

Proposal for Beam Time and Research Program at IFJ PAN LINAC

1. General Information

Project Title: Study of fission processes induced by protons, alpha particles, and heavy ions

Principal Investigator (PI): M. Ciemala,

Co-Investigators / Research Team: Ch. Schmitt, et al.

2. Particle and Energy Selection

Please check the required particle and the target energy section:

Primary Particle:

Proton (p⁺)

Deuteron (2H⁺ / d)

Alpha (4He²⁺)

Lithium-7 (7Li³⁺)

Other (e.g., 16O⁸⁺): heavy ions if available

Acceleration Stage (Energy):

Section 1: 2.5 MeV/u

Section 2: 12.5 MeV/u

Section 3: 250 MeV/u (Future expansion / High energy)

Custom Energy: variable energy from preferred in the range of 20 MeV up to 200 MeV

3. Abstract of Planned Research

(Provide a brief description of the experiment, its scientific goals, and the expected outcome – max 300 words)

The proposed experimental setup leverages high-energy light and heavy-ion beams (10 MeV to 200 MeV) to investigate nuclear fission dynamics and the properties of nuclei at high excitation energies. By integrating high-energy gamma-ray calorimeters (e.g., PARIS) and charged-particle telescopes (e.g., KRATTA) with a dedicated gas-based fission fragment detector coupled with neutron detectors, we aim to achieve a near "full-event reconstruction" of the fission process.

A key advantage of this proposal is utilizing the LINAC's high-energy output to drive inelastic scattering-induced fission reactions, such as (p,p'f). By detecting the scattered beam-like particles within the charged-particle array, we can precisely tag the excitation energy of the fissioning nucleus. This allows for a systematic mapping of the transition from asymmetric to symmetric fission modes as a function of specific energy and mass, moving beyond the limitations of broad, unselected energy distributions.

The LINAC's capability up to reach 200 MeV is critical for probing the fission of sub-actinide nuclei (²⁰⁸Pb, ¹⁹⁷Au, ¹⁸⁶W, etc.), which possess high fission barriers (25 MeV to 30 MeV) often inaccessible at lower-energy facilities. With the addition of a fission fragment detector, fragment

masses will be determined via Time-of-Flight (ToF), synchronized with the LINAC's pulsed beam structure. Furthermore, this setup enables the study of Giant Dipole Resonances (GDR) and Pygmy Dipole Resonances (PDR) populated during the fission reaction.

4. Technical Beam Requirements

Please specify the desired beam parameters to ensure the feasibility of the experiment:

Intensity / Current:

Required current on target: 1 nA to 500 nA (e.g., 10 pA – 10 nA)

High intensity requirements (if applicable): _____ mA

Time Structure:

Pulse repetition rate: 100 ns | 200 ns | 400 ns | Other: _____

Bunch width (Sigma/FWHM): < 0.5 ns

Requirement for zero dark current (no background between pulses)

Beam Spot Geometry:

Desired spot size on target: submillimeter sigma mm (e.g., < 0.5 mm)

Requirement for no beam halo

Energy Resolution:

ΔE requirement: better than 100 keV (e.g., < 10 keV)

5. Application Category

Fundamental Nuclear Physics

Medical Applications

Electronics Irradiation

Material Science / Biophysics

6. Additional Infrastructure Needs

The experimental setup requires detectors for fission fragments (including a gas system), gamma rays, and charged particles. A neutron detector array would also be of great interest to provide a nearly complete identification of the particles created during the fission and from fragments de-excitation.