

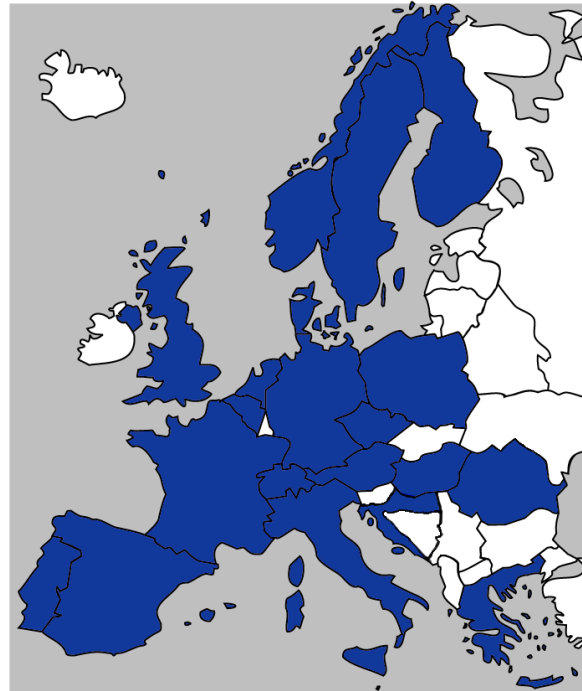


# **News from NuPECC**

**(Nuclear Physics European Collaboration Committee)**

**ANPhA Symposium, November 24-25, 2016, Sendai**

**Gabriele-Elisabeth Körner, Scientific Secretary**



**27 members from 20 countries  
+ 4 institutional members:  
ECT\*, FAIR, SPIRAL2 and JINR  
+ 5 observers (including ANPhA Chair)**

**<http://www.nupecc.org>**



**The mission of NuPECC is to**

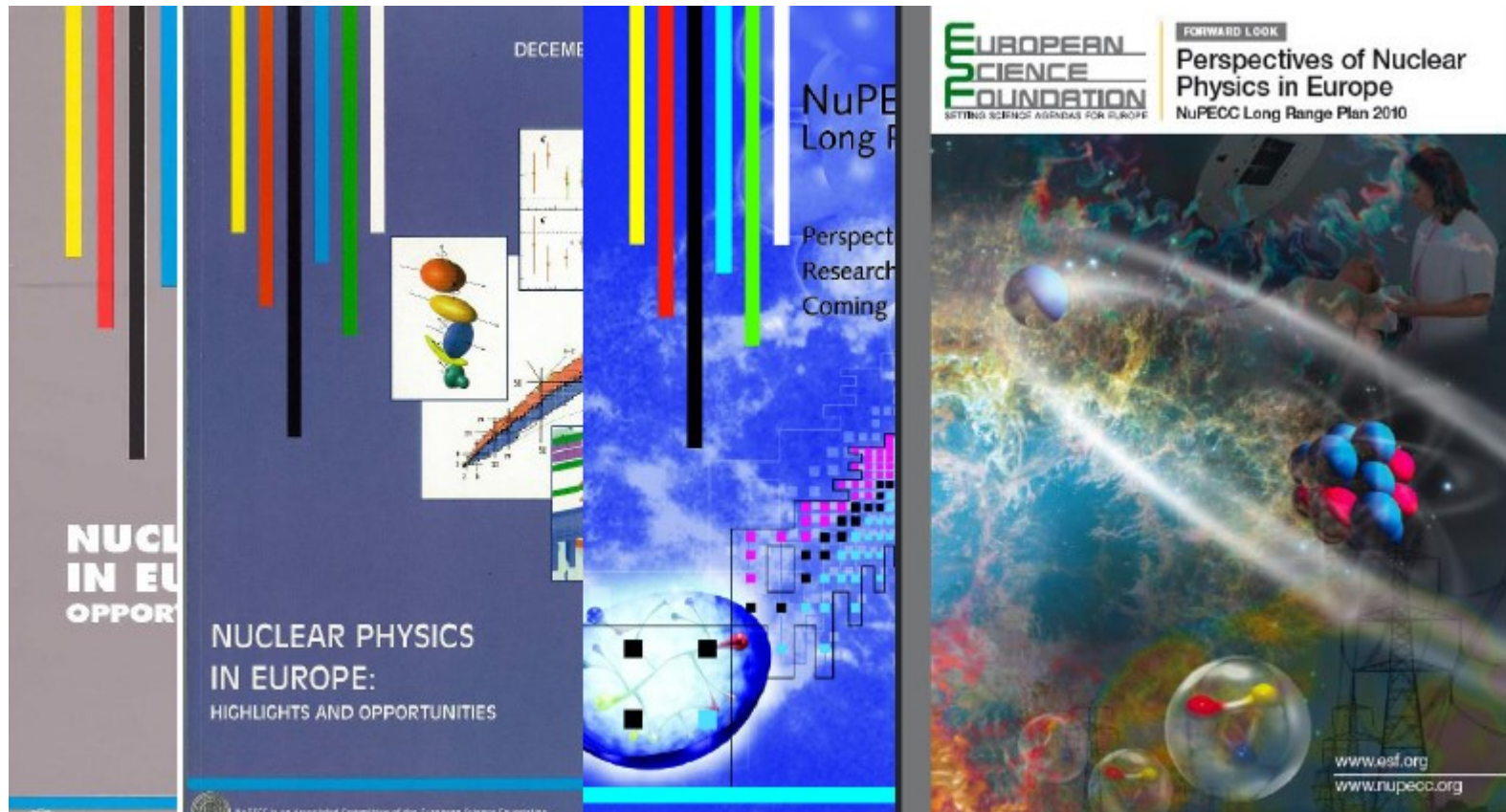
- **define a network of complementary facilities within Europe and encourage optimisation of their usage;**
- **provide a forum for the discussion of the provision of future facilities and instrumentation;**
- **provide advice and make recommendations on the development, organisation, and support of European nuclear research and of particular projects.**



**Nuclear Physics News – 4 times a year - ~ 6400 copies**  
**Editorial Board Members from Japan and China**  
**Laboratory portraits on RIKEN and HIRFL**  
**Next year: Editorial by Dong-Pil Min**



# NuPECC Long Range Plan 1991 – 1997 – 2004 – 2010



## ESFRI

The European Strategy Forum on Research Infrastructures (ESFRI) was established 2002 with a mandate from the EU Council to:

- *support a **coherent and strategy-led approach** to policy-making on research infrastructures in Europe*
- *facilitate multilateral initiatives leading to the better use and development of research infrastructures*

ESFRI brings together representatives of Ministers of the 28 Member States, 12 Associated States, and of the European Commission that are the decision makers and financers of the ESFRI Research Infrastructures

- **Indicates strategies for the necessary major financial investment (~20 b€) and long term commitment for operation (~2 b€/year) (+15% of current effort)**

First Roadmap 2006, updates every 2 years, next one in 2018  
<http://www.esfri.eu/roadmap-2016>

- The Roadmap identifies **new pan-European Research Infrastructures or major up-grades to existing ones**, corresponding to the needs of European research communities in the next 10 to 20 years, in all fields of Research
- The Roadmap also identifies the **ESFRI Landmarks** that are implemented projects leading in their domain and structuring the European and global landscape.

