Recent developments in Europe: new facilities and new funding bids

Brian Fulton
Chair of NuPECC
(University of York)

NuPECC – what it is and how it operates
Recent developments
Pointers towards the future

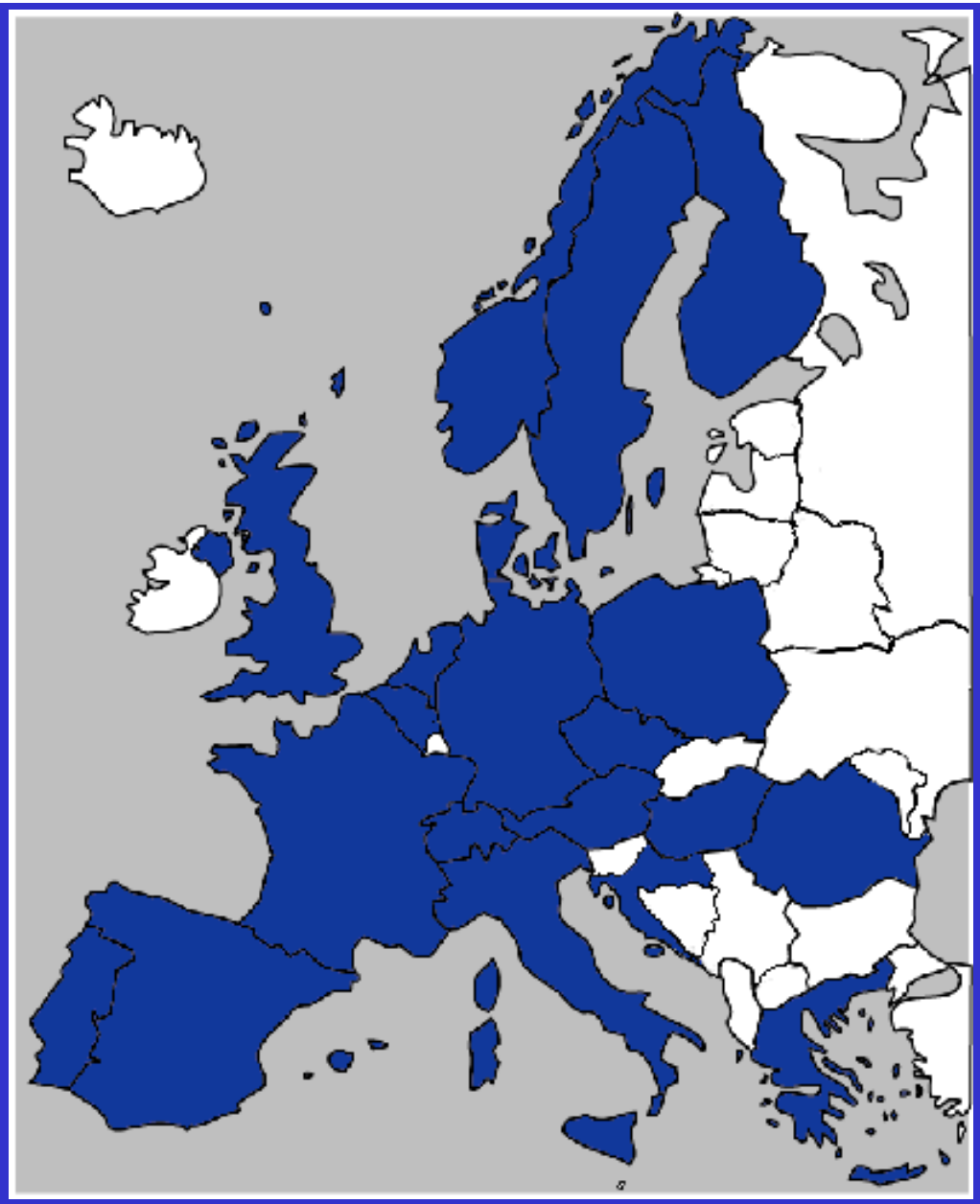
What NuPECC is (and is not)

NuPECC (Nuclear Physics European Collaboration Committee) is an Expert Committee of the European Science Foundation

It is funded by subscribing national funding agencies who nominate expert scientists as representatives (usual period is three years)

The objective of NuPECC is:

"To strengthen European collaboration in nuclear science through the promotion of nuclear physics and its trans-disciplinary use and application in collaborative ventures between research groups within Europe and particularly those from countries linked to the ESF"



Currently 28 members from 20 countries.

NuPECC is **NOT**

A body which dictates national policies – although national funding agencies take account of NuPECC recommendations

A body which dictates European policy – although it acts closely with the European Commission

A body which reacts to specific charges – NuPECC decides on its own agenda and actions

NuPECC strives to maintain its independence and to maintain the trust of the community it serves

How NuPECC operates

The committee (28 members) meets three times each year.

Meetings are hosted in turn by each country and start with a half day presentation on nuclear science activities in that country (this enables NuPECC members to keep up to date with developments)

A chair is elected to serve for three years

A scientific secretary (Sissy Koerner) looks after the administration and maintains the website (http://www.nupecc.org)

Working groups are established as required, e.g. for

Preparing reports (see later)
Meeting with other organisations

Community "Town Meetings" are organised when issues of particular importance are being considered (e.g. Forward Looks)

The chair, or nominated member, represents NuPECC on various related bodies (e.g. Governing Boards of ECT* and I3HP, NSAC, ESFRI, IUPAP, ECFA etc.)

NuPECC reports + publications

For full list see the website http://www.nupecc.org

Nuclear Physics News — Four issues per Year

Regular journal with a circulation of 6,000 throughout Europe, North America and Japan.

Long Range Plans — Approximately 5 year intervals

Come back to this later

Hand book for facility access — Every 3-4 years

A full listing of all accelerator facilities in Europe with details of beams, experimental facilities, PAC arrangements and contact details. Also the contact details for all nuclear physics groups in European labs, institutes and universities

Topical Reports — As opportunities arise

Radioactive Beam Facilities (2000)
Computational Nuclear Physics (2000)
ELFE Physics Motivations (2001)
Impact, Applications, Interactions of Nuclear Science (2002)
High Intensity Stable Beam Physics (2007)

Personnel Survey

A survey of the resources (personnel and finance) by country and by sub-area. First report 1997 and a revision in 2007.

Brochures

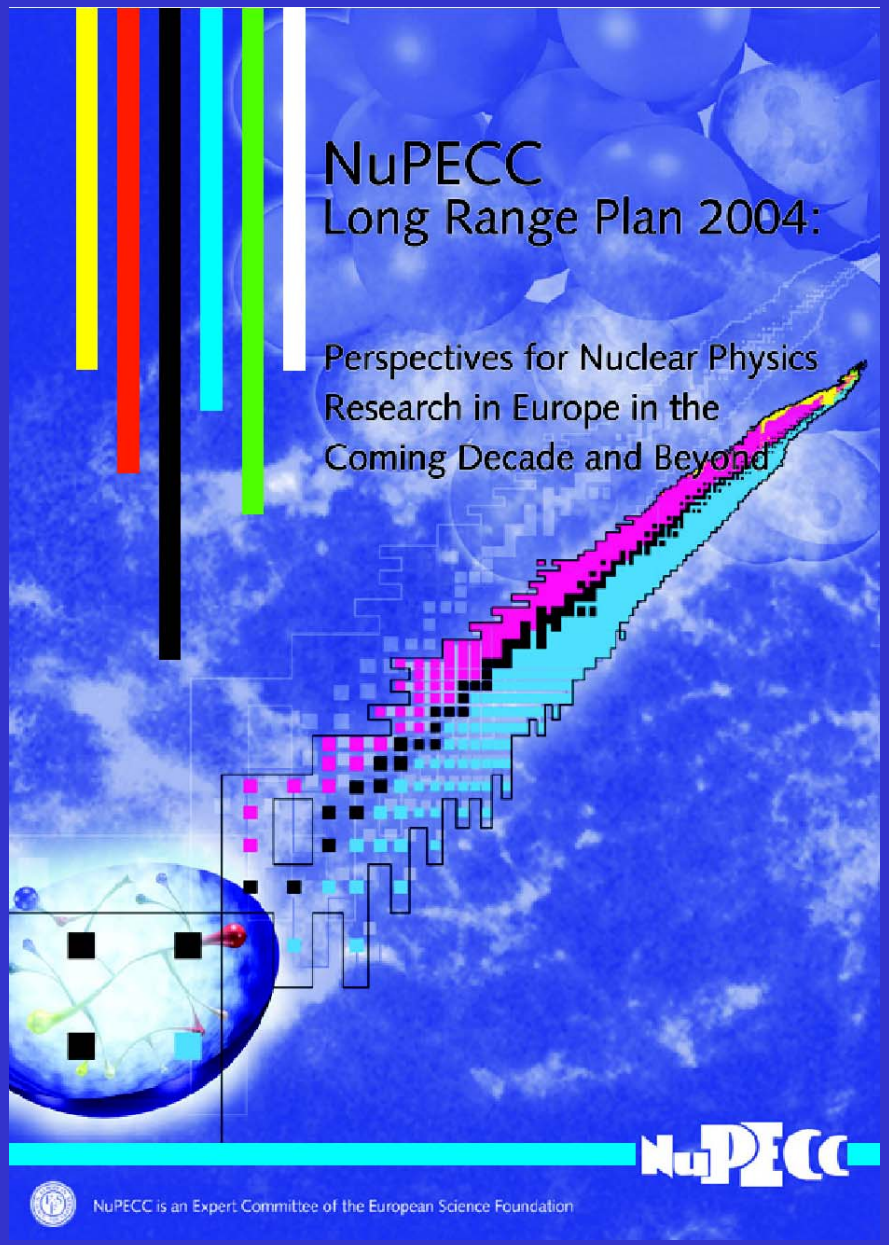
For the non-specialist

Radioactive Beams (2000)
Nature at the Femtoscale (joint with FINUPHY) (2003)

Outreach activities

PANS (Public Awareness of Nuclear Science)
http://www.nupeec.org/pans
NUPEX (Nuclear Physics Experience)
http://www.nupex.org

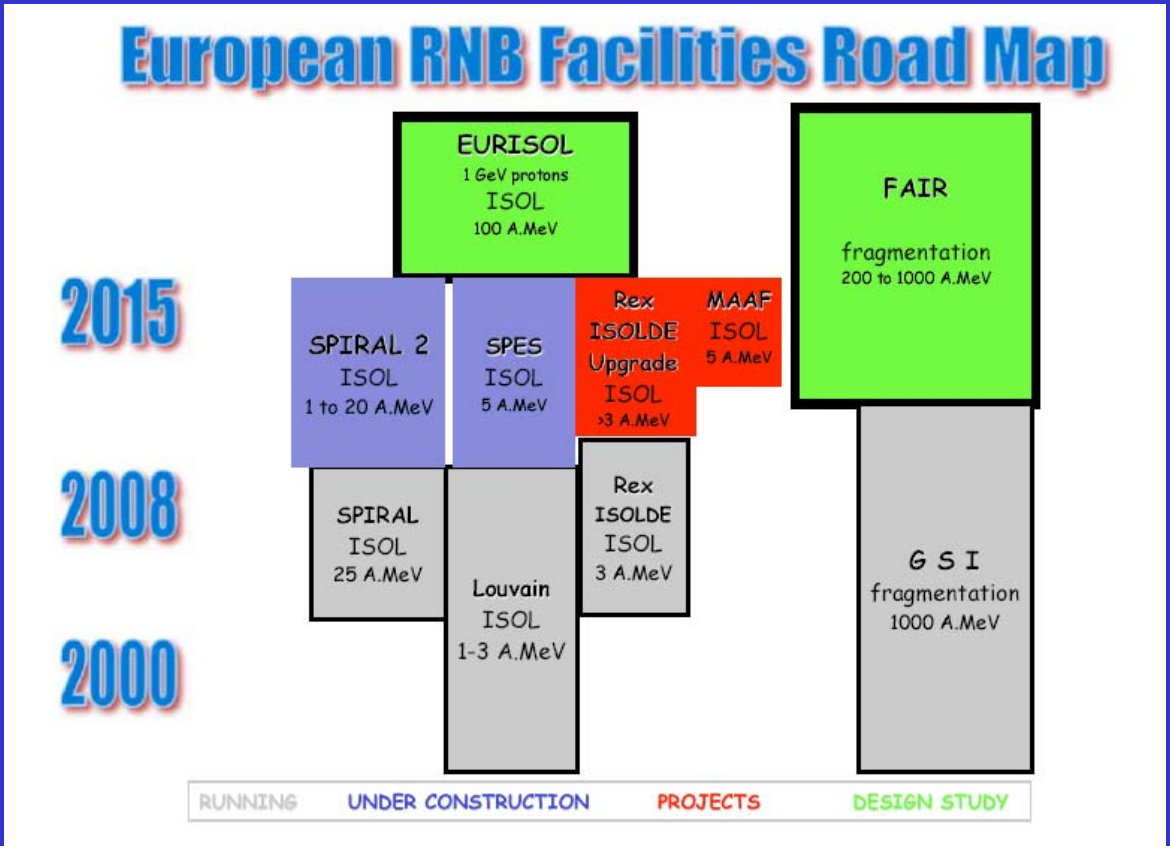
Long Range Plan (2004)



Copies available from
Sissy Koerner or download
(http://www.nupecc.org)

Recommendations from the LRP relevant to new facility construction

NuPECC's vision, first articulated in the "Working Group on Radioactive Beam Facilities (2000)" is for two flagship RBF facilities in Europe, based on the complimentary approaches of ISOL and Fragmentation production. For the last six years, European physicists have been working to realise this goal



The ESFRI process and new European facilities

ESFRI is the European Strategic Forum for Research Infrastructures

It was established in 2005 by the European Commission, with the support of EUROHORCs (EUROpean Heads Of Research Councils)

Its role is to advise the Commission on what large scale research infrastructures are needed in Europe, in particular which might be funded under the next Framework Programme (funding cycle)

(a "Roadmap")

The ESFRI working group on nuclear physics approached NuPECC for input on the most important RI projects in nuclear physics

The ESFRI Roadmap identifies 35 large scale facilities for construction of which 2 are for NP

FAIR (GSI in Germany)
SPIRAL-2 (GANIL in France)

Both have funding approved by the national governments and both have been approved for pre-funding in FP7 (~ € 10M)

