ECOS-EURISOL Joint Town Meeting

Institut de Physique Nucléaire, Orsay

EURISOL

October 28-31, 2014

The LINCE project at Huelva

I. Martel

Department of Applied Physics
University of Huelva
Spain

ECOS-EURISOL Joint Town Meeting

Institut de Physique Nucléaire, Orsay

EURISOL ENSAR October 28-31, 2014

The ECOS-LINCE project in Europe:

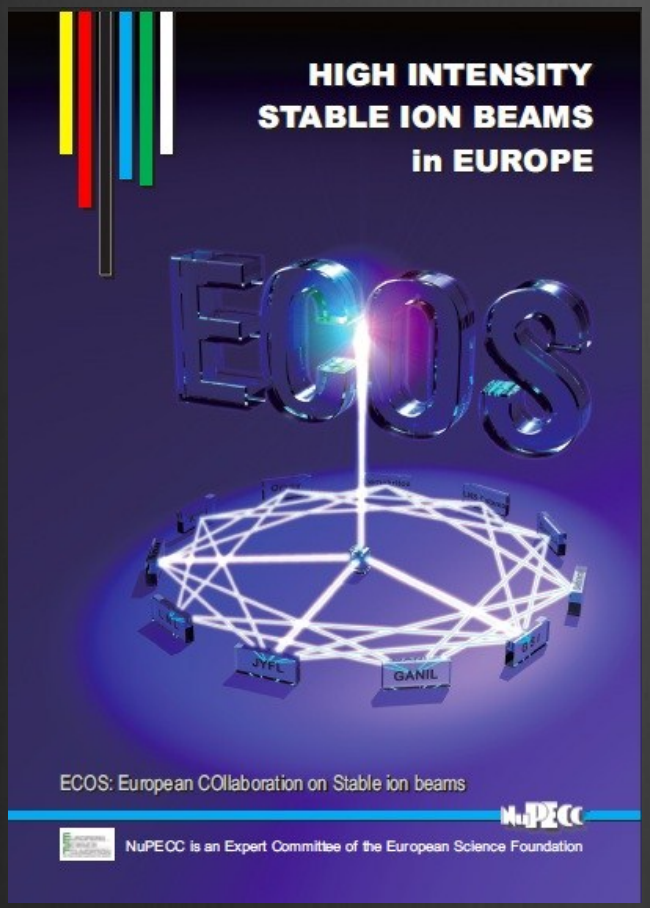
A new high-intensity stable beam facility at EU

I. Martel

Department of Applied Physics
University of Huelva
Spain

Punta Umbría Beach
Huelva (Spain)

HIGH INTENSITY STABLE ION BEAMS IN EUROPE



ECOS: **E**uropean **Co**llaboration on **S**table ion Beams. (http://www.ensarfp7.eu/project/ecos)

Expert working group of the Nuclear Physics European Collaboration Committee (NuPECC)

ECOS REPORT: Describe the research perspectives at EU with high intensity stable ion beams, categorize existing facilities and identify the opportunities for a dedicated new facility in EUROPE

IV: Concluding remarks and recommendations

…"The long-term goal for a new dedicated high intensity stable ion beam facility in Europe, with energies at and above the Coulomb barrier, is considered to be one of the important issues to be discussed in the next Long Range Plan of the nuclear physics community."…

ECOS-LINCE proposal

ECOS-LINCE facility: a FIRST CLASS High intensity heavy-ion accelerator for stable ions, with energies at and above the Coulomb barrier.

LINCE; high-intensity (superconducting LINAC)

- Wide range of ions, from protons to Uranium
- Wide range of energies, up to 10 A MeV for 238U
- High Intensity accelerator (1 mA light ions → 10 particle-microamp heavy ions)

LINCE energy booster (using heavy-ion synchrotron)

- 50 MeV/u to 200 MeV

PROGRAM:

