

# WP04-NA3 Roadmap and pre-design of future irradiation facilities

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<https://indico.cern.ch/event/983095/>

<https://indico.cern.ch/event/1029314/>



# WP04-NA3 Roadmap and pre-design of future irradiation facilities

- In this WP, the objective is to define long-term scientific, technological and industrial needs for upgrades of the current and future irradiation facilities
  - **4 Tasks** (Task 4.1 = Management)
  - **3 Beneficiaries**



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**ELI Beams**



**GSI**

# WP04-NA3 Main tasks

- Three main technical tasks:
  1. **Definition of the key performance parameters matrix for the evaluation and identification of the limitations and challenges in long-term**
  2. **Investigate innovative future solutions for current irradiation facilities**
  3. **Design study of new irradiation facilities**

**Main objective: identify limiting factors of current irradiation facilities and propose solutions for the upgrade of existing facilities and the development of future irradiation ones**

# WP04-NA3 Task 4.2 : Key performance parameters for current and new facilities



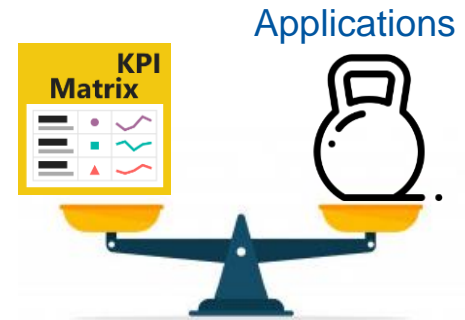
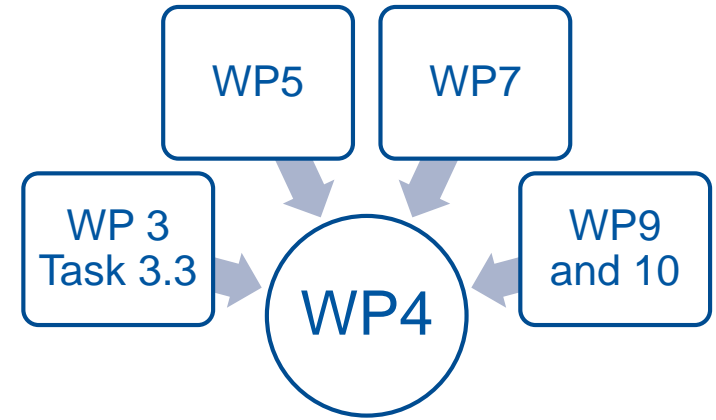
- ❑ **Task Leader:** CERN
- ❑ **A fellow will be recruited at CERN**

**CERN**

- ➔ Identify technological limiting factors for available irradiation test facilities based on current industrial and scientific requests;
- ➔ Identify operational issues and challenges for radiation testing coping with different applications and environments;
- ➔ Identify new facilities currently not adapted for radiation testing but that can be used for components qualification and system-level testing;

# WP04-NA3 Task 4.2 : Identification

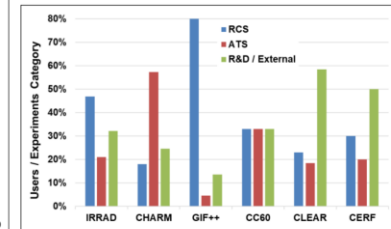
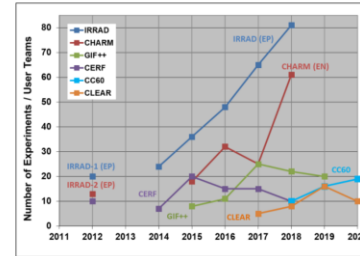
- Strong synergies with all the WPs in order to retrieve facilities information and feedbacks
- Identify KPIs such as:
  - Beam/irradiation parameters
  - Availability
  - Services
  - Penetration in matter
  - Cost per unit
  - Post irradiation support
- Identify common applications that can ensure a weighted evaluation of the KPIs
- Include in the scoring process the facilities that have not been used yet for irradiations highlighting their potential



# WP04-NA3 Task 4.2 : CERN facilities

- ➔ Similar exercise has been already carried out with CERN facilities (internal and external)
- ➔ KPIs have been identified for each facilities
- ➔ Applications have been identified among the accelerators and experiments community
- ➔ KPIs matrix with weighted performances have been discussed in details
- ➔ Propositions and suggestions have been provided to the management for future upgrades and future facilities (Task 4.3)
- ➔ <https://edms.cern.ch/document/2446501/1>

