

TASCA 12

11th Workshop on

Recoil Separator for Superheavy Element Chemistry

September 14, 2012

GSI, Darmstadt, Germany

A new heavy-ion accelerator lab at University of Huelva

I. Martel

University of Huelva



CENTRO DE INVESTIGACIÓN
DE LA ENERGÍA
PCTH –HUELVA (SPAIN)



ENERGY RESEARCH CENTRE

The main objective of the Energy Research Centre (CIE): promoting technical and scientific research of excellence, with specific emphasis in the development of **renewable energies, fundamental research on structure of matter, and the transfer of technologies to industry: energy, aerospace, health, and new materials.**

- Fundamental and applied research
- Investment in scientific infrastructures
- **University research centre**/ international users

<http://www.uhu.es/gem/CIE/>

Promoted by University-UHU and Technological Park –PCTH & research groups:

Engineering School –ETSI

FQM318 “Structure of Matter” (Applied Physics Department)

TEP 192: “Control and Robotics” (Dep. DIESIA)

TIC165: “Electronics Systems and Mechatronics” (Dep., DIESIA)

TEP 182: “Electro-technology and electronics” (Electrical engineering Department)

Hospital Juan Ramón Jiménez -Huelva: CTS 616: “Health research & oncology ”

Ciemat -Madrid: “Fusion Technology”

CSIC-Madrid: “Structure of Matter”



CIE-ORGANIZATION

The constitution of the Energy Research Centre was approved by Government Council of University of Huelva 20 December 2011,

- More than 50 permanent researchers/ 5 groups
- Administration and technical staff

Administrative structure → “University Research Centre” [Centro de Investigación Universitario](#)

- Vice-president of Research
- Government of the Centre:
 - Government Council: researchers and representatives.
 - Director, Deputy director, Secretary
 - Department representatives
 - Consultants: Research projects and technology transfer, Scientific Committee, Consultant Council

DIRECTOR		
DEPARTMENTS		
Nuclear Technology and Structure of Matter	Modelling, instrumentation and control of renewable energy systems	Quality control of electrical power, energy efficiency and distributed generation
32 scientists	16 scientists	10 scientists
SCIENTIFIC INFRASTRUCTURES		



LINAC RESEARCH FACILITY

User oriented facility for producing intense HEAVY ION BEAMS for basic research on nuclear physics and applications. **UNIVERSITY FACILITY** (→students/masters/PhDs/etc).

→ OPEN INTERNATIONAL COLLABORATION ←

<http://www.uhu.es/gem/LRF/>

High intensity superconducting linac.

- Wide range of heavy ions
- Wide range of energies, from keV/u ~15 MeV/u
- Maximum intensity for HI (~100uA, ⁴⁰Ar)
- protons up to 30 MeV (~1 mA); up to 70 MeV (nA)

PROGRAM: Basic nuclear physics

- Nuclear reactions and spectroscopy with stable, high intensity, beams:
→European **ECOS** initiative for high energy accelerators:

Super-heavy ion physics & Nuclear astrophysics

→ long periods of beam time demanded

Nuclear structure studies at low medium and high-spin

Clusters and molecules in nuclei

Ground-state properties

Near barrier transfer and fusion

IGISOL type ion source: stopped beams (beta-decay, beta-particle, masses, etc).



APPLIED PHYSICS AND INDUSTRY

Project driven by applications and industry:

Health/Hospitals :

- Development of radiopharmaceuticals for cancer therapy
- Treatment of tumours by proton irradiation (proton therapy)

→ Proton-therapy & radio-pharmacy industry

Aerospace:

- Development and certification of electronics for aerospace.

→ Aerospace industry (AEROPOLIS, INTA,)

New materials:

- Microfilters/membranes for industry.
- Surface modification by ion implantation.

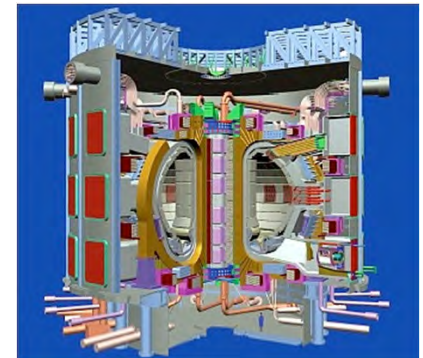
→ Semiconductor, biomedical, petrol industry (AIQB, CEPSA,)

Renewable energy:

- Development of technologies for fusion energy production (international projects ITER, DEMO).

→ Energy industry (IBERDROLA, ENDESA, EMPRESARIOS AG,...)

Radio-nuclide	Half-life	E mean (keV)	E _γ (keV)	Range
Y-90	64 h	934 β	-	12 mm
I-131	8 days	182 β	364	3 mm
Lu-177	7 days	134 β	208, 113	2 mm
Tb-161	7 days	154 β 5, 17, 40 e ⁻	75	2 mm 1-30 μm
At-211	7.2 h	5870 α	-	45 μm
Tb-149	4.1 h	3967 α	165,...	25 μm
Er-165	10.3 h	5.3 e ⁻	-	0.6 μm