PART 2 Recent Developments

Reports
- Stable Beam Physics
- Personnel survey
- Survey of small facilities

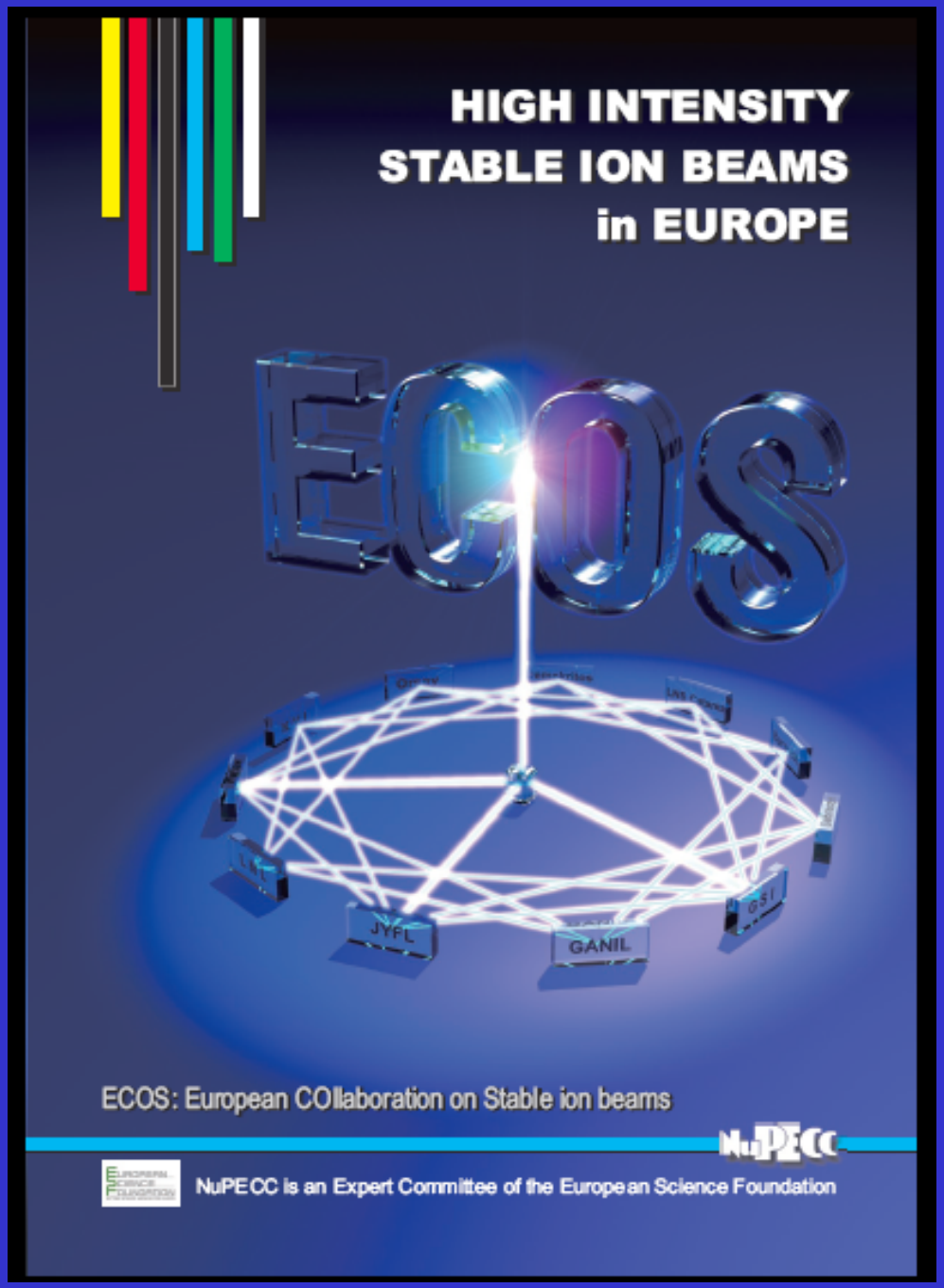
Mass evaluations

NuPNET – coordinating funding agencies

New facilities
- FAIR
- SPIRAL-2

New EU funding bids
- Nuclear Physics
- Hadron Physics

Stable Beam Physics



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(http://www.nupecc.org)

Science case
High intensity sources
High power accelerators
High power targets
High speed data recording

Personnel survey

NuPECC Survey 2006

on Resources in

Nuclear Physics Research

in NuPECC Member Countries

NuPECC is an Expert Committee of the European Science Foundation

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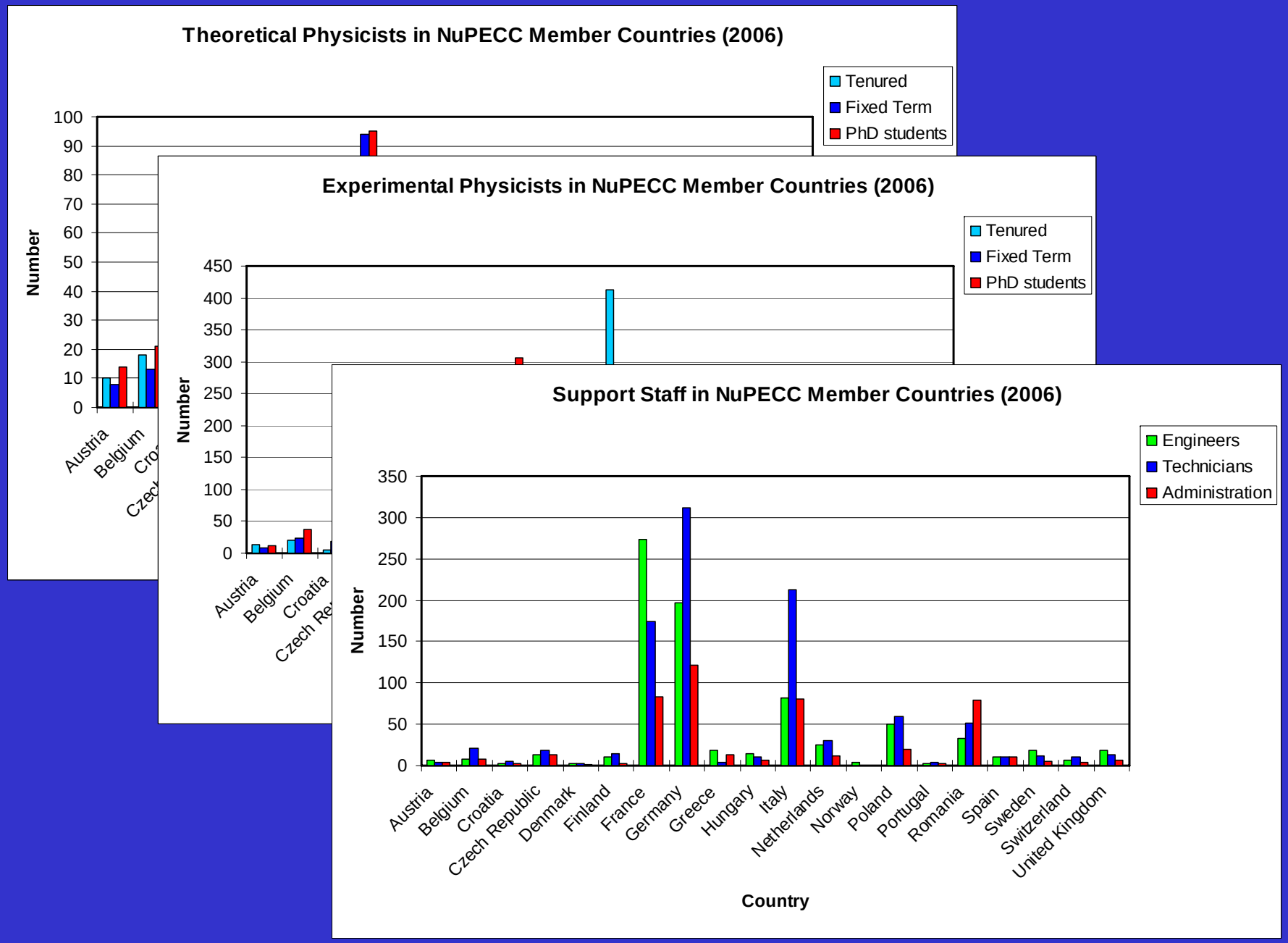
Copies available from
Sissy Koerner or download
(http://www.nupecc.org)

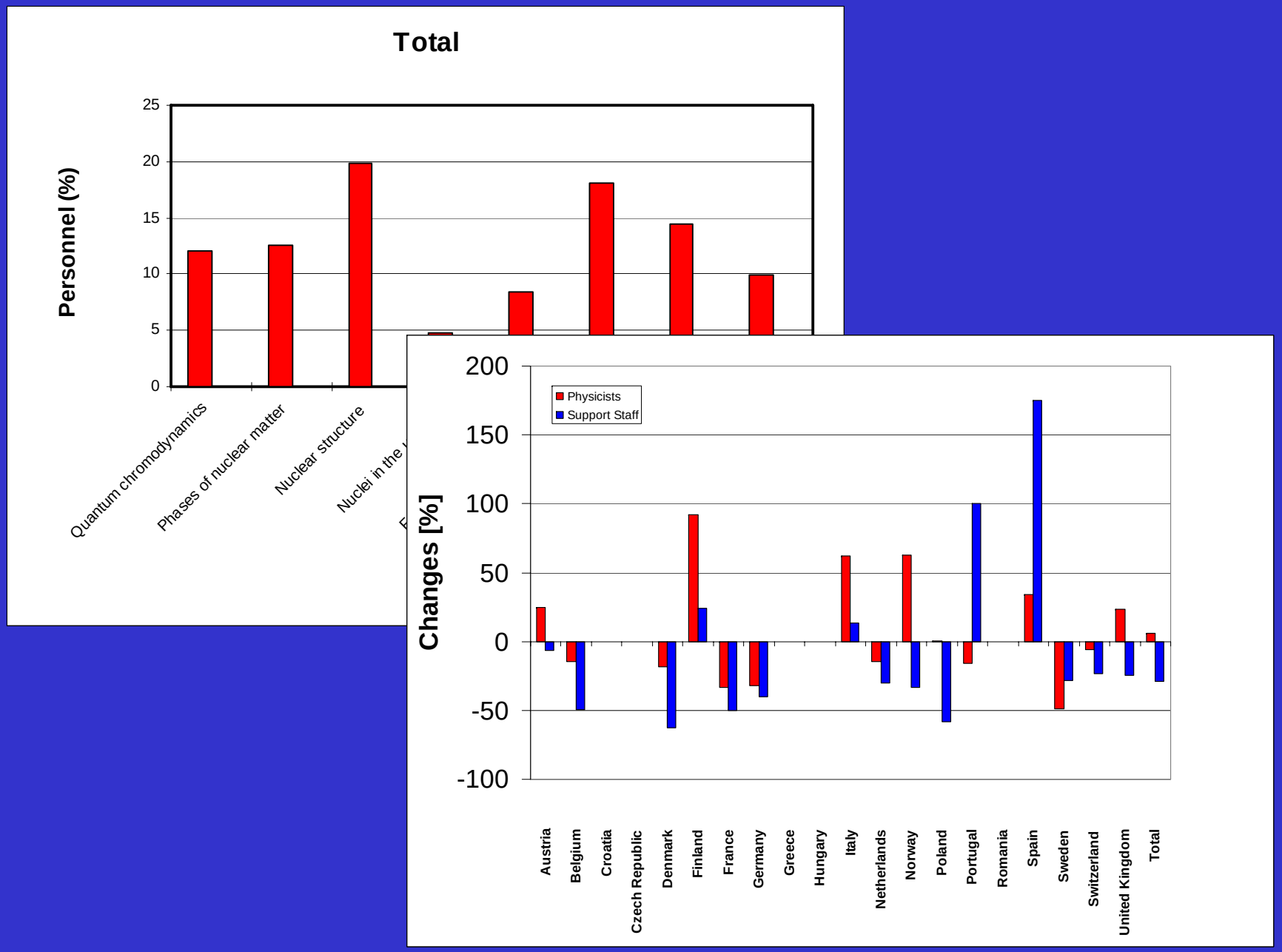
Numbers by country:

- Permanent
- Temporary
- Student
- Support
- Theory/Experiment

Split between sub-fields

Change over last decade


Theoretical Physicists in NuPECC Member Countries (2006)
Tenured
Fixed Term
PhD students
Number
100
90
80
70
60
50
40
30
20
10
0
Austria
Belgium
Experimental Physicists in NuPECC Member Countries (2006)
Tenured
Fixed Term
PhD students
Number
450
400
350
300
250
200
150
100
50
0
Austria
Belgium
Croatia
Support Staff in NuPECC Member Countries (2006)
Engineers
Technicians
Administration
Number
350
300
250
200
150
100
50
0
Austria
Belgium
Croatia
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Italy
Netherlands
Norway
Poland
Portugal
Romania
Spain
Sweden
Switzerland
United Kingdom
Country


Total
Personnel (%)
25
20
15
10
5
0
Quantum chromodynamics
Phases of nuclear matter
Nuclear structure
Physicists
Support Staff
Changes [%]
200
150
100
50
0
-50
-100
Austria
Belgium
Croatia
Czech Republic
Denmark
Finland
France
Germany
Greece
Hungary
Italy
Netherlands
Norway
Poland
Portugal
Romania
Spain
Sweden
Switzerland
United Kingdom
Total

Survey of small facilities

Survey of small scale facilities and networking of applications (report on NuPECC website)

Belgium:	1	IKS KU Leuven
Croatia	2	Rudjer Boskovic Institute Zagreb
Czech Republic:	2	Nucl. Phys. Inst. Acad. Sci. Rez
Germany	6	RUBION Bochum, HISKP Uni. Bonn, IKP Technische Univ. Köln, Univ. Darmstadt, MLL Garching, IKP II.Physik Univ. Göttingen
Greece	1	Demokritos Athens
France:	2	IPN Orsay and CEN Bordeaux
Hungary:	2	Inst. Nucl. Research Debrecen
Italy:	3	LNS Catania, LNGS Assergi, LABEC Firenze
Norvegia:	1	SAFE Oslo
Poland:	2	INP Cracow and HIL Warsaw Univ.
Portugal	1	ITN Lisbon
Romania:	1	CRAI Bucharest
Spain:	2	CNAM Madrid and CNA Seville
Switzerland	1	ETH Zürich
TOTAL	**27**	

Mass evaluations

Mass Evaluations

Concern expressed at lack of European support for data stewardship

NuPECC Actions:

- Presentation by Jag Tuli at Helsinki Town Meeting
- Article in Nuclear Physics News
- Approach to NuPNET (see later)
- Group coordinated to seek funding from EU

NuPNET – coordinating funding agencies

NuPNET

NuPNET is a new venture in Nuclear Physics – it is one of a number of ERANETs funded by the EU

ERANET's are designed to bring together the different national funding agencies in a forum where they can discuss how to coordinate and fund particular areas of science

NB Only "funders" are member, not scientists.

Could solve the problem of coordinating the funding for projects like AGATA, ECT* etc.