- Basic and fundamental science
- Applications of nuclear physics

Basic Nuclear Physics

- **The totality of the ECOS physics case**

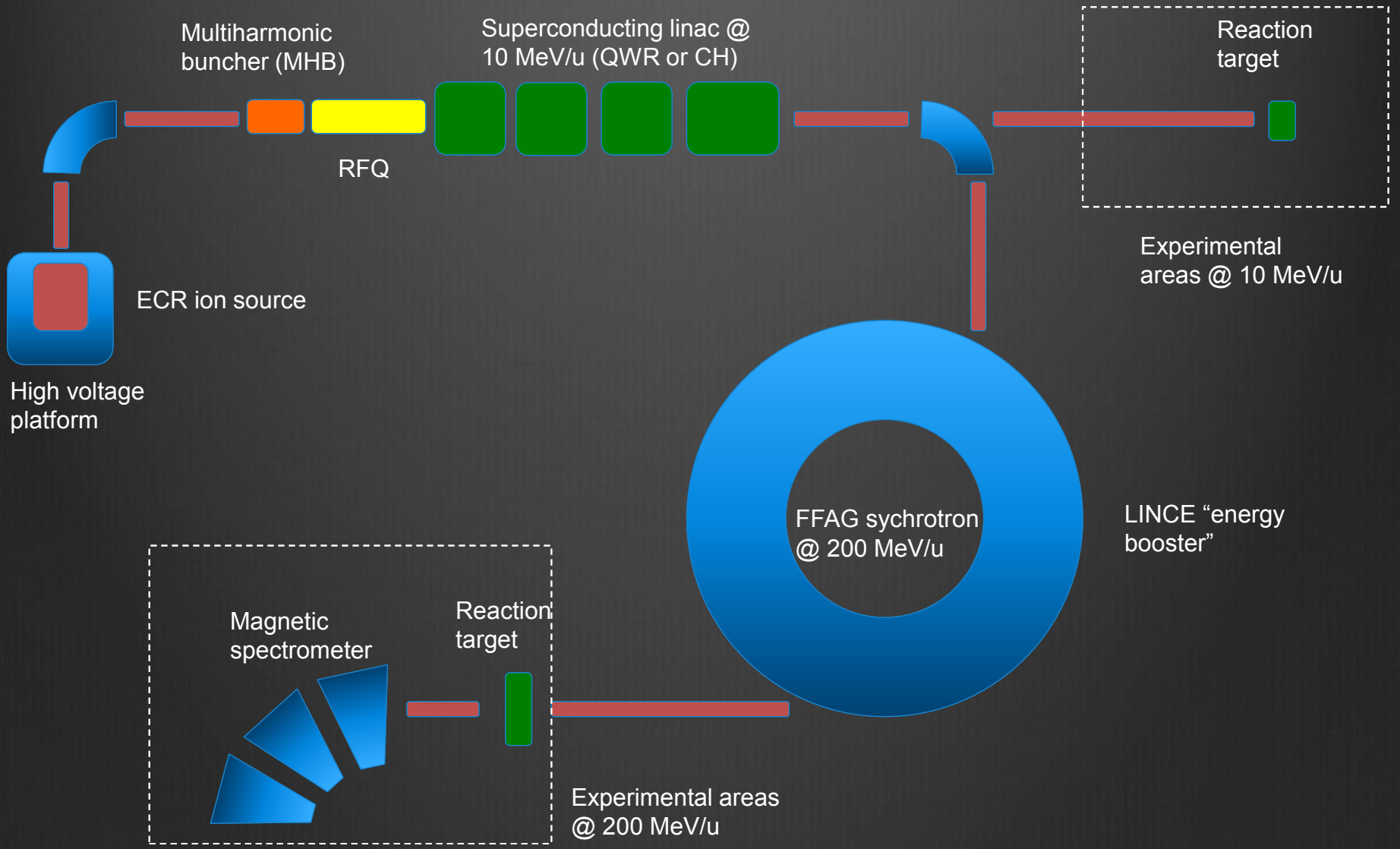
  - Nuclear structure, low medium and high spin
  - Reaction mechanisms
  - Charge exchange reactions
  - Isomers
  - Ground state properties
  - Astrophysics
  - Superheavies

- **Energy booster:**

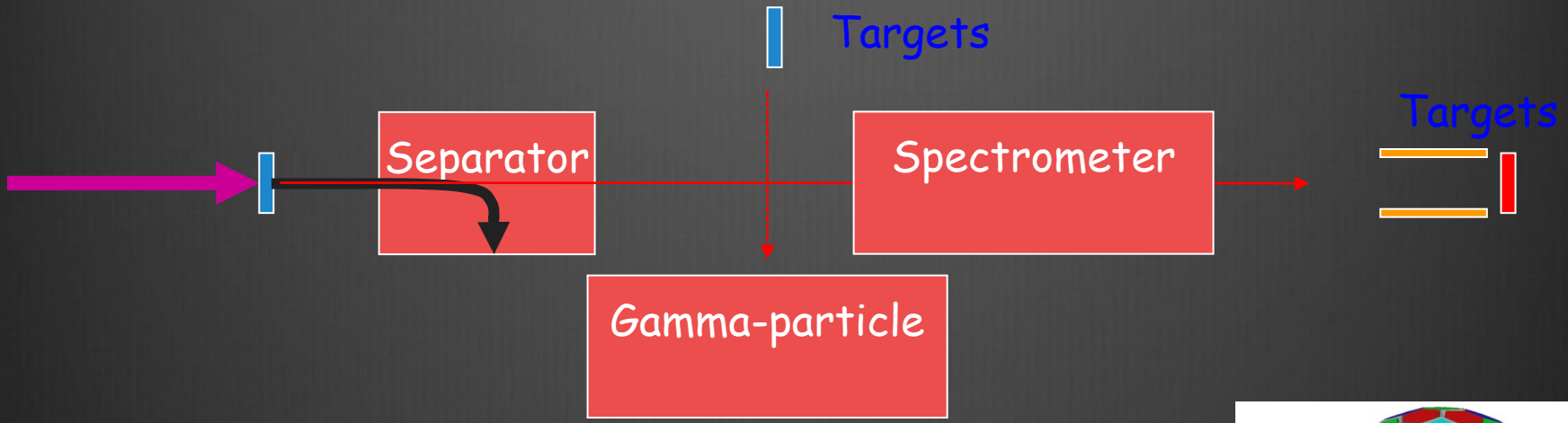
  - Nuclear equation of state (EOS), symmetry energy, etc
  - Fundamental physics: e.g., neutrinoless double-beta decay