EUROPEAN UNION ERDF PROGRAM: European Regional Development Funds

- UNDEVELOPED REGIONS OF EUROPE (HUELVA)
- EU: > 75 % COST SUPPORT OF INFRASTRUCTURE
- PARTICIPATION OF LOCAL INDUSTRY

FINANCIACIÓN UE-FEDER		M euro	2011	2012	2013	2014	2015	2016	2017
INNPLANTA 2010	BUILDINGS	10.8							
INNPLANTA 2011	ACCELERATOR	15.4							
ININTERCONECTA-12	I+D+i	9							
INTERREG 2012	PROTONTHERAP.	10							
INNPLANTA 2012	FUSION TECH.	7.1							
?? UE 2013, 2014 ??, etc	Commissioning								

LRF- CONSTRUCTION PHASES

	Características	COSTE /Tiempo	Comentarios
FASE 1 Aeroespacio, Energía, Materiales	20 MeV protones 9 A MeV iones Pesados	15.5 Meur 3/4 años	Auxiliares, Cryogenia, Fuente de iones, LEBT, RFQ, 14 x SC + criomódulos, 2 x líneas de haz
FASE 2 Radioisótopos	55 MeV protones 15 A MeV iones pesados	6 Meur 3 años	14 x SC + criomódulos, Ext. Cryogenia, areas experimentales completas
FASE 3 Protonterapia/IGISOL	72 MeV protones 18 A MeV iones pesados	4 Meur 2 años	7 x SC + criomódulos



