

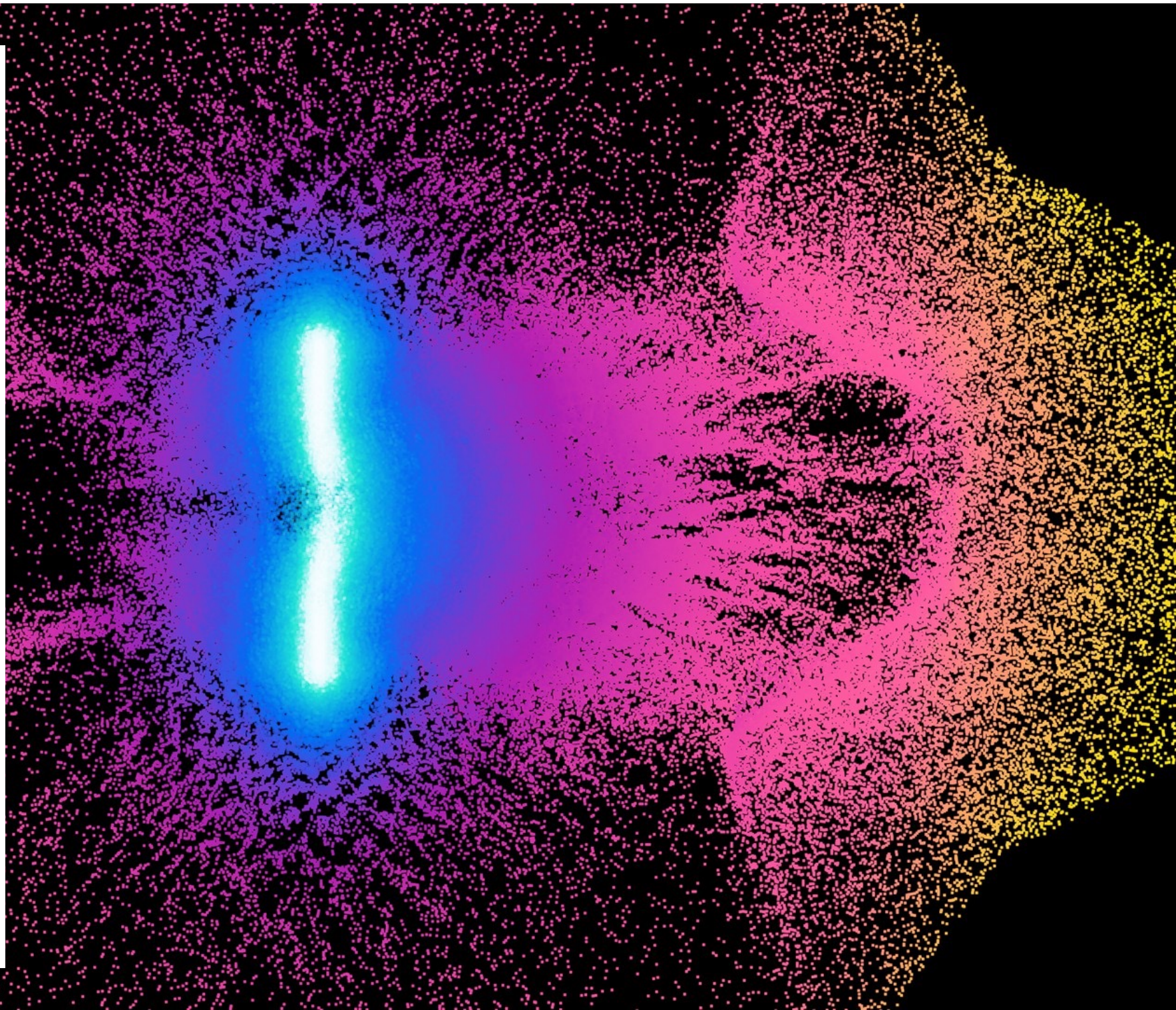
4U-PI KICK-OFF MEETING
15–16 SEPTEMBER 2026 | ELI BEAMLINES

WP3

Development of Neutron Sources for Radiobiology and Material Investigations

WP Leader: Domenico Doria (ELI-NP)

Lead beneficiary: ELI-NP



WP at a glance

Neutron beamlines with clinically relevant parameters.

ONE-SENTENCE PURPOSE

High-flux laser-driven neutron sources for users' experiments in radiobiology and material science

Lead beneficiary	ELI-NP (IFIN-HH)
WP leader	Domenico Doria (ELI-NP)
WP deputy leader	Károly Osvay (ELI-ALPS)
Duration	M2–M47
Effort	182.05 person-months
Participating beneficiaries	ELI-ALPS, ELI-ERIC, CLF-UKRI, MIR, HUN-REN, FE

