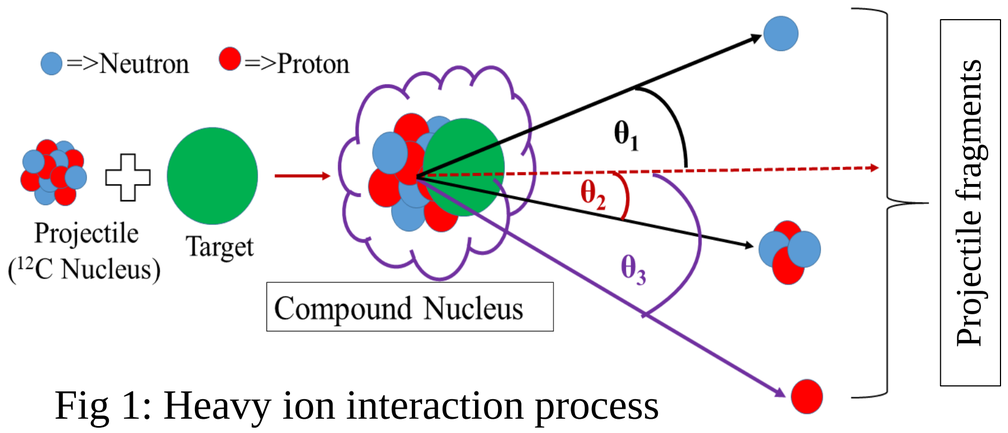

Fig 1: Heavy ion interaction process

Materials and methods

➢The production of projectile isotopes and secondary particles can be described by the well know model JQMD[1]. This model has incorporated in Particle and Heavy Ion Transport code System (PHITS)[2].

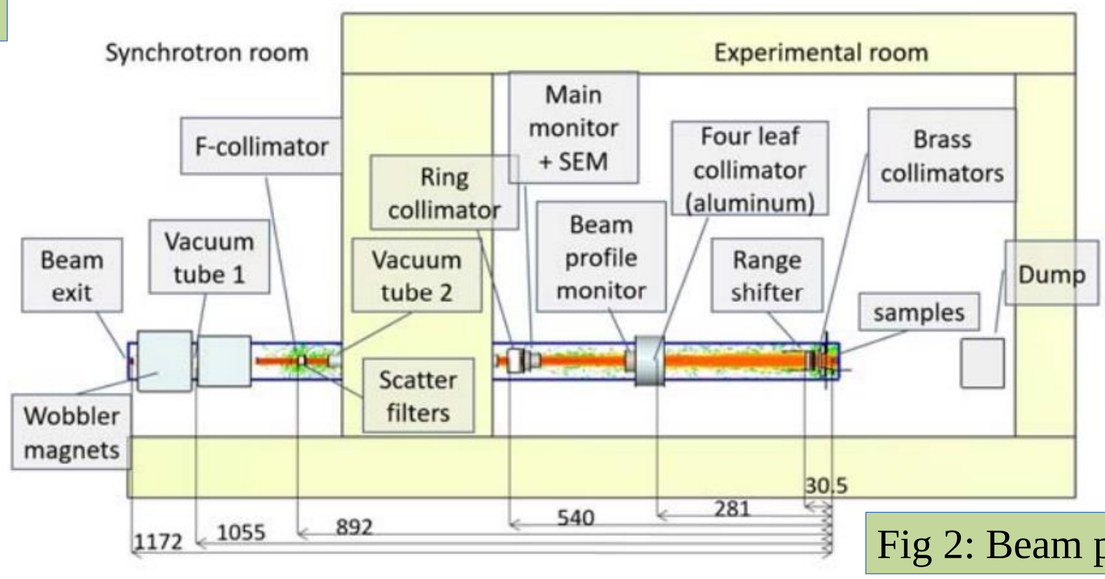

Fig 2: Beam path in HIMAC[3].

$$\sigma_{TCC} = -\frac{M_T}{\rho N_A x}\ln\left(\frac{N_{out}}{N_{in}}\right)$$

$$\sigma_{mc} = -\frac{M_T}{\rho N_A x}\ln\left(\frac{N_{in} - \sum_{m=9}^{15} N_{mc}}{N_{in}}\right)$$

Using these two equations total charge changing cross section and isotope production can be calculated.