IMPACT ON LOCAL ECONOMY

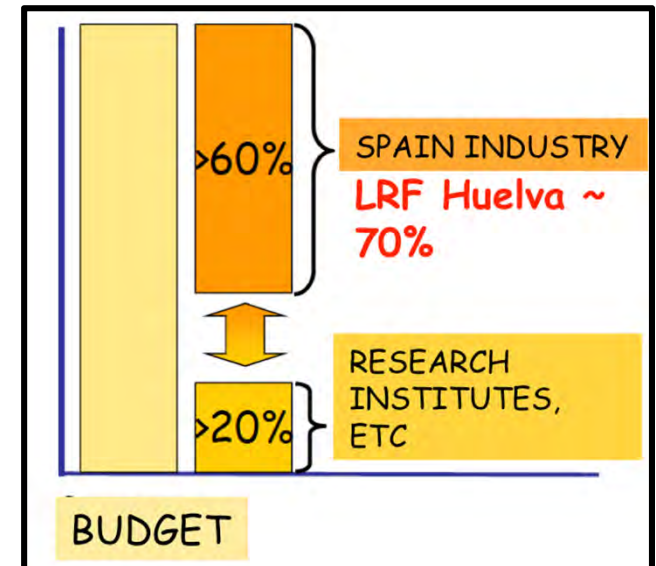
-JOB CREATION

-IMPROVE AND DEVELOP INDUSTRIAL CAPACITIES ON ACCELERATOR TECHNOLOGY AT EU & LOCAL INDUSTRY

-PARTICIPATION IN LARGE SCIENTIFIC INFRASTRUCTURES

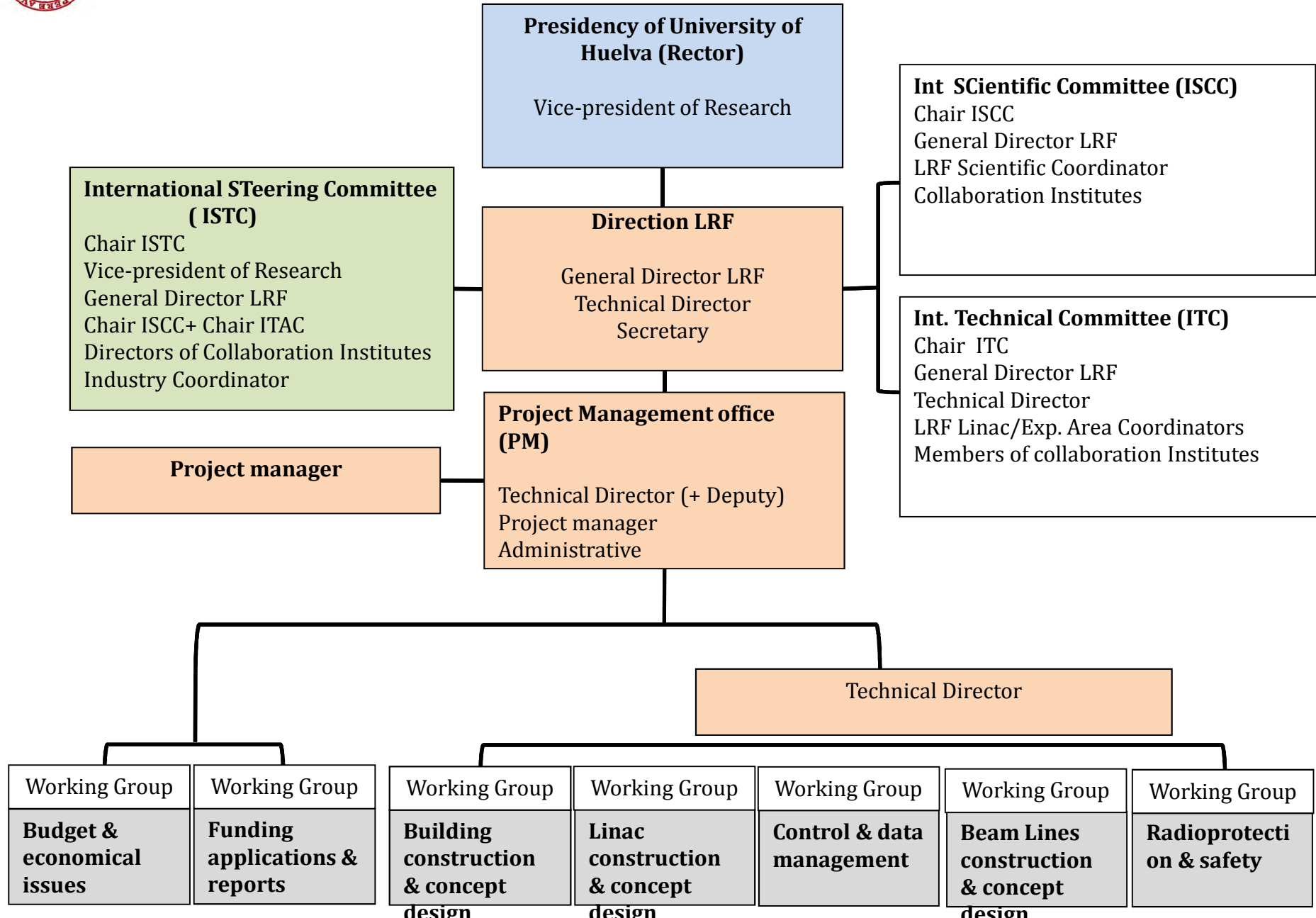
→ “INDUSTRY OF SCIENCE” ←

ACS, France	IBERDROLA, Spain
ADEVICE, Spain	IDOM, Spain
AIR LIQUIDE, France & Spain	I2FACTORY, Spain
ALTER TECHNOLOGY, Spain	INDRA, Spain
APLICACIONES TECNOLÓGICAS, Spain	INGESER, Spain
A-V-S, Spain	JEMA, Spain
CIBERNOS, Spain	LINDE KRYOTECHNIK AG, Switzerland & Spain
CRIO LAB, Portugal	PANTECHNIK, France
EBS Group, Italy & Spain	PRAXAIR, EEUU & Spain
ELYTT ENERGY, Spain	SEVEN SOLUTIONS, Spain
EMPRESARIOS AGRUPADOS, Spain	THARSIS TECHNOLOGY, Spain
	TTI NORTE, Spain





CONSTRUCTION & COMMISIONING PHASE



Presidency of University of Huelva (Rector)

Vice-president of Research

International Steering Committee (ISTC)

Chair ISTC