PRIMARY USERS / BENEFICIARIES

*Radiobiology and Material Investigations;
Preclinical studies; Neutron imaging*

MAIN DEMONSTRATOR / RESULT

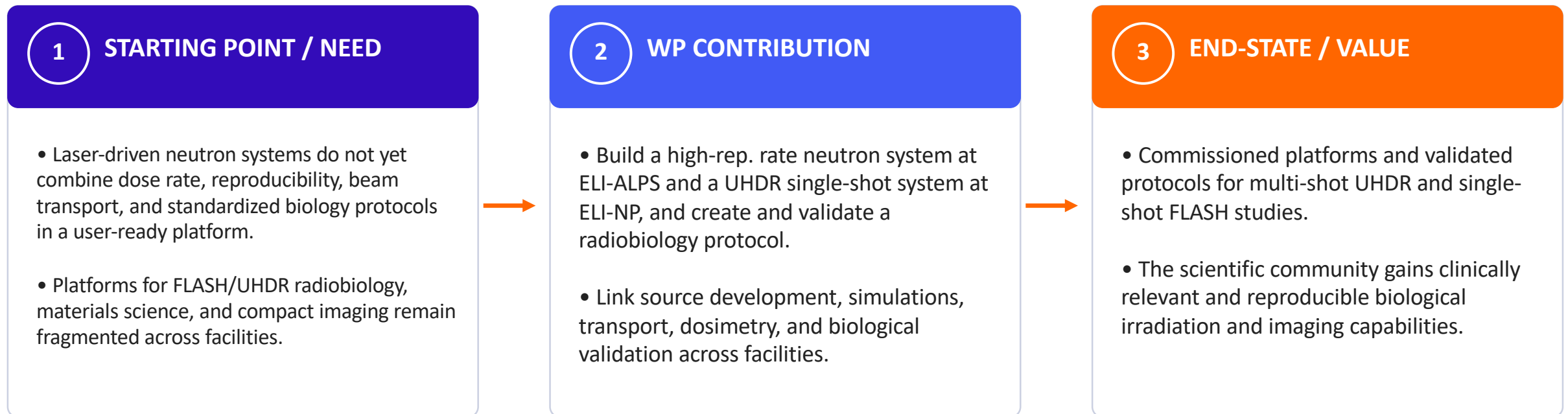
*Commissioned neutron platform enabling
FLASH/UHDR studies*

KEY INTERFACES

*WP2: Provide complementary ion and neutron sources
WP4: Provide neutron beams, datasets, and protocols for applications
WP5: WP3 benefits from diagnostics/AI for dosimetry, monitoring, and optimization.
WP6: WP3 benefits from AI/ML tools to optimize performance.
WP7: Disseminates, exploits, and translates results into industrial applications.*

Why this WP matters

Translate the DoA into a simple logic that is clear to the whole consortium: need → contribution → value.



Links to 4U-PI Specific Objectives: SO3, SO4 (direct); SO6 (enabling diagnostics and dosimetry).

Main pathways: scientific and biomedical impact

Objectives and expected outcomes

Separate what the WP aims to achieve from the concrete end-state that will demonstrate success.

OBJECTIVES — as from the official DoA

- Development and validation of two complementary neutron platforms: at kHz operation and single-shot operation.
- Establish fast and epithermal neutron generation via pitcher–catcher reactions (${}^7\text{Li}(p,n)$, ${}^9\text{Be}(p,n)$, ${}^2\text{H}(d,n)$) and advanced targets.
- Design and optimize moderators (cryogenic hydrogen, water, plastics) and compact transport systems for delivery to irradiation stations.
- Develop *in vitro* and *in vivo* radiobiology methods and dosimetry, benchmarked against conventional neutron sources.
- Commission sources for pre-clinical studies and pilot BNCT experiments.
- Characterise neutron imaging beamlines for industrial, security, and fusion applications.

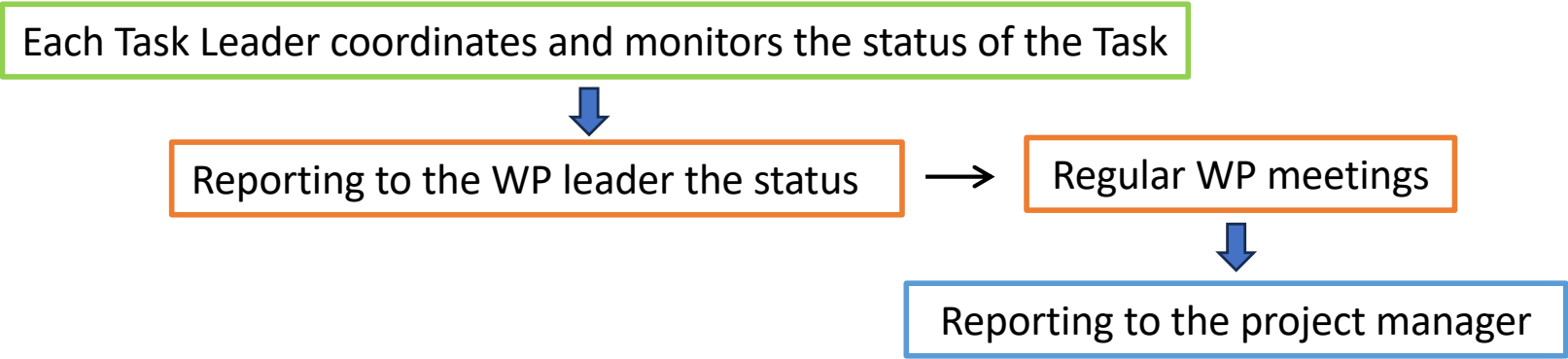
EXPECTED OUTCOMES — describe the end-state

- Dual complementary neutron platforms: high repetition rate, high average flux (ELI ALPS) vs. single-shot, ultrahigh peak flux (IFIN-HH).
- Validated fast and epithermal neutron generation and transport systems at IFIN-HH and ALPS.
- Standardised, reproducible radiobiology and dosimetry methodologies for pulsed neutron sources.
- First demonstration of pulsed UHDR neutron irradiation and pilot BNCT proof-of-concept studies.
- Commissioned imaging platforms for material inspection, homeland security, and fusion material testing.

