MediNet
the detector-oriented Network of ENSAR2
for ion-beam therapy

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on behalf of MediNet Network

Topics

- ENSAR2 project
- MediNet Task 1
- MediNet Task 2
- MediNet & ENLIGHT

Introduction to:

ENSAR2

- **European Nuclear Science and Applications Research- 2**
- Funded by the EC under 'Infrastructures', budget of 10 M€ in four years.
- Coordinating Institution: **GANIL** (CAEN, France)
- Coordinator: **Muhsin Harakeh**, KVI-CART Groningen & GANIL

Integrating Activity for European nuclear scientists who are performing research in three of these major subfields:

Nuclear Structure

Nuclear Reactions

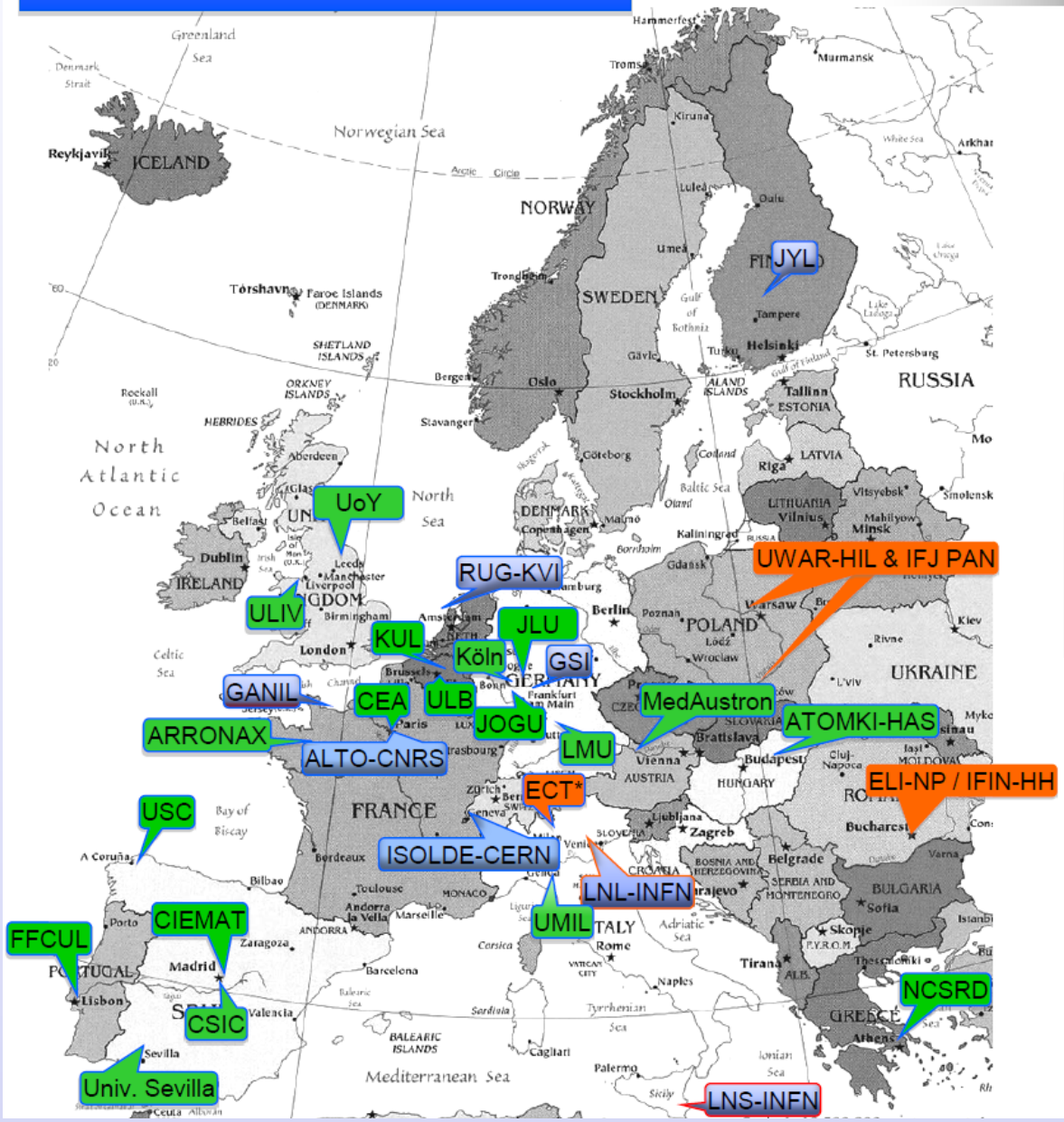
Applications of Nuclear Science

ENSAR2: a powerful structure

- Its core aim is to provide access to nine of the complementary world-class large-scale facilities:
- **GANIL (F), GSI (D), LNL-LNS (I), JYFL (FI), KVI-CART (NL), CERN-ISOLDE (CH), ALTO (F), IFIN-HH/ELI-NP (RO) and NLC (PL).**
- These facilities provide stable and radioactive ion beams of excellent qualities ranging in energies from tens of keV/u to a few GeV/u and intense photon beams up to 20 MeV energy.
- The stable-ion beams range from protons to uranium.
- The high-intensity, high-energy photon beams are produced by laser back-scattering from high-energy electron beams.

FP8 ENSAR2

Partners of ENSAR2



7 ⇒ 10 TNA Facilities

30 ⇒ 30 beneficiaries
15 countries

Community: 2700-3000 scientists and highly qualified engineers

Close collaboration with infrastructures outside Europe:
Canada: TRIUMF
China: IMP Lanzhou
Japan: RIKEN & RCNP
Russia: Dubna/JINR
South Africa: iThemba
United States: NSCL & ANL

Transnational Access activities (TA's)

N°	Title	Facility Location
WP16	GANIL-SPIRAL2	Caen (France)
WP17	LNL-LNS	Legnaro, Catania (Italy)