RECHERCHE

Motivations for a Nuclear Physics ERANET- NUPNET

In our field the challenge is to merge the national programs to create a stronger and more cohesive research activity which is truly European in scope

Two conditions are required

1- Independent scientific assessment of the field:

emerging areas ,key developments, needed instruments , recommendations and scientific priorities . *This is done by NuPECC and respected*

2. ***The scientific agreed list of science directions and facility requirements should be matched by an effective procedure for bringing together different national funding agencies to achieve these goals.***

- ***This requires:***
- ***1/ recognition by the funding agencies of the common scientific objectives and***
- ***2/ a means of aligning national priorities to the commonly agreed European research goal with regard to the corresponding infrastructures.***

NUPNET Proposal

20 participants
Funding agencies and ministries
From 14 EU countries

A stepwise approach

Mid-2008

Information exchange and Census of resources for Nuclear Physics Funding Bodies

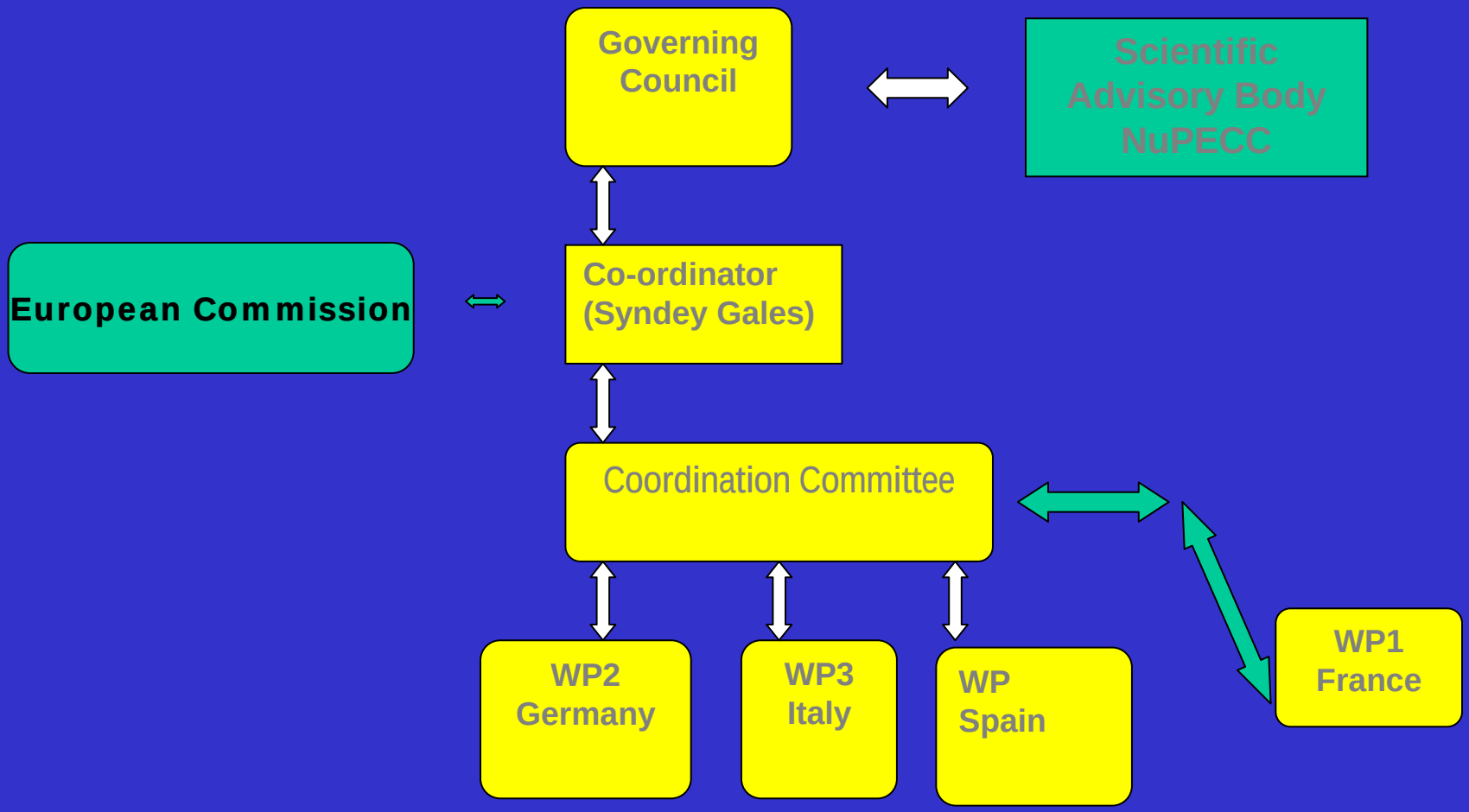
Mid-2009

Agreement on an Action Plan for Infrastructures (Resource and financial Action plan of Agencies)

Mid -2010

Implementation of pilot projects of the Action plan

Structure of the Project
NuPECC as advisory Body




FAIR

Layout of the FAIR Facility

Gain Factors

- Beam **intensities** up by factors of 100 - 10000
- Beam **energies** up by a factor 20
- Production of **antimatter** beams
- Factor 10 000 up in beam **brilliance** via cooling
- Efficient **parallel** operation of programs

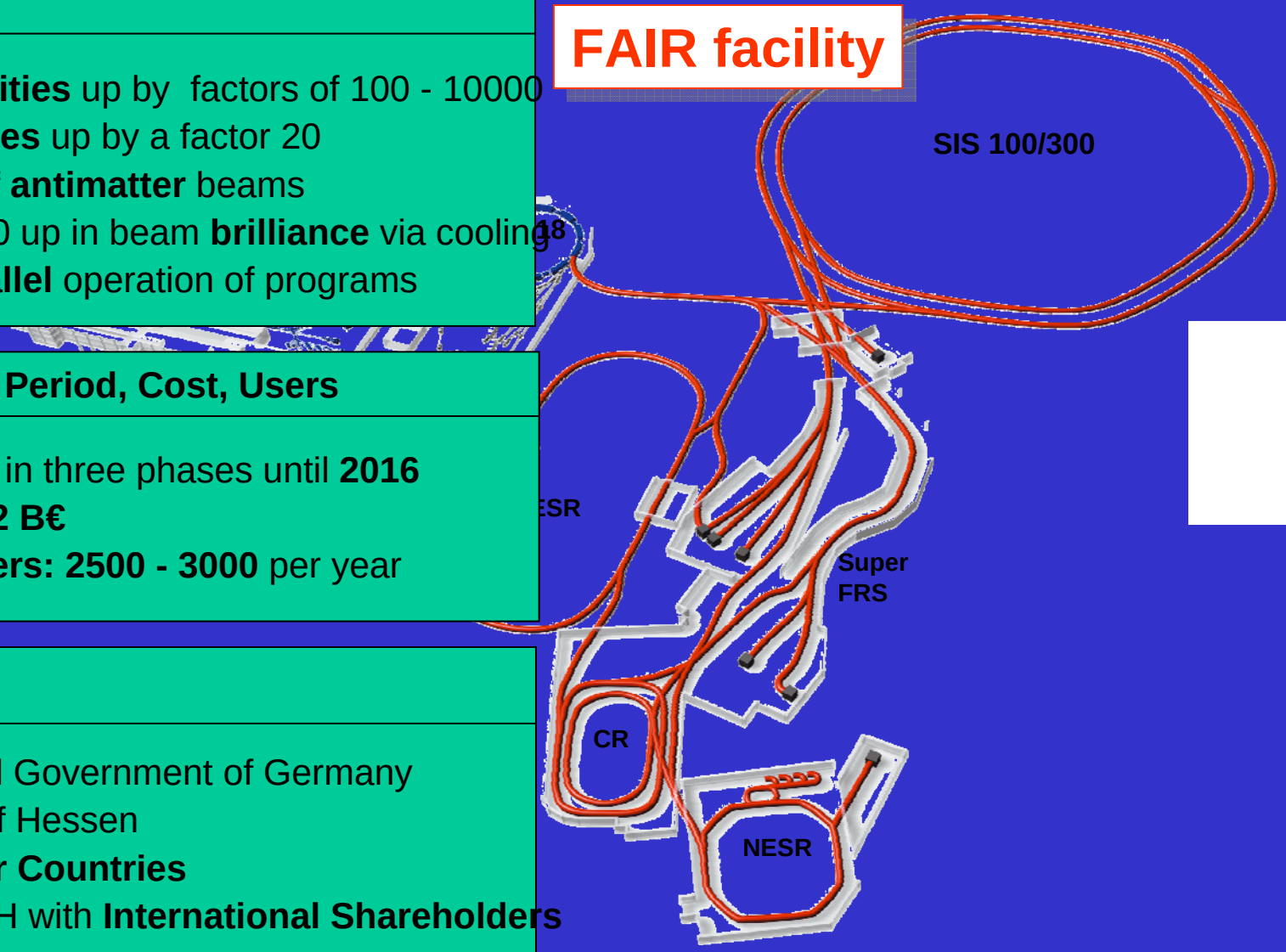
Construction Period, Cost, Users

- Construction in three phases until **2016**
- Total cost **1.2 B€**
- Scientific **users: 2500 - 3000** per year

Financing

- 65 % Federal Government of Germany
- 10 % State of Hessen
- **25 % Partner Countries**

→ FAIR GmbH with **International Shareholders**



Facility for Antiproton and Ion Research

14 Partner Countries so far:


Austria


China


Finland


France


Germany


Greece


India


Italy


Poland


Romania


Russia


Spain


Sweden

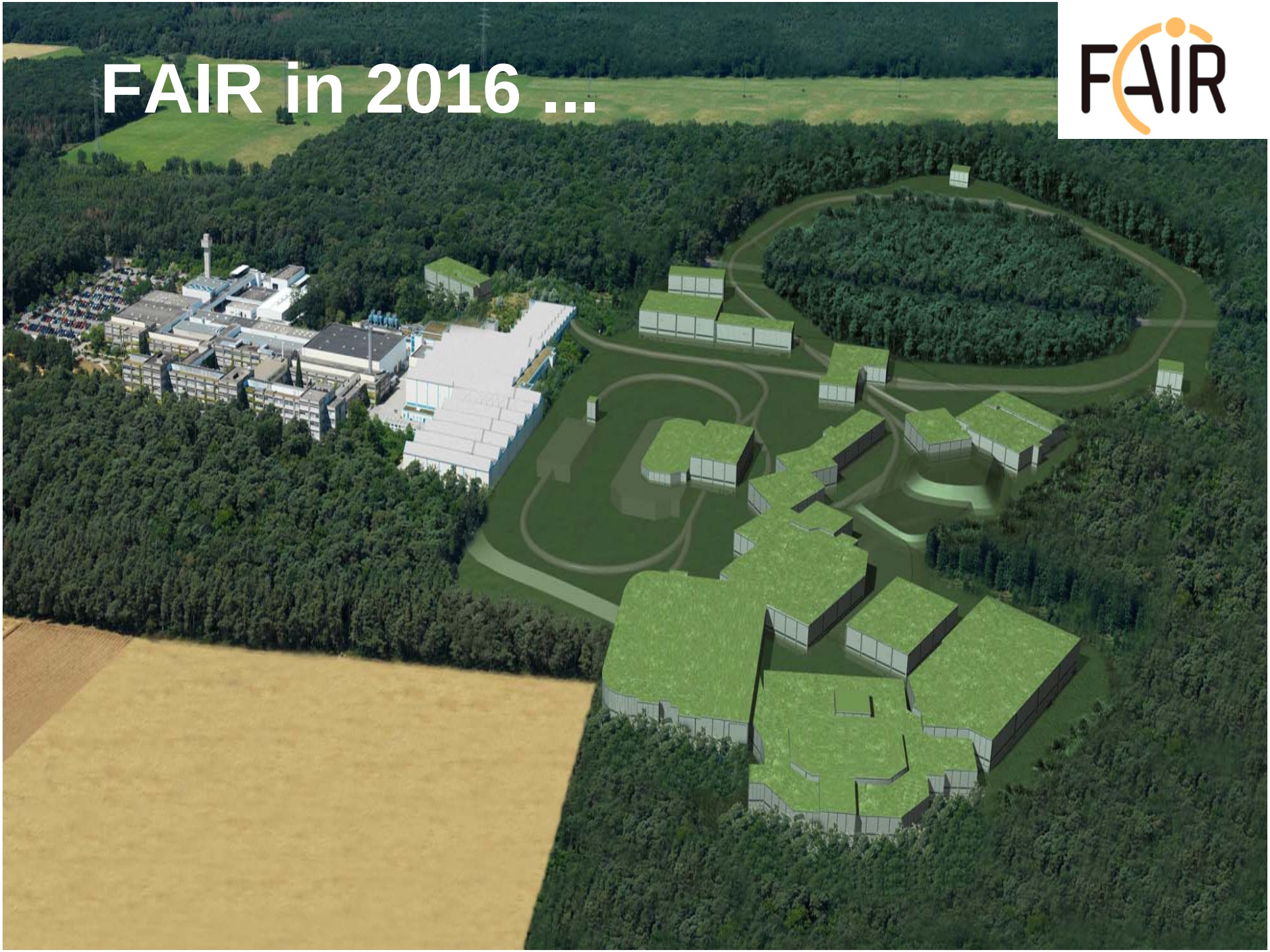

UK

Observers:



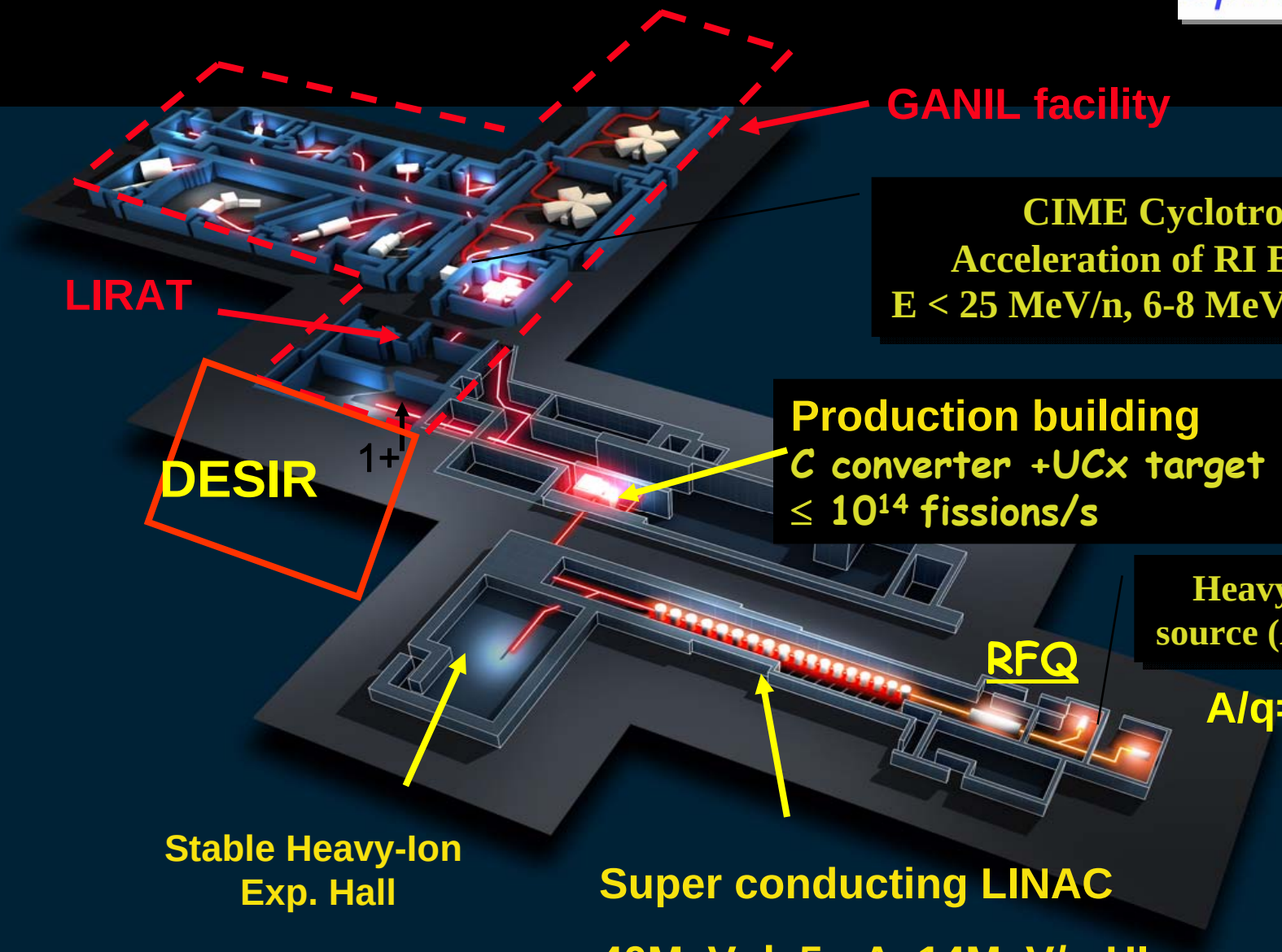

The project is now underway

FAIR in 2016 ...