WP team and responsibilities

Make accountability visible: who leads, who contributes, and who is responsible for each output or decision.

ROLE / TASK	LEAD PERSON & BENEFICIARY	CONTRIBUTING BENEFICIARIES	RESPONSIBILITY / DECISION RIGHTS
WP leadership	D. Doria, ELI-NP	K. Osvay (ELI-ALPS)	Coordination, monitoring, reporting, escalation
T 3.1	D. Doria, ELI-NP	K. Osvay (ELI-ALPS)/ ELI-ERIC, CLF-UKRI	Coordination, monitoring, reporting
T 3.2	R. ERHAN ,ELI-NP	L. ROSTA (MIR)/ ELI-ALPS, ELI-ERIC, CLFUKRI, HUN-REN	Coordination, monitoring, reporting
T 3.3	R. Szabo, ELI-ALPS	V. Nastasa (ELI-NP)	Coordination, monitoring, reporting
T 3.4	K. Osvay, ELI-ALPS	M. Cernaianu (ELI-NP)/ HUN-REN, MIR, ELI-ERIC	Coordination, monitoring, reporting
T 3.5	M. Cernaianu, ELI-NP	M. Ehret (ELI-BL)/ ELI-NP, ELI-ALPS, FE	Coordination, monitoring, reporting



Task overview

Give the audience the complete map before discussing individual tasks in more detail.

TASK ID & OFFICIAL TITLE	TIMING	TASK LEAD	CONTRIBUTORS	MAIN OUTPUT / HAND-OFF
T 3.1 —Exploring novel fast neutron sources	M2–M30	ELI-NP	ELI ALPS, ELI ERIC, CLF-UKRI	Design, Report
T 3.2 — Efficient generation and transport of epithermal neutrons	M6–M36	ELI-NP	ELI ALPS, ELI ERIC, CLF-UKRI, MIR, HUN-REN	Design, Report
T 3.3 — Radiobiology methodologies with neutron beams	M2–M24	ELI-ALPS	ELI NP	Protocol
T 3.4 — Commissioning with pilot radiobiology experiments	M12–M45	ELI-ALPS	ELI NP, HUN-REN, MIR, ELI-ERIC	Platform validation
T 3.5 — Characterisation of neutron imaging platforms	M12–M47	ELI-NP	ELI ERIC, ELI ALPS, FE	Platform validation

T 3.1 — Exploring novel fast neutron sources

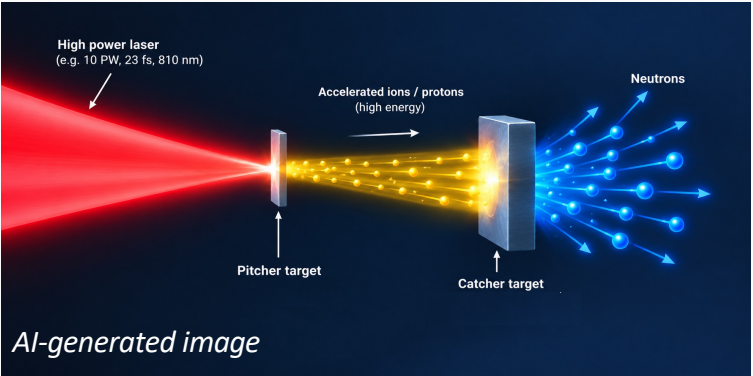
PURPOSE & SCOPE

- Establish fast neutron generation using pitcher–catcher configurations.
- Targeting $>10^{10}$ n/sr flux and $>10^{14}$ n/sr/s rates per shot with the 10 PW laser.
- Building cryogenic targets for hydrogen or deuterium acceleration at one shot per minute.
- Building a kHz neutron source system able to handle several watts of average dissipated power.