Facility	Location	Particle Type	Energy / Momentum	Intensity / Activity	Beam Spot	Beam structure	Availability
IRRAD	PS East Area (T8)	p <sup>+</sup>	24 GeV/c	~1.3x10 <sup>10</sup> p/cm <sup>2</sup> /s	12x12mm <sup>2</sup> (FWHM)	1-3 spill/CPS (30s) spill = 0.4s	May-November (PS operation)
CHARM	PS East Area (T8)	mixed-field (24 GeV/c p <sup>+</sup> )	n <sup>0</sup> (thermal - HE) + HEH >100MeV	HEH/cm <sup>2</sup> /h Long: 10 <sup>10</sup> -10 <sup>11</sup> HEH/cm <sup>2</sup> /h TID: 0.01-100 Gy/h	secondary environment from target	1-3 spill/CPS (30s) spill = 0.4s	May-November (PS operation)
GIF <sup>++</sup>	SPS North Area (H4)	γ + μ	0.662 MeV + 100 GeV μ	147Bq (~1Gy/h at 1m.) + 10 <sup>6</sup> particles/spill	panoramic (537°) + 100x100mm <sup>2</sup>	Continuous + spills/SPS cycle	all year + 6-8 weeks/year (SPS operation)
CC60	Prevision Site	γ	1.17 MeV, 1.33 MeV	107Bq (~3Gy/h at 1m.)	standard	continuous	all year
VESPER	CLEAR	e <sup>-</sup>	200MeV	~1x10 <sup>9</sup> e/cm <sup>2</sup> /s	20x12mm <sup>2</sup>	0.8-5Hz frequency / pulse ~1μs	CLEAR operation
CERF	SPS North Area (H4)	mixed-field (120 GeV/c HEH)	n <sup>0</sup> (<10-100 MeV) + HEH	max: 10 <sup>7</sup> particles/spill (on the target)	tertiary environment from target	spills/SPS cycle (few sec. spill)	few weeks/year (SPS operation)
CALLAB	Prevision Site	γ, β, n, X-ray	depending on the source	100MBq - 3TBq	depending on the source	Continuous	All year



Facilities	Sensors & Detectors	Electronics	System test	Materials
Proton				
IRRAD	55	38.5	29	26.5
PSI	21	39.5	17	0
Neutron				
CALLAB	17	19.5	14	0
JDI	45	31.5	15	34.5
CHIPR	19	30	20	0
ILL	19	23	15	0
Gamma				
CC60	38	37.5	33	31.5
GIF++	44	13	18	19.5
IONISOS	25	11.5	14	26.5
SCK	22	0	0	0
SANDIA	0	0	0	36
RGS	0	0	0	35
X-Ray				
EP-ESE	31	27.5	0	0
ETH Zurich	28	21.5	0	0
Mixed Field				
CHARM	37	51.5	52	0
Others				
VESPER (electrons)	18	18	15	0
RADEF (electrons)	16	0	0	0
UCL (IONS)	17	26	0	0

# WP04-NA3 Task 4.3 : Future solutions for current irradiation facilities



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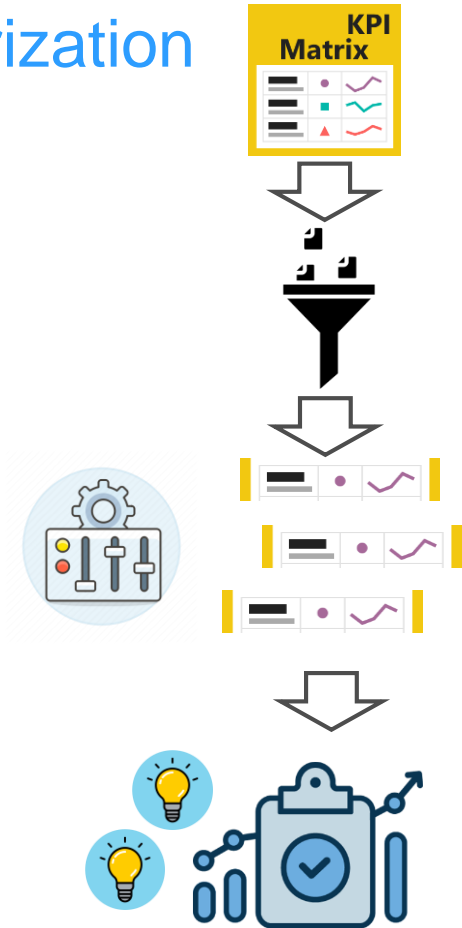
**ELI Beamlines**

□ **Task Leader:** CERN, ELI

- ➔ Study solutions for increasing the usability of the existing facilities, including virtual access;
- ➔ Propose techniques and methods to overcome technological bottlenecks in the short term;
- ➔ Propose long-term strategic plans for facilities upgrades and user support;
- ➔ Guide research groups and facilities coordinators in their efforts to fulfill the long-term requirements that the applications and the technology impose.

