

# ***NuPECC Report***

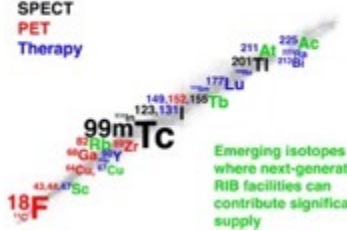
***IUPAP WG9 meeting  
Avignon 03/06/2023***

- **Recent Results from European Nuclear Physics Facilities (examples)**
- **NuPECC and 2024 Long Range Plan for Nuclear Physics in Europe**

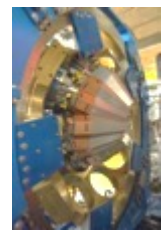
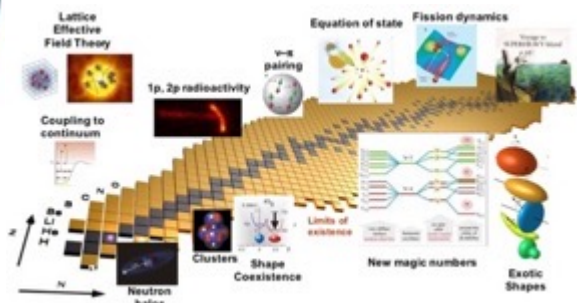
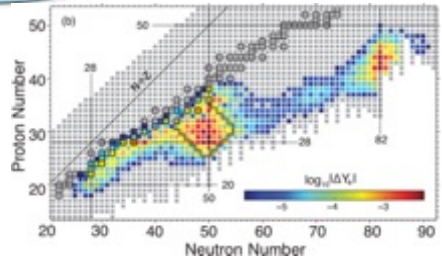
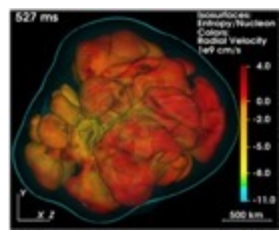
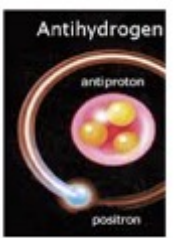
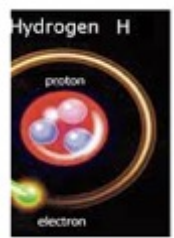
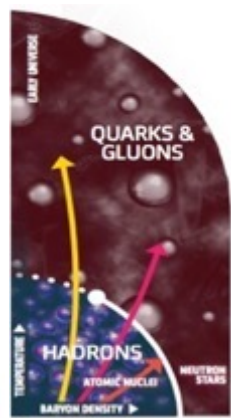
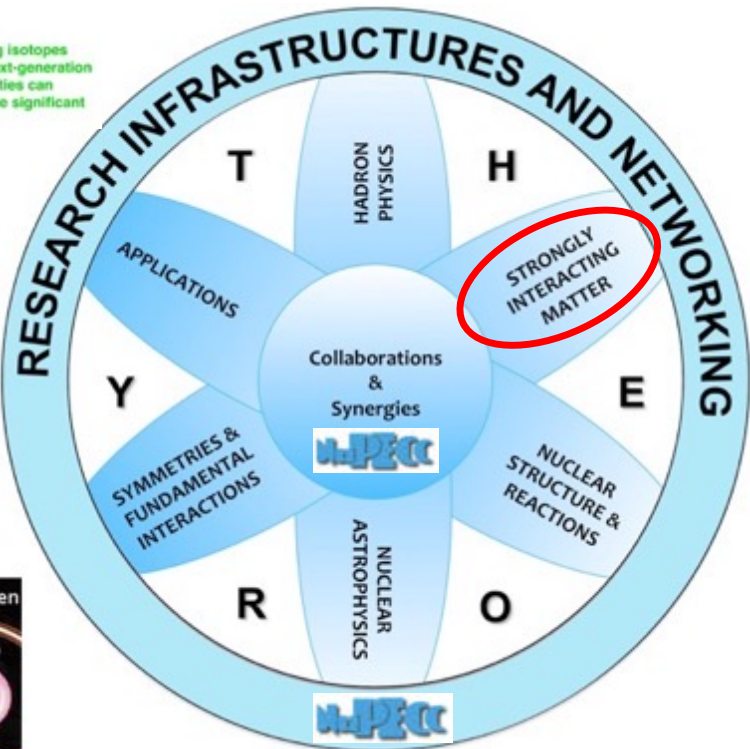
<http://www.nupecc.org>

Nuclear medicine perspective

SPECT  
PET  
Therapy



Emerging isotopes where next-generation RIB facilities can contribute significant supply

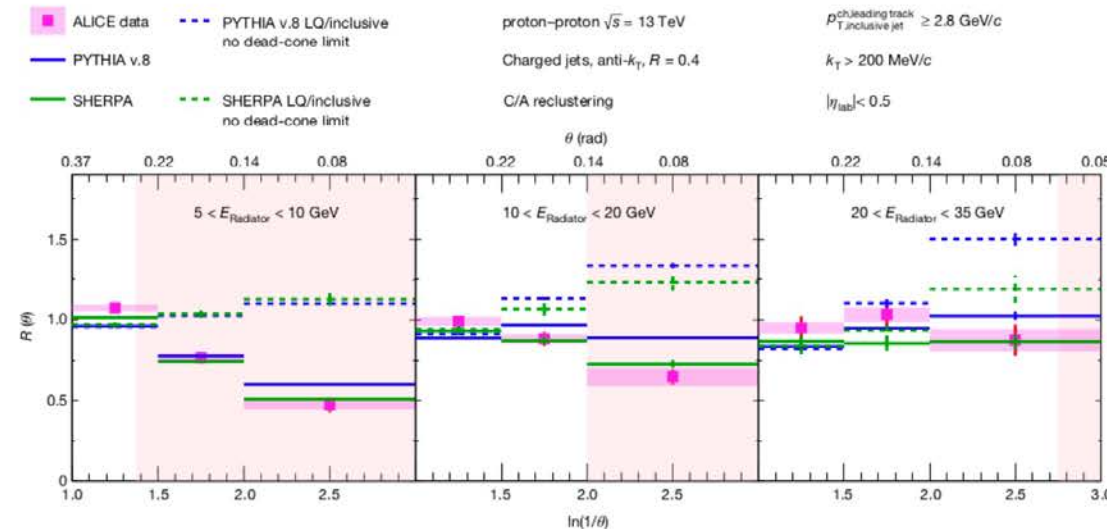
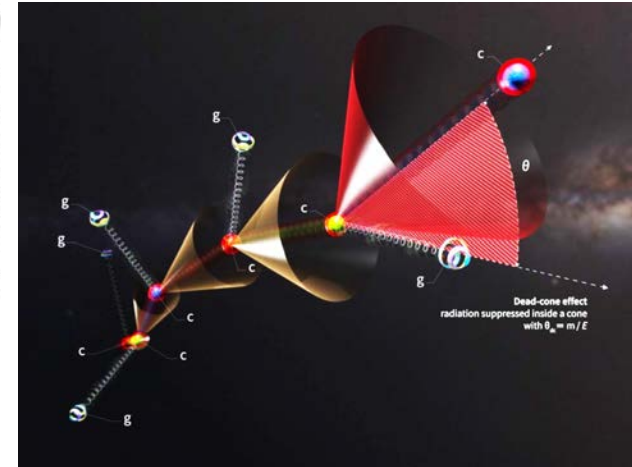


## Now: ALICE's High-impact HF result (2022)

### Direct observation of the dead-cone effect in quantum chromodynamics

<https://doi.org/10.1038/s41586-022-04572-w> ALICE Collaboration<sup>✉</sup>

nature



$$R(\theta) = \frac{1}{N^{D^0 \text{ jets}}} \frac{dn^{D^0 \text{ jets}}}{d \ln(1/\theta)} \bigg/ \frac{1}{N^{\text{inclusive jets}}} \frac{dn^{\text{inclusive jets}}}{d \ln(1/\theta)} \bigg|_{k_T, E_{\text{Radiator}}}$$