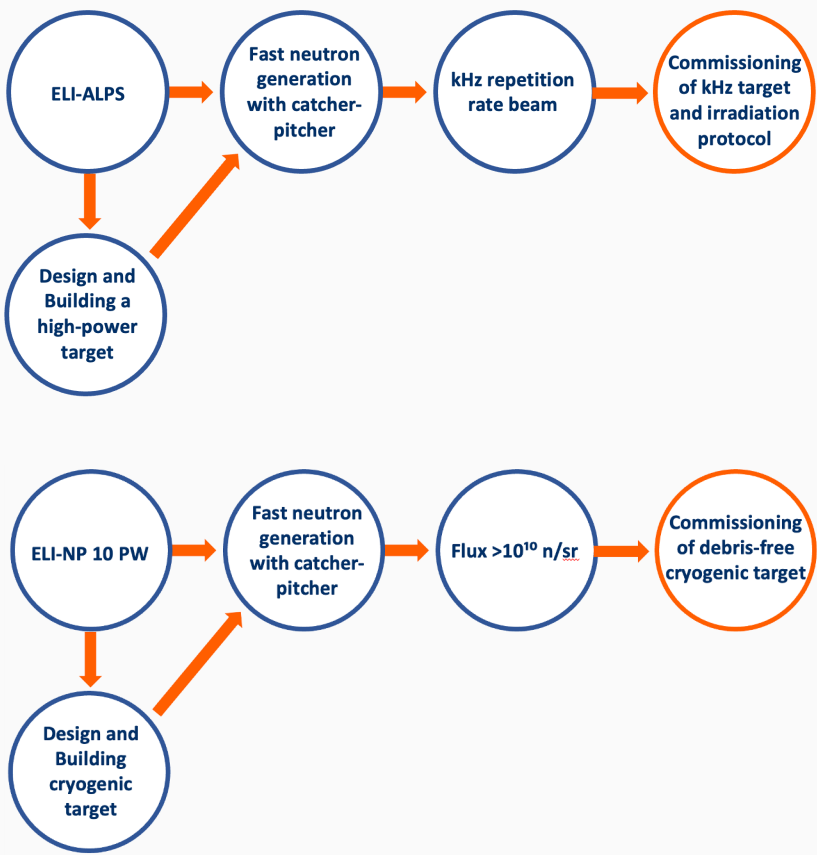
MAIN ACTIVITIES & OUTPUT

- Study of nuclear reactions, exploiting the 10 PW laser to accelerate protons and deuterons beyond the state of the art.
- Proof-of-principle experiments at ELI Beamlines (P3 platform) to test flux enhancement via radiation pressure acceleration.
- Proving a stable kHz neutron source working in continuous runs based on a catcher-converter and a liquid-jet target.
- Deliver D3.1, D3.2

Lead: ELI-NP | **Partners:** ELI-ALPS, ELI-ERIC, CLF-UKRI
Timing: M2–M30 | **Output / hand-off:** D3.1, D3.2



Task logic



T 3.2 — Efficient generation and transport of epithermal neutrons

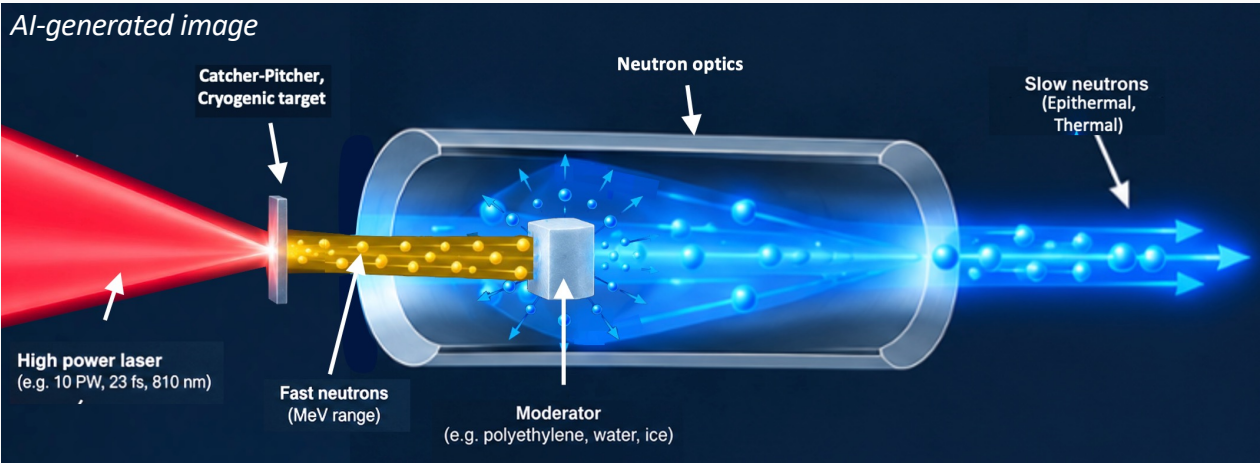
PURPOSE & SCOPE

Development of neutron moderation and transport systems for high-peak-flux (ELI-NP/IFIN-HH) and high-repetition-rate (ELI ALPS).

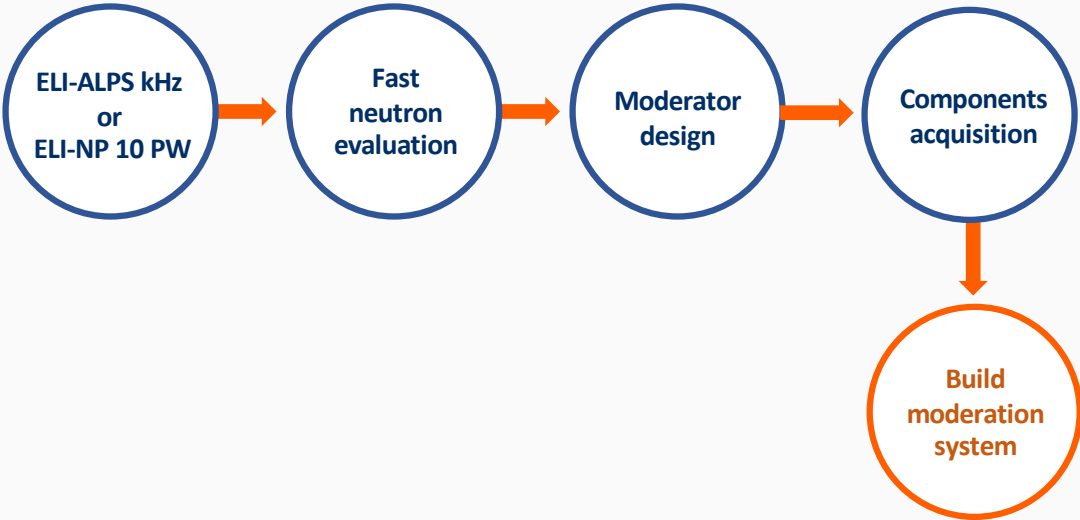
MAIN ACTIVITIES & OUTPUT

Design, build, and test the two systems with the aim of minimizing flux losses.