					Agreement, 2012 ERIC under preparation			IBIT
<b>E-ELT</b>	European Extremely Large Telescope	2006	2024*		Programme of ESO	1,000	40	PHYSICAL SCIENCES & ENGINEERING
<b>ELI</b>	Extreme Light Infrastructure	2006	2018*		AI/SBL, 2013 ERIC under preparation	850	90	
<b>EMFL</b>	European Magnetic Field Laboratory	2008	2014		AI/SBL, 2015	170	20	
<b>ESRF UPGRADES</b>	Phase I Phase II: Extremely Brilliant Source	2006 <del>2016</del>	2015 2022*		Programme of ESRF	180 150	82	
<b>European Spallation Source ERIC</b>	European Spallation Source	2006	2025*		ERIC, 2015	1,843	140	
<b>European XFEL</b>	European X-Ray Free-Electron Laser Facility	2006	2017*		GmbH, 2009	1,400	115	
<b>FAIR</b>	Facility for Antiproton and Ion Research	2006	2022*		GmbH, 2010	1,262	234	
<b>HL-LHC</b>	High-Luminosity Large Hadron Collider	<del>2016</del>	2026*		Programme of CERN	1,370	100	
<b>ILL 20/20</b>	Institut Max von Laue-Paul Langevin	2006	2020*		Programme of ILL	171	92	
<b>SKA</b>	Square Kilometre Array	2006	2020*		SKAO, 2011	650	75	
<b>SPIRAL2</b>	Système de Production d'Ions Radioactifs en Ligne de 2e génération	2006	2016		Programme of GANIL	110	5-6	
<b>IFPC GENIE</b>	Construction and Commissioning Control Systems, Plants, Assemblies	2014	2022		Management, Institut européen, 2012	NA	10	

**3 landmarks: ELI-NP, FAIR, SPIRAL2**



# ELI: Extreme Light Infrastructure (distributed facility)

## 3 locations: Prague, Debrecen, Bucharest

### ELI Nuclear Physics in Romania



#### Phase

Structural Funds approved in Sept. 2012  
Start construction June 2013

Projected completion date: end of 2018-  
Fully operation facility +1-2 years

**Building under construction**  
( Completed June 2016)

**Major equipment:**  
two 10PW lasers under construction

**Gamma Beam System under construction**

**1PW achieved ,installation start Nov 2016**  
**Commisioning End of 2018**



#### Budget break-down 2012 – 2017:

Building	66 M€
Staff	34 M€
Scientific equipment	169 M€
Others	24 M€
<b>Total</b>	<b>293 M€</b>

### RA1: High-Power Laser System

RA1/TDR1: Laser Beam Delivery Systems

### RA2: High-Brilliance Gamma Beam

RA2/TDR1: Gamma Beam Delivery and Diagnostics

RA2/TDR2: Positron Production by Gamma Beam

RA2/TDR3: Gamma Beam Industrial Applications

### RA3: Nuclear Physics with High-Power Lasers

RA3/TDR1: Laser-driven Nuclear Physics

RA3/TDR2: High Field QED Experiments

RA3/TDR3: Materials in extreme environments for energy, accelerators and space applications

### RA4: Nuclear Physics and Applications with high-brilliance Gamma Beams

RA4/TDR1: Nuclear Resonance Fluorescence Experiments

RA4/TDR2: Photofission Experiments

RA4/TDR3: Gamma above n threshold

RA4/TDR4: Charged Particles Detection

RA4/TDR5: Radioisotopes production for medical applications

### RA5: Fundamental Physics with combined Laser and Gamma Beams

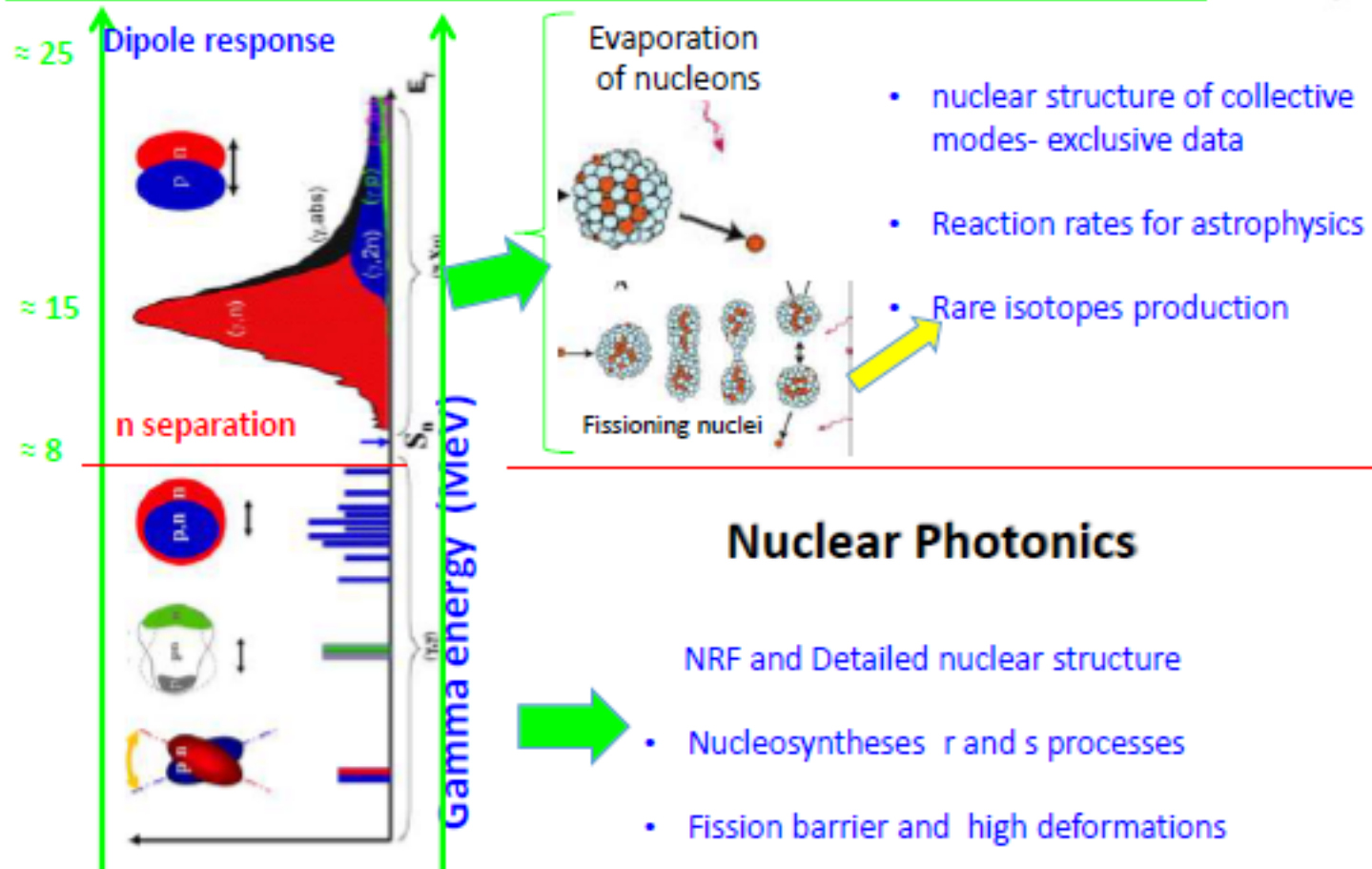
RA5/TDR1: Combined laser and gamma beams experiments

#### *Transversal TDR's*

Monitoring and Control Systems; Safety and Radiation Protection Dosimetry



## Electromagnetic excitation of nuclei by $\gamma$ beams





**ELI-NP building is ready,  
installation of equipment has started**

## Facility for Antiproton & Ion Research

Nuclear Structure & Astrophysics  
(Rare-isotope beams)