Vice-president of Research
General Director LRF
Chair ISCC+ Chair ITAC
Directors of Collaboration Institutes
Industry Coordinator

Direction LRF

General Director LRF
Technical Director
Secretary

Int Scientific Committee (ISCC)

Chair ISCC
General Director LRF
LRF Scientific Coordinator
Collaboration Institutes

Int. Technical Committee (ITC)

Chair ITC
General Director LRF
Technical Director
LRF Linac/Exp. Area Coordinators
Members of collaboration Institutes

Project manager

Project Management office (PM)

Technical Director (+ Deputy)
Project manager
Administrative

Technical Director

Working Group

Budget & economical issues

Working Group

Funding applications & reports

Working Group

Building construction & concept design

Working Group

Linac construction & concept design

Working Group

Control & data management

Working Group

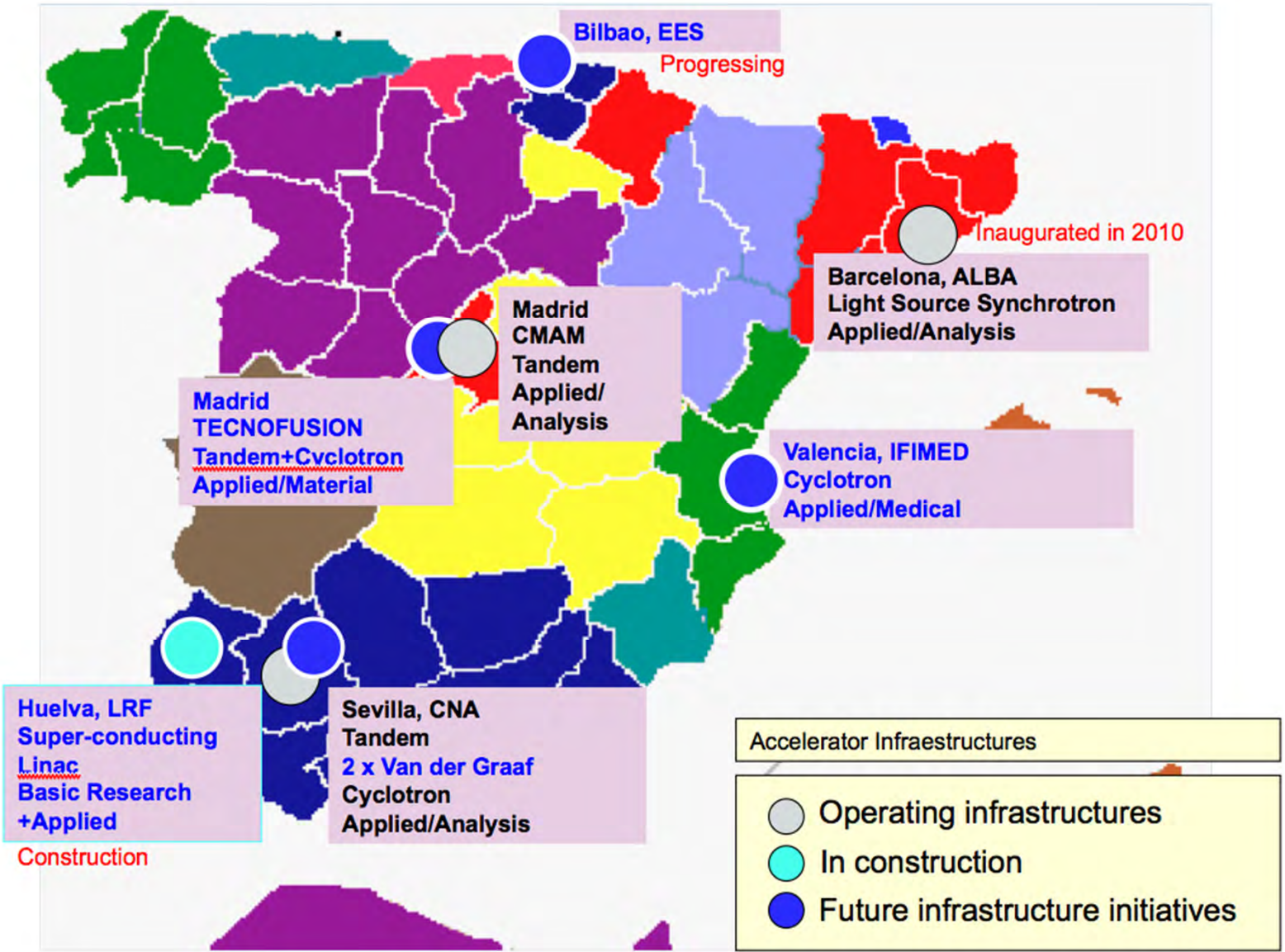
Beam Lines construction & concept design