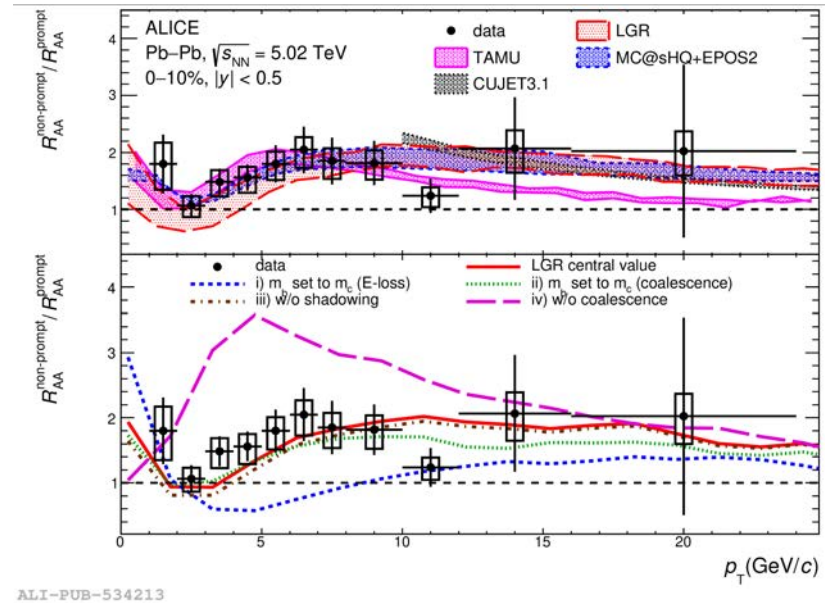
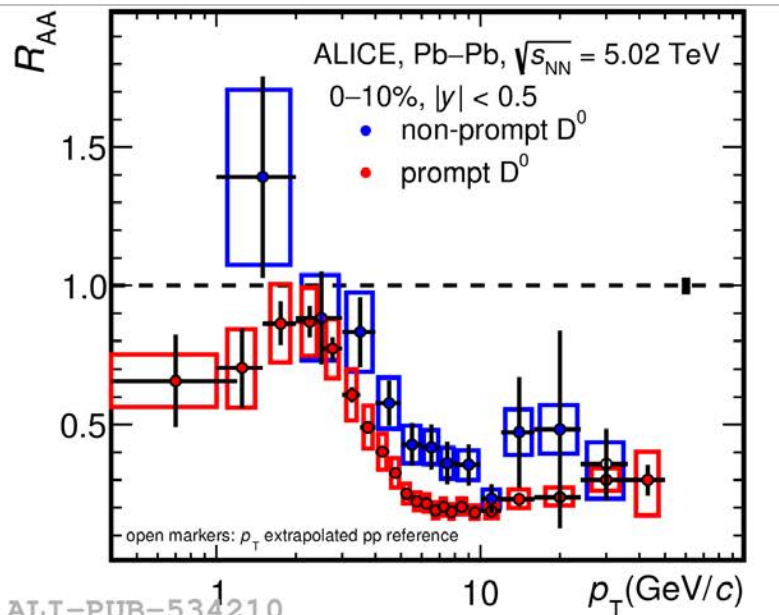
“We report the direct observation of the QCD dead cone by using new iterative declustering techniques to reconstruct the parton shower of charm quarks. This result confirms a fundamental feature of QCD. Furthermore, the measurement of a dead-cone angle constitutes a direct experimental observation of the non-zero mass of the charm quark, which is a fundamental constant in the standard model of particle physics.”

Courtesy of G. G. Barnaföldi

## Probing the QGP with Heavy Flavour particles at ALICE/LHC

Charm and beauty: prompt and non-prompt D mesons

Non-prompt/prompt ratio



ALICE, JHEP 12 (2022) 126

Beauty (non-prompt D mesons) less suppressed than charm: large mass quarks lose less energy  
Qualitatively in line with both collisional and radiative energy loss; model calculations to determine mechanism

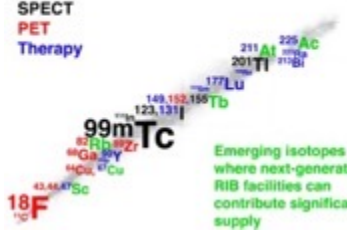
*Courtesy of M. Van Leeuwen*



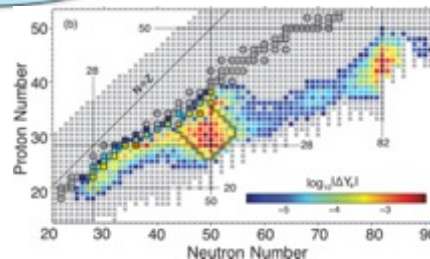
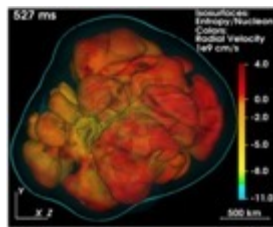
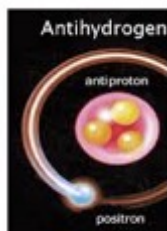
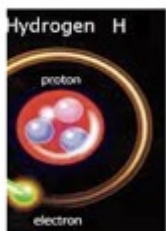
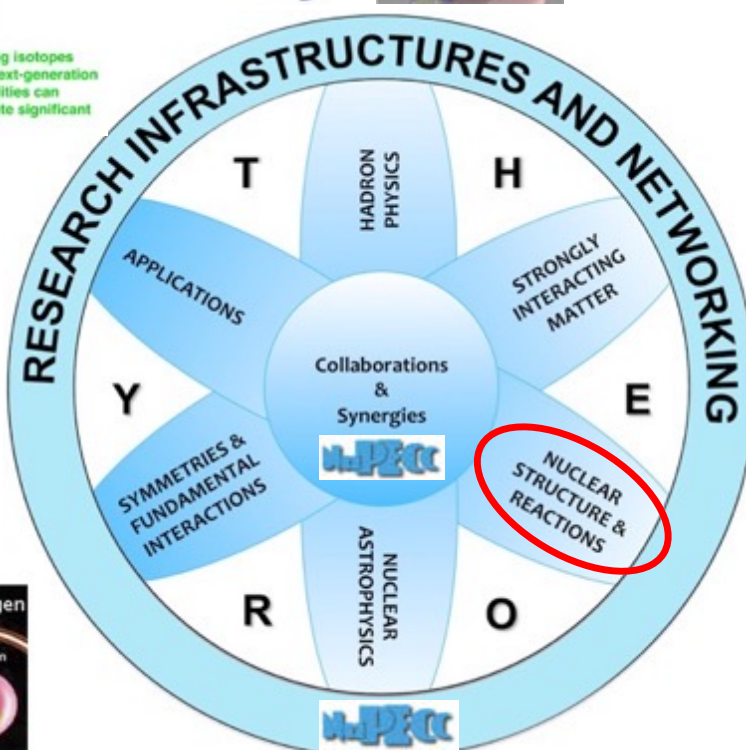
<http://www.nupecc.org>

Nuclear medicine perspective

SPECT  
PET  
Therapy

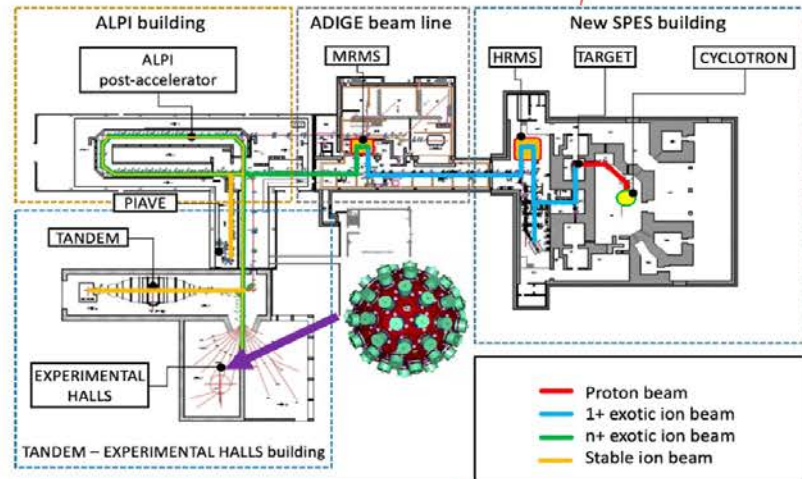


Emerging isotopes where next-generation RIB facilities can contribute significant supply