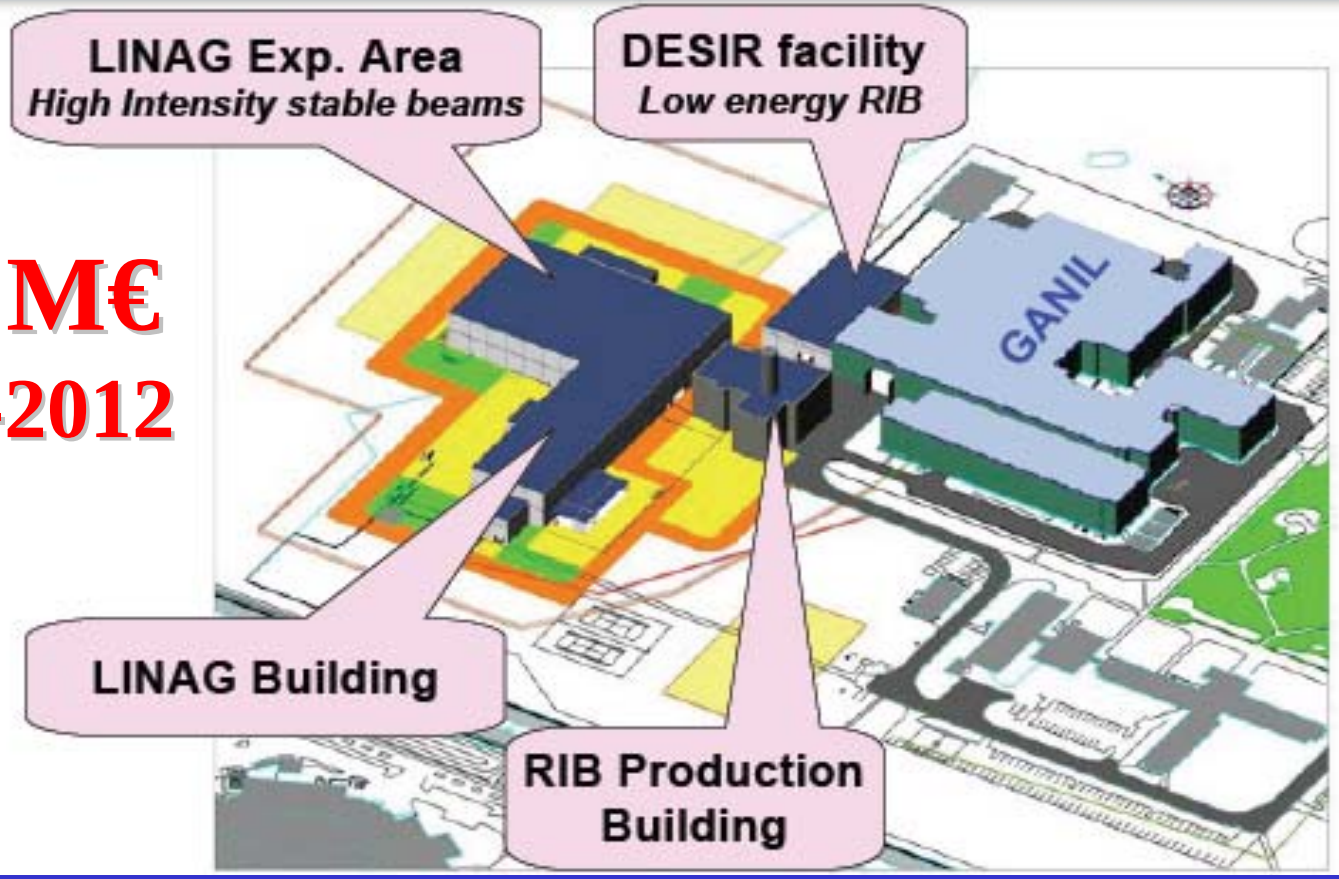


SPIRAL-2

SPIRAL 2@GANIL – Next generation of ISOL Facility



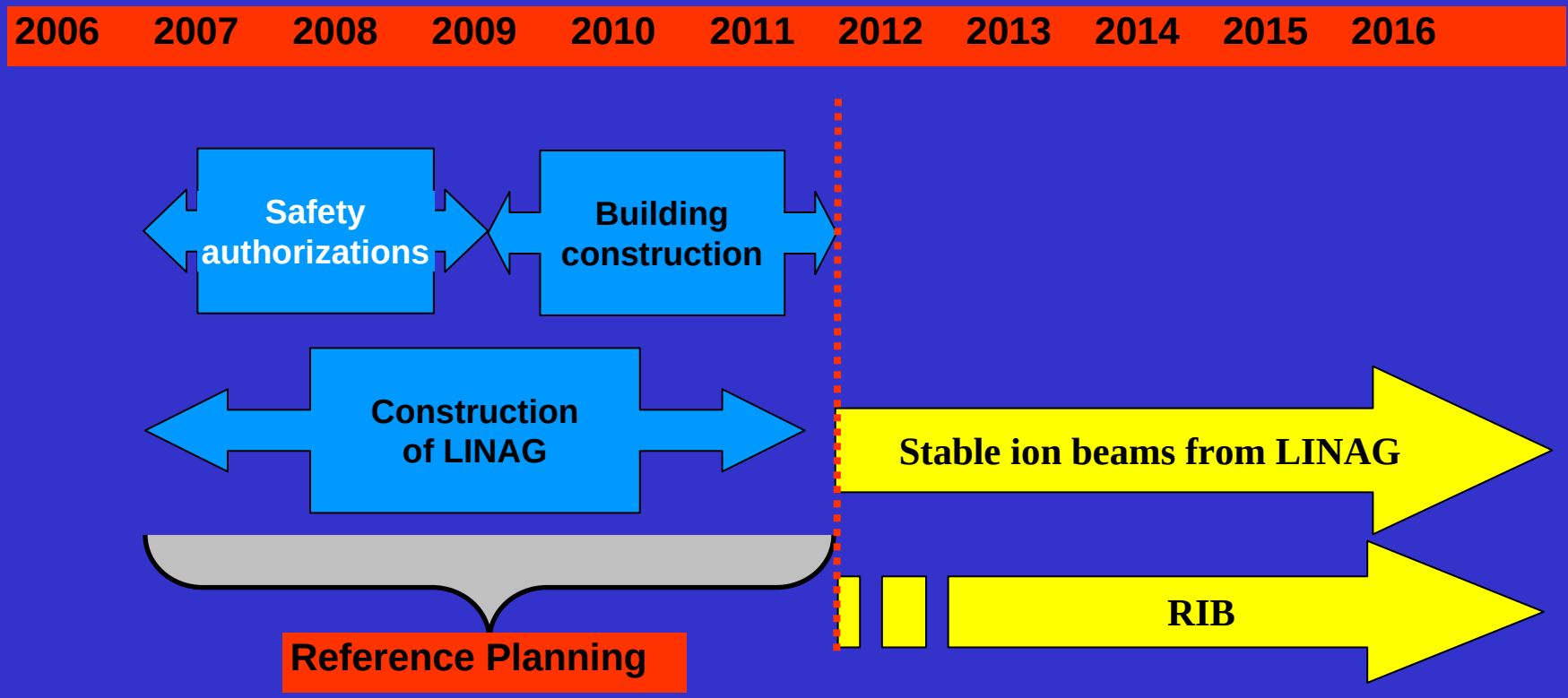
SPIRAL 2 Layout



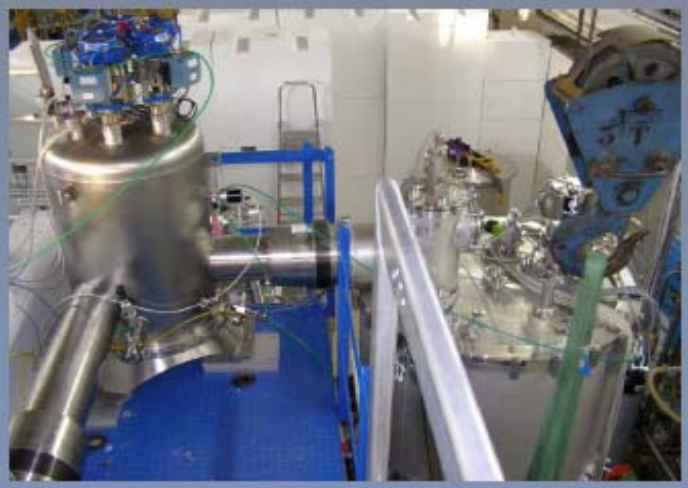
136 M€
2006-2012

Investment (with 10% contingencies): 136 M€
CNRS, CEA, Local Region
Total cost: 190 M€
In the investment budget 26M€ are expected to come from EU and international partners

SPIRAL 2 Schedule



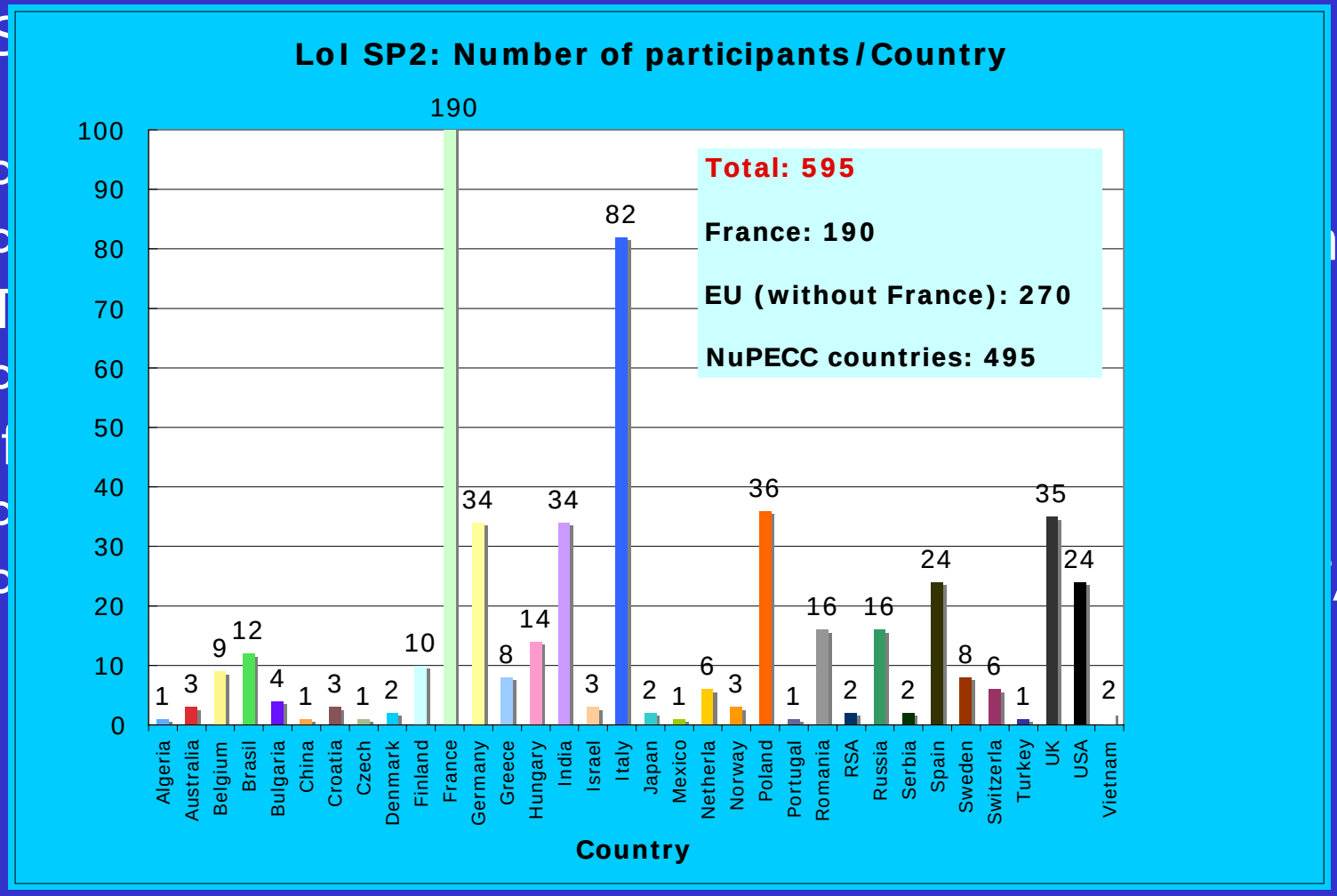
Full test of first Cryomodule at IPNO – Jan08-sucessful