Working Group

Radioprotection & safety

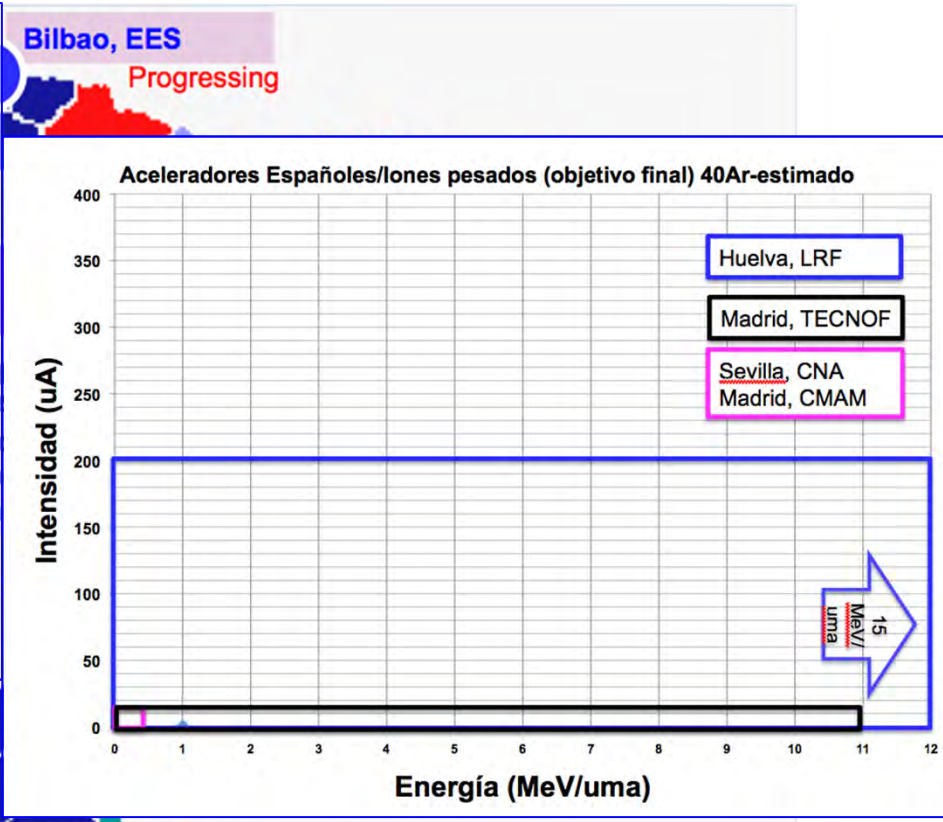
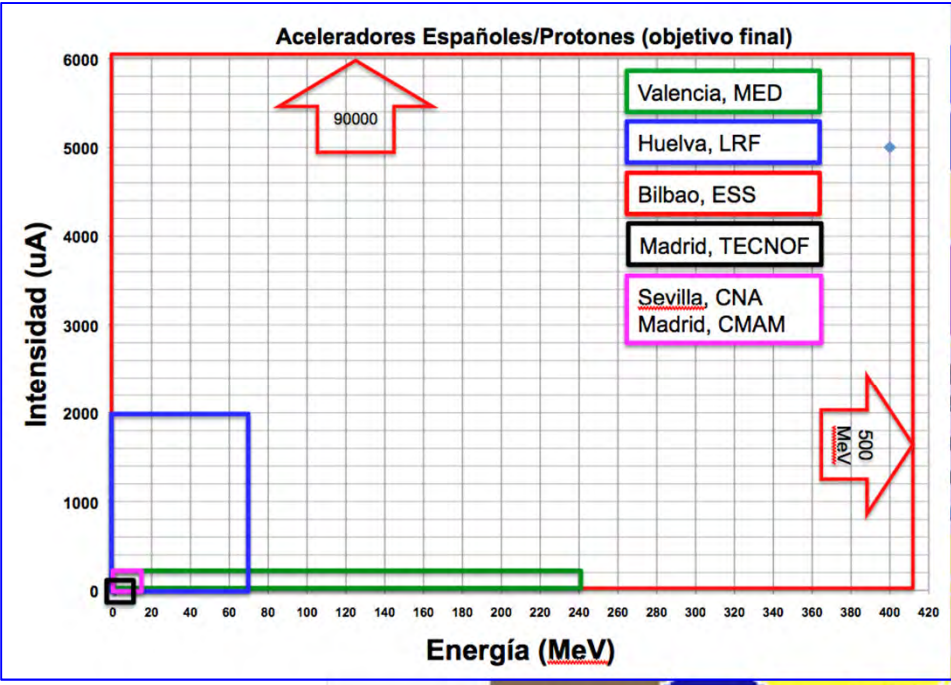