## NUCLEAR PHYSICS: AGATA @ LNL

THE ADVANCED GAMMA TRACKING ARRAY AGATA



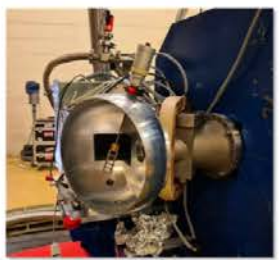
At present

- AGATA has been installed** between Sept. 21 and April 22:
- Many LNL departments have collaborated to the **site preparation** and to the **AGATA  $\gamma$ -spectrometer installation** together with the scientific collaboration
  - Many ancillary detectors are used during the scientific campaigns
  - AGATA performs some experiments in coincidence with the **large solid angle magnetic spectrometer PRISMA** which was upgraded on purpose.
  - AGATA started the commissioning with beam on **April 22** and the **first campaign** just following.
  - The **second campaign** with heavy ion beam from PIAVE is ongoing successfully.

**Main characteristics**

- Solid angle:  $\sim 1\pi$  (starting configuration in 2022)
  - $\epsilon_{ph} \sim 10\%$  @ 1 MeV at the close up position
- 
- Graph showing Efficiency (%) vs Energy (MeV). Two curves are shown: 'nominal position 23.5 cm' (red) and 'close up position 18 cm' (green). The red curve starts at ~18% at 200 MeV and drops to ~8% at 2000 MeV. The green curve starts at ~12% at 200 MeV and drops to ~6% at 2000 MeV.

- Electronics: fully digital



28/03/2023

20

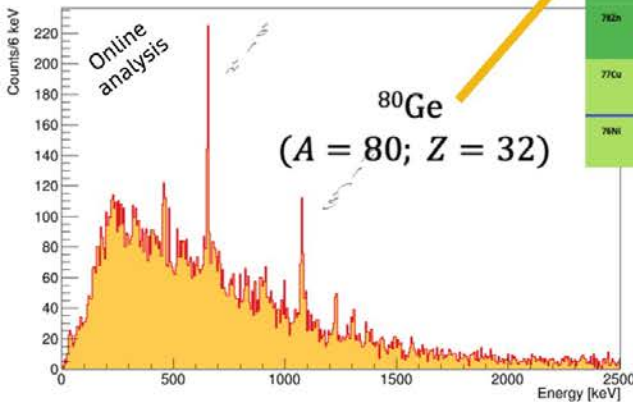
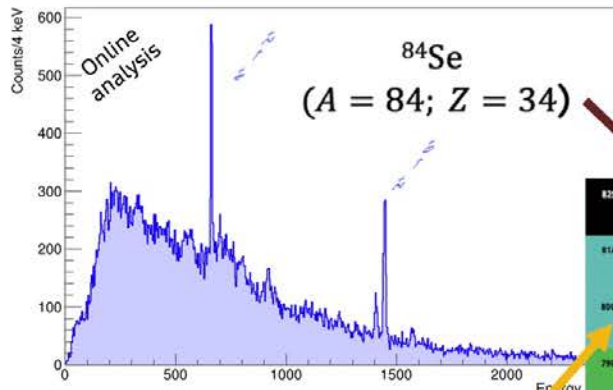
*Courtesy of T. Marchi*



## FIRST AGATA PHYSICS CAMPAIGN

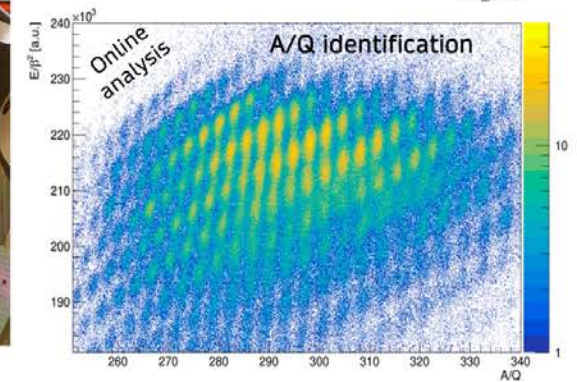
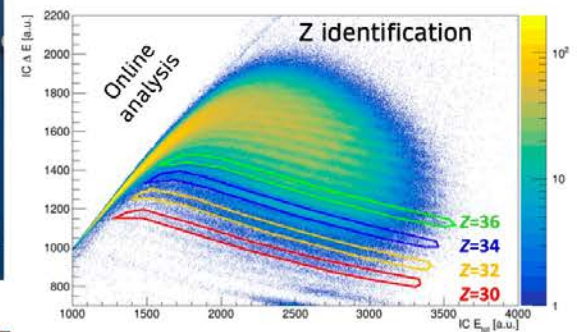
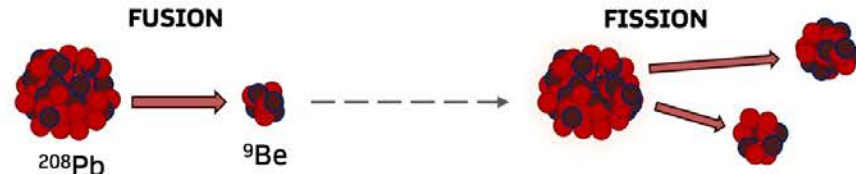
### Fusion-Fission reactions for N=50 studies

1.3 GeV  $^{208}\text{Pb} + ^9\text{Be}$



82Se	83Se	84Se	85Se
81As	82As	83As	84As
80Ge	81Ge	82Ge	83Ge
79Ga	80Ga	81Ga	82Ga
78Zn	79Zn	80Zn	81Zn
77Cu	78Cu	79Cu	80Cu
76Ni	77Ni	78Ni	79Ni

**N=50**



Courtesy of T. Marchi

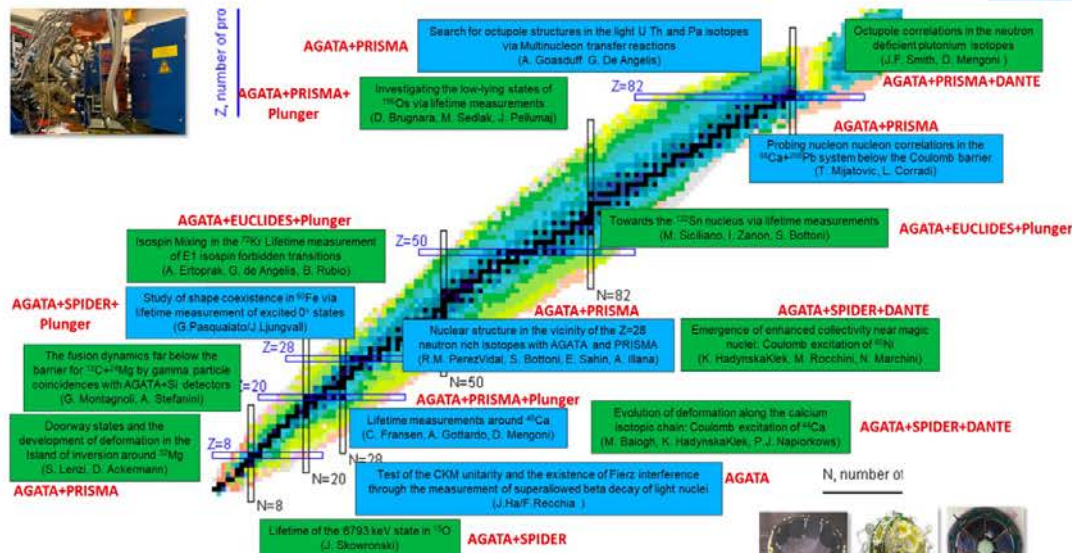
## PAC MEETING, 5-7 DEC 2022

### TAP complex

- Available days: 154d (23 Jan – 28 Jul)
- N° of proposals: 23 NP – 5 IP – 1 Lol
- N° of requested days: 280 NP – 18 IP
- Backlog: 47d NP – 4d IP
- Director + DA + RP: 11d + 20d + 2d