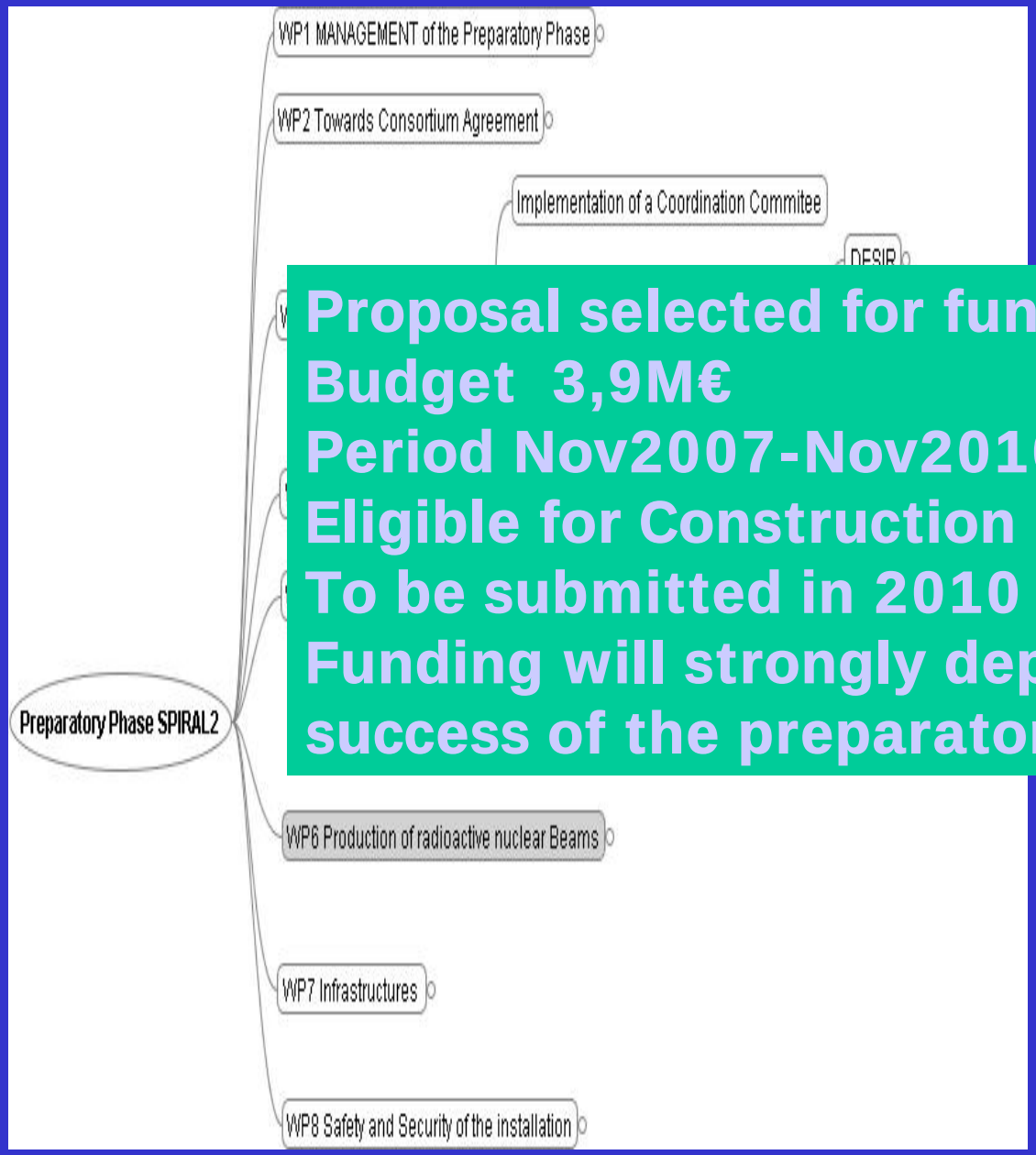
β 0.12 Cryomodule Tests
IPN Orsay Dec.07 - Jan 08

T. Junquera, GANIL 08/02/08

LoI SPIRAL 2 –A very positive response of the International community



SPIRAL2-FP7 –Preparatory Phase

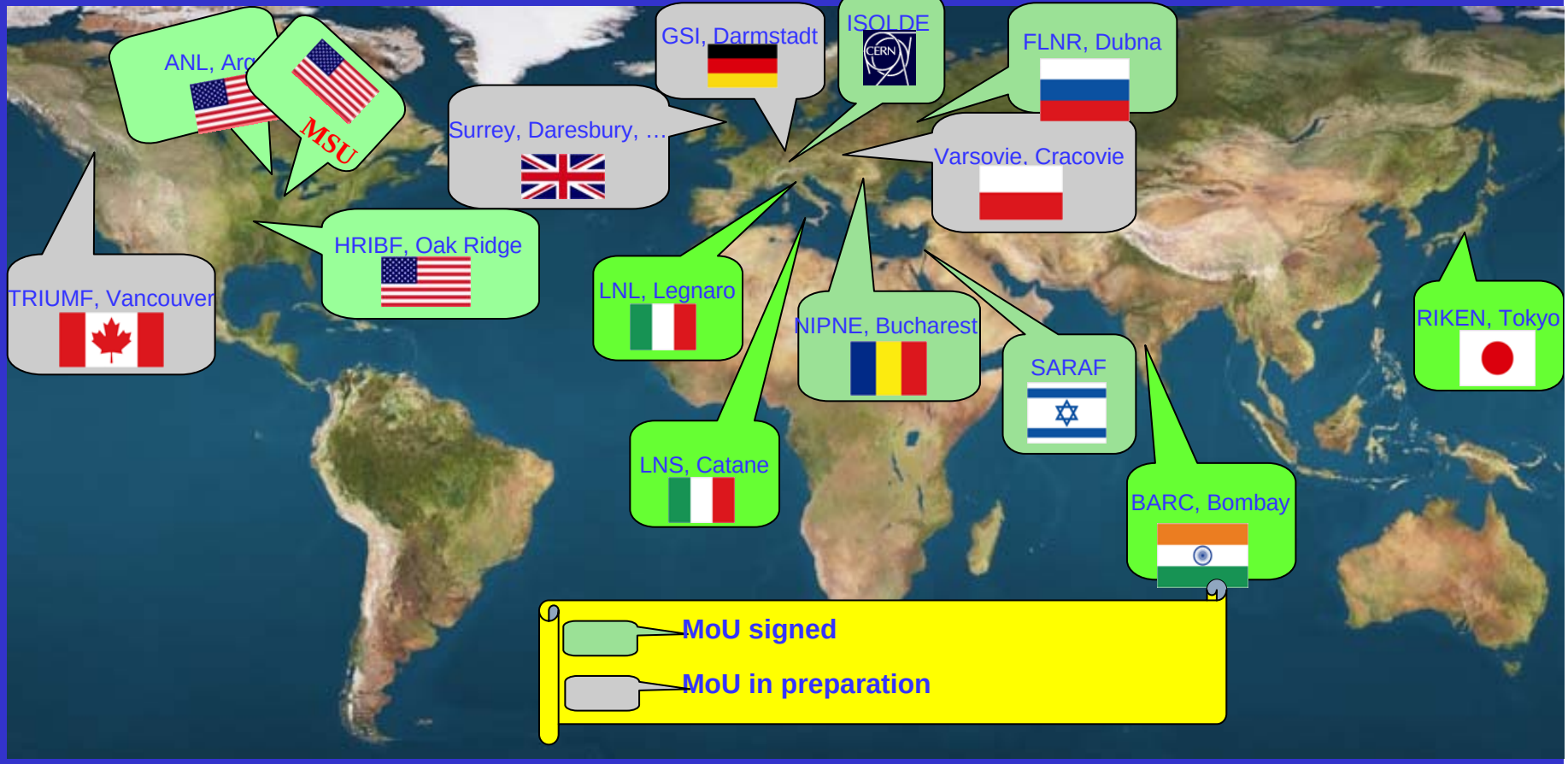


Proposal selected for funding Sept 07
Budget 3,9M€
Period Nov2007-Nov2010 - 3 years
Eligible for Construction
To be submitted in 2010
Funding will strongly depends on the success of the preparatory phase

- *Partners*

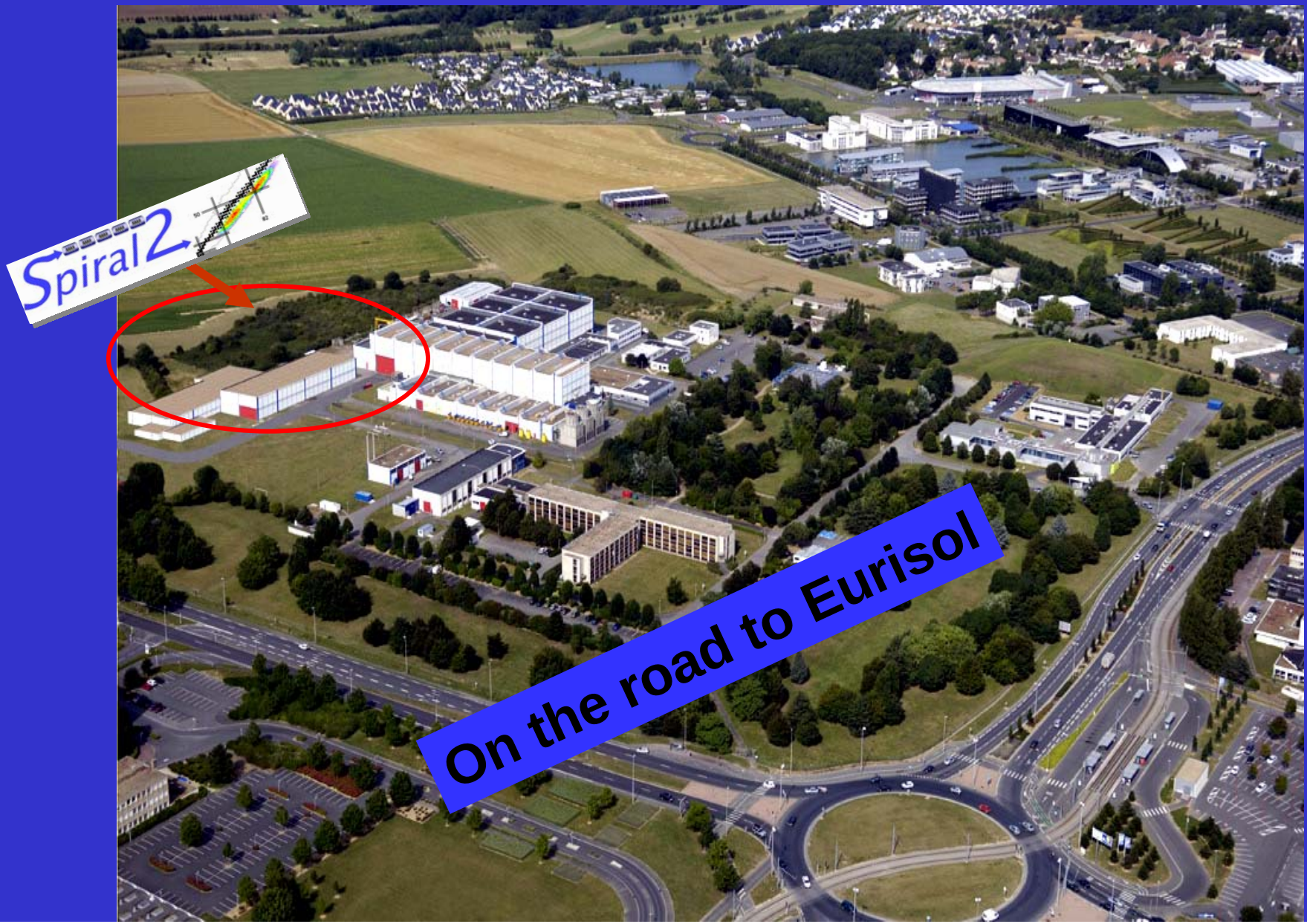
INFN (Italie),
BARC-TIFR Bombay (India)
ISOLDE CERN (Suisse)
Consortium of the UK laboratories lead by
f Surrey
ouver
e Bucarest
Argonne & Oak Ridge (USA)
MSEP Vinca (Serbie)
GSI-FAIR (Allemagne)
KU Leuven (Belgique)
JYFL/ Jyvaskyla (Finlande)
CRC/Louvain La Neuve
LMU & TMU/Munich),
⇒ 3 Associated Countries, 2 ICPC+ USA et Canada

International Collaborations



GANIL-SPIRAL2 2012

A future leading facility for the physics of nuclei far from stability



The directors of both laboratories have asked me to emphasise that participation from the USA would be very much welcomed, either through formal agreements or as individual groups

New EU funding bid for Nuclear Physics

In the current funding period, the EU has a call out for Integrating Activities (IA's)

These combine three aspects:

- Trans National Access
- Joint Research Activities
- Networks

Two bids have gone forward from the community:

ENSAR (European Nuclear Science and Applications Research)

successor to EURONS

HADRON PHYSICS 2

successor to Hadron Physics

ENSAR	13.968 M Euro	40 Institutions

8 TNA + 9 JRA + 7 NA

(GSI, GANIL, Legnaro, Catania, Jyvaskyla, KVI, ISOLDE, Alto)

Coordinator: Mushin Harekah (KVI)

Hardon Physics 2	22.8 M Euro	54 Institutions

10 TNA + 19 JRA + 8 NA

(GSI, MAMI, COSY, LNF, ELSA, Max-Lab, TSL, ECT*, ZIB, SZJ-NIC)

Coordinator: Carlo Guraldo (INFN)

PART 3 Pointers to the Future

The OECD Global Science Forum, at the instigation of the USA (Denis Kovar, DoE), have established a "Working group on Nuclear Physics" Denis Kovar (Chair)

The IUPAP have established WG9 "Committee on International Collaboration in Nuclear Physics Tony Thomas (Chair)

Two developments which NuPECC is interested in pushing:

EURISOL
Electron Ion Collider

EURISOL

EURISOL Multi-Megawatt ISOL facility

2000-2003 EURISOL Feasibility Study (FP5)