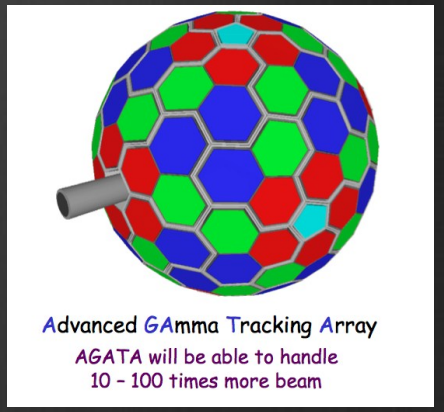
Objective: build a heavy-ion facility to carry out studies demanding high intensity stable beams and/or long run experiments (months of continuous beam time!)

LINCE CONCEPTUAL LAYOUT



Typical experimental setup





SPECIFIC DEVELOPMENTS

- High intensity LINAC
- High intensity energy booster (SYNCRHOTRON)
- High resolution spectrometers (MAGNEX)
- High power THIN targets

→ New generation of gamma & particle detectors (FAZIA, AGATA, LYCCA, MONSTER, GASPARD-HYDE,…) with new generation electronics and data correlation systems.

Proposed LINCE working parameters

LINCE must provide 7000 hours of availability/year, with high stablity and reliability for long run experiments: 5000 hours for ECOS science and 2000 hours for Applications. → VERY STABLE AND RELIABLE MACHINE CONCEPT

Main characteristics:

- Protons to Uranium: 1 mA max intensity at target → eg., ^{48}Ca (8+) > 10 pμA
- CW LINAC, energy up to 10 MeV/u (Range: protons 45 MeV, ^{238}U @ 8.5 MeV/u). Based on superconducting QWR cavities and/or CH structures.
- SYNCHROTON, energy up to 50 MeV/u - 200 MeV. Based on FFAG (superconducting cavities, magnets).
- Full-SC ECR ion source for high-charged & high-intensity ion beams (eg, ^{238}U @ 34+). High stability and reliability.
- CW RFQ for $1 \leq A/q \leq 7$.
- High resolution magnetic spectrometer.

TAKE ADVANTAGE OF RECENT DEVELOPMENTS FOR HIGH INTENSTY LINACS (SPIRAL2, FAIR, FRIB, ATLAS upgrade)

Pre-design studies

On-going actions at University of Huelva in collaboration with industry (2012-2014)

- Beam dynamics, transport to exp. lines and building integration
- Design studies of ECR, buncher, warm magnets, RFQ, SC QWR, couplers, SC magnets, and criomodules
- RFQ model in Al (one full section) and in Cu (one vane) + brazing tests
- Ion source test bench
- Model of MH Buncher
- Machining and welding tests with Nb
- Parts of one QWR resonator
- Cryogenics Lab for cavity testing, including one multi-propose cryostat
- RF lab for testing resonators
- Specific design of selected elements

Industry & Universities Technology Transfer Project funded by National Government in Spain (5 Universities, 7 large companies, 5 SME's).