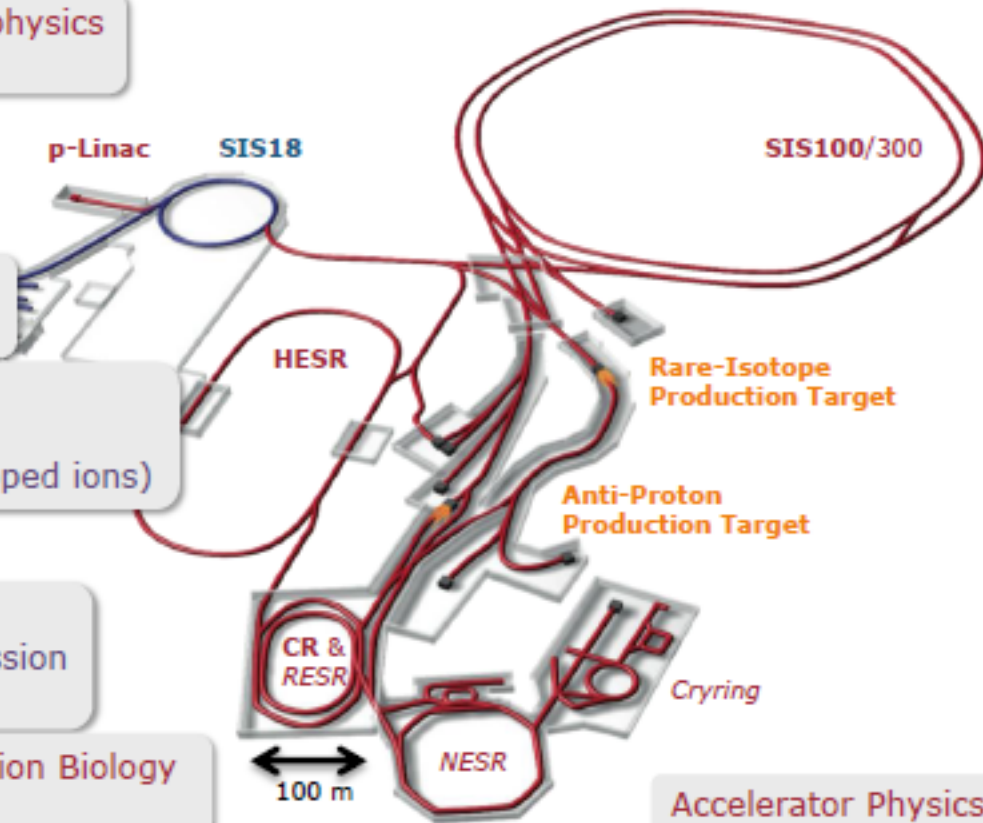
Hadron Physics  
(Stored and cooled  
14 GeV/c anti-protons)

QCD-Phase Diagram  
(HI beams 2 to 45 GeV/u)

Fundamental Symmetries  
& Ultra-High EM Fields  
(Antiprotons & highly stripped ions)

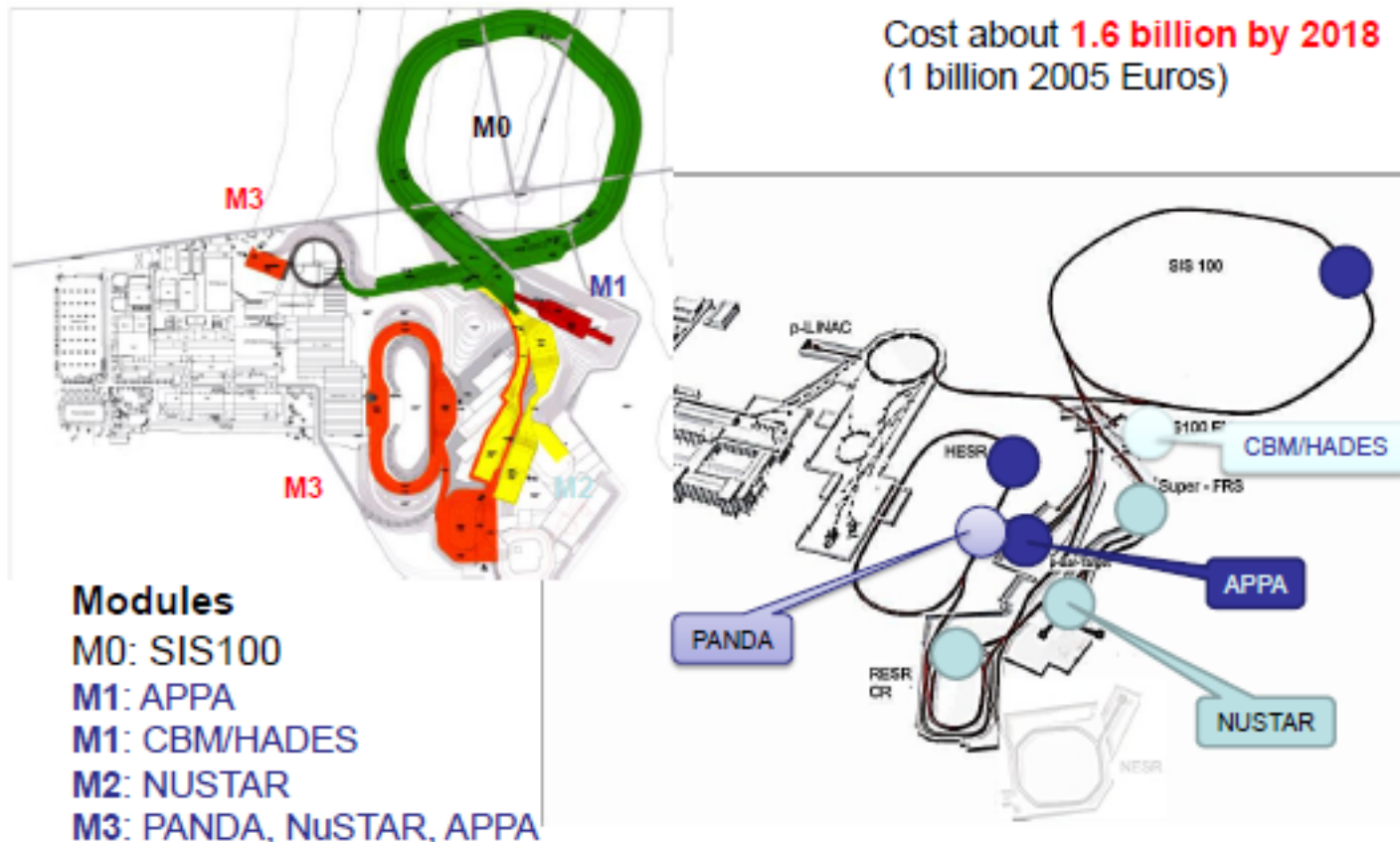
Dense Bulk Plasmas  
(Ion-beam bunch compression  
& petawatt-laser)

Materials Science & Radiation Biology  
(Ion & antiproton beams)



## Modularised Start Version (MSV)

Cost about **1.6 billion by 2018**  
(1 billion 2005 Euros)



## The 4 Scientific Pillars of FAIR

---

**APPA:** Atomic, Plasma Physics and Applications

**CBM:** Compressed Baryonic Matter

**NUSTAR:** Nuclear Structure, Astrophysics and Reactions

**PANDA:** Antiproton Annihilations at Darmstadt

MSV provides for outstanding and world-leading research programmes in all four scientific areas, Biomedicine and Materials Science for in total **2500 - 3000 users**