SINERGIES WITH COMPLEMENTARY PROJECTS IN SPAIN





SINERGIES WITH COMPLEMENTARY PROJECTS IN SPAIN



Huelva, LRF
Super-conducting
Linac
Basic Research
+Applied
Construction

Sevilla, CNA
Tandem
2 x Van der Graaf
Cyclotron
Applied/Analysis

Accelerator Infraestructures

- In construction
- Future infrastructure initiatives
- Operating infraestructures

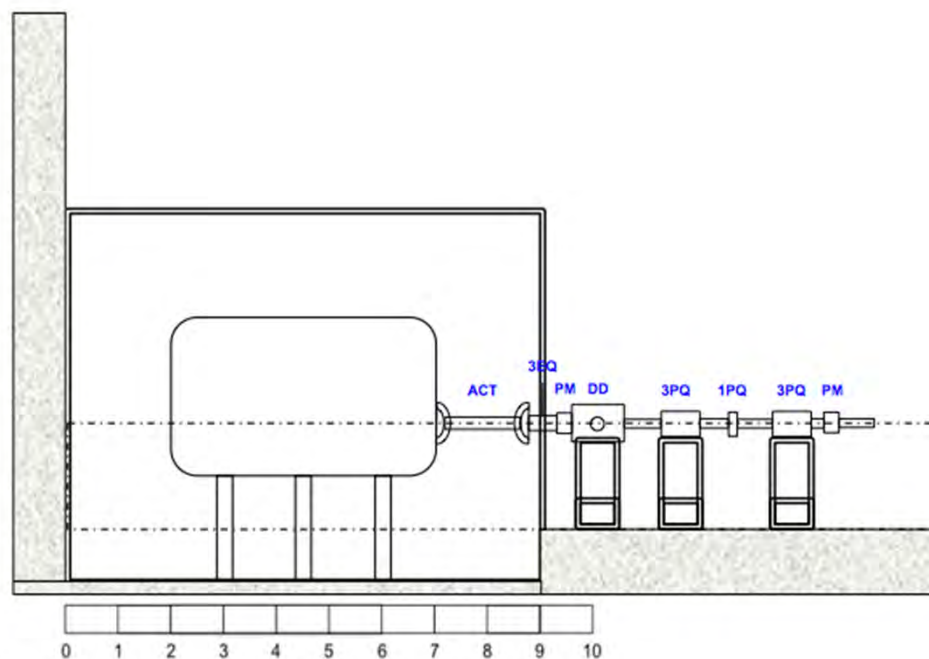


ION SOURCE & INTENSITIES

Similar system to LEGIS del Laboratori Nazionali di Legnaro (*Review of Scientific Instruments* 81 (2010) 02A315).

Wide range of ions & high intensity: Commercial options/ ECR ion source (Pantechnik).

H 1+: 2 mA	Kr 1+: 1 mA
H ₂ 1+: 1 mA	Kr 14+: 15 μA
H ₃ 1+: 500 μA	Ag 4+: 250 μA
He 1+: 2 mA	Ag 20+: 4 μA
He 2+: 1 mA	Xe 1+: 500 μA
C 1+: 500 μA	Xe 26+: 5 μA
C 4+: 50 μA	Ta 14+: 4 μA;
C 6+: 3 μA	Ta 20+: 0.8 μA
N 1+: 1 mA	Au 26+: 10 μA
N 6+: 10 μA	Au 32+: 0.2 μA
O 1+: 1 mA	Pb 20+: 10 μA
O 6+: 200 μA	Pb 27+: 1 μA
Ne 1+: 1 mA	
Ne 8+: 25 μA	→ ²³⁸ U 28+: 1 μA
Al 7+: 30 μA	→W 25+: 1-2 μA
Si 9+: 20 μA	
Fe14+: 20 μA	→ Emittance 4 RMS < 0.3 mr
Ar 1+: 1 mA	→ Good intensity stability (< 6%/2h)
Ar 14+: 1 μA	





PRELIMINARY LINAC PARAMETERS AND CONFIGURATION

LRF-Huelva (P. Ostroumov, ANL)

Specifications:

- High intensity Heavy ion accelerator up to 15 MeV/u (40Ar 200uA, 130Xe 10 uA)
- H, D 1mA, 30 MeV; H, 1uA 72 MeV