Pre-design studies

ECR Source 14/18GHz
HV Platform 250 KV

MHB1 f = 18.125 MHz
MHB2 f = 36.250 MHz

RFQ f = 72.75MHz

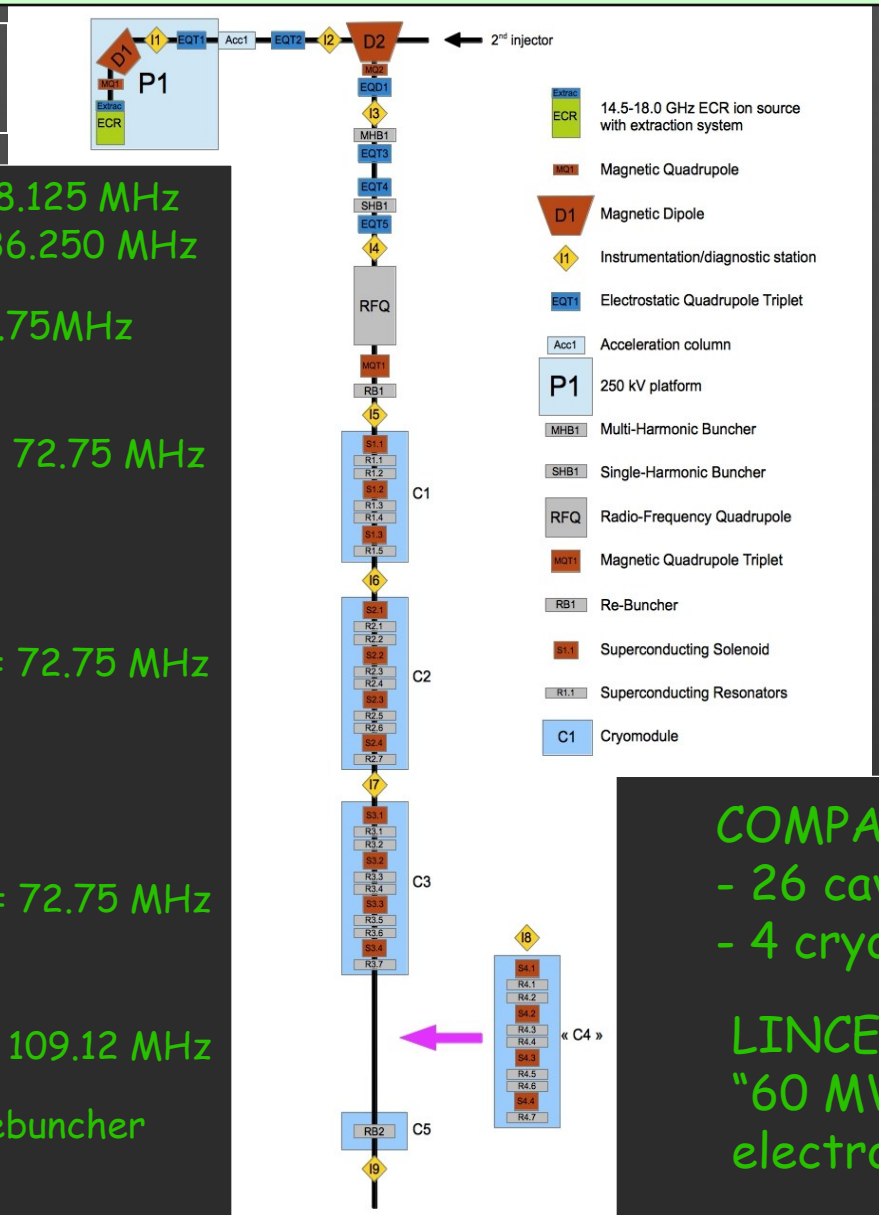
C1: β = 0.045, f = 72.75 MHz

C2: β = 0.077, f = 72.75 MHz