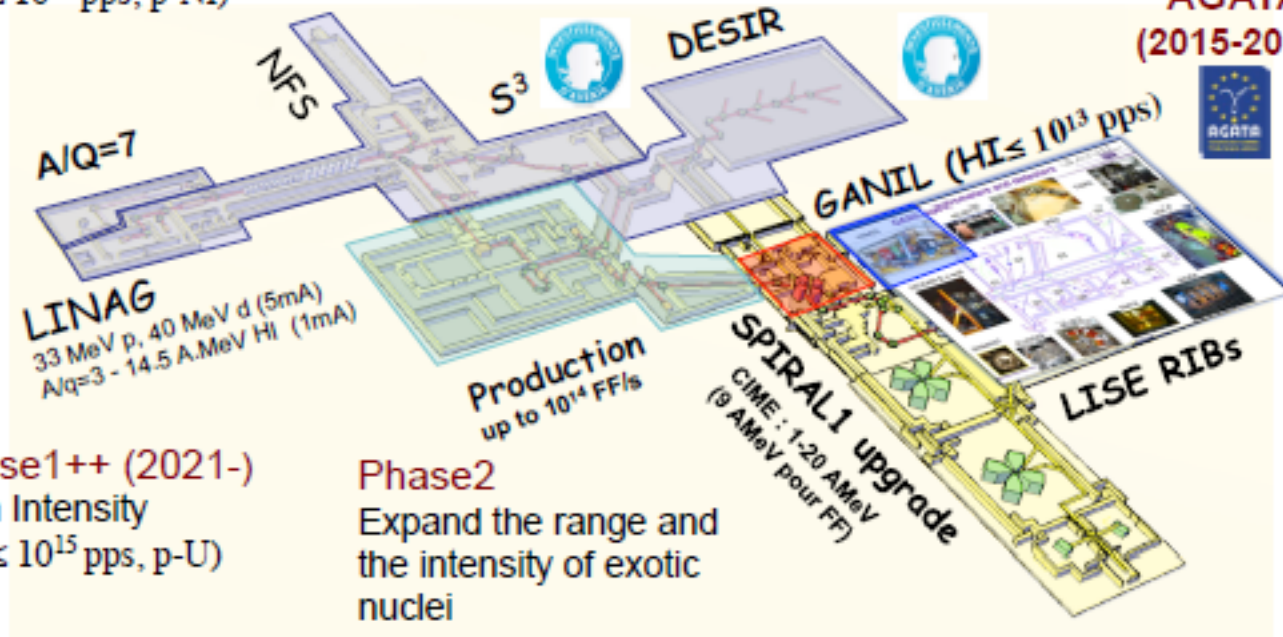
Scientific program is competitive and world class

### Phase1 (2016-)

Increase the intensity of stable beams  
High intense neutron source  
( $HI \leq 10^{15}$  pps, p-Ni)

DESIR Phase1+ (2020-)  
Low energy facility

AGATA  
(2015-2018)



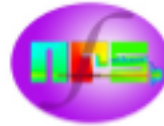
Phase1++ (2021-)  
High Intensity  
( $HI \leq 10^{15}$  pps, p-U)

Phase2  
Expand the range and  
the intensity of exotic  
nuclei

SPIRAL1 Upgrade (2017-)  
New light RIBs from  
beam/target fragmentation

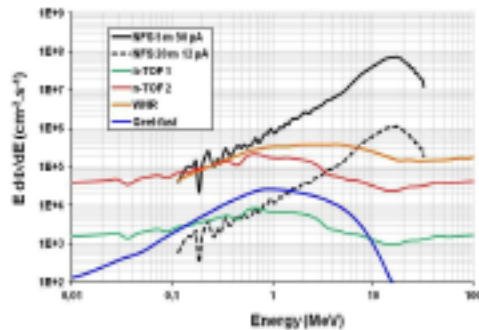


## Neutrons For Science



### NFS Physics case (11 Lols)

- Fission reactors of new generation
- Fusion technology
- Studies related to hybrid reactors (ADS)
- Basic data for evaluated data bases
- Nuclear medicine and biology
- Development of new detectors



### High Intense neutron flux :

$$\Phi > 1,5 \cdot 10^{13} \text{ n/s in } 4\pi$$

Continuous or mono energetic spectra  
Well collimated neutron beam

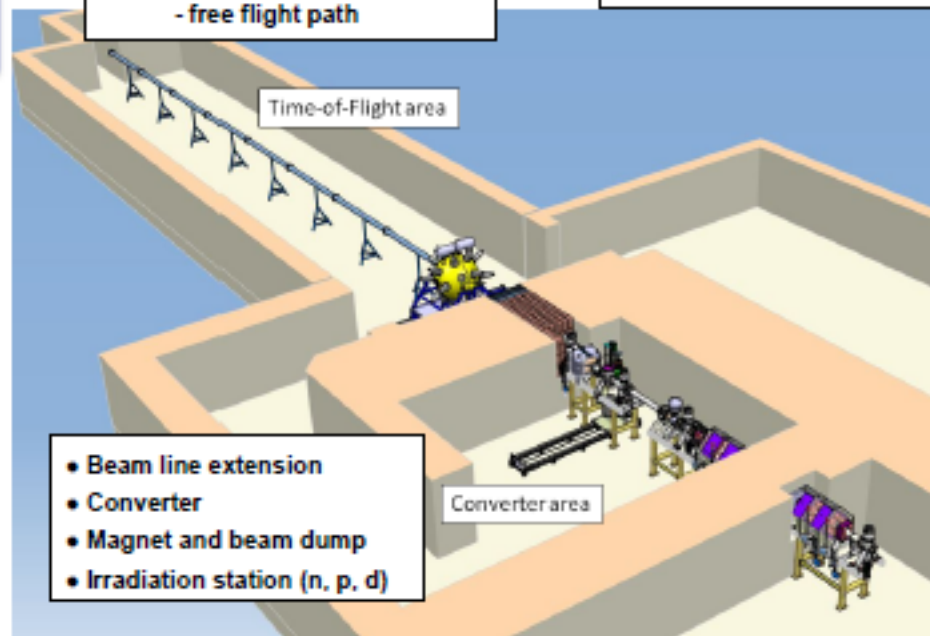
First experiment in 2016

- Beam at  $0^\circ$
- Collimator  $\leftrightarrow$  beam quality
- Size (L x l) = (28m x 6m)
  - TOF measurements
  - free flight path

$$I < 50 \mu\text{A}$$

$$P < 2 \text{ kW}$$

Use of radioactive samples  
A < 1 GBq for thin layers  
A < 10 GBq for thick samples