WP18	ISOLDE	Geneva (Switzerland)
WP19	JYFL	Jyväskylä (Finland)
WP20	ALTO	Orsay (France)
WP21	GSI	Darmstadt (Germany)
WP22	KVI-CART	Groningen (Netherlands)
WP23	NLC (IFJ PAN & SLCJ)	Krakow, Warsaw (Poland)
WP24	IFIN-HH / ELI-NP	Bucharest (Romania)
WP25	ECT*	Trento (Italy)

→ Other activities: Detector innovation, Theoretical support, MC Simulations, sources and accelerator technologies

MediNet:

Nuclear Physics for Medicine

Task 1:

Research on
Detector Instrumentation for Radiation Therapy

Task Coordination: Peter Thirolf, LMU Munich

Research Topics in Particle Therapy: Task 1 Objectives

- **beam delivery optimization**:
  conventional accelerators, next-generation (rapid cycling, high fluence), new concepts (laser acceleration)
- **in-vivo-monitoring** of delivered dose
- **dosimetry**

→ essential: nuclear detection techniques (particles, photons)
→ large efforts devoted to innovative detector technology

Task 1 objectives: improved detection techniques

- **large-area** transmission detectors (e.g. ionization chambers)
- **non-destructive** (e.g. inductive) beam intensity measurements
- improved imaging technology (proton and **ion radiography** and tomography)
- in-situ **PET** systems
- **prompt-γ** imaging detectors, vertex imaging
- **online reliable** dosimetry

→ towards clinically applicable detector systems **with maximum benefit for patients**

Task 1 Participants

- Task1 participants: **14 groups** from **6 countries**
  - carry cutting-edge expertise and **detection technologies** for radiation therapy (hardware & MC simulations)
  - strong connection to operating or planned **particle therapy facilities**

  → clinical translation of the pursued developments

- involvement of **industrial partners**:
  - considered on the basis of existing contacts and collaborations of partner institutions