Lead: ELI-NP | **Partners:** ELI-ALPS, ELI-ERIC, CLF-UKRI, MIR, HUN-REN
Timing: M6–M36 | **Output / hand-off:** Epithermal neutron optimization



Task logic



T 3.3 — Radiobiology methodologies with neutron beams

PURPOSE & SCOPE

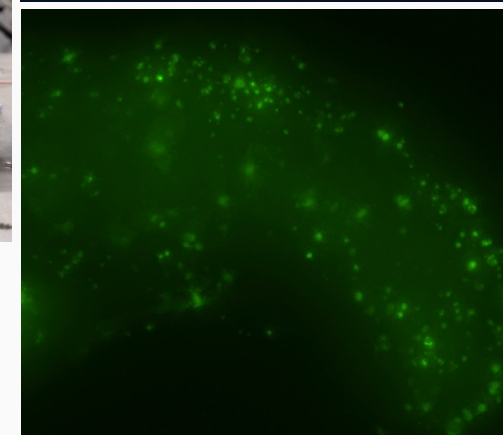
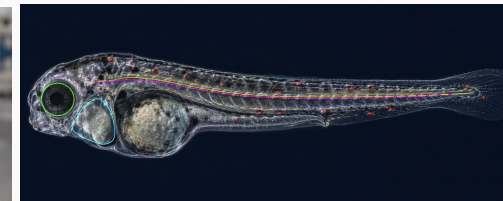
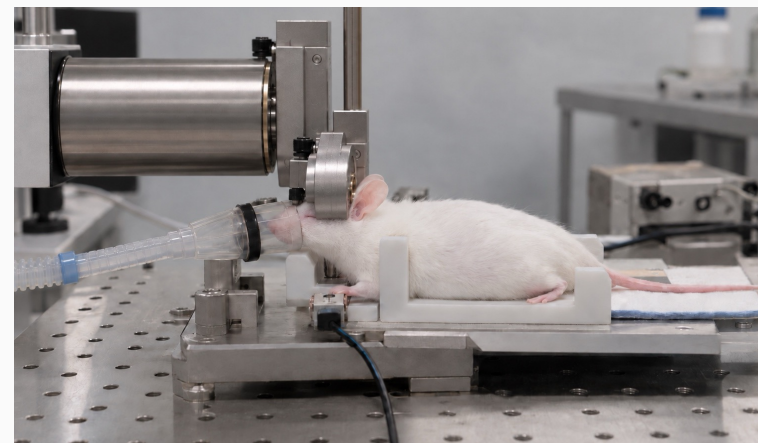
- This task will establish standardised methodologies for radiobiology experiments with pulsed fast and epithermal neutron beams.

MAIN ACTIVITIES & OUTPUT

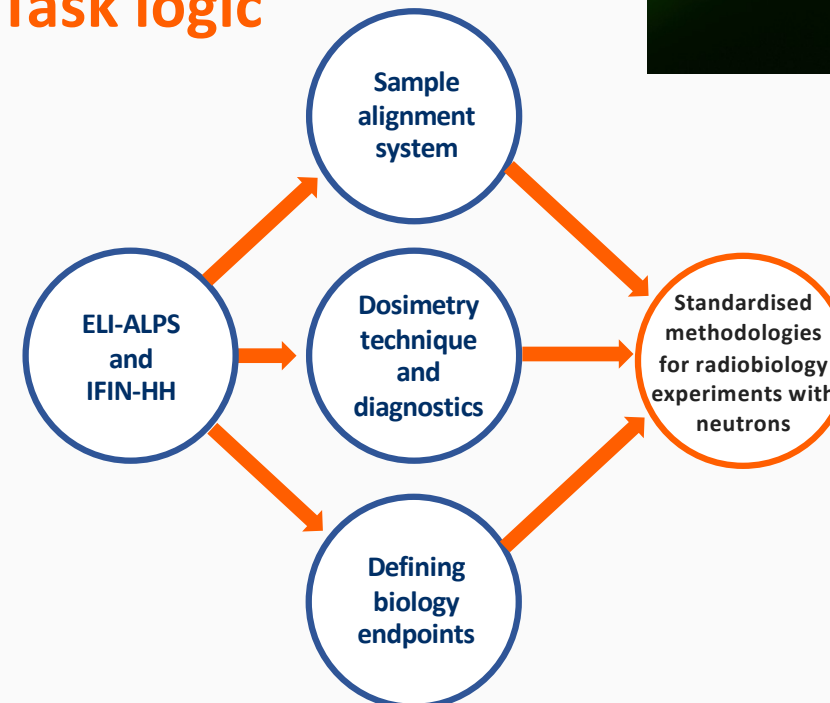
- Sample positioning and environmental control systems will be developed, along with beam alignment and delivery procedures optimised for reproducibility in both in vitro and in vivo models.
- Dosimetry strategies will be designed and validated in collaboration with WP5.
- Biological endpoints will be studied to build robust datasets under laser-driven neutron conditions.