### SECOND AGATA PHYSICS CAMPAIGN



Priority A  
Priority B

### CN

- Available days: 116
- N° of proposals: 14 IP – 3 NP
- N° of requested days : 145
- Backlog (NP): 31d
- Director: 10d



### AN2000

- Available days: 90
- N° of proposals : 14 IP only
- N° of requested days: 140
- Backlog: 33d
- Director: 10d



The EUROpean Laboratories for Accelerator Based Sciences (EURO-LABS) project



### Transnational Access provided to international users

**DURATION:** September 2022- August 2026 (4 years)  
**TOTAL BUDGET:** 14.5 M€  
**TOTAL EC CONTRIBUTION:** 14.2 M€  
**CONSORTIUM:** 33 participants from 18 countries

Courtesy of T. Marchi



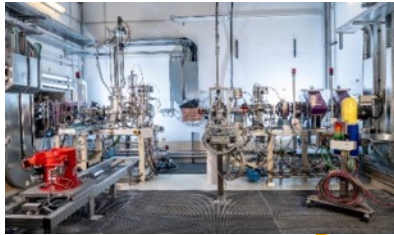


## Caen, France

### Experimental program in full swing

EXPERIMENTAL ROOM NFS  
(NEUTRONS FOR SCIENCE)

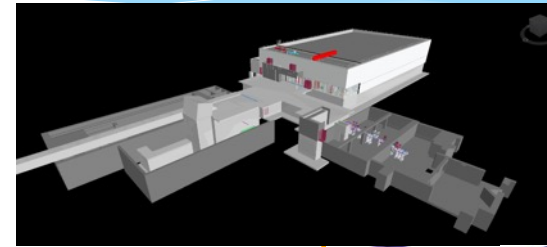
**NFS**



Convertor room



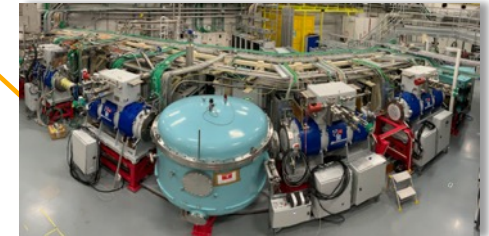
Time of Flight room



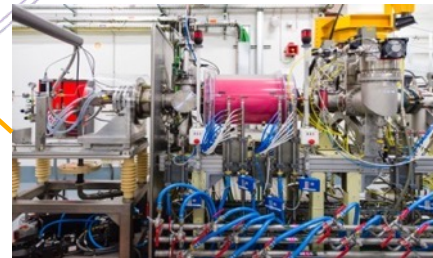
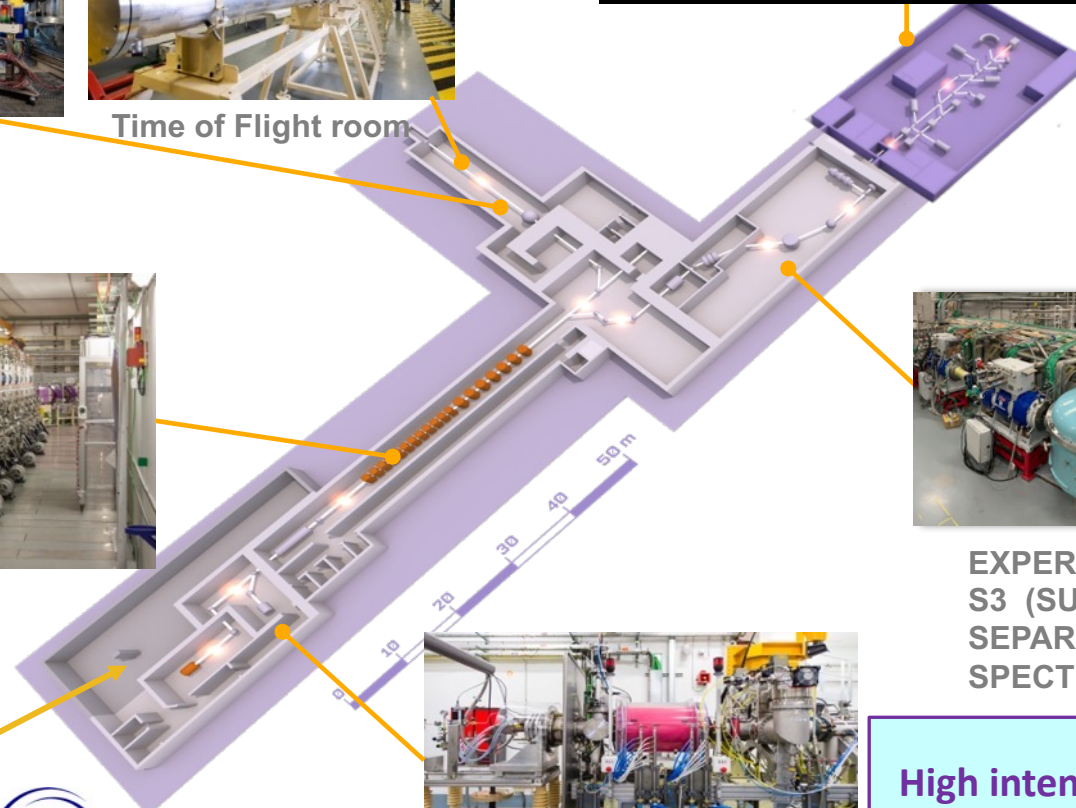
EXPERIMENTAL ROOM DESIR  
(Desintegration, Excitation and Storage of Radioactive Ions)



LINEAR accelerator (LINAC)



EXPERIMENTAL ROOM S3 (SUPER SEPARATOR SPECTROMETER)



ION SOURCE



High intensity beams :

- 5 mA, 33 MeV protons
- 5 mA, 40 MeV deuterons
- 1 mA, <14,5 MeV/A heavy ions

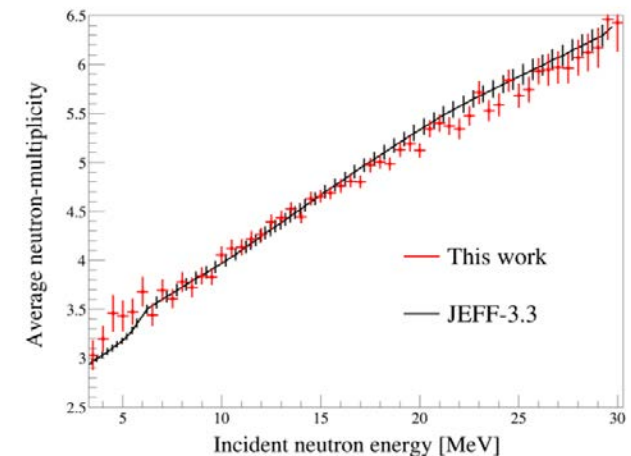
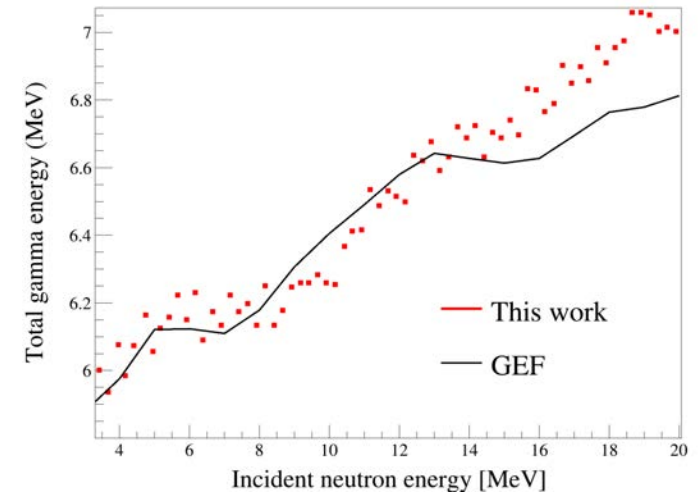
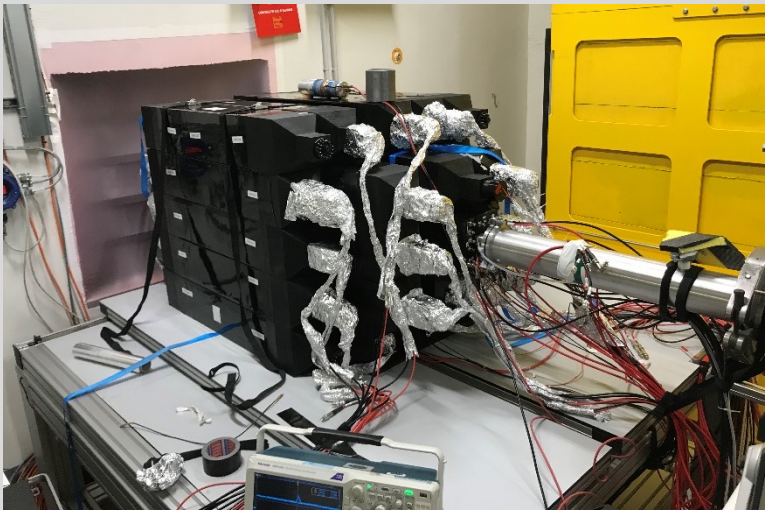