C2: β = 0.077, f = 72.75 MHz

C3: β = 0.15, f = 109.12 MHz

Rebuncher

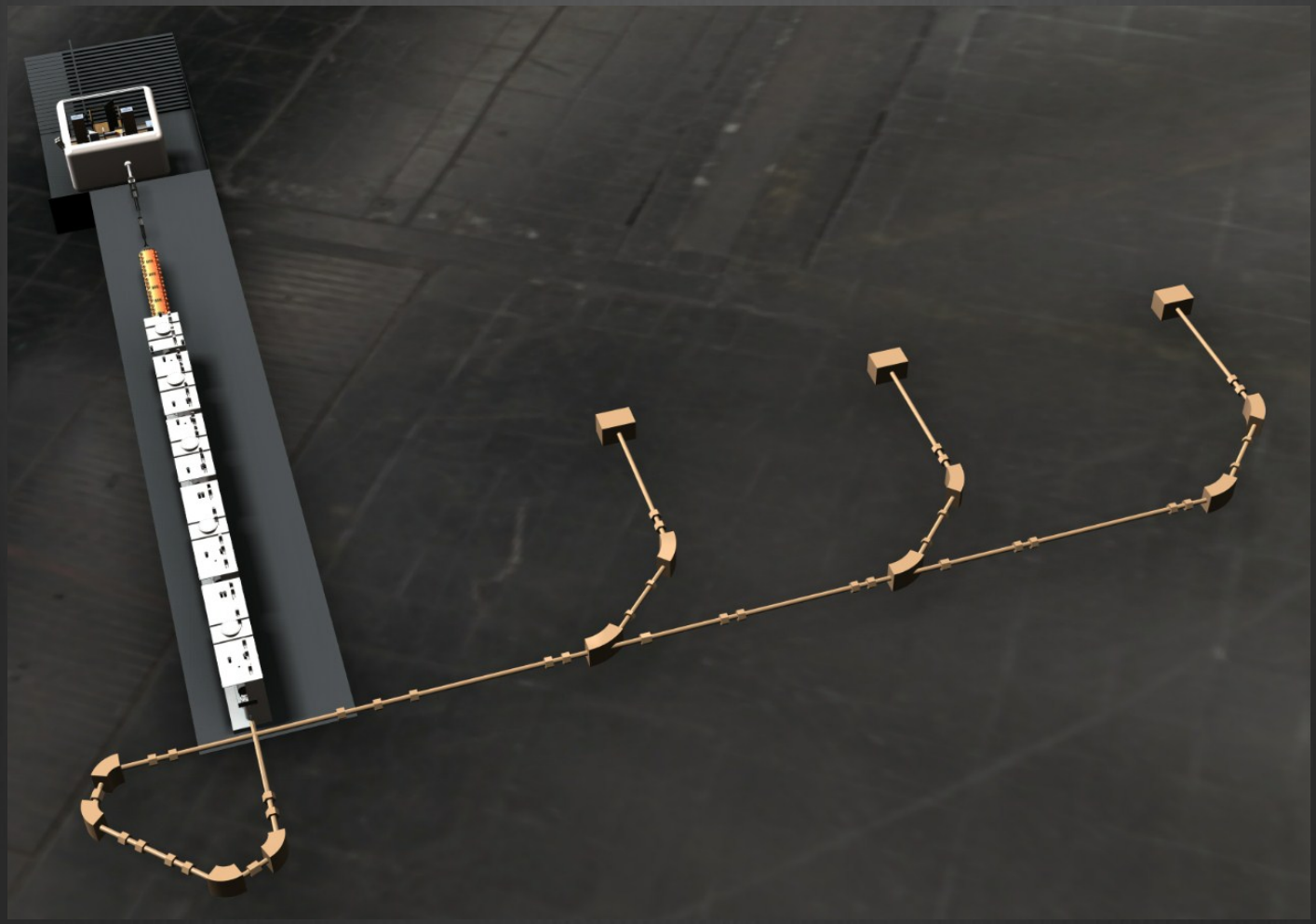


COMPACT DESIGN:
- 26 cavities
- 4 cryomodules

LINCE LINAC:
"60 MV equivalent electrostatic accelerator"