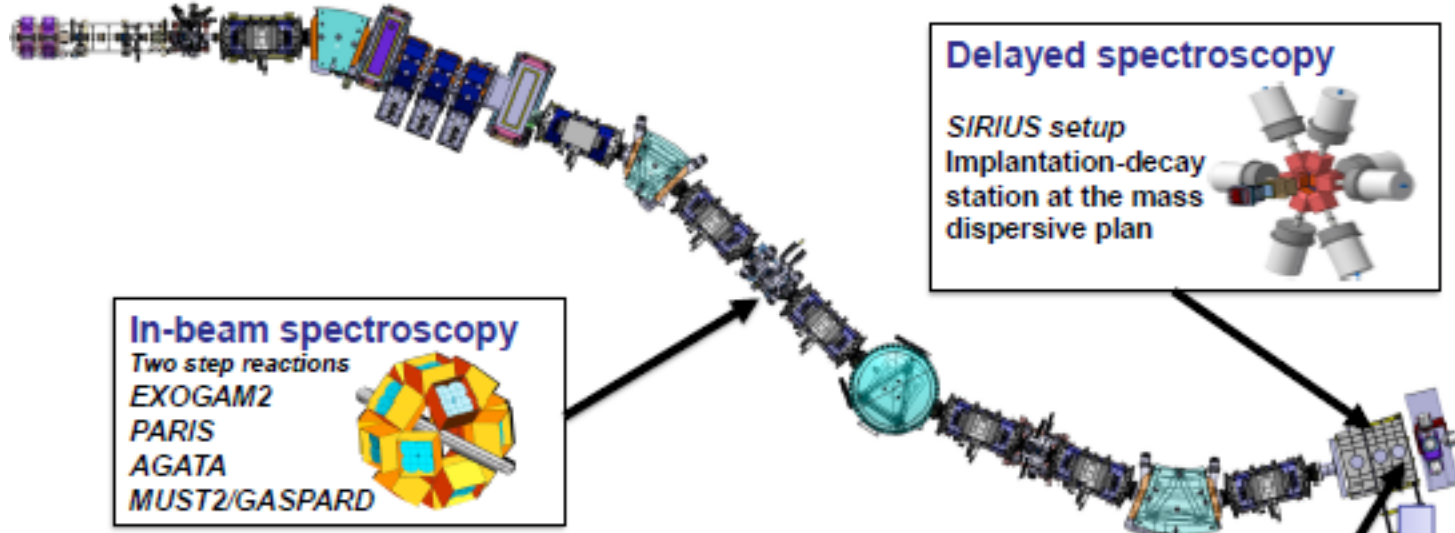
## S3

### High Resolution and High Transmission versatile separator-spectrometer



S3 ready by the of end 2016

- ⊙ Multistep separation
- ⊙ Large acceptance
- ⊙ Mass resolution ( $\Delta M/M=460$ )