Lead: ELI-ALPS | **Partners:** ELI-NP

Timing: M2–M24 | **Output / hand-off:** radiobiology protocol that will benefit the scientific community. Dosimetry development along with WP5.



Task logic



T 3.4 — Commissioning with pilot radiobiology experiments

PURPOSE & SCOPE

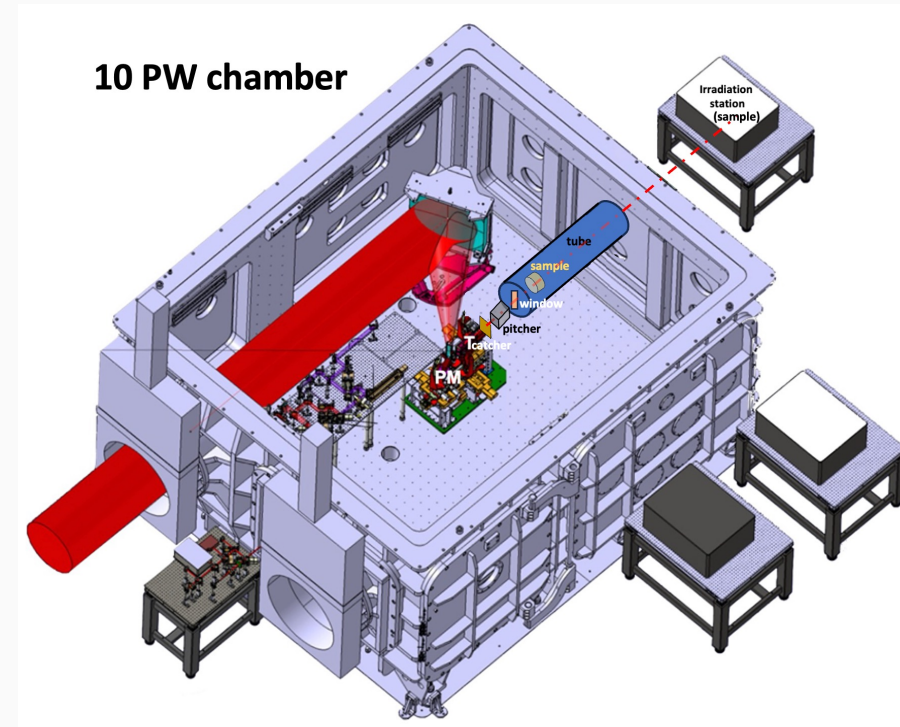
- Commissioning of laser-driven fast and epithermal neutron platforms for biomedical use.
- Provide the first biological results with such beamlines.
- Development of epithermal neutron sources for Boron Neutron Capture Therapy (BNCT).

MAIN ACTIVITIES & OUTPUT

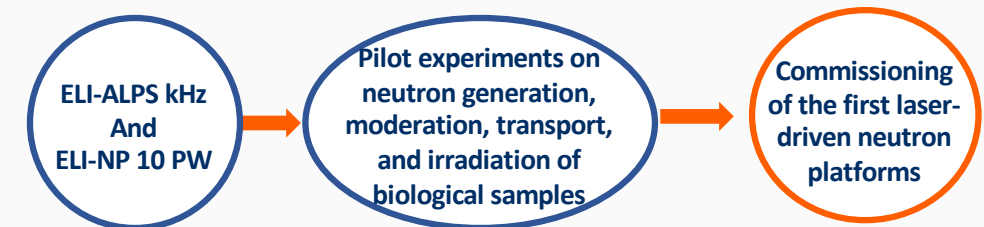
- Proof-of-concept studies that include phantom measurements and dose simulations to benchmark delivery and reproducibility, with comparisons to accelerator-based facilities at HUN-REN and MIR for reference standards.
- Pilot experiments on neutron generation, moderation, transport, and irradiation of biological samples.
- Deliver MS7, MS8, D3.3 and datasets for WP4.

Lead: ELI-ALPS | **Partners:** ELI-NP, HUN-REN, MIR, ELI-ERIC

Timing: M12–M45 | **Output / hand-off:** MS7, MS8, D3.3 and WP4 datasets



Task logic



T 3.5 — Characterisation of neutron imaging platforms

PURPOSE & SCOPE

- Quantitative characterisation of neutron imaging beamlines at ELI ALPS and IFIN-HH

MAIN ACTIVITIES & OUTPUT

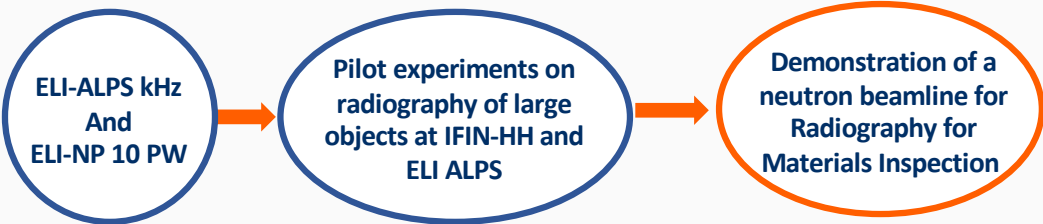
- Mapping of flux homogeneity and measurement of spatial resolution of the neutron beam.
- Demonstration of imaging of representative samples (linked to WP4 and WP5).
- Deliver: D3.4. validation (linked to WP4); reference parameters for industrial, security, and fusion-relevant imaging.