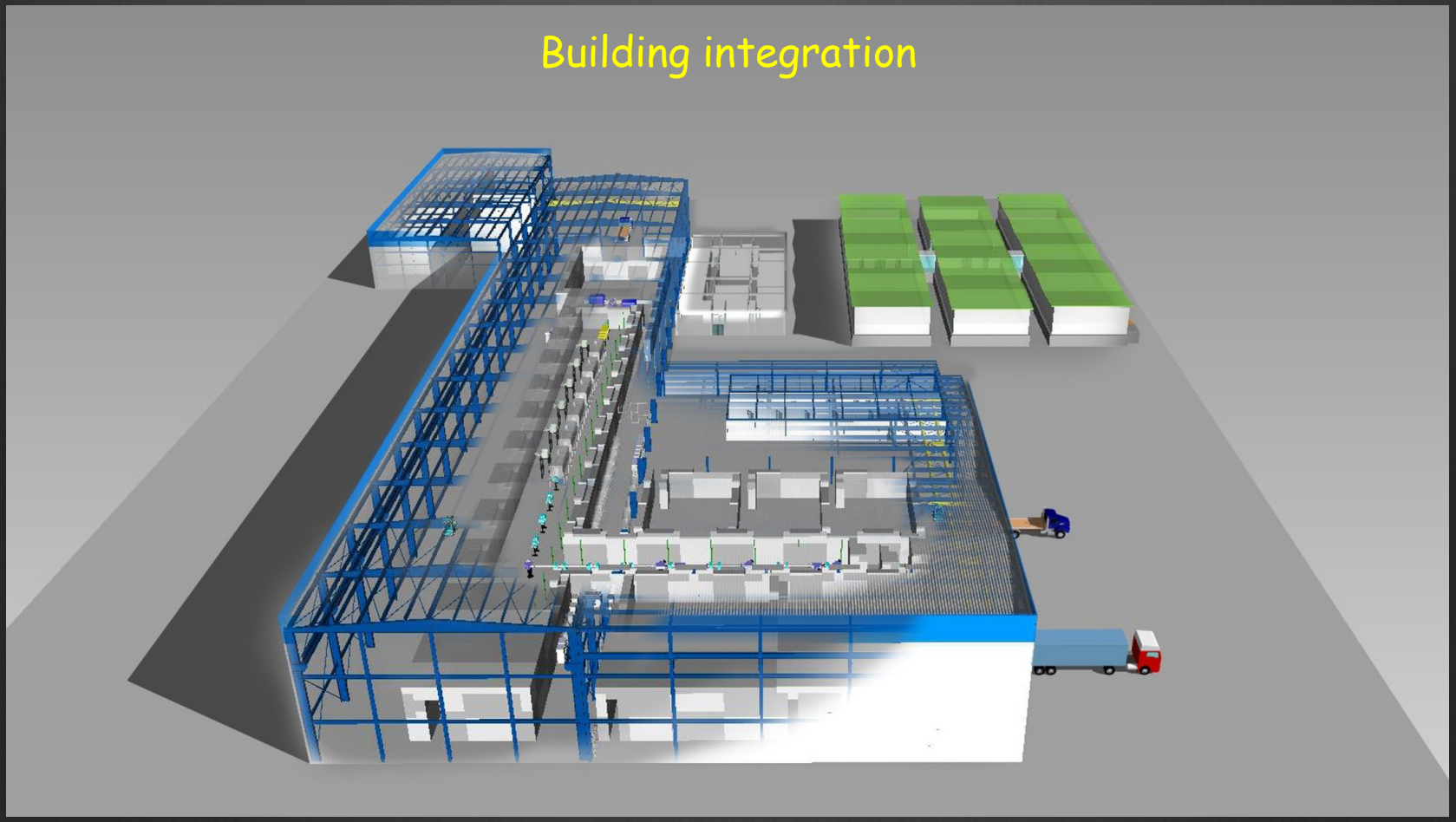
Pre-design studies

LINCE LINAC layout



Pre-design studies

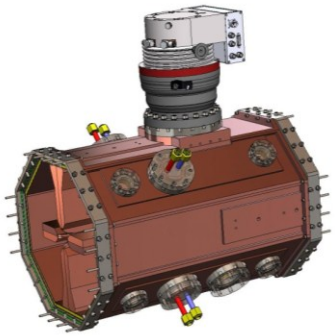
Building integration



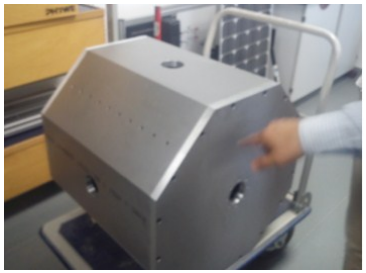
Pre-design studies

Test prototypes designed and fabricated at Univ. Huelva

RFQ



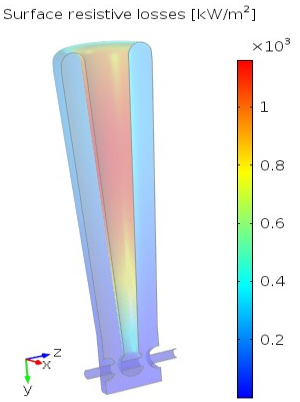
Calculation/design



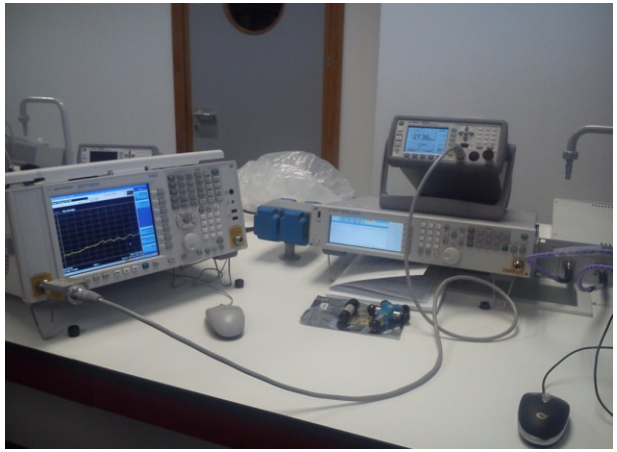
Cold model

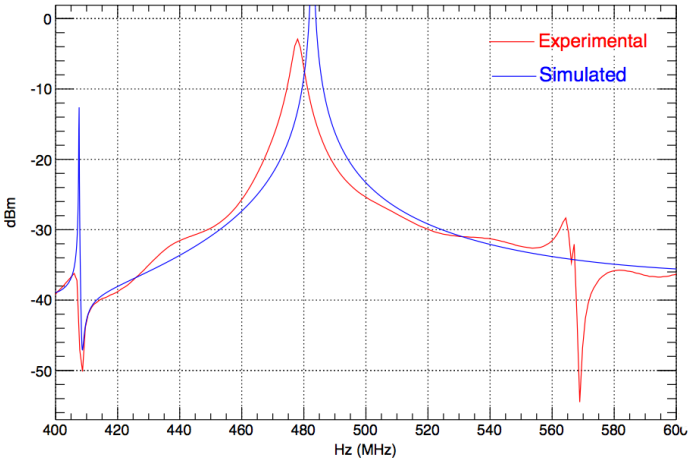
Test model section OFC with LNL (Italy)