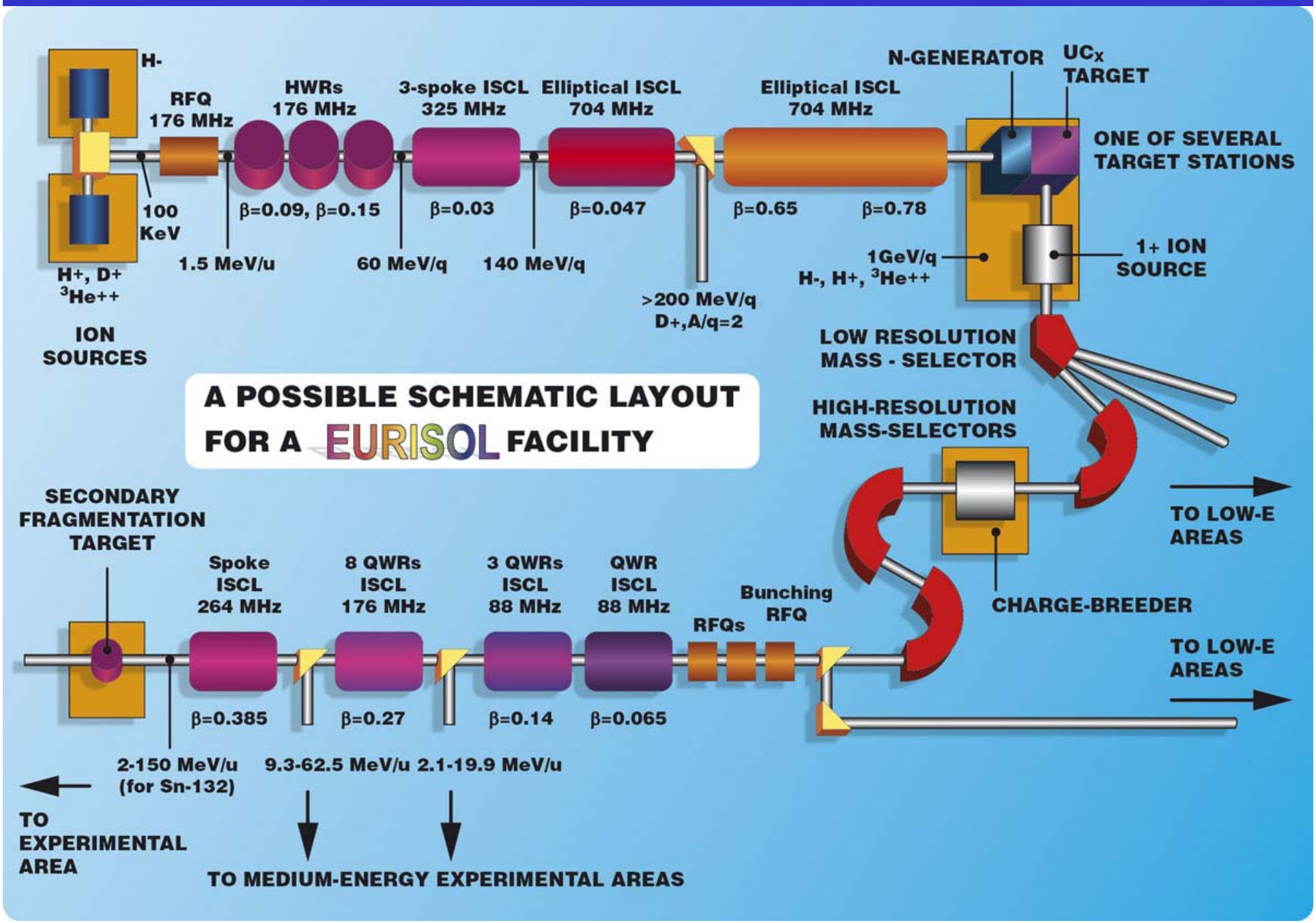
Report published 2004

http://www.ganil.fr/eurisol

2005-2009 EURISOL Design Study **(€ 9.2M)**(FP6)

Engineering studies and technical prototyping

http://www.eurisol.org


H-
RFQ
176 MHz
HWRs
176 MHz
3-spoke ISCL
325 MHz
Elliptical ISCL
704 MHz
Elliptical ISCL
704 MHz
N-GENERATOR
UCx
TARGET
ONE OF SEVERAL
TARGET STATIONS
100
KeV
β=0.09, β=0.15
β=0.03
β=0.047
β=0.65
β=0.78
1GeV/q
H-, H+, 3He++
1+ ION
SOURCE
H+, D+
3He++
ION
SOURCES
1.5 MeV/u
60 MeV/q
140 MeV/q
>200 MeV/q
D+,A/q=2
LOW RESOLUTION
MASS - SELECTOR
A POSSIBLE SCHEMATIC LAYOUT
FOR A EURISOL FACILITY
HIGH-RESOLUTION
MASS-SELECTORS
SECONDARY
FRAGMENTATION
TARGET
Spoke
ISCL
264 MHz
8 QWRs
ISCL
176 MHz
3 QWRs
ISCL
88 MHz
QWR
ISCL
88 MHz
RFQs
Bunching
RFQ
TO LOW-E
AREAS
CHARGE-BREEDER
TO LOW-E
AREAS
β=0.385
β=0.27
β=0.14
β=0.065
2-150 MeV/u
(for Sn-132)
9.3-62.5 MeV/u
2.1-19.9 MeV/u
TO
EXPERIMENTAL
AREA
TO MEDIUM-ENERGY EXPERIMENTAL AREAS

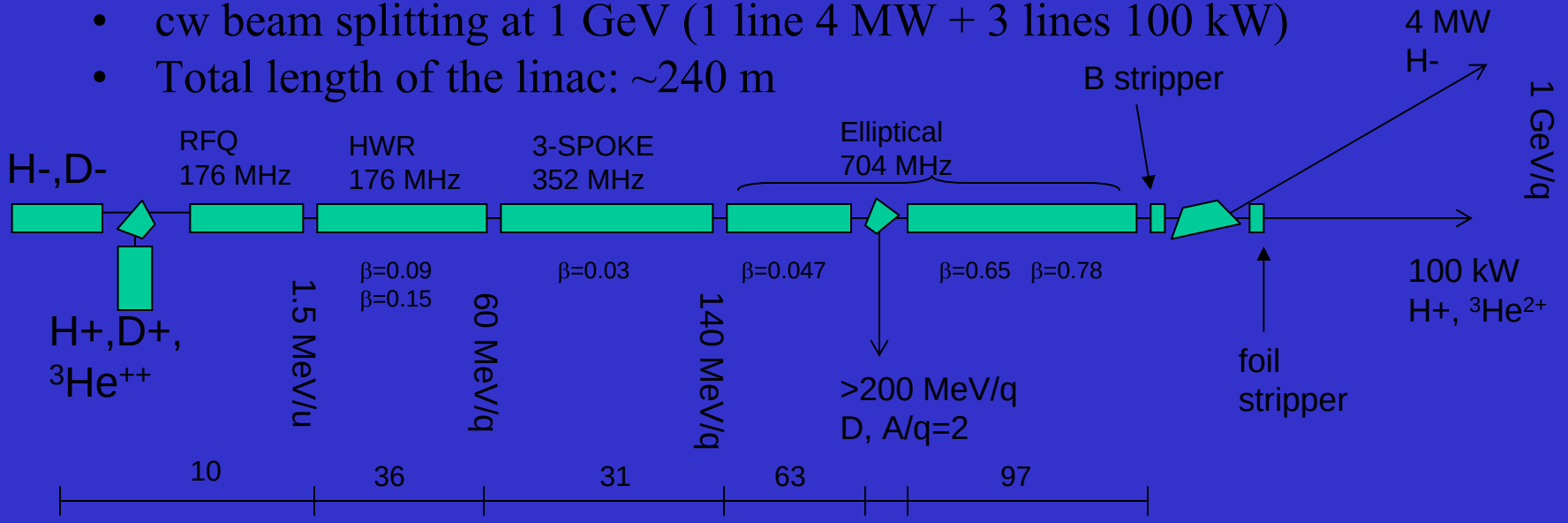
EURISOL Design Study

The Main Challenges

- Design a 5MW; 1GeV proton driver with additional capability of 200 AMeV deuterons and A/Q=2 Heavy Ions (Task7) ; build and test prototypes of the cavities (task 8).
- Design a liquid Hg converter which will accept 5 MW of beam power (task 2).
- Design a UCx target which will make the most efficient use of the neutrons produced (task 4).
- Evaluate the safety constraints of the above set up (task 5).
- Design an efficient multi-user beam distribution system (task 9).
- Design a superconducting HI LINAC capable of accelerating ^{132}Sn up to 150 AMeV (task 6)
- Investigate technologies for the instrumentation of the future (task 10)
- Provide a conceptual study for a beta-beam neutrino facility (task 12).

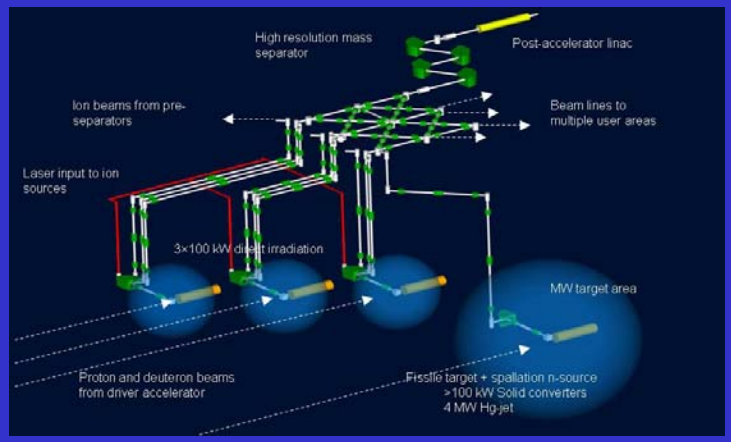
New baseline scheme with extended capabilities

- 2 injection lines for H,D, He and A/q=2 ions
- SARAF scheme up to 60 MeV/q
- IPNO scheme from 60 to 140 MeV/q
- CEA scheme from 140 to 1000 MeV/u
- cw beam splitting at 1 GeV (1 line 4 MW + 3 lines 100 kW)
- Total length of the linac: ~240 m

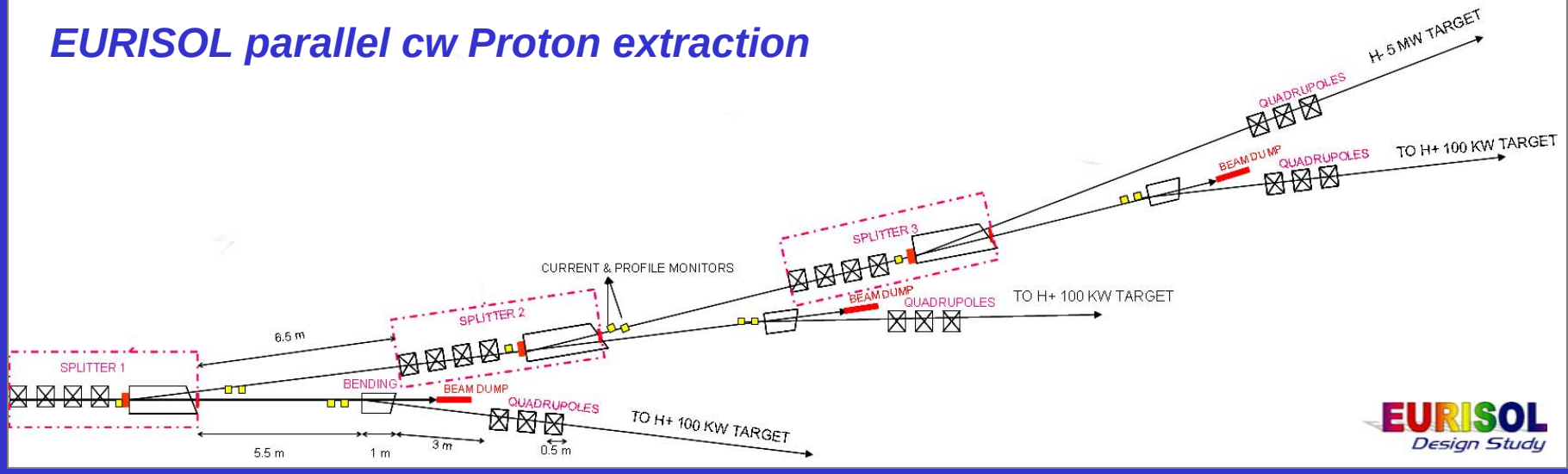


1 GeV Multiple Extraction

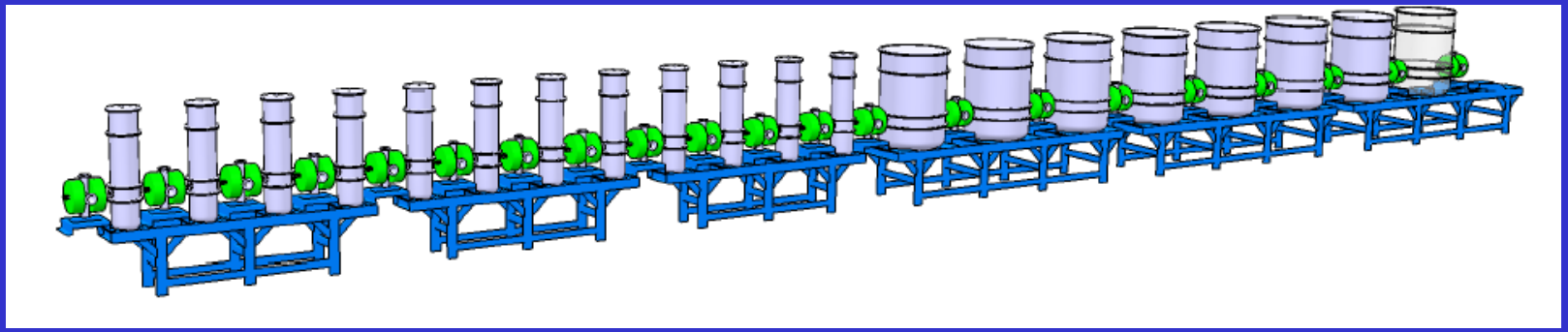
- 3 splitting stations
- 4 simultaneous users for cw proton beams:
  - 1×4 MW
  - $3 \times 0 \div 100$ kW (continuously adjustable)
- Unique ability of EURISOL at present



EURISOL parallel cw Proton extraction



Design of the post-accelerator



SPIRAL-2 philosophy : Smoothest beam dynamics (regular FDO lattice, low number of β-sections), Modular solution and simple cryostats, Separated vacuum (safety with FP), Warm focusing (easier for alignement), Possibility to insert diagnostics at each period, ease of tuning

Main technical requirements:

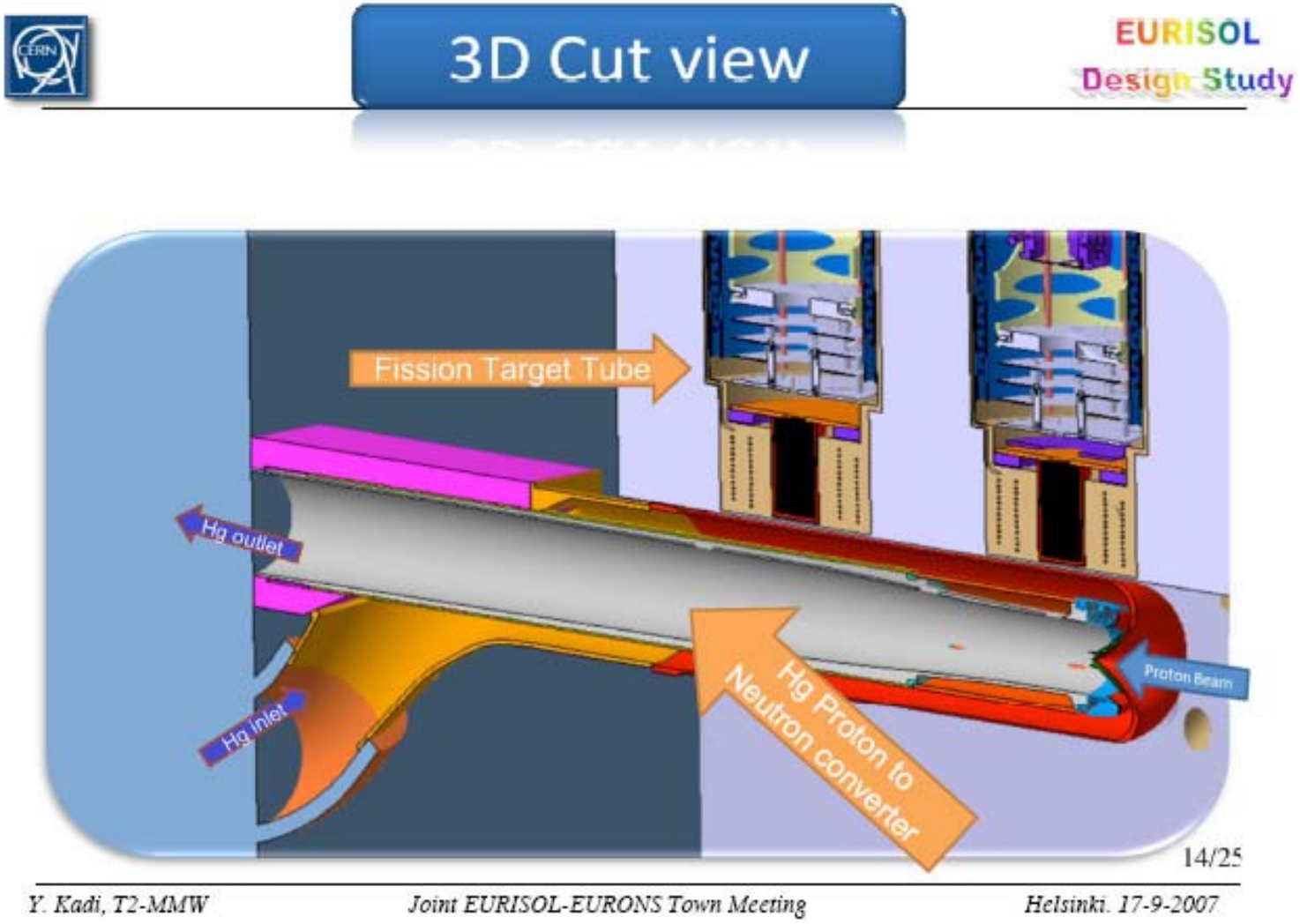
Only 2-gap cavities (high q/A acceptance)

Max. accelerating fields 7.8 MV/m

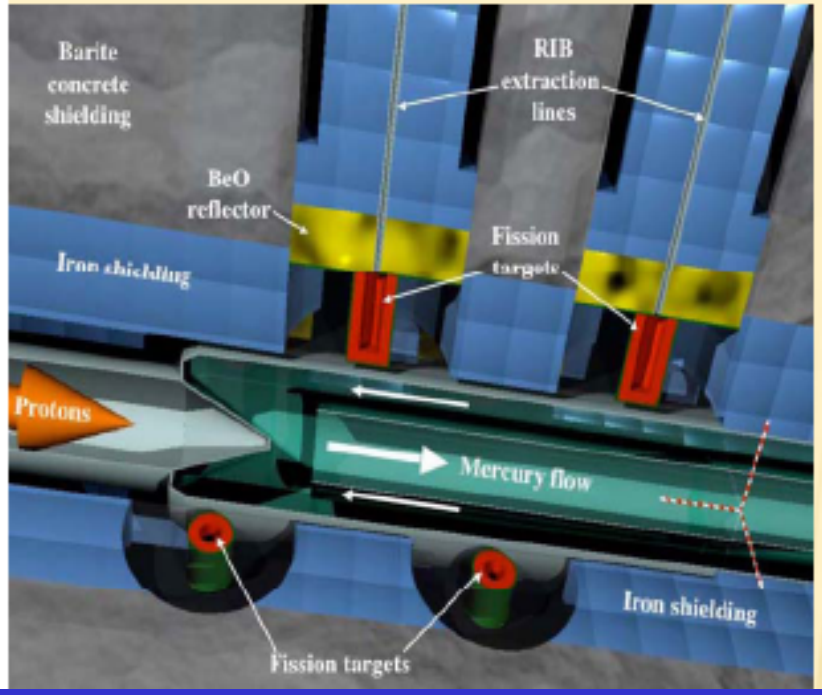
Nominal operation for A/Q between 4 and 8

$^{132}Sn^{25+}$	Section 1	Section 2	Section 3	Section 4	TOTAL
Cavity Freq.	88.05 MHz	88.05 MHz	176.1 MHz	264.15 MHz	-
Cavity β	0.065	0.14	0.27	0.385	-
# cav./ cryo	1 QWR	3 QWR	8 HWR	14 SPOKE	-
# cavities	15 cav	27 cav	80 cav	154 cav	**276 cav**
Length	17.9 m	26.1 m	59.0 m	103.8 m	**206.8 m**
Ouput energy range	-	2.1 – 19.9 MeV/A	9.3 – 62.5 MeV/A	20.0 – 150.0 MeV/A	**2.1 – 150.0 MeV/A**

New Target Concept

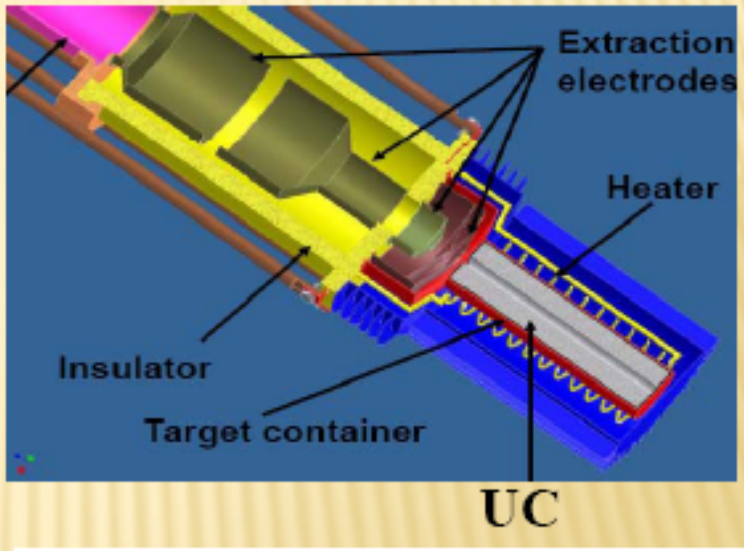


Reactor Type Target



Integration of Fission Target

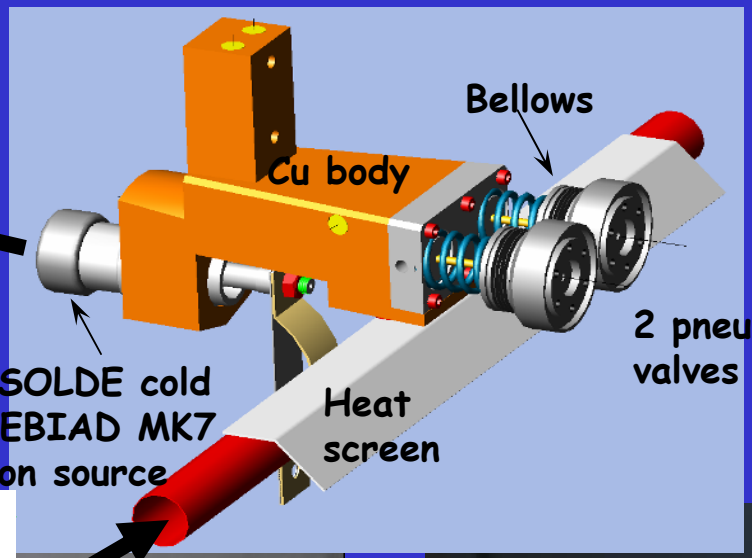
MAFF concept



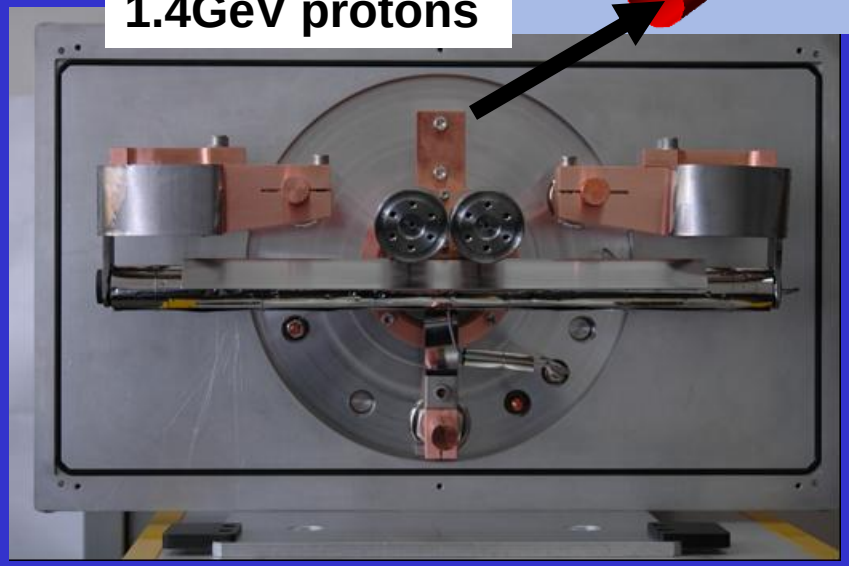
Concept Validated by International Advisory Board

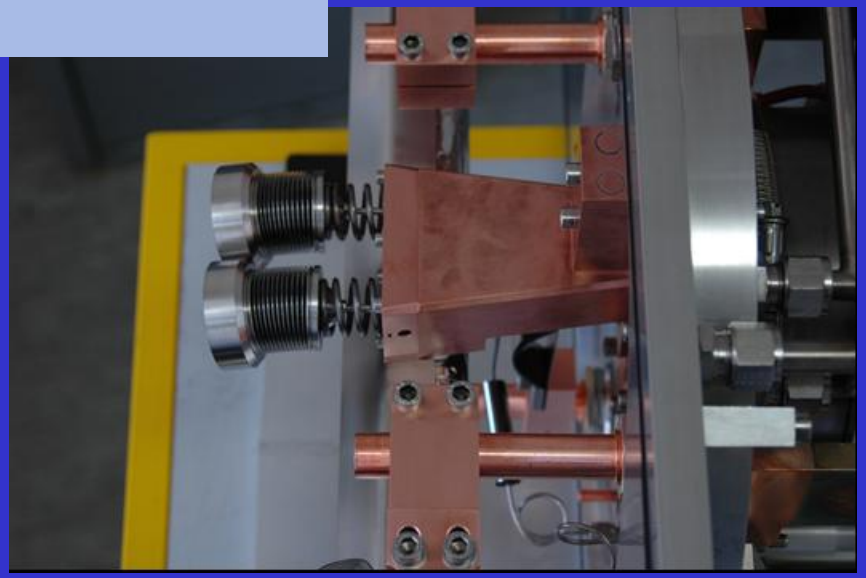
Double effusion line prototype

(E. Bouquerel, L. Penescu)