Results and discussion:

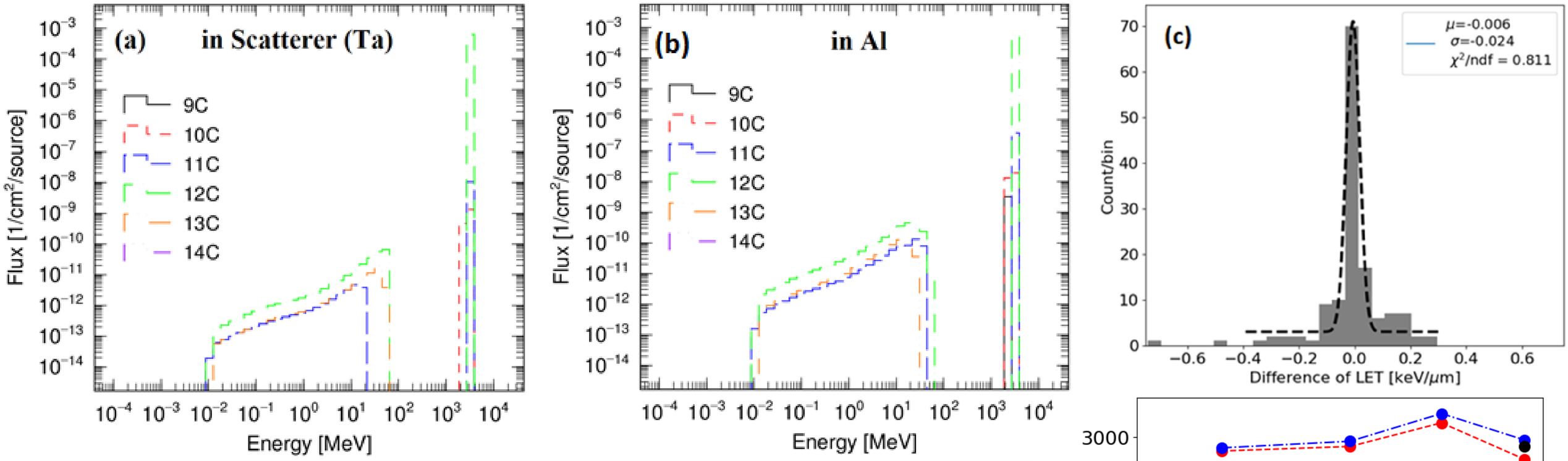

Fig 3: PHITS calculated flux of different isotopes produced in scatterer,Ta (a) and in beam monitor, Al (b) along the beam path (Fig 2). Because of very insignificant difference of LET as shown in the Fig 3(c), these isotopes are not separable for passive track detector like CR-39.

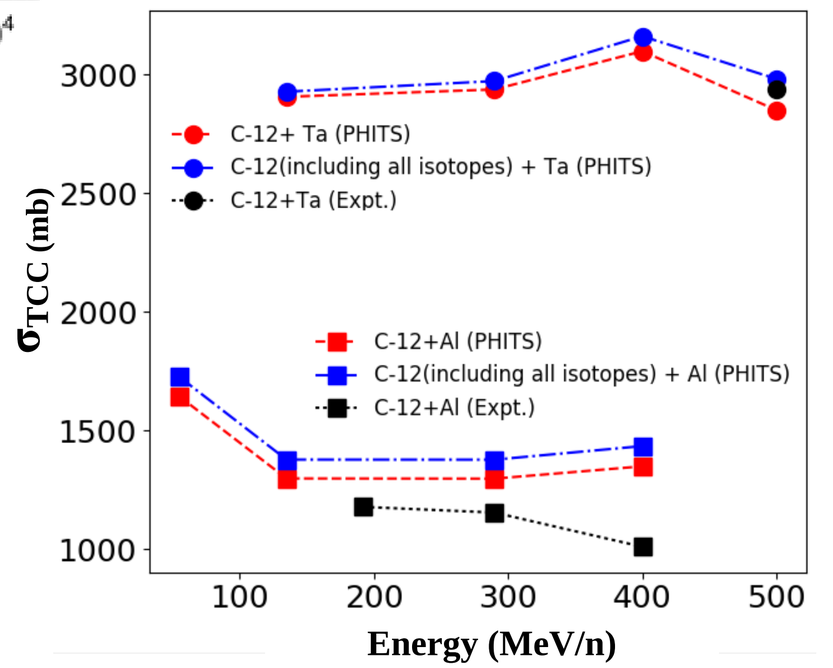

Fig 4. PHITS calculated total charge changing cross section for C+Al and C+Ta with (blue) and without (red) considering the isotopes.

Conclusions:

- ❑ Large amount of isotopes of projectiles produced along beam path which contaminate the pure beam.
- ❑ The contribution from the isotopes during the experimental measurement could be useful to explain the discrepancy in calculated and experimental result[4,5].

References:

1. *K. Niita et al. Phys. Rev. C52, 2620 (1995)*
2. phits.jaea.go.jp
3. O. Ploc et al., *IEEE Aerosp. Conf. Proc. 2017*
4. A. N. Golovchenko et al., RM, 45, 2010
5. Zhang et al., RM 126, 2019