Spokesperson : G. Bélier, CEA-DAM-DIF

- (n,xn) reaction are important channels in the 5-50 MeV range
- (n,xn) cross-section measurement of actinide is very difficult:
  - radioactive sample
  - prompt neutron fission

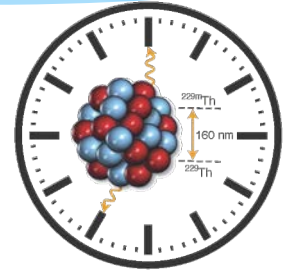
## Experimental technique :

- Veto fission (fission chamber)
- $4\pi$  neutron detector SCONE
- $6 \text{ MeV} < E_n < 20 \text{ MeV}$

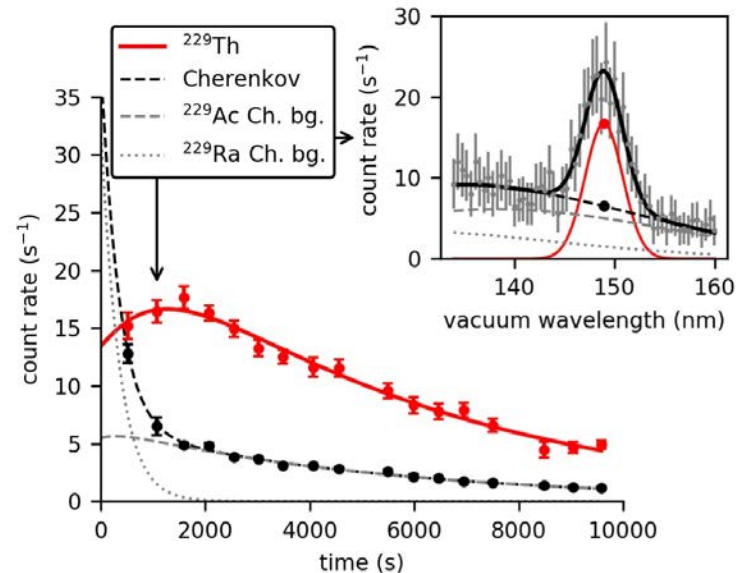
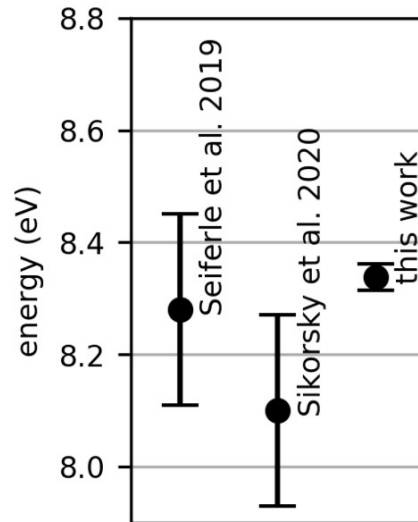
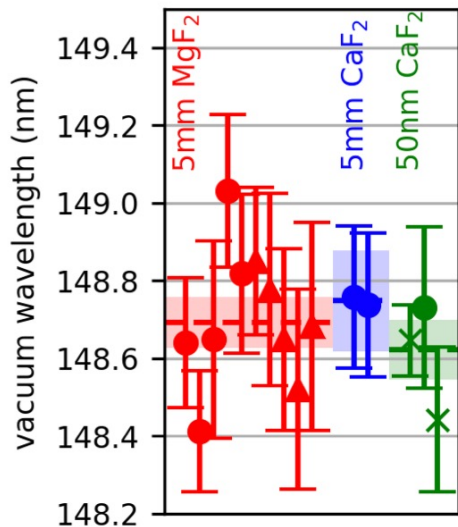


## Observation of the radiative decay of the $^{229m}\text{Th}$ nuclear clock isomer

Kraemer, S. *et al. Nature* 617, 706–710 (2023)



- $^{229m}\text{Th}$  properties:  $E^* = 8.338(24) \text{ eV}$
- half-life of  $^{229m}\text{Th}$  embedded in  $\text{MgF}_2$  is determined to be  $670(102) \text{ s}$





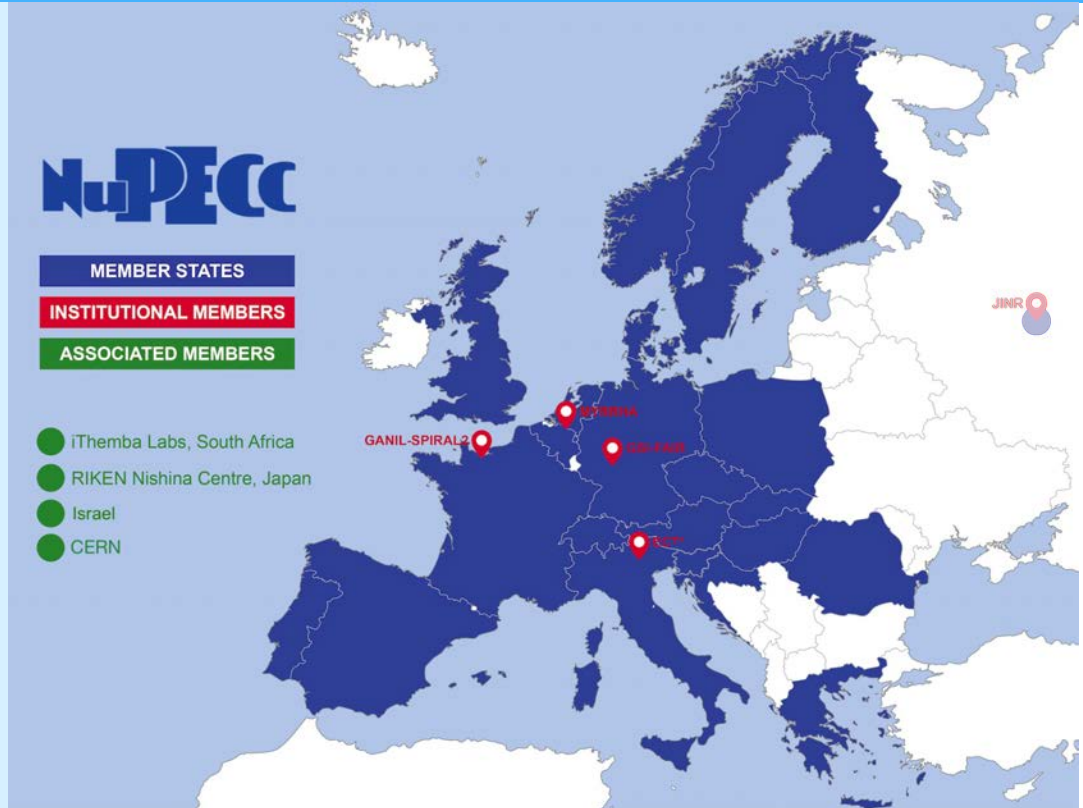
## Nuclear Physics European Collaboration Committee (NuPECC) Is the European Expert Board for Nuclear Physics hosted by European Science Foundation