QWR beta = 0.045



HIGH-POWER RF LAB AT UNIVERSITY OF HUELVA

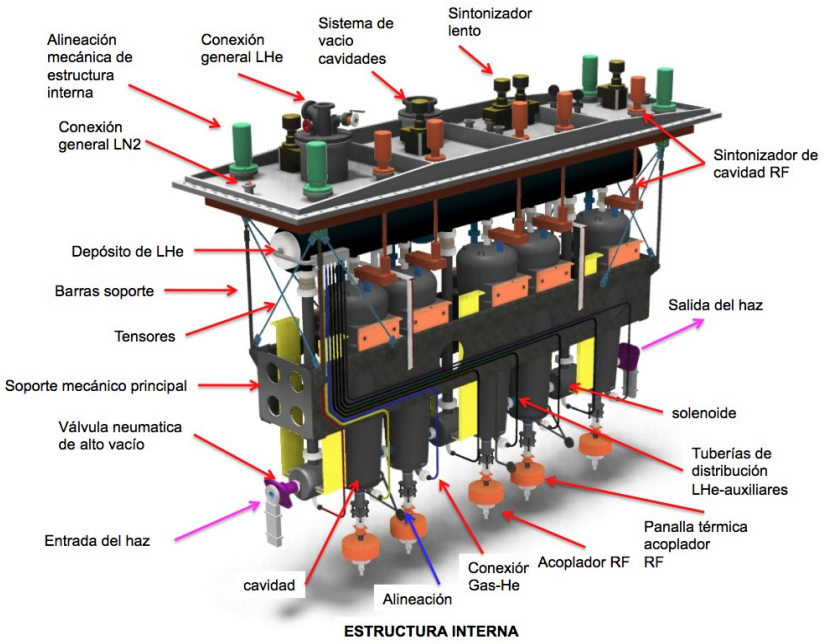




Pre-design studies

Test prototypes designed and produced by local industry

ACCELERATOR Cryomodule design



ESTRUCTURA INTERNA

CRYOMODULE CONSTRUCTION

ECOS-LINCE:
Possible European Sites

…ANY REGION AT THE UNION!!

Why "LINCE" in Spain?

- Spain has no dedicated nuclear physics facility: boost visibility and impact of Nuclear, Particle, Astroparticle physics communities.
- LINCE is an opportunity to build in Spain an European facility with the support of NuPECC Committee and European Labs. (Example: ELI-NP at Romania)
- A young and dynamic group in accelerators/instruments is being formed in Spain (CONECTA).
- Very strong support from Spanish High-Technology Companies and Industrial associations (INEUSTAR, FOE, AIQBE, etc):
  - technology transfer
  - technological return
  - National needs of industry (Aerospace, Medicine, Materials,…)
- Need to invest in reinforcing the R&D activity of Spanish industry to improve competiveness in the international markets, and in particular nuclear and particle physics projects for international collaborations (CERN, FAIR, ILC, ESS, etc).
- Andalusia: "Convergence European region" which qualifies for EU funds in Horizon 2020.
- We can design and fabricate accelerator components → industrial return

- HUELVA, A POSSIBLE SITE FOR LINCE

PARQUE CIENTÍFICO TECNOLÓGICO DE HUELVA (PCTH, Aljaraque)

ENERGY RESEARCH CENTER → INTERACTION WITH INDUSTRY
FORMER LINAC PROJECT- Linac Research Facility

Possible planning & status

Pre-design (going on)	Detailed design HORIZON 2020(?)	Construction	Commissioning
2012-15	2016/18	2019/22	2023

ECOS-LINCE DESIGN STUDY: PARTICIPATION OF NUCLEAR PHYSICS LABORATORIES IN EU

INFRADEV	
Participant	Country
ALBA	Spain
CEA/IRFU	France
CNRS-IPNO	France
FABIS	Spain
GANIL	France
GSI	Germany
IFJ-PAN	Poland
INFN-LNS/LNL	Italy
STFC-Oxford	United Kingdom
UHU	Spain
CERN (* tbd)	Switzerland
TOTAL	**3 Meuro**

WORK PACKAGES	
WP1	**Beam dynamics**
WP2	**Technology of accelerators**
Task 1	Ion source
Task 2	Buncher
Task 3	RFQ
Task 4	Cryomodules & cavities
Task 5	Thin Target developments
WP3	**Post acceleration (FFAG)**
WP4	**Spectrometer**
Task1	Superconducting magnet
Task2	Optical design
Task3	GEM detector
WP5	**Hardware/Software for safe operation**
WP6	**Dissemination and outreach**
WP7	**Site location study**
WP8	**Economical and legal issues**

INFRADEV APPLICATION

INFRADEV APPLICATION:

1. FIRST DRAFT OF APPLICATION IS ALMOST READY: a very important and remarkable effort of the ECOS community during July/August 2014.
2. THE COLLABORATION WAS SETTLED DOWN.