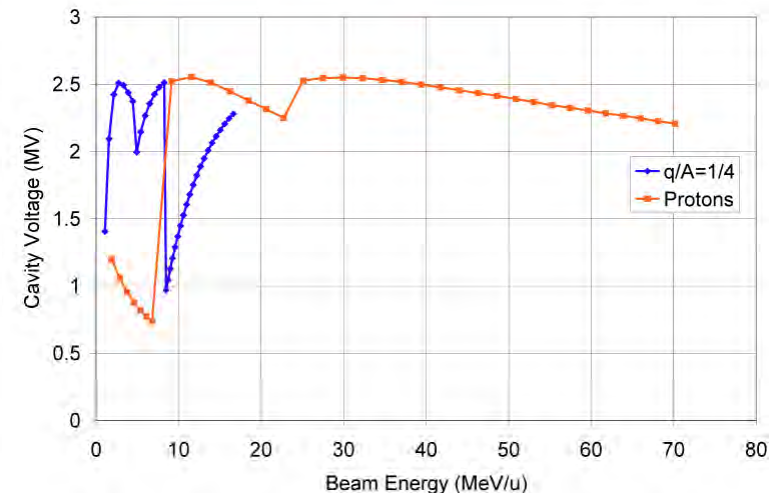
→ limited by ECR ion source

Configuration :

- Ion source + Low Energy Beam Line
- 400 kV HV platform → (ion implantation & LE astrophysics)
- MBH: Multi Harmonic Buncher
- RFQ: “Radio Frequency Quadrupole” accelerator (injector)
- 35 SC cavities

Table 5. Main parameters of the Linac

	Frequency, MHz	β_{OPT}	Number of cavities	Comments
MHB*	36.375 (the 1 st harmonic)	N/A	1	
RFQ	72.75	N/A	1	Based on ANL 60.625 MHz RFQ
QWR1	72.75	0.077	7	Design is available as ANL/ATLAS upgrade cryomodule
QWR2	109.125	0.15	7	Design is available as ANL/ATLAS upgrade cryomodule
HWR	181.875	0.25	14	Prototype cavity ($f=170$ MHz) was demonstrated at ANL





LOCATION



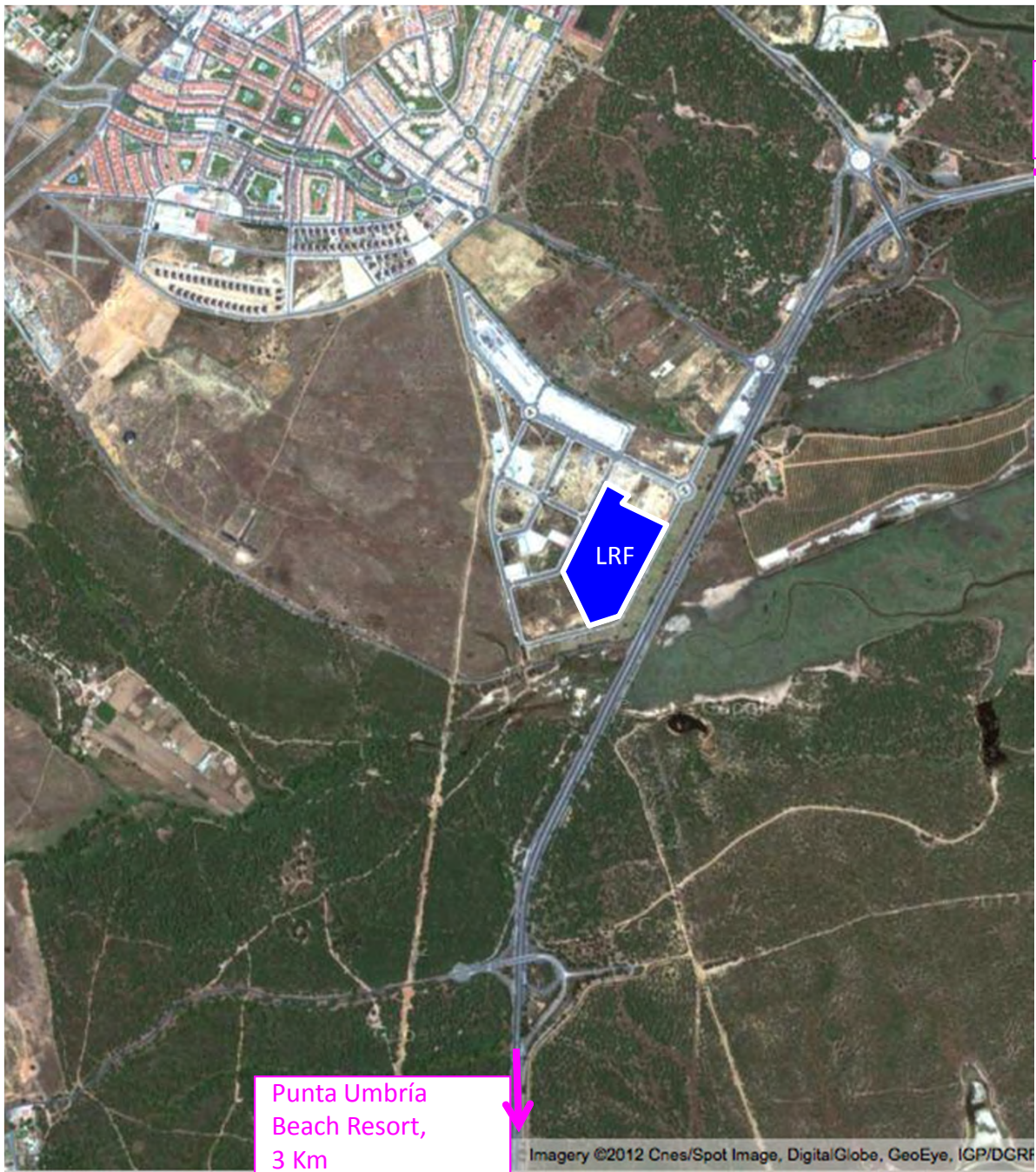
Huelva

© 2012 Cnes/Spot Image
© 2012 Tele Atlas
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Google

