ISRS Collaboration meeting

ISOLDE Superconducting Recoil Separator

09:00	**ISRS Project Status, funding, and planned activities.**	*Ismael Martel*
	Video conference	09:00 - 09:30
	Status of the CERN 90.deg CCT dipole magnet	*Glyn Kirby*
	Video conference	09:30 - 10:00
10:00	**Physics of AGATA and ISRS**	*Andrea Gottardo*
	Video conference	10:00 - 10:30
	Coffee break	
	Video conference	10:30 - 11:00
11:00	**Study of beam dynamics, injection, and extraction**	*Javier Resta Lopez*
	Video conference	11:00 - 11:30
	Buncher system	*Ibon Bustinduy et al.*
	Video conference	11:30 - 12:00
12:00	**Straight solenoids and cryostats**	*Ismael Martel et al.*
	Video conference	12:00 - 12:30
	Lunch break	
	Video conference	12:30 - 13:00
13:00	**Magnetic measurement system**	*Mr Ben Shepherd*
	Video conference	13:00 - 13:20
	Focal plane detectors	*Olof Tengblad*
	Video conference	13:20 - 13:40
	Open discussion	*Ismael Martel*
	Video conference	13:40 - 14:00
14:00	**SAC meeting**	*Sean John Freeman*
	Video conference	14:00 - 15:00
15:00		

MINISTERIO DE CIENCIA E INNOVACIÓN
Plan de Recuperación, Transformación y Resiliencia
Financiado por la Unión Europea NextGenerationEU
CERN
ISOLDE

ISRS Project Status, funding, and planned