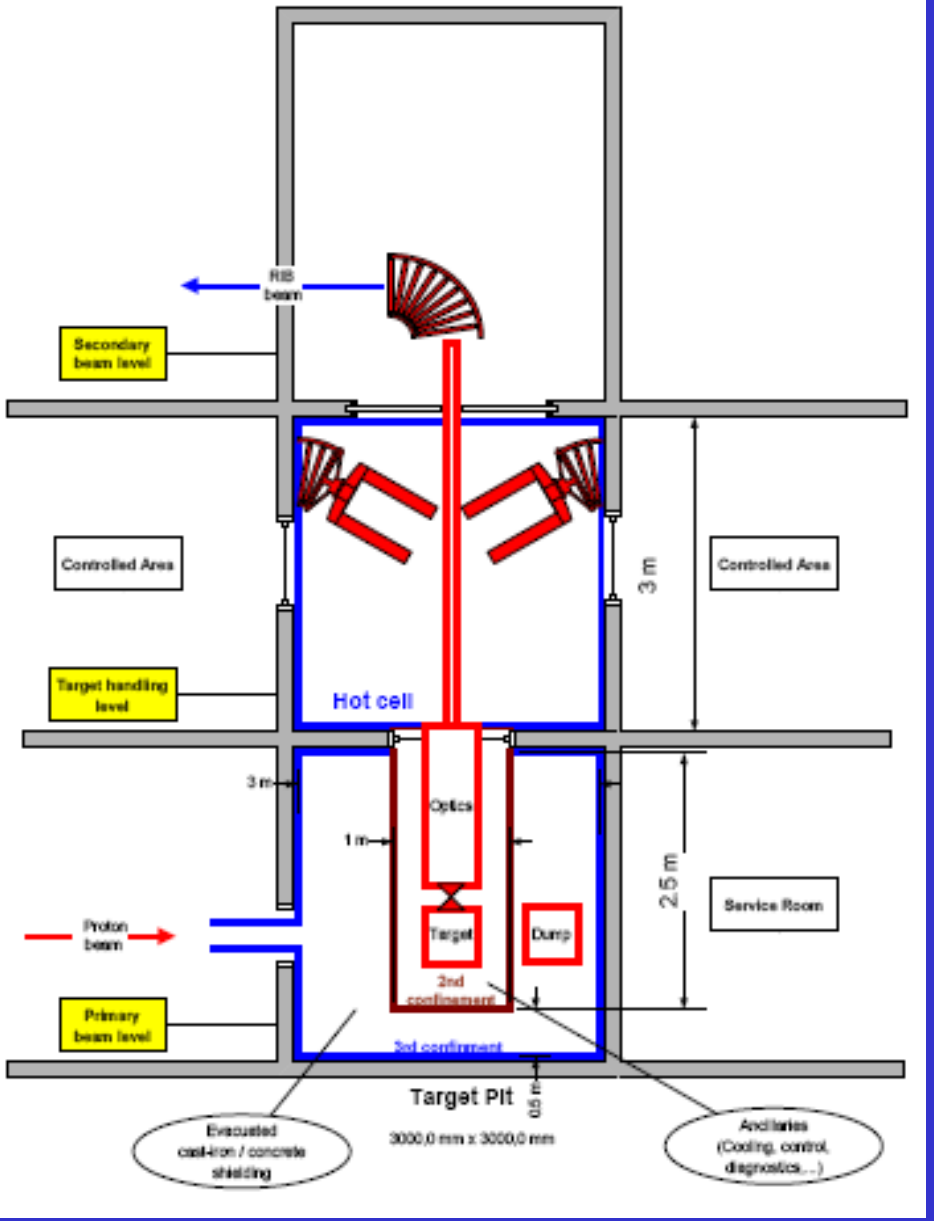


2xwater cooled transfer lines
2x20cm containers

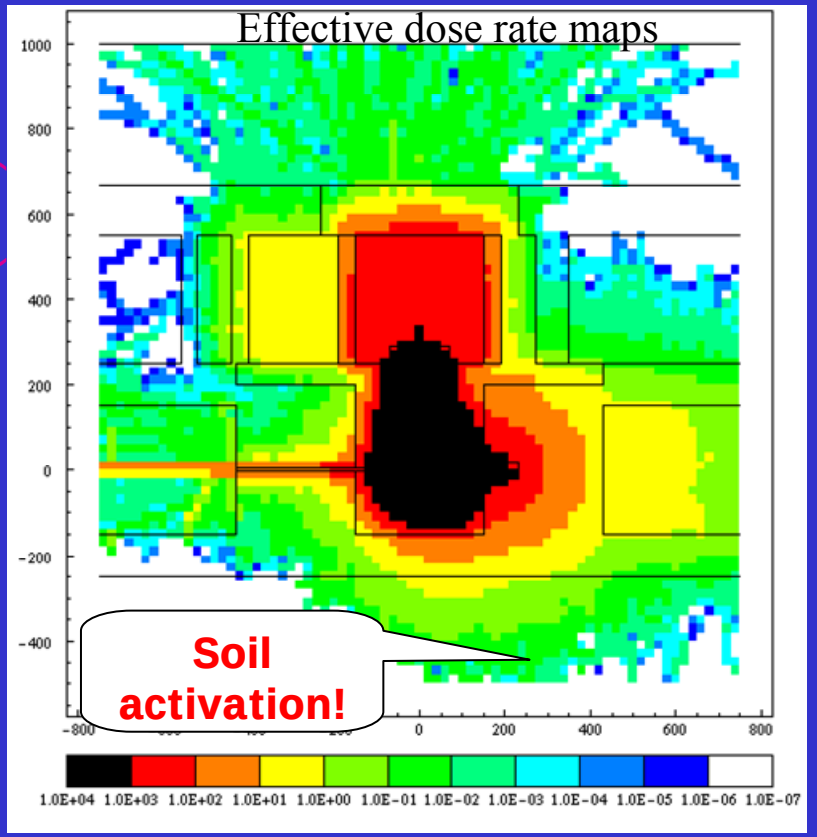




Conceptual design of 100kW target station



- Underground target position
- Front-end retracts vertically
- Hot-cell for target exchange
- Separator in 3rd level
- Neighboring hot-cell accessible during run



Proposal for the Future of EURISOL

- EURISOL has made use of EC instruments: 5th framework RTD and 6th framework DS.
- Major advances have been achieved and a large community with varied technical expertise has developed and must continue to be nurtured
- Full engineering report necessary before Pre-construction phase: No (evident) EC instrument for funding.
- We (the EURISOL DS MB) propose to form a EURISOL collaboration consisting of laboratories interested in participating in the continuing effort.

Electron Ion Collider

Future lepton scattering facilities

NuPECC working group

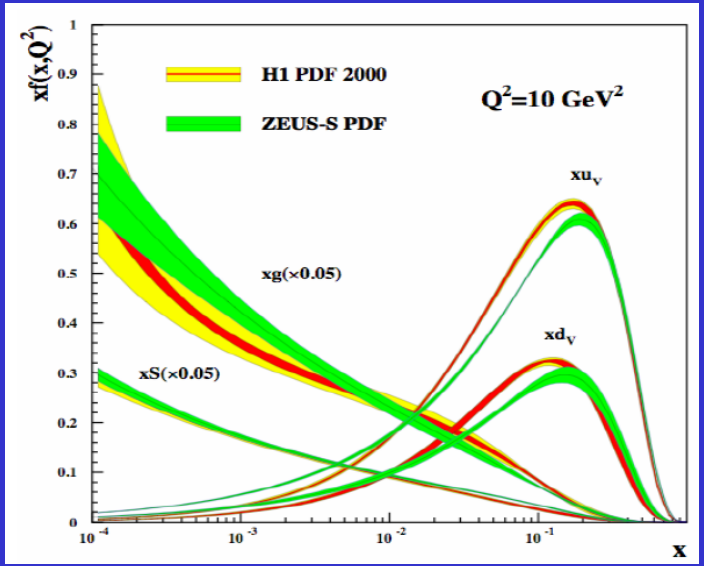
Tullio Bressani, INFN, Torino Univ.
Jens Jørgen Gaardhøje, Niels Bohr Inst.
Günther Rosner, Glasgow Univ. (chair)
Hans Ströher, FZ Juelich

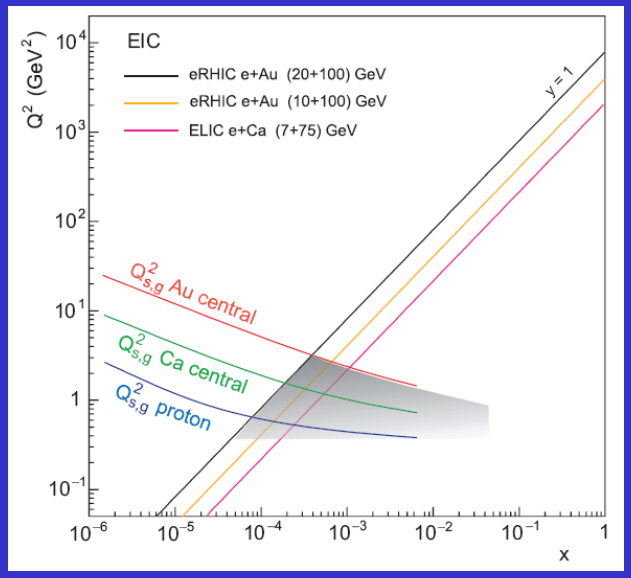
(No externals yet)

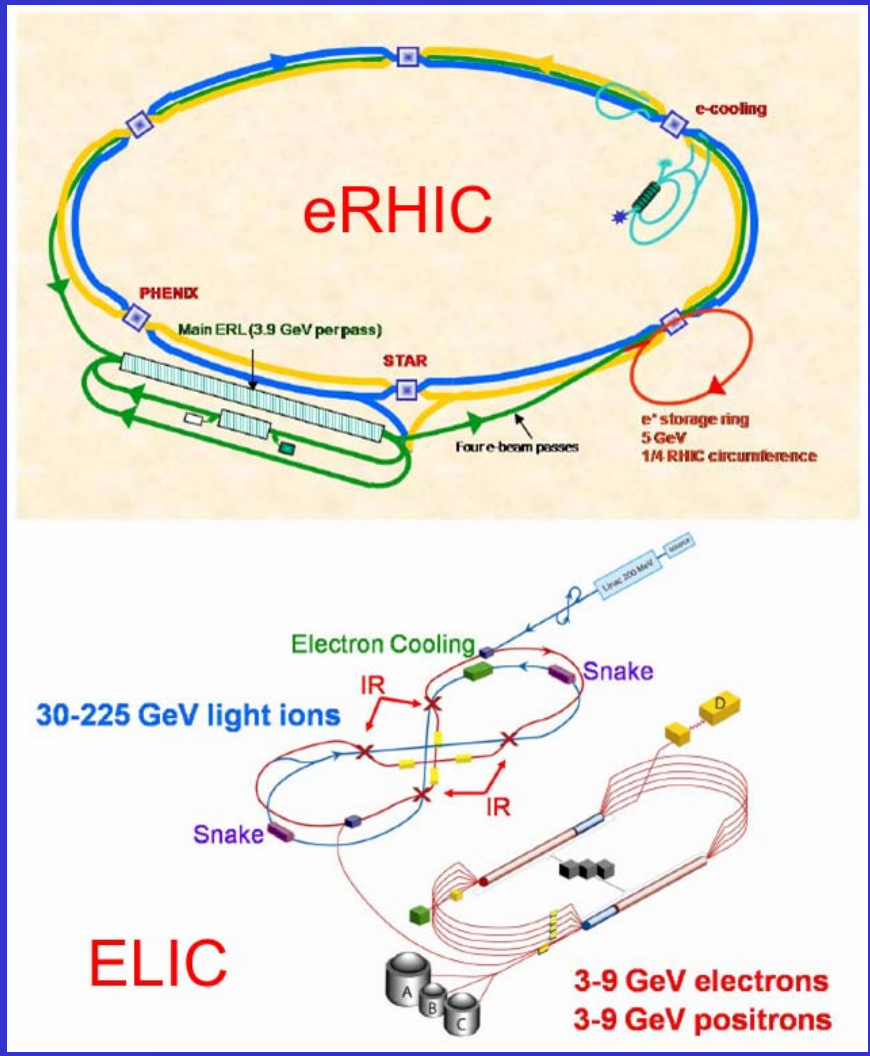
European issues

- Since the 1980's
  - ELFE @ Saclay (≥2 GeV e^- fixed target)
  - ELFE @ DESY (≥10 GeV e^- fixed target)
  - ELFE @ CERN (≥20 GeV e^- fixed target)
  - EIC @ GSI (ep/eA collider)
  - TESLA N (≥200 GeV fixed target)
  - EVELYN @ DESY (≥50 GeV fixed target)
- Problems
  - Difficult international environment
  - No adequate host lab

USA: Electron-Ion Collider 20-100 GeV_{com}

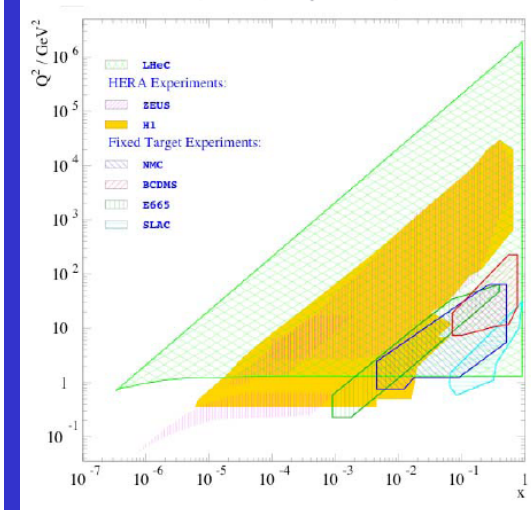






CERN: Large Hadron electron Collider

LHeC Inclusive Kinematics

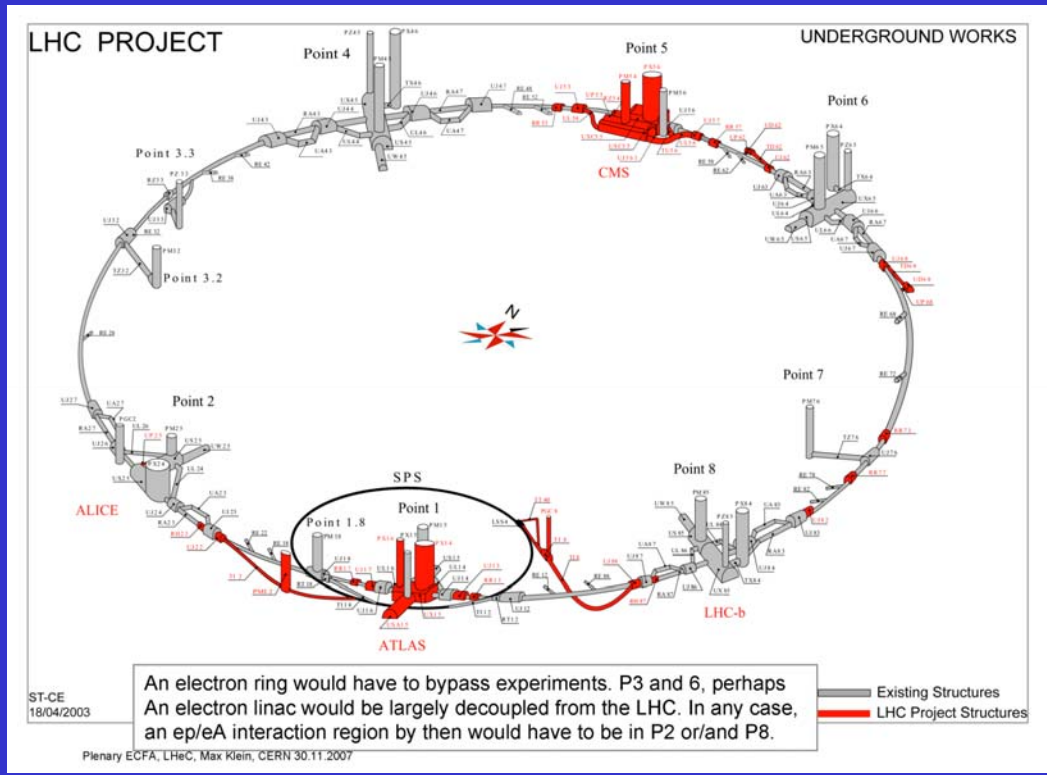


$E_e = 70$ GeV
$E_p = 7$ TeV
$\sqrt{s} = 1.4$ TeV
(5 x HERA)

- Extension to higher Q^2 in x range covered By HERA
- Extension of low x (high W) frontier

$W \leq 1.4$ TeV
$x \geq 5.10^{-7}$ at $Q^2 \leq 1$ GeV^2

- Unprecedented lumi = 10^{33} cm^{-2} s^{-1} !!!
- eA mode possible using LHC ion beam



LHeC roadmap

- Feasibility study endorsed by CERN and ECFA
- First ECFA-CERN Workshop on the LHeC in Divonne, 1-3/9/08
- Goal: Conceptual Design Report by end of 2009, early 2010, on:
  - Accelerator
  - Interaction regions
  - Detector
  - Infrastructure
  - Physics
    - New Physics
    - High Precision QCD + electroweak
    - High parton densities (low x + eA)

What does the landscape look like?

- ≥ 2007:
  - Accelerators
    - MAX-lab, MAMI C, BEPCII, LHC, JPARC
  - Experiments
    - HERMES, COMPASS, BESIII, WASA, ALICE
- > 2012:
  - Accelerators
    - JLab 12 GeV, FAIR, DAFNE 2?, Super-B factory?, RHIC 2?
  - Experiments
    - CLAS 12, GlueX, PANDA, CBM, COMPASS?, KLOE 2?, Super-BELLE?
- > 2017:
  - Accelerators
    - Proton-antiproton collider at FAIR?
    - EIC?
  - Experiments
    - PAX?
    - Electron-ion exp.?
- > 2022:
  - Accelerator
    - LHeC?

Stress:

Early stages – physics priorities not yet established

Not a foregone conclusion that LHeC will be choice

Interaction between USA and European communities should be stimulated (both NP and PP)

THE END