Representing  
about 6000 scientists

### Composition:

- 34 representatives from 22 countries (new members Slovakia, Slovenia, Ukraine), 3 ESFRI NP Infrastructures & ECT\*  
*JINR Dubna – suspended in March 2022*
- 4 associated members
  - CERN
  - Israel
  - iThemba Labs
  - Nishina Center
- 9 observers (ESF, NPD/EPS, ECFA, NSAC, ANPhA, ALAFNA, CINP, IAEA, APPEC)

3 regular Committee meetings/y



34 Years of NuPECC activities

<https://nupecc.org>

***Nuclear Physics in Ukraine:  
current state and development after more than  
one year of war***

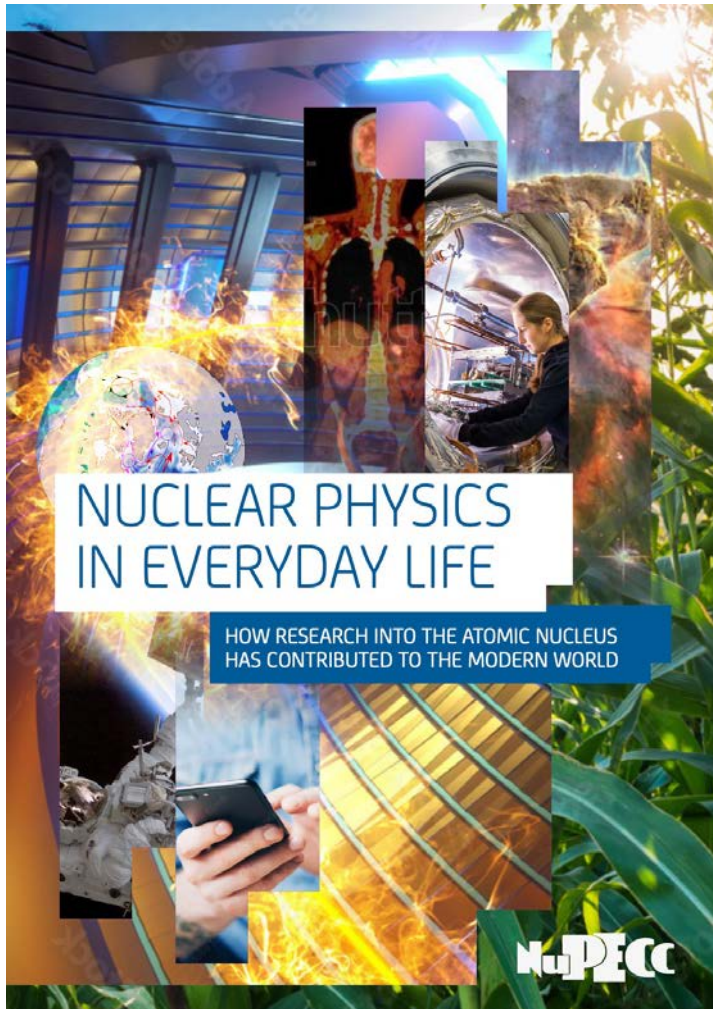
**Presentation of Prof. Ihor Kadenko at the NuPECC meeting  
in Debrecen on June 1, 2023**

[https://indico.ph.tum.de/event/7281/contributions/7311/attachments/5170/6678/  
Presentation%20NuPECC%20Debrecen%202023%20Kadenko\\_UKR.pptx](https://indico.ph.tum.de/event/7281/contributions/7311/attachments/5170/6678/Presentation%20NuPECC%20Debrecen%202023%20Kadenko_UKR.pptx)

***From North and East to West and Center of Ukraine***

- **Chornobyl Zone (11 km to the border of Belorussia)**
- **Kharkiv (Pyatykhatky, 20 km to the border of Russia)**
- **Sumy (50 km to the border of Russia)**
- **Uzhgorod (500 km to the border with Belorussia)**
- **Kyiv (120 km to the border with Belorussia)**
- **Conclusions**





*NuPECC report on*  
**Nuclear Physics in  
Everyday Life**  
*(100 pages, open access on-line and  
printed version available with)*

[https://nupecc.org/pub/np\\_life\\_print.pdf](https://nupecc.org/pub/np_life_print.pdf)

- **Climate & Environment**
- **Energy** (electric power generation, waste management, **nuclear data**)
- **Health** (radioisotopes for therapy and diagnosis, hadrontherapy)
- **Everyday life products**
- **Cultural heritage and Forensics**
- **Space technology & exploration**

## Nuclear Physics facilities

## NuPECC 2017 LRP

Complete urgently the construction of the ESFRI flagship FAIR and develop and bring into operation the experimental programme of its four scientific pillars APPA, CBM, NUSTAR and PANDA



Support for construction, augmentation and exploitation of world leading ISOL facilities in Europe towards EURISOL



Support for the full exploitation of existing and emerging facilities



Support for ALICE and the heavy-ion programme at the LHC with the planned experimental upgrades

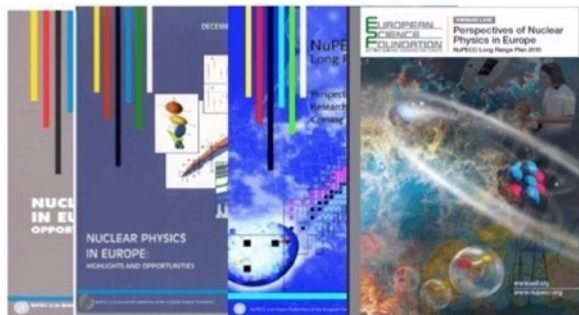


Support to the completion of AGATA array in full geometry





1991 1997 2004 2010



- The LRP identifies opportunities and priorities for the nuclear science in Europe
- The LRP provides national funding agencies, ESFRI and European Commission with a framework for coordinated advances in nuclear science in Europe

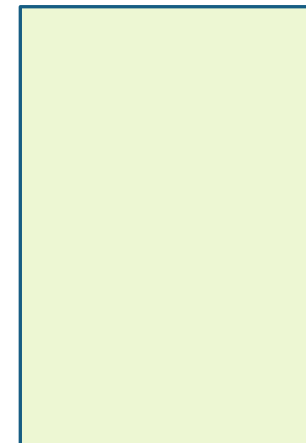
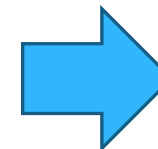


## Assessment of Implementation of the NuPECC Long Range Plan 2017

February 2022

**LIAISONS:** G. AARTS, D. BETTONI, S. COURTIN, P. GIUBELLINO, J. GÓMEZ CAMACHO, A. GÖRGEN, R.-D. HERZBERG, D. IRELAND, B. KRUSCHE, M. LEWITOWICZ, A. MAJ, U. MEISSNER, E. NAPPI, G. NEYENS, L. POPESCU, B. SHARKOV, E. WIDMANN,

**Contributors:** H. Abele, N. Alahari, W. Barth, D. Bemmerer, K. Blaum, F. Bossi, A. Bracco, M. Chioffi, A. Denig, M. Doser, S. Freeman, M. Gazdzicki, F. Gélis, H. Goutte, M. Grecco, M. Harakeh, M. Hori, G. Imbriani, E. Khan, K. Kirch, W. Korten, A. Laird, J. P. Lansberg, D. Lunney, F. Maas, G. Martinez-Pinedo, S. Masciocchi, A. Mengoni, O. Navillat-Cuncic, D. Rifuggiato, P. Rossi, E. Scomparin, J. Simpson, H. Schmieden, O. Schneider, N. Severijns, Th. Stöhlker, J. Stroth, H. Ströher, U. Thoma, S. Ulmer, C. A. Ur, Ch. Weinheimer, U. Wiedner, H. Wittig