Task 1: Partner Institutions and Expertise

Institution	Participants	Expertise
CSIC/IFIC + Univ. of Valencia / Spain	C. Lacasta, J. Oliver, G. Llosa, I. Torres	PET, photon tracking, (d-)SiPM, DAQ, electron.
Delft University of Technology/ The Netherlands	D. Schaart, D. Lathouwers, M. Engelsman, B. Wolterbeek	novel scintillators, TOF-PET, (d-) SiPM
GSI Darmstadt / Germany	B. Voss	tracking detectors, GEM
CNRS: IPN Lyon / France	E. Testa	prompt-γ, electronics
CNRS: LPSC Grenoble / France	Y. Arnoud, D. Dauvergne	beam monitoring det.
CNRS: LPC Clermont-Ferrand /Fran.	G. Montarou	nucl. electronics (ASIC)
Univ. Giessen (JLU) / Germany	K.-Th. Brinkmann	Si detectors, SiPM
KVI-CART/Univ. of Groningen/ The Netherlands	P. Dendooven, S. Brandenburg, E. v.d. Graaf, A. Biegun	(TOF-)PET, (d-)SiPM, prompt-γ, beam expts.
LIP, University of Coimbra / Portugal	P. Crespo	PET, prompt-γ
LMU Munich / Germany	K. Parodi, P. Thirolf	PET, dosimetry, prompt-γ
OncoRay + TU Dresden / Germany	W. Enghardt, G. Pausch	prompt-γ
Univ. Complutense + Univ. Carlos III, Madrid / Spain	L. M. Fraile, J. Udias, J.J. Vaquero	PET detectors, phoswich det., SiPM, electronics
University of Pisa / Italy	A. Del Guerra	PET, (d-)SiPM, γ-detector
Univ. di Roma "La Sapienza"/ Italy	V. Patera	pixel det., DAQ, tracking

Specific Goals of Task 1

- Specific working groups
- Provide a **training** ground **for students** (MSc and PhD level) by mutual exchange within a mobility program
- **Act as a forum** for establishing new collaborations between **ENSAR-2** groups and preparing joint projects of ENSAR-2 laboratories and **high-tech companies** involved in detector R&D
- Foster the **liaison** and shared knowledge with **US** and **Japan** communities

- wherever appropriate: **coordinate experimental efforts**, potentially helpful to

  (i) avoid duplicate work

  (ii) have an easier/**fair**er **comparison** of different **detector** systems by

  (a) agreeing on common experimental protocols and
  (b) possibly agreeing to test different systems at the same time in one location

  (iii) generally enable progress in a more efficient way

Subtask 1: Working Group Activities (Task 1)

- mission of Task 1 within MediNet:

  - **to promote the information exchange of ongoing R&D work in the general field of radiation detection instrumentation**

  WG1: **Detector** developments for **photon** detection
  (converner: Denis Dauveregne, LPSC Grenoble/France)

  WG2: **Detector** developments for **charged particle** detection
  (convener: Vincenzo Patera, Univ. "La Sapienza", Rome/Italy)

  WG3: Novel **scintillators** and their application
  (convener: Jose Udias, UCM Madrid/Spain)

  WG4: Developments of new **photosensors**
  (MCP-PMT's, SiPM's, dSiPM's, radiation hardness)
  (convener: Dennis R. Schaart, TU Delft/Netherlands)

  WG5: Development of efficient **data acquisition electronics**
  (convener: Gerard Montarou, LPC Clermont-Ferrand/France)

- part of working group activities:
  coordinated experimental efforts, e.g. via **comparative studies** of complementary (or alternative) detector approaches, **pursued by joint experimental campaigns**.

Subtask 2: Mobility Program (Task 1)

- objective: network **exchange** of (**young**) **researchers** in the field of detector instrumentation for radiation therapy

→ addresses central goal within Task 1:

- exchange of knowledge and expertise on detector developments

→ enable **direct contact** of young researchers involved in the various R&D projects at the partner institutions

→ mutual lab visits and joint research work:

- **widen the horizon** of involved young scientists
- **enhance** their physical **understanding** and practical skills
- enable a direct **flow of information**
- form a basis for **future collaborations**, paving the way for new ideas and projects

- envisaged: seed a lively exchange culture:

partner institutions will **temporarily host young scientists** from network member groups for internships or research visits within their ongoing R&D projects on detector developments

Goals of Task 1 of

- disseminate results within the community
  → avoid costly parallel developments
- promote exchange of knowledge and technology
- provide a forum for discussion and stimulation of novel ideas:
  → especially with clinicians to answer more efficiently to therapeutic's requirements
- define clinical feasibility of the developments
- organize communication via network and working group meetings, maintain a joint website

MEDINET
Task 2:

Nuclear Tools for Ion Beam Therapy:
Focus on radiation quality

Task 2 Objectives

11 groups in multidisciplinary approach from 7 countries, 3 proton/ion-therapy facilities:

Three objectives:

- the study of hard and soft tools for the characterization of the **radiation quality**: tissue equivalent proportional counters, solid-state microdosimeters, MC codes, dedicated software.
- the study of the **correlation of physical measurements and biological effects** of primary particles and fragment; MC codes, cell signalling, biomarker; biological dosimetry.
- Bio-compatibility and imaging compatibility of the detectors.