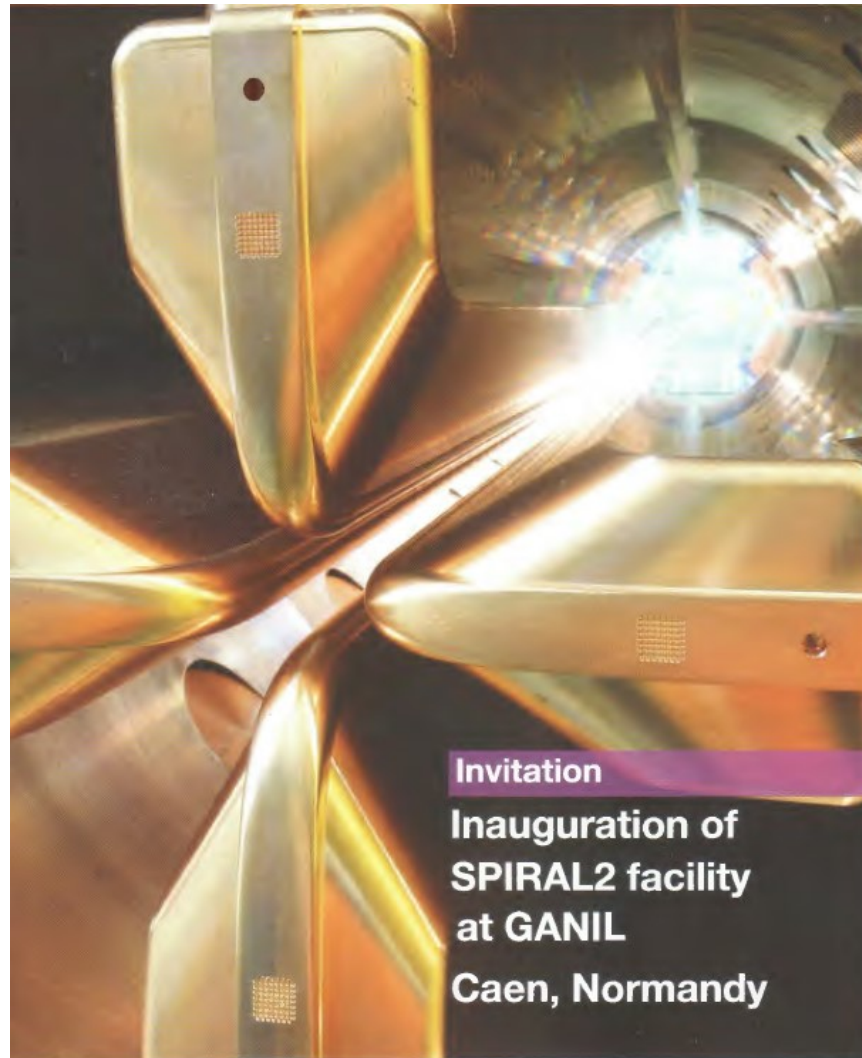


**In-beam spectroscopy**  
 Two step reactions  
 EXOGAM2  
 PARIS  
 AGATA  
 MUST2/GASPARD

**Delayed spectroscopy**  
 SIRIUS setup  
 Implantation-decay station at the mass dispersive plan

**Ground state properties**  
 (mass, size, moments, spins)  
 REGLIS<sup>3</sup> setup  
 Low Energy Branch

DESIR

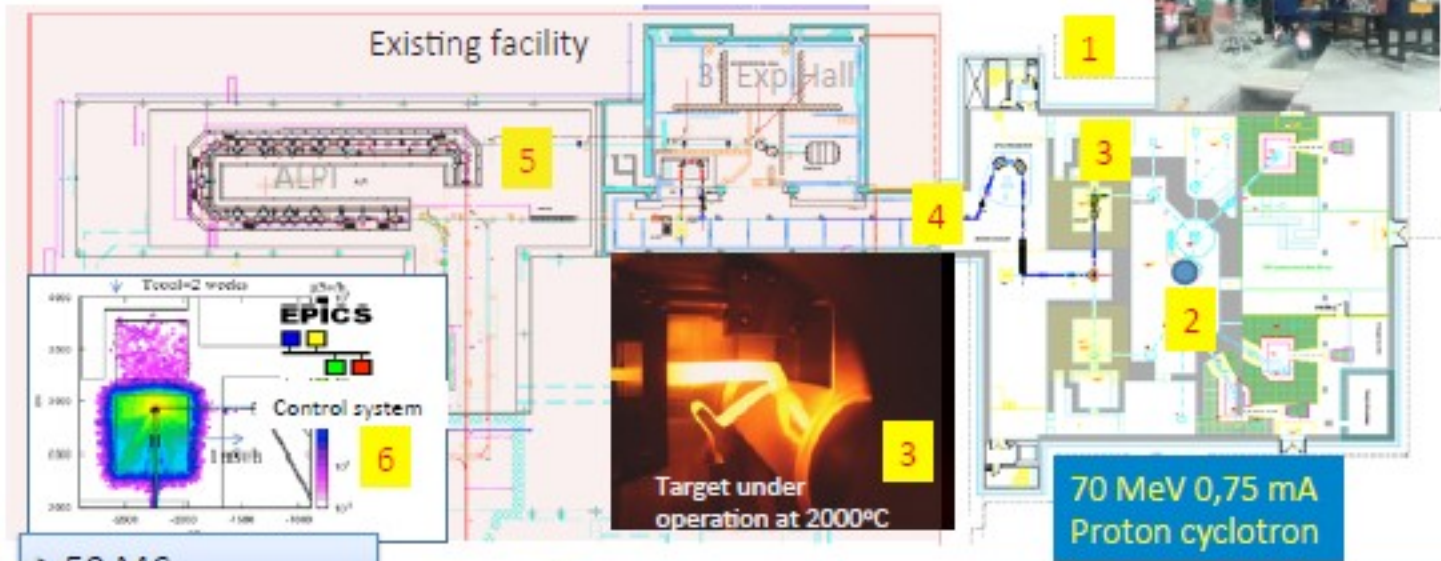


Invitation

Inauguration of  
SPIRAL2 facility  
at GANIL

Caen, Normandy

## SPES Facility at LNL Legnaro



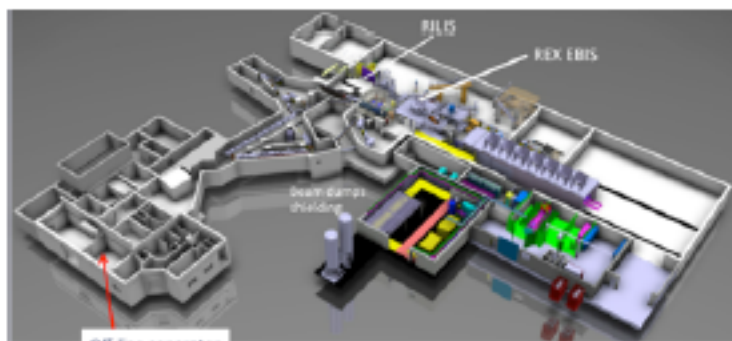
≥ 50 M€,  
first beams by 2019



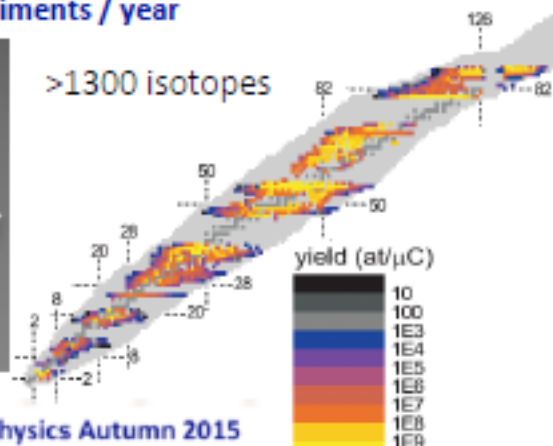
SPES sub-systems	
1	Building and infrastructures <b>with 2 ISOL bunkers for radioactive beam</b> and application area for radioisotopes and neutrons
2	Cyclotron 70 MeV protons with 2 independent exits
3	ISOL UCx target designed for $10^{13}$ f/s - <b>direct production with p</b>
4	Beam transport with <b>High Resolution Mass Separation</b>
5	<b>Reacceleration</b> with ALPI superconductive linac (10A MeV A=130)
6	Radioprotection, safety & controls

# HIE-ISOLDE Facility

- ISOLDE is the CERN radioactive beam facility (approved 50 y ago!)
- Provides low energy or post-accelerated beams
- Run by an **international collaboration** since 1965. Presently 13 members (B, CERN, Dk, E, F, Ge, Gr, I, India, N, R, S, UK)
- **> 500 Users from 100 Institutions, 50 experiments / year**



>1300 isotopes



✓ HIE STAGE 1



Physics Autumn 2015

@ 4.3 MeV/u

Spring 2016 5.5 MeV/A

✓ HIE STAGE 2



2017  
10 MeV/A

Started Jan 2010  
Budget 35 M€

✓ HIE STAGE 3 WITH CHOPPER LINE 2018 (LS2)



## Radiative beams @ 5.5 MeV/u

- HIE-ISOLDE stage 1 with 2 cryomodules producing physics
- First radioactive beams on 9 September 2016  $^{110}\text{Sn}$
- Coulomb excitation of  $^{78}\text{Zn}$ ,  $^{110}\text{Sn}$ ,  $^{132}\text{Sn}$ ,  $^{142}\text{Xe}$

Celebración el 28 de Septiembre de 2016



## EURISOL – Distributed Facility (DF)



**Members Initially:**  
GANIL-SPIRAL2  
HIE-ISOLDE/CERN  
SPES-INFN

**Candidate - future facility:**  
ISOL@MYRRHA

**EURISOL MoU member:**  
COPIN Consortium Poland

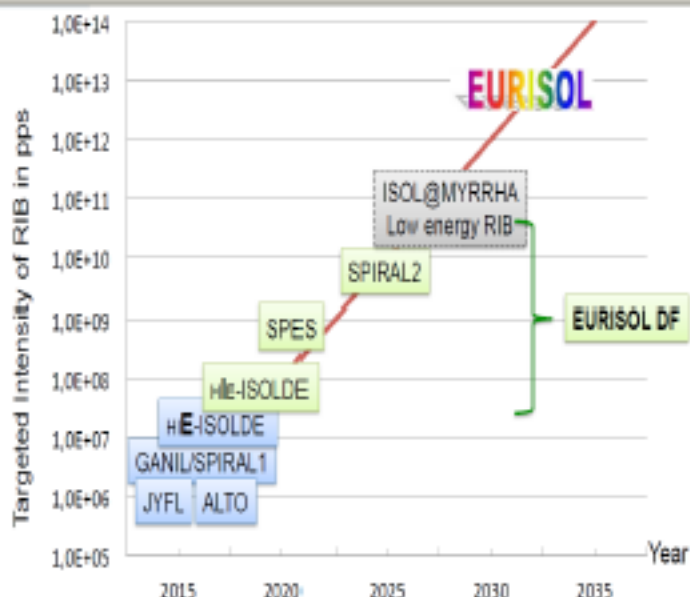
**Smaller scale ISOL facilities:**  
ALTO, JYFL?

Project to be submitted for  
the 2018 update of the  
ESFRI roadmap

## EURISOL Distributed Facility (DF) Initiative

Project to be submitted for the 2018 update of the ESFRI roadmap

EURISOL DF: Intermediate step towards single site project



Complementarities: Instrumentation eg. AGATA, FAZIA, GASPARD, PARIS  
Challenges: High-power targets & sources, purification of RIB

EURISOL DF



- A distributed laboratory for radioactive beams:
- **More exotic beams** available
- Coordination of competences to face EURISOL technologic challenges
- **Joint effort** to manage the activity at European level