**NuPECC LRP 2017**

<https://www.nupecc.org/lrp2016/Documents/lrp2017.pdf>

**February 2022**

[https://nupecc.org/2017\\_LRP\\_Assessment\\_of\\_Implementation\\_final.pdf](https://nupecc.org/2017_LRP_Assessment_of_Implementation_final.pdf)

**NuPECC LRP 2024**

**Launched in May 2022 in Madrid**

## first steps

- **June 2021 – March 2022:** Assessment of the implementation of the 2017 LRP  
[http://nupecc.org/2017\\_LRP\\_Assessment\\_of\\_Implementation\\_final.pdf](http://nupecc.org/2017_LRP_Assessment_of_Implementation_final.pdf)
- **Beginning of May 2022:** Nomination of the LRP Steering Committee chosen among the NuPECC representatives
- **May 2022-October 2022:** Call for contributions from the community

## Steering Committee of NuPECC LRP 2024

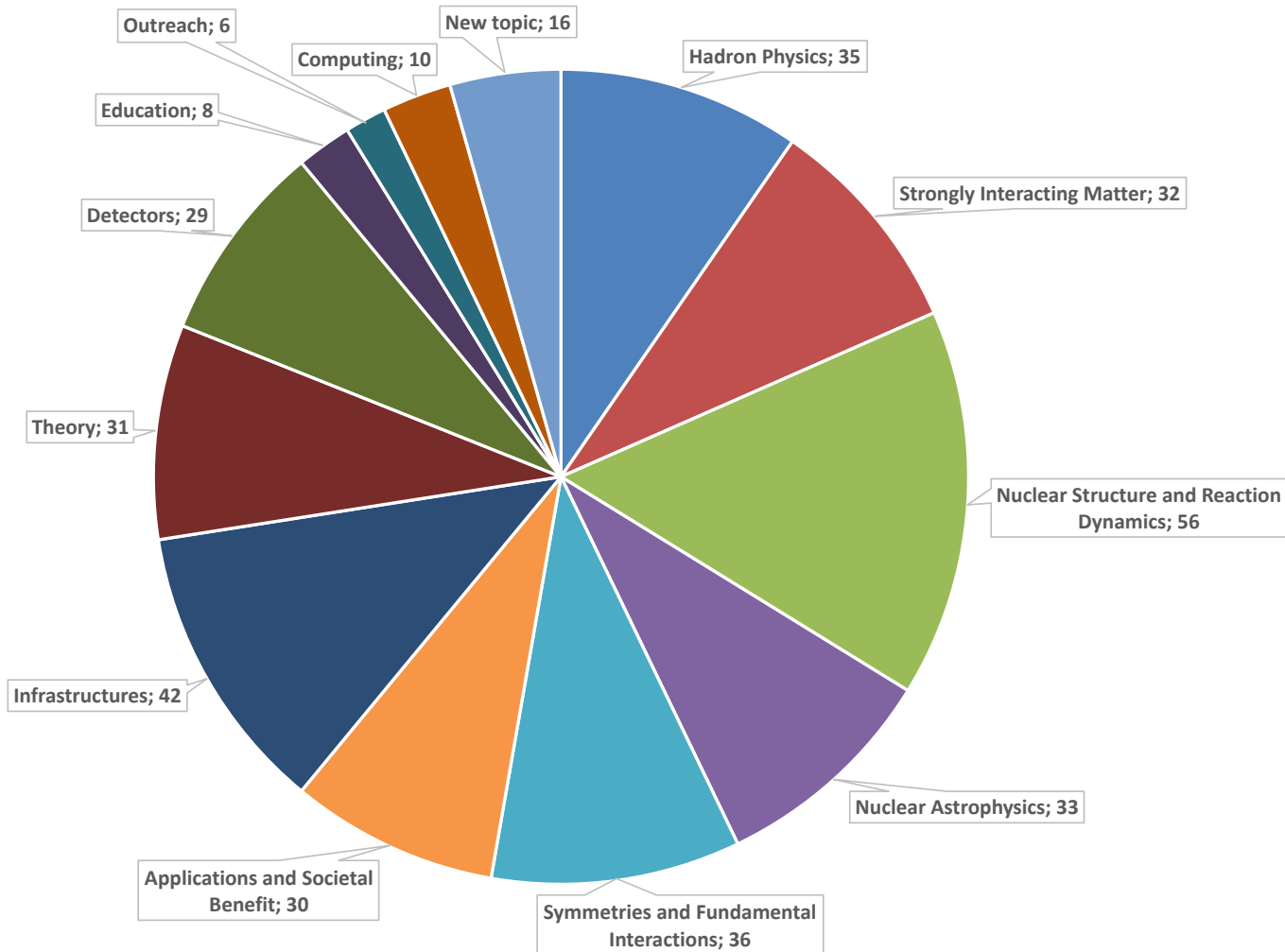
**28 members**

## NuPECC Members Associated Members and Observers

Name	Country/Institution
Gert Aarts	UK/ECT*
Daniel Bemmerer	Germany
Diego Bettoni	Italy
Sandrine Courtin	France
Paolo Giubellino/Yvonne Leifels	Germany
Joaquin Gomez-Camacho	Spain
Paul Greenlees	Finland
Andreas Haungs	APPEC
Rolf-Dietmar Herzberg	UK
Dave Ireland	UK
Karl Jakobs	ECFA
Klaus Kirch	Switzerland
Sissy Koerner	NuPECC
Marek Lewitowicz Chair	NuPECC
Adam Maj	Poland
Ulf Meißner	Germany
Joachim Mnich	CERN
Eugenio Nappi	Italy
Lucia Popescu	Belgium
Patricia Roussel-Chomaz	France
Hervé Moutarde	France
Hiroyoshi Sakurai	Japan
Raimond Snellings	The Netherlands
Martin Venhart	Slovakia
Jelena Vesic	Slovenia
Vladimir Wagner	Czech Republic
Eberhard Widmann	Austria
Gail Dodge	NSAC/US



### Contributions per topic



### LRP

### Contributions:

- 159 contributions submitted
- by > 400 individual scientists, collaborations, infrastructures, and research institutions in Europe

[https://nupecc.org/?display=lrp2024/call\\_for\\_input](https://nupecc.org/?display=lrp2024/call_for_input)

## organisation &amp; timeline

- **October 2022 – November 2022:**
  - definition of Thematic Working Groups (TWG) of LRP by the Steering Committee;
  - proposal for Conveners of TWG by the Steering Committee
- **1&2 Dec. 2022: Conveners approved at the NuPECC meeting**
- **December 2022 – February 2023: TWG formed**
- **Now: Thematic Working Groups Kick-off meetings (see <https://nupecc.org/?display=lrp2024/main> )**
- **Analysis of submitted contributions by TWG**