Google earth

38°49'49.71" N 4°02'21.94" W elev 556 m

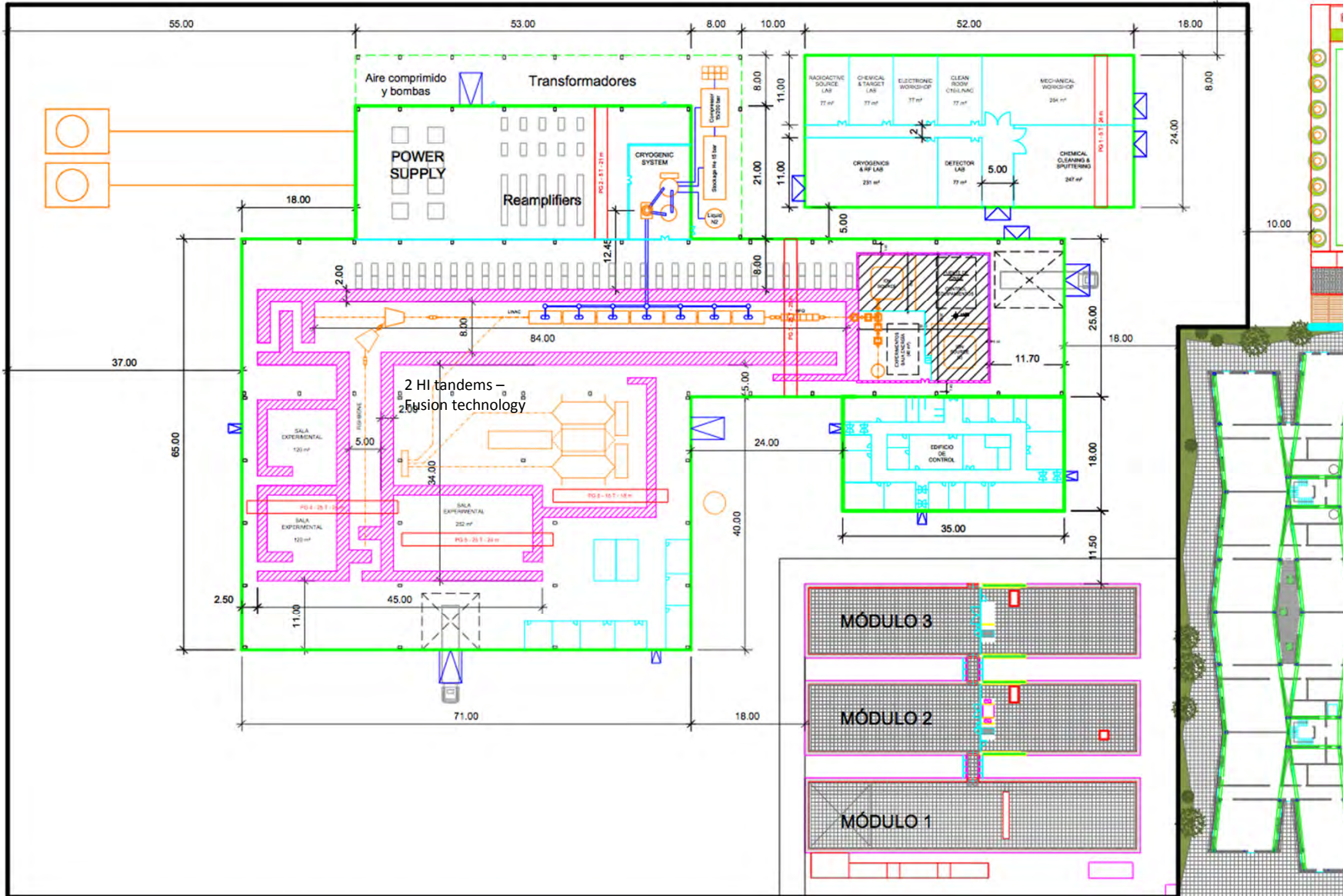
Eye alt 1318.04 km



Huelva City
3 Km

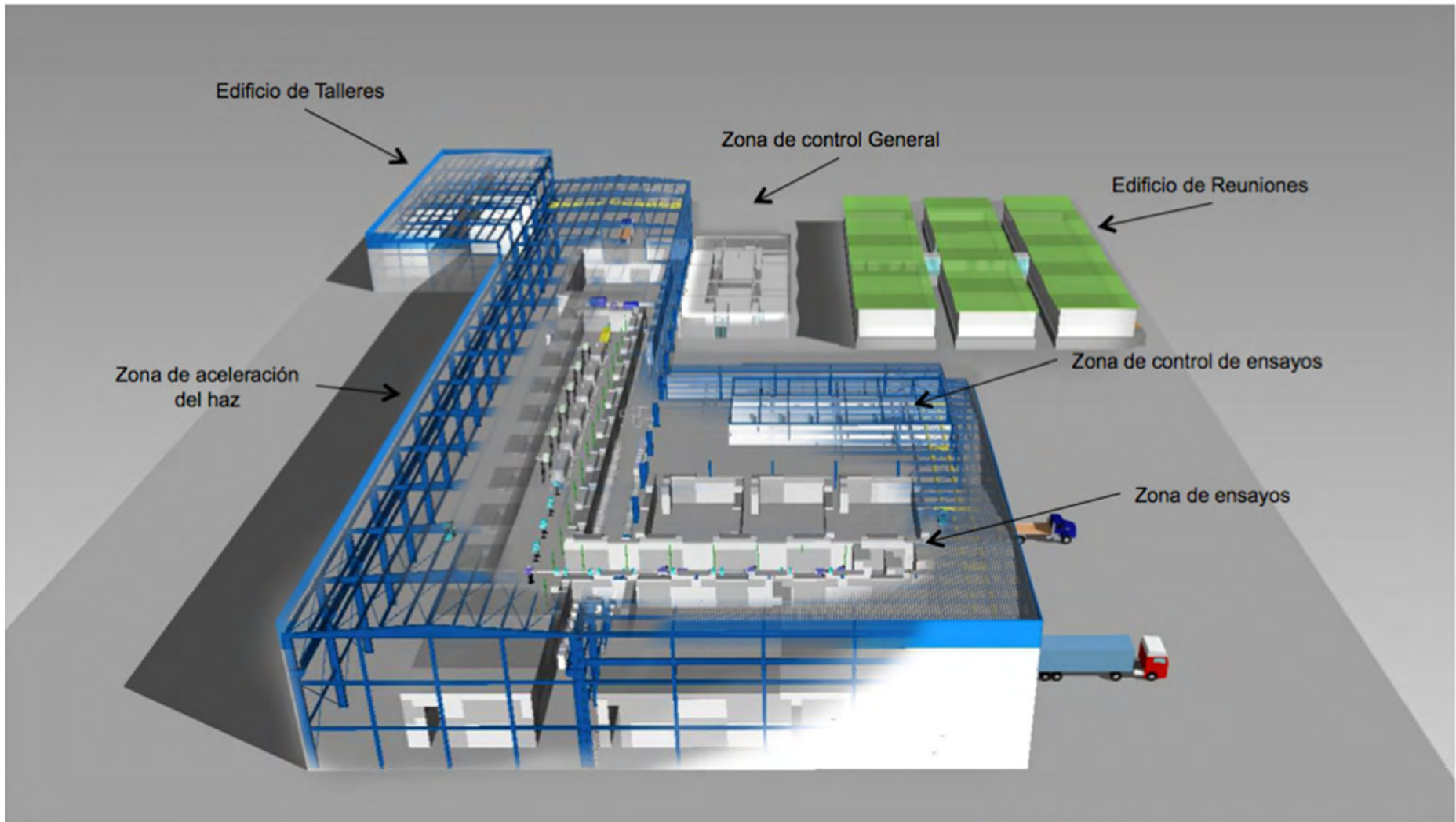


Punta Umbría
Beach Resort,
3 Km



COURTESY OF ALGAIDA S.L.

I. Martel, University of Huelva (Spain)



COURTESY OF IDOM S.A.



SUMMARY & CONCLUSIONS

A new superconducting high-intensity heavy-ion linac is being build at University of Huelva:

- High Intensity Superconducting Linac as base design (from the beginning)
- Using most modern SC technology (ANL, Spiral2, LNL, ...)
- Large range of ions & high intensities

→ **LRF STAGE: @ STARTING POINT**
 → **OPEN COLLABORATION/ MACHINE CAPACITIES**

<http://www.uhu.es/gem/CIE/>
<http://www.uhu.es/gem/LRF/>

International collaboration:

ANL - Chicago, USA
 CEA-Saclay, France
 CENBG – Bordeaux, France
 CIEMAT-Madrid, Spain
 CMAM-Madrid, Spain
 CNA-Seville, Spain
 CSIC-Madrid, Spain
 FSU-Tallahasee, USA
 FLNR-Dubna, Russia
 GANIL-Caen, France
 GSI-Darmstadt, Germany

Hospital JRJ-Huelva, Spain
 HIL-Warsaw, Poland
 IFIC-Valencia, Spain
 ISOLDE/CERN-Geneva, Switzerland
 IPN-Orsay, France
 KU-Leuven, Belgium
 LNL-Leñaro, Italy
 LNS-Catania, Italy
 ORNL-Tennessee, USA
 RBI-Zagreb, Croatia
 Univ. Birmingham, UK
 Univ, Complutense-Madrid, Spain

Univ. Edimburg, UK
 Univ. Granada, Spain
 Univ. Huelva, Spain
 Univ. Ioannina, Greece
 Univ. Jyväskylä - JYFL, Finland
 Univ. Padua, Italy
 Univ. Salamanca, Spain
 Univ. Seville, Spain
 Univ. UNED-Madrid, Spain
 Univ. UPV-Bilbao, Spain
 Univ. Surrey, UK
 Univ. York, UK
 (...)