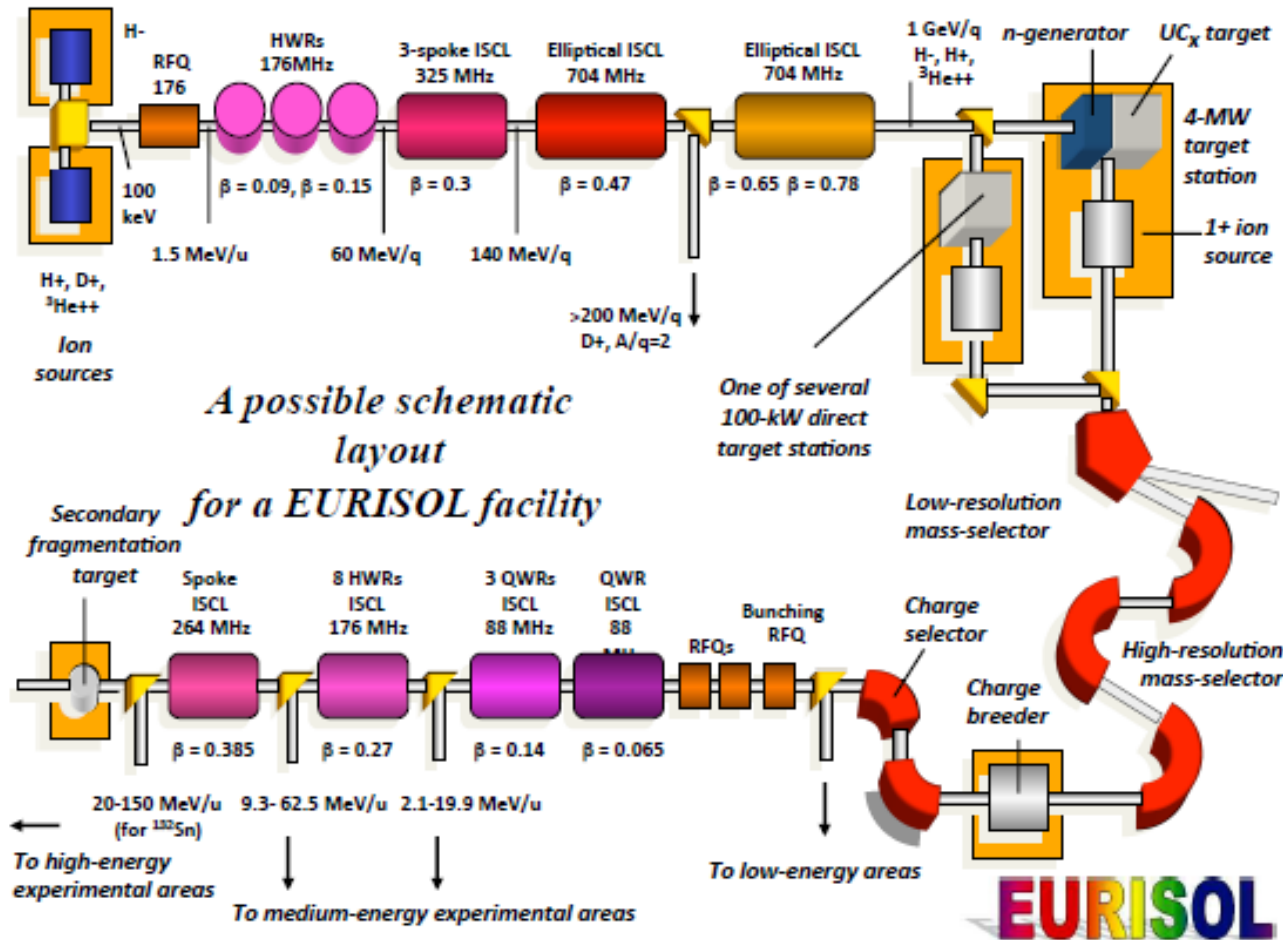


## EURISOL – Distributed Facility (DF) Initiative

EURISOL-DF working groups for the preparation of the ESFRI-list proposal:

- WG1: Science & applications (together with EURISOL User Group?): Coordinator R. Raabe
- WG2: Technical R&D – accelerators: Coordinator A. Facco
- WG3: Technical R&D – beam handling, targets and ion sources: Coordinator M. Borge
- WG4: Technical R&D – spectrometers & detectors: Coordinator H. Savajols
- WG5: EURISOL-DF & relationships with ESFRI & EC and its future legal structure: Coordinator: A. Bracco

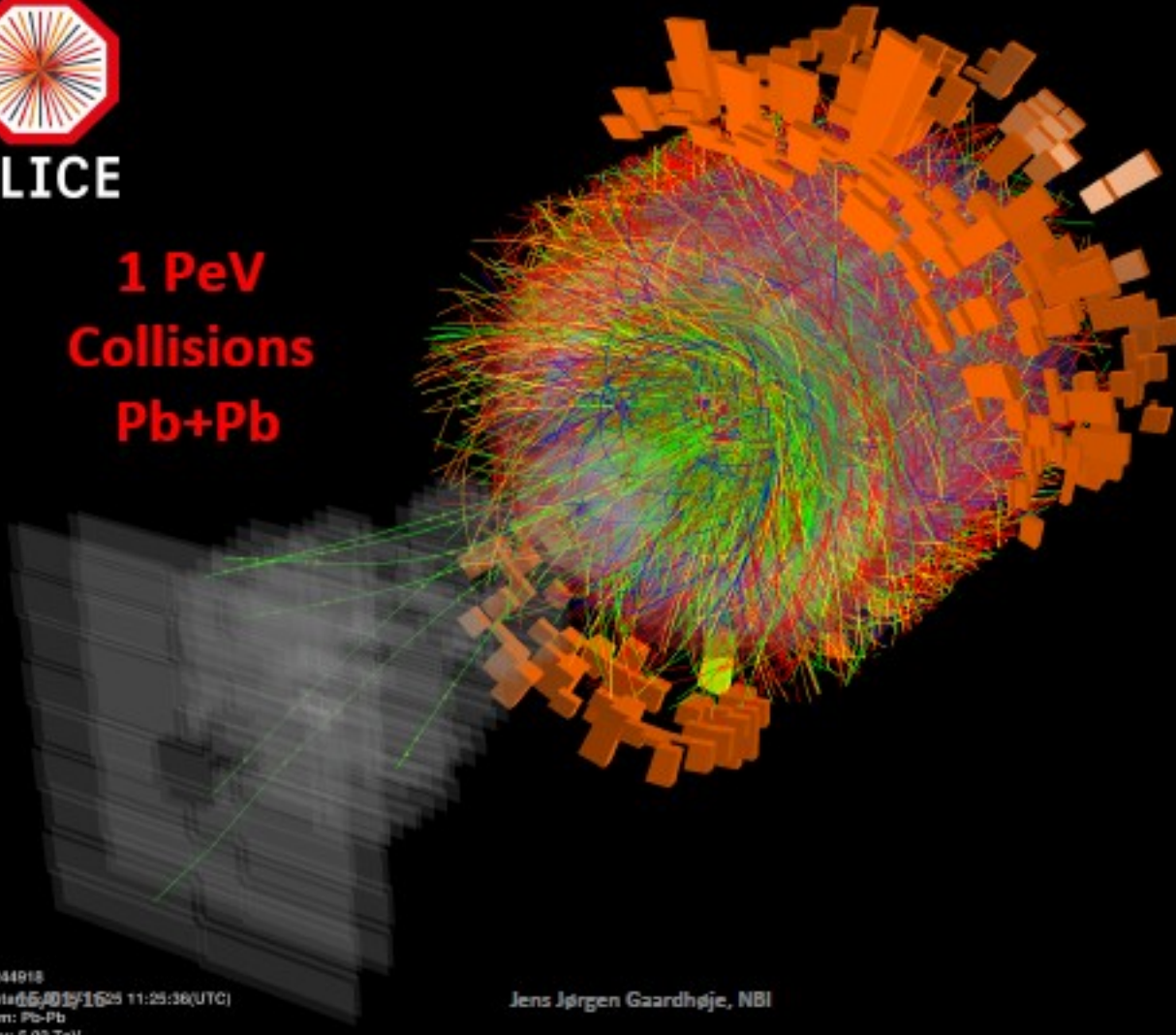
# Long Term Future ...





ALICE

**1 PeV  
Collisions  
Pb+Pb**



Run: 244918  
Timestamp: 2015-05-16 11:25:36(UTC)  
System: Pb-Pb  
Energy: 5.02 TeV

Jens Jørgen Gaardhøje, NBI



## ALICE upgrades (details)

From run3 onwards:

Pb+Pb interaction rate will be 50 KHz (  $L = 6 \cdot 10^{27} \text{ cm}^{-2} \text{ s}^{-1}$  ).

This requires:

- **New TPC RO chamber design (GEM)** instead of gating grid
- **New high resolution Si Inner Tracker.**
- **Continuous read out** of most detectors
- Increased data compression, online pattern recognition
- Improved DAQ, Trigger detectors (FIT) etc...
- Improved calorimetry

Physics Focus will be on rare probes.