Lead: ELI-NP | **Partners:** ELI-ERIC, ELI-ALPS, FE
Timing: M12–M47 | **Output / hand-off:** D3.4



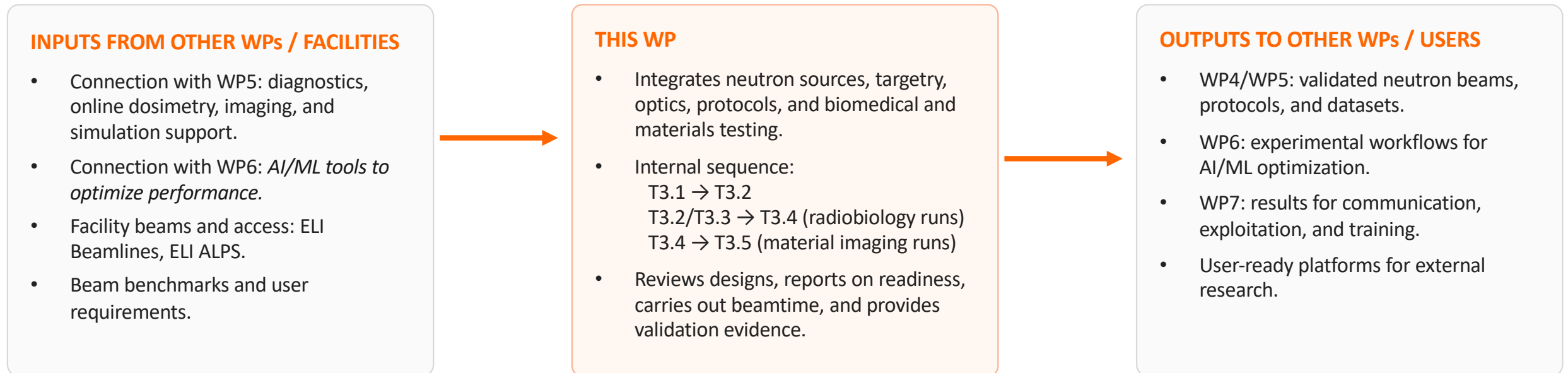
*X-ray and neutron radiography.
Credit: NIST*

Task logic



Interfaces and dependencies

Show the inputs, hand-offs and timing dependencies that require coordination beyond the WP itself.



Milestones

Use the official milestone wording and explain what evidence will prove that each milestone has been achieved.

MS NO.	OFFICIAL MILESTONE NAME	LEAD	DUE	MEANS OF VERIFICATION	WHAT SUCCESS LOOKS LIKE (Minimum goals)
MS7	Clinically relevant experiment using neutrons produced up to kHz repetition rate at ELI ALPS	ELI-ALPS	M24	Feasibility report	- ELI-ALPS kHz system capable of irradiating biological samples with clinically relevant doses (a few Gy for cells, about 10 Gy for zebrafish, up to about 3hrs of exposure, best efforts <1hr). Dose rate and FLASH effect are not significant for the milestone. - Making a proper dose measurement device; - Biological effect validation (whatever effect) and the influence of gamma exposure to be understood).
MS8	Installation, integration, and functional test of the 10-PW neutron source and transport system for user experiments	ELI-NP/IFIN-HH	M46	Visual inspection and commissioning report	- Design, building and commissioning a transport system (target(pitcher) – catcher – moderator for a single shot at 10 PW laser, achieving a neutron beam parameters $>10^{10}$ n/sr flux and $>10^{14}$ n/sr/s rates per shot at neutron source. - Performing a pilot experiment using the commissioned transport system for imaging (radiobiology wished but not necessary).

Present only the milestones assigned to, or critically dependent on, your WP. Use project months and state the evidence needed for verification.

Deliverables

Clarify what each deliverable will contain, who must contribute, and when internal drafting and review should begin.

D NO.	OFFICIAL TITLE	LEAD	DUE	TYPE / LEVEL	CONTENT, CONTRIBUTORS & INTERNAL REVIEW
D 3.1	Technical report on kHz neutron generation and dosimetry at ELI ALPS	ELI-ALPS	M18	R / SEN	Development and commissioning of kHz target and converter as well as sample irradiation protocols for high-average flux neutron beams
D 3.2	Technical Report on Cryogenic Target for neutrons at IFIN-HH	ELI-NP/ IFIN-HH	M24	R / SEN	Development and commissioning of debris-free cryogenic target delivery system for single-shot neutron generation
D 3.3	Demonstration of Epithermal Neutron Beams	ELI-NP /IFIN-HH	M42	DEM / PU	Pilot experiments on neutron generation, moderation, transport, and irradiation of biological samples
D 3.4	Demonstration of Neutron Radiography for Materials Inspection	ELI-NP/ IFIN-HH	M47	DEM / PU	Pilot experiments on radiography of large objects at IFIN-HH and ELI ALPS

