Proposal for Beam Time and Research Program at IFJ PAN LINAC

1. General Information

Project Title: Radiobiological response to proton irradiation enhanced by metallic nanoparticles

Principal Investigator (PI): Bartosz Klębowski

Co-Investigators / Research Team: Joanna Depciuch-Czarny

2. Particle and Energy Selection

Please check the required particle and the target energy section:

Primary Particle:

[X] Proton (p+)

[ ] Deuteron (2H+ / d)

[ ] Alpha (4He2+)

[ ] Lithium-7 (7Li3+)

[ ] Other (e.g., 16O8+): _____

Acceleration Stage (Energy):

[] **Section 1:** 2.5 MeV/u

[X] **Section 2:** 12.5 MeV/u

[X] **Section 3:** 250 MeV/u (Future expansion / High energy)

[ ] **Custom Energy:** 5 – 12.5 MeV/u (Variable range within section limits)

3. Abstract of Planned Research

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

This proposal aims to investigate the radiobiological effects of proton irradiation combined with metallic nanoparticles (NPs) as potential radiosensitizers using the planned linear accelerator at IFJ PAN. The project will simulate proton therapy conditions, where cancer cells are irradiated in the presence of selected NPs to enhance radiation-induced damage and improve therapeutic efficiency.

The main scientific objective is to determine how proton beam parameters, particularly absorbed dose, beam energy and beam time structure (continuous-like *vs* pulsed delivery), influence NPs-assisted radiosensitization in a broad panel of cancer cell lines. While dose is the primary determinant of biological response, beam energy may indirectly affect treatment outcome through differences in LET, penetration depth and secondary electron production. Pulsed beam delivery may additionally modify radiochemical and biological processes such as reactive oxygen species generation and DNA damage repair kinetics.

The study will include multiple *in vitro* cancer models representing tumors of different biological origin and radiosensitivity. Biological endpoints will involve cell viability, clonogenic survival, oxidative stress, apoptosis/necrosis detection and NPs uptake. Complementary imaging and

spectroscopic methods may also be applied to correlate NPs physicochemical transformations with cellular response after irradiation.

The expected outcome is the identification of irradiation conditions and NPs properties that maximize proton-induced radiosensitization while maintaining acceptable toxicity in non-irradiated controls. The project is also expected to provide new mechanistic insight into the interplay between proton beam quality, delivery mode and NPs-mediated enhancement effects.

These studies would support the development of next-generation particle radiotherapy strategies and strengthen the interdisciplinary scientific potential of the future IFJ PAN linear accelerator in radiobiology, medical physics and nanomedicine.

4. Technical Beam Requirements

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

Intensity / Current:

Required current on target: 0.1 – 1 nA

High intensity requirements (if applicable): _____ mA

Time Structure:

Pulse repetition rate: [ ] 100 ns | [ ] 200 ns | [ ] 400 ns | [X] Other: flexible (user-selectable pulse repetition rate)

Bunch width (Sigma/FWHM): < 0.5 ns

[ ] Requirement for zero dark current (no background between pulses)

Beam Spot Geometry:

Desired spot size on target: 5 – 20 mm

[ ] Requirement for no beam halo

Energy Resolution:

ΔE requirement: < 1% preferred

5. Application Category

[ ] **Fundamental Nuclear Physics**

[X] **Medical Applications**

[ ] **Electronics Irradiation**

[ ] **Material Science / Biophysics**

6. Additional Infrastructure Needs