## Long Term Schedule: ALICE will run *at least* until LS4



**PHASE I Upgrade**  
 ALICE, LHCb major upgrade  
 ATLAS, CMS, "minor" upgrade

Heavy Ion Luminosity from  
 $10^{27}$  to  $7 \times 10^{27} \text{ cm}^{-2} \text{ s}^{-1}$



**Upgraded ALICE will run at least to 2029**

**PHASE II Upgrade**  
 ATLAS, CMS major upgrade

**HL-LHC, pp luminosity**  
 from  $10^{34}$  (peak) to  $5 \times 10^{34}$  (levelled)



## **NuPECC Long Range Plan 2016/2017**

- **General Introduction including Education, Theory, Computing, Data Evaluation ...**
- **Facilities and Instrumentation**
- **Summary and Recommendations**
- **Reports from 6 Working Groups**
  - **Hadron Physics**
  - **Properties of Strong-Interaction Matter**
  - **Nuclear Structure and Reaction Dynamics**
  - **Nuclear Astrophysics**
  - **Symmetries and Fundamental Interactions**
  - **Applications and Societal Benefits**



# **WG1: Hadron Physics**

## **Diego Bettoni, Hartmut Wittig**

- \* **Introduction** (DB+HW)
- \* **Theoretical framework** (Nora Brambilla)
- \* **Experimental Methods** (DB, Dave Ireland, Andrea Bressan)
- \* **Hadron Spectroscopy** (Dave Ireland)
- \* **Hadron Structure** (Nicole D'Hose, Andrea Bressan, Carlos Munoz)
- \* **Hadronic Interactions** (Andrzej Kupcs)
- \* **Lattice QCD** (HW)
- \* **Physics Perspectives** (DB+HW)
- \* **Recommendations** (DB+HW)



## **WG2: Properties of Strong-Interaction Matter**

**Silvia Masciocchi, François Gélis**

1. Introduction: Fundamental properties of strongly interacting matter
2. High temperature matter
3. High density matter
4. Facilities, computing, and instrumentation
5. Recommendations





## **WG3: Nuclear Structure and Reaction Dynamics**

### **John Simpson, Elias Khan**

- 1. Theory (Christian Forssen and Achim Schwenk)**  
Forssen, Gargano, Mora, Schwenk
- 2. Nuclear structure (Alexandre Obertelli)**  
Bruce, Gargano, Dullman, Dombradi, Fornal, Forssen, Guttormsen  
Greenlees, Grevy, Jungclaus, Karpov, Kalantar, Leoni, Moro, Raabe,  
Rejmund, Obertelli, Pietralla, Riisager, Schwenk, Scheidenberger, Ur
- 3. Reaction Dynamics (Antonio Moro)**  
Karpov, Moro, Szilner, Ur
- 4. The Nuclear Equation of State (Giuseppe Verde)**  
Forssen, Guttormsen, Leoni, Kalantar, Schwenk, Ur, Verdi
- 5. Facilities and instrumentation (Stéphane Grevy)**  
Grevy, Kalandar, Leoni, Riisager, Scheidenberger, Szilner, Ur, Verde



## **WG4: Nuclear Astrophysics**

### **Gabriel Martinez Pinedo, Alison Laird**

- Nuclear Theory for Nuclear Astrophysics (Matthias Hempel, Nils Paar, Stefan Typel)
- Stable, gamma and neutrons beams (Gyürky György, Rene Reifarth, Nicolas de Seréville)
- Radioactive beams (Beyhan Bastin, Cesar Domingo Pardo, Anu Kankainen)
- Observations and data for Nuclear Astrophysics (Roland Diehl, Peter Hoppe, Cristina Chiappini)
- Astrophysical modelling (Andreas Bauswein, Raphael Hirschi, Samuel Jones, Friedrich Röpke)



## **WG5: Symmetries and Fundamental Interaction**

**Klaus Kirch, Klaus Blaum**

- 1. Introduction**
- 2. SM Parameters**
- 3. Searches beyond the SM**
- 4. Future Directions**
- 5. Recommendations**



# **WG6: Applications and Societal Benefits**

## **Marco Durante, Alain Letourneau**

### Introduction

#### 1. Energy applications

- 1.1 Next generation fission reactors
- 1.2 Accelerator driven sub-critical systems
- 1.3 Fusion reactors
- 1.4 Nuclear power sources for space applications
- 1.5 Future perspectives and recommendations

#### 2. Health applications

- 2.1 Particle therapy
- 2.2 Imaging
- 2.3 Radioisotope production
- 2.4 Radioprotection

#### 3. Environmental and Space applications

- 3.1 Climate and earth science
- 3.2 Environmental radioactivity
- 3.3 Space radiation

#### 4. Societal applications

- 4.1 Heritage Science
- 4.2 Nuclear security and counter terrorism

#### 5. Cross-disciplinary impact in other domains

- 5.1 Material sciences
- 5.2 Atomic and Plasma physics

#### 6. Summary and recommendations



Town Meeting  
Darmstadt  
January 11-13, 2017

<http://indico.gsi.de/conferenceDisplay.py?confId=5177>



Suchen




# NuPECC Long Range Plan 2017, Town Meeting


11-13 January 2017  
darmstadtium


Europe/Berlin timezone


- Overview
  - Preliminary Program (pdf)
  - Registration
    - Registration Form
  - List of registrants
  - Venue and Travel information
  - Accommodation
- 
- Support
    - [sissy.koerner@ph.tum.de](mailto:sissy.koerner@ph.tum.de)

The purpose of this meeting is to provide a forum for the whole community, where the NuPECC Long Range Plan 2017 will be presented, discussed and finalised.

 Starts Jan 11, 2017 08:00  
Ends Jan 13, 2017 12:00  
Europe/Berlin

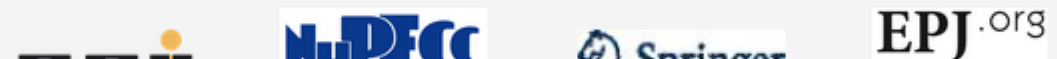
 darmstadtium  
europium 3  
Schlossgraben 1  
64283 Darmstadt  
Germany

 [Programme](#)

 Organizing Committee:  
Angela Bracco  
Gabriele-Elisabeth Körner

Local Organizing Committee:  
Karlheinz Langanke  
Karin Füssel  
Klaus-Dieter Groß  
Sandra Schecker  
Sabine Shaw

This meeting is sponsored by:





NuPECC LRP2017 Town Meeting, Darmstadt January 11-13, 2017

**Preliminary Programme**

Wednesday, January 11, 2017	Thursday, January 12, 2017	Friday, January 13, 2017
8:00-8:45 Registration		
8:45-9:00 Welcome	9:00-9:45 WG3: Nuclear Structure & Reaction Dynamics	9:00-10:45 NSAC ANPhA CERN
9:00-9:30 Outline LRP2017 <i>Angela Bracco</i>	9:45-10:30 Discussion WG3	
10:45-11:15 Coffee Break	10:30-11:00 Coffee Break	10:45-11:15 Coffee Break
11:15-13:00 Future Large-Scale Facilities <i>FAIR:</i> <i>EURISOL-DF</i> - <i>Spiral2:</i> - <i>HIE-ISOLDE:</i> - <i>SPES:</i> <i>ELI-NP:</i>	11:00-11:45 WG4: Nuclear Astrophysics	11:15-11:30 Introduction to Panel Discussion <i>Angela Bracco</i>
	11:45-12:30 Discussion WG4	11:30-12:30 Panel discussion of overall recommendations, priorities & roadmap <i>LRP2017 Steering Committee</i>
12:30-12:45 Farewell		
13:00-14:30 Lunch	12:30-14:00 Lunch	
14:30-15:15 WG1: Hadron Physics	14:00-14:45 WG5: Symmetries & Fundamental Interaction	
15:15-16:00 Discussion WG1	14:45-15:30 Discussion WG5	



**Thanks to Angela Bracco, Jens Jørgen Gaardhøje,  
Sydney Galès, Marek Lewitowicz,  
Gianfranco Prete, Giorgio Rossi,  
Boris Sharkov for providing input**



**Thank you for your attention!**