OVERAL BALANCE VERY POSITIVE!!

STILL TO DO:

1. Need of more detail for physics cases and applications.
2. Still to complete missing data and sections.
3. Review of the document: summarize, remove repetitions, redundancies: → suppress about 10-15 PAGES (depends on final version) to fit application.
4. Review of the budget, equilibrate and explain the requested man power and costs, to the activities.
5. Energy booster up to 50-200 MeV/u: decision based on physics.

Present → Huelva Univ. with help of ECOS collaborators (contract/sabbatical of international recognized expert)

INFRADEV APPLICATION

SOME MISSING PARTS:

1.3 Concept and approach

- Describe the positioning of the project e.g. where it is situated in the spectrum from 'idea to application', or from 'lab to market'. Refer to Technology Readiness Levels where relevant. (See General Annex G of the work programme);
- Describe any national or international research and innovation activities which will be linked with the project, especially where the outputs from these will feed into the project;

1.4 Ambition

- Describe the advance your proposal would provide beyond the state-of-the-art, and the extent the proposed work is ambitious. Your answer could refer to the ground-breaking nature of the objectives, concepts involved, issues and problems to be addressed, and approaches and methods to be used.

2. Impact

2.1 Expected impacts

Please be specific, and provide only information that applies to the proposal and its objectives. Wherever possible, use quantified indicators and targets.

Describe how your project will contribute to:

the expected impacts set out in the work programme, under the relevant topic;

improving innovation capacity and the integration of new knowledge (strengthening the competitiveness and growth of companies by developing innovations meeting the needs of European and global markets; and, where relevant, by delivering such innovations to the markets;

Describe any barriers/obstacles, and any framework conditions (such as regulation and standards), that may determine whether and to what extent the expected impacts will be achieved. (This should not include any risk factors concerning implementation, as covered in section 3.2.)

INFRADEV APPLICATION

3. Implementation

3.1 Work plan — Work packages, deliverables and milestones

Please provide the following:

- timing of the different work packages and their components (Gantt chart or similar);
- graphical presentation of the components showing how they inter-relate (Pert chart or similar).

Give full details. Base your account on the logical structure of the project and the stages in which it is to be carried out. Include details of the resources to be allocated to each work package. The number of work packages should be proportionate to the scale and complexity of the project.

You should give enough detail in each work package to justify the proposed resources to be allocated and also quantified information so that progress can be monitored, including by the Commission.

3.3 Consortium as a whole

The individual members of the consortium are described in a separate section 4. There is no need to repeat that information here.

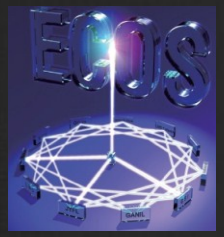
- Describe the consortium. How will it match the project's objectives?
- How do the members complement one another (and cover the value chain, where appropriate)? In what way does each of them contribute to the project? How will they be able to work effectively together?
- If applicable, describe the industrial/commercial involvement in the project to ensure exploitation of the results and explain why this is consistent with and will help to achieve the specific measures which are proposed for exploitation of the results of the project (see section 2.3).

Summary and conclusions

- The actual concept of ECOS-LINCE includes a LINAC system up to 10 MeV/u and an Energy Booster up to 200 MeV/u.
- Although there is an existing report from 2008, physics cases and applications must be updated and new report should be produced.
- A users community should be gather together to make this project a reality.
- A preliminary design of ECOS-LINCE LINAC, including transport to experimental areas, building and needed infrastructures is being carried out within the ECOS group, to be completed by spring 2015.
- As a result, some test infrastructures an expertise are being developed at Huelva University.
- The INFRADEV application is in good shape, still some more effort is needed to finish to complete budgets and the few remaining sections/items.
- Preliminary results of ECOS LINCE design linac (based on SC QWR), including concept design of ion source , RFQ, QWR, Buncher, Tests cryostat and experimental areas was presented at IPAC'14.
- Several talks of ECOS-LINCE have been given recently in Spain (CPAN Meeting December 2013 in Santiago de Compostela, NUSTAR Meeting 2014 in Valencia, CPAN Meeting October 2014 in Seville)

OVERAL BALANCE VERY POSITIVE → WE ARE DOING A VERY GOOD JOB GUYS!!

THANKS !



EURISOL

ENSAR

CPAN
Ingenio 2010

Universidad de Huelva

CENTRO DE INVESTIGACIÓN DE LA ENERGÍA
HUELVA (SPAIN)