## Theory/Exp.

TWG Number	TWG	Coordinators	Coord. e-mails	Liaisons	Liaisons e-mails
1	Hadron Physics	Karin Schönning (Uppsala)	<a href="mailto:karin.schonning@physics.uu.se">karin.schonning@physics.uu.se</a>	Diego Bettoni	<a href="mailto:bettoni@fe.infn.it">bettoni@fe.infn.it</a>
		Constantia Alexandrou (CY)	<a href="mailto:c.alexandrou@cyi.ac.cy">c.alexandrou@cyi.ac.cy</a> <a href="mailto:alexand@ucy.ac.cy">alexand@ucy.ac.cy</a>	Dave Ireland	<a href="mailto:david.ireland@glasgow.ac.uk">david.ireland@glasgow.ac.uk</a>
2	Strongly Interacting Matter at Extreme Conditions	Laura Fabbietti (TUM)	<a href="mailto:laura.fabbietti@ph.tum.de">laura.fabbietti@ph.tum.de</a>	Gert Aarts	<a href="mailto:g.aarts@swansea.ac.uk">g.aarts@swansea.ac.uk</a>
		Urs Wiedemann (CERN)	<a href="mailto:Urs.Wiedemann@cern.ch">Urs.Wiedemann@cern.ch</a>	Raimond Snellings	<a href="mailto:R.Snellings@uu.nl">R.Snellings@uu.nl</a>
3	Nuclear Structure and Reaction Dynamics	Silvia Leoni (Univ. Milano)	<a href="mailto:silvia.leoni@mi.infn.it">silvia.leoni@mi.infn.it</a>	Adam Maj	<a href="mailto:adam.maj@ifj.edu.pl">adam.maj@ifj.edu.pl</a>
		Tomas Rodriguez (UCM)	<a href="mailto:tomasrro@ucm.es">tomasrro@ucm.es</a>	Jelena Vesic	<a href="mailto:jelena.vesic@ijs.si">jelena.vesic@ijs.si</a>
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				Patricia Roussel-Chomaz	<a href="mailto:patricia.chomaz@ganil.fr">patricia.chomaz@ganil.fr</a>
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		Charlot Vandevorde (GSI)	<a href="mailto:C.Vandevorde@gsi.de">C.Vandevorde@gsi.de</a>	Vladimir Wagner	<a href="mailto:wagner@ujf.cas.cz">wagner@ujf.cas.cz</a>
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		Jana Guenther (U. Wuppertal)	<a href="mailto:jguenther@uni-wuppertal.de">jguenther@uni-wuppertal.de</a>		
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10	Nuclear Science - People and Society Training, Careers & Diversity Education and Outreach	María García Borge (Madrid)	<a href="mailto:mi.borge@csic.es">mi.borge@csic.es</a>	Rolf-Dietmar Herzberg	<a href="mailto:rdh@liverpool.ac.uk">rdh@liverpool.ac.uk</a>
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Over 200 members of TWGs

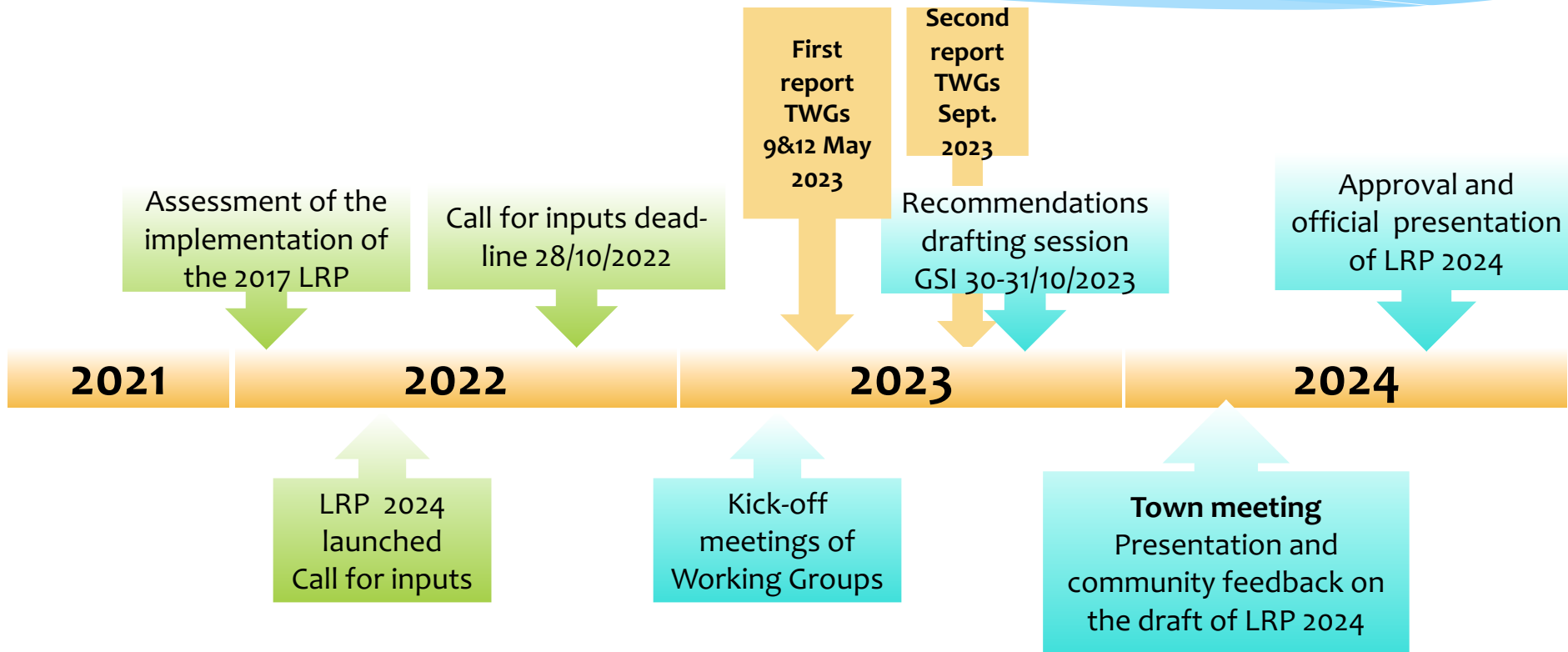


Number	TWG	Coordinators	Liaisons	First meetings
1	Hadron Physics	Karin Schönning (Uppsala)	Diego Bettoni	March 17, 2023
		Constantia Alexandrou (CY)	Dave Ireland	April 23, May 5-8
2	Strongly Interacting Matter at Extreme Conditions	Laura Fabbietti (TUM)	Gert Aarts	March 17, 2023
		Urs Wiedemann (CERN)	Raimond Snellings	April 28, May 9
3	Nuclear Structure and Reaction Dynamics	Silvia Leoni (Univ. Milano)	Adam Maj	Feb. 7, 2023 (informal)
		Tomas Rodriguez(UCM)	Jelena Vesic	April 13-14, 2023 IJCLab Orsay
4	Nuclear Astrophysics	Anu Kankainen (JYFL)	Daniel Bemmerer	March 17, 2023 (Open on-line)
		Jordi Jose (Barcelona)	Sandrine Courtin	June 15-16, Barcelona
5	Symmetries and Fundamental Interactions	Pierre Delahaye (GANIL)	Eberhard Widmann	March 8, 2023 (TWG closed)
		Paolo Crivelli (ETH)	Klaus Kirch	March 24, 2023 CERN; End of May
6	Infrastructures	Wolfram Korten (CEA, Saclay)	Joaquin Gomez-Camacho	March 17, 2023, March 28, 2023 GSI, April 13
			Patricia Roussel-Chomaz	April 17; May 15, June 20
7	Applications and Societal Benefit	Thomas Cocolios (KU Leuven)	Lucia Popescu	Feb. 7, 2023
		Charlot Vandevorode (GSI)	Vladimir Wagner	April 12, 2023; June 21
8	Nuclear Physics Tools Detectors and experimental techniques	Silvia Dalla Torre (INFN)	Eugenio Nappi	April 17-18, 2023 LNF Frascati (Detectors); May 3 June 1
8	Nuclear Physics Tools Computing, Machine Learning and Artificial Intelligence	Valerio Bertone (CEA Saclay)	Hervé Moutarde	June 16, 2023 & Second half of June
		Jana Guenther (U. Wuppertal)		
9	Open Science and Data	Antoine Lemasson (GANIL)	Marek Lewitowicz	March 23rd, 2023 May 17, 2023
10	Nuclear Science - People and Society Training, Careers & Diversity Education and Outreach	María García Borge (Madrid)	Rolf-Dietmar Herzberg	March 23rd, 2023
		Christian Diget (York)	Yvonne Leifels	April 17, 2023

≥ 24 meetings already held

green – past meetings  
blue – planned meetings

See <https://indico.ph.tum.de/category/61/>



## LRP2024 Thematic Working Groups (> 200 members)

- All TWG composition well defined
- 10/10 TWG planned/run first meetings

## LRP2024 Report

- Guidelines for the LRP2024 Report with a template sent on 11 April 2023
- Dead-line for drafts of TWG reports and recommendations: **15 Oct. 2023**