Task 2: Partner Institutions and Contributions

Institution	Participants	Expertise
University of Warsaw, Poland	Jerzy Jastrzebski Urszula Kazmierczak	Biological Effects of Ions
IFJ Krakow, Poland	Pawel Olko	IB Therapy
INFN-LNS-Catania, Italy	Giacomo Cuttone, Francesco Romano	MS simulation, IB therapy, Biological Dosimetry
Universität Basel, Switzerland	Marco Dominietto	Imaging/bio compatibility
INFN-LNLegnaro, Italy	Valeria Conte Paolo Colautti	Microdosimetry, Tissue Eq. Proportional Counters
VINS University of Belgrade, Serbia	Ivan Petrovic Aleksandra Ristic Fira	Cell signaling, Biological Dosimetry
ENLIGHT, CERN	Manjit Dosanjh	ENLIGHT Liaisoning
LPC Clermont-Ferrand, France	Gerard Montarou	IB Therapy, Detectors
NuPECC	Angela Bracco	NuPECC Liasoning
GSI, Germany	Michael Scholz, Ulrich Weber	RB, IB Therapy, Detectors
	Marco Durante	Detectors, RB, IB Therapy
MedAustron, Austria	Giulio Magrin	Microdosimetry, IB Therapy

Working Group Activities, Task 2

WG6: **Monte Carlo codes,** benchmark at ion beam therapy energies
Conveners: Pablo Cirrone, INFN-Catania; Lydia Maigne, LPC Clermont-Ferrand

WG7: **Biological dosimetry,** primary and secondary particles **and cell signaling**, foci formation and repair mechanisms
Conveners: Aleksandra Ristic Fira, VINS Belgrade; Manjit Dosanjh, ENLIGHT, CERN

WG8: **Microdosimetry**, Gaseous and Solid State detectors
Conveners: Marzena Rydygier, IFJ Krakow; Paolo Colautti, LNL-Legnaro

WG9: **Detector compatibility for in-vivo applications**: Imaging and biological compatibility
Conveners: Marco Dominietto, Basel University; Francesco Romano, INFN-Catania

Advisory Committee, Task 2

Advisors from European ion-beam therapy facilities,
the potential users:

- Radiation Oncologists
- Medical Physicists
- Representatives form ENLIGHT and NuPECC

Participating to WGs activities

- addressing the **needs** of the users
- assessing clinical **feasibility** of the tools
- providing **feedback** on results
- being engaged in some non-trivial questions

→ The ENLIGHT network is the natural place where the clinical users can discuss the proposed nuclear tools and provide the knowledgeable feedback for optimization and prompt implementation of the instruments in the medical practice.

Point for thorough discussion

A. The specifying radiation quality in phantoms is straightforward. Should we aim to **use the detectors during treatment** as well? At what conditions?

B. Conventional microdosimeters refer the measure to tissue equivalent target. Dosimetry and TPS refer to water. To which target should microdosimetry in ion-beam therapy refer: **water? tissue? other?**

C. The dependence of the biological effectiveness on the radiation quality can be expressed by the curves RBE(LET). Should the detector **assess LET and particle type as well?**

D. Specification of the Radiation Quality with **LET or lineal energy parameters?**

E. How should we combine information collected at **micrometric** level (e.g. via lineal energy spectra) to assess the radiation quality at a **millimetric** level, feasible for clinical use?

A proposal for a joint activity

An ENLIGHT out-reach activity for ENSAR2 members

Long time has passed but still old ideas about ion-beam therapy resist also within the nuclear physicists about the unjustifiable cost, the lack of evidence, and the large differences in performing ion-beam therapy.

We think that an **action** is advisable from the ion-beam therapy community, ENLIGHT, to the nuclear physics community, ENSAR2 presenting the evidences (and eventually the needs of research in the field).

Nuclear physics community in each country can be an important link to health decision makers.

One proposal:
Half-a-day monographic presentation during periodic Ensar2 meetings.

Timeframe: In one or two years.

Thank you