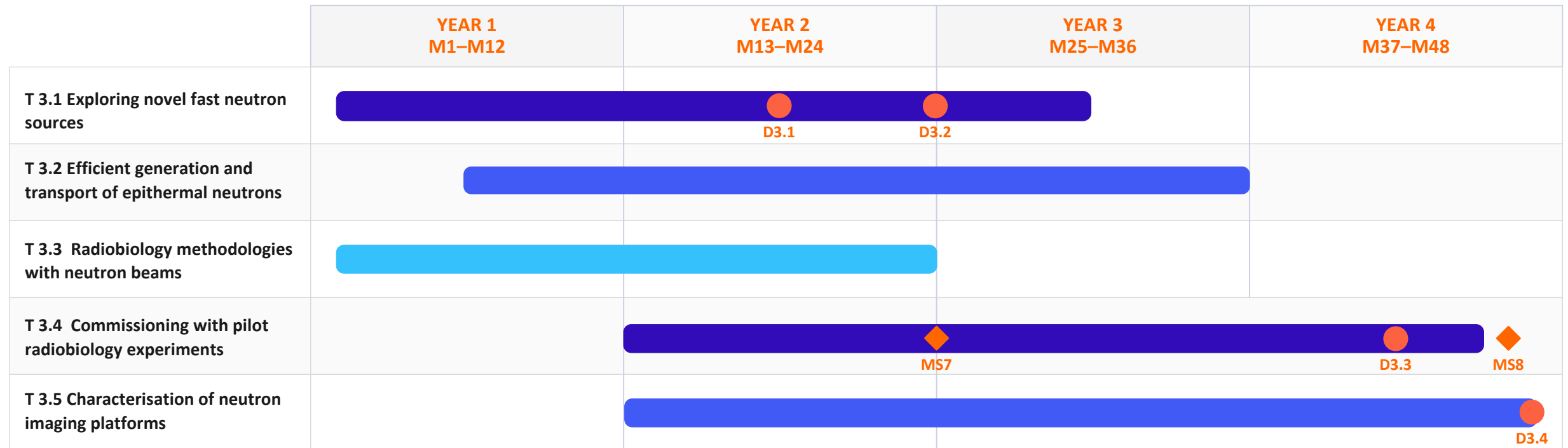
Type
DEM — Demonstrator, pilot, prototype
R — Document, report

Level
SEN – Sensitive
PU - Public

Flag sensitive deliverables and agree an internal drafting, quality-control and approval schedule well before the EU due month.

Timeline and critical path

Show the sequencing of tasks, major hand-offs, milestones, and deliverables across the 48-month project.



Legend: task activity bars | ◆ milestone | ● deliverable | M1 = September 2026

Key risks and mitigation

Focus on the few risks that require active WP-level management or coordination with other partners.

RISK / UNCERTAINTY	LIKELIHOOD / SEVERITY	OWNER	MITIGATION / CONTINGENCY	EARLY WARNING OR DECISION TRIGGER
Delays in the technical design phase	L / M	the task lead	Reuse of existing technical designs; modular design approach; early design reviews with contingency planning	Latest decision on M12
Supply chain delays or cost escalation for critical equipment	M / M	the task lead	Advance procurement planning; multiple qualified suppliers; framework agreements; reuse of existing components where feasible	Market evaluation
Insufficient laser beamtime for commissioning experiments at ELI facilities	M / M	ELI-NP/ ELI-ALPS	Submission of “user-assisted commissioning” proposals with external teams; prioritisation of beamtime in coordination with facility management	Not obtaining beamtime by M24
Damage to optics and detectors during high-flux/ high-repetition tests	L / M	ELI-NP/ ELI-ALPS	Pre-testing at suppliers and dedicated benches; gradual ramp-up of repetition rates; sacrificial optics for protection; redundancy in detectors	Active check for rising damages and efficiency loss
Radioprotection challenges from prompt dose and nuclear activation	L / M	ELI-NP/ ELI-ALPS	Rely on existing shielding and expertise at ELI facilities; Monte Carlo-based shielding design; active monitoring; contingency via shot limitation or burst-mode operation	Periodic check for activation

Do not reproduce the full project risk register. Select 3–5 risks that the WP team will actively monitor and be ready to escalate.

First six months: immediate actions

A concrete WP3 kick-off agenda for M2–M6

During the kickoff meeting

Launch T3.1 to T3.3.

BY M3

- Agree on requirements for D3.1 and D3.2.
- D3.3: Start the design of the compact moderation and transport systems for epithermal neutrons.
- Start working on Radiobiology methodologies.
- Establish shared technical data and risk tracking.

BY M6

Hold the first design reviews; confirm procurement priorities, the test sequence, and the commissioning roadmap.

REQUESTS TO THE CONSORTIUM AT KICK-OFF

Wednesday, 16 September 2026

09:00 - 11:00 | **Breakout sessions: WP3 meeting**

Agenda:

- Introduction of the WG and the Task Leaders and Co-Leaders (All)
- Brief introduction to WP3 and official presentation of the Task leadership (L. Giuffrida and D. Margarone)
- Short presentations of Tasks 3.1–3.5
- General discussion (All)

Project timing reference: M1 = September 2026; M6 = February 2027.

Thank you.

Questions & discussion

WP3 – Development of Neutron Sources for
Radiobiology and Material Investigations
WP Leader Domenico DORIA | ELI-NP/IFIN-HH



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