# WP04-NA3 Task 4.3 : Extraction and parametrization

- Extract from the Key Performance Indicators found in the Task 4.2 the ones that can be improved
- Based on these parameters provide suggestions and ideas on in the short, medium and long term
- Solutions can be on:
  - Improving user support: standard mechanical and electrical structure cross-facilities
  - Beam quality improvements: energy modulation, flux tuning
  - Radiation environment improvements : shielding, target materials (mixed field facilities), post-irradiation handling
  - Others i.e virtual access





# WP04-NA3 Task 4.4 : Design study of new irradiation facilities

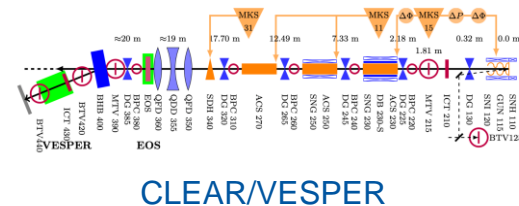
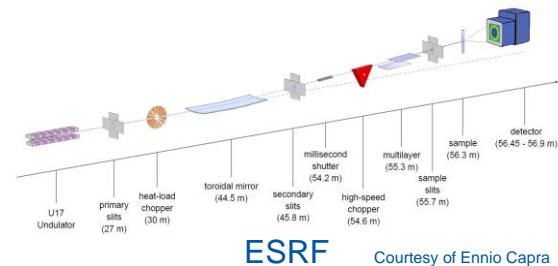


Task Leader: CERN, ELI

CERN

ELI Beamlines

- ➔ Study design for innovative beam facilities
  - ➔ High-energy heavy ions at CERN (CHIMERA)
  - ➔ Laser Plasma Accelerators
  - ➔ Pulsed X-rays to mimic heavy ion SEE effects
  - ➔ High-energy electron beam at CLEAR
- ➔ Study solutions for future infrastructure:
  - ➔ IFMIF-DONES: International Fusion Materials Irradiation facility
  - ➔ ISIS-II project : Next generation spallation source, successor to ISIS
  - ➔ Beam Dump Facility at CERN



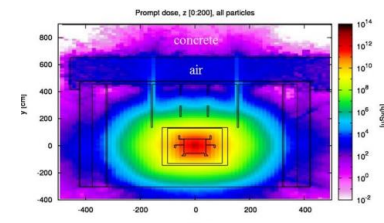
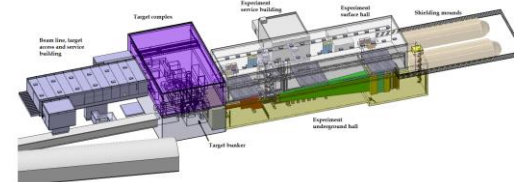
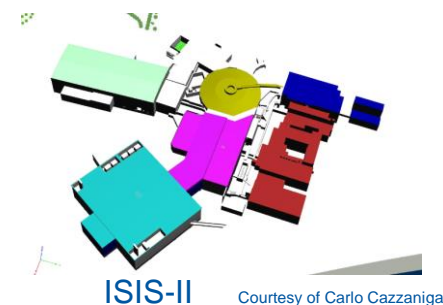
# WP04-NA3 Task 4.4 : Design study of new irradiation facilities

## → ISIS-II

- Next generation spallation source, successor to ISIS, to be developed in the next decades to be ready for construction after 2030.
- It is not an upgrade of ISIS, which will operate for many years to come, but a new facility in the UK, complementary to European Spallation Source.

## → Beam Dump Facility

- Foreseen to be located at the North Area of the SPS
- envisaged to be for the Search for Hidden Particle (SHiP) experiment
- Beam momentum of 400 GeV/c
- Beam intensity on the target  $4.0 \times 10^{13}$  per cycle of 7 seconds



BDF Facility

# WP04-NA3 Task 4.4 : Design study of new irradiation facilities



- ➔ Laser-based facility in their infancy for radiation production
- ➔ Increased interest because of progress in operational parameters
  - ➔ Worldwide: 43 lasers  $\geq$  1PW ; 8 lasers  $\geq$  10PW
  - ➔ Three laser facilities in RADNEXT
- ➔ Pros & Cons of radiation testing at laser facilities
  - ➔ Plus: very short pulse, very high dose rate, very easy passive measurements
  - ➔ Minus: repeatability, beam quality
- ➔ Need to train laser scientists on radiation damage
- ➔ Need to devise working protocol for laser facilities



# Thanks for your attention!



*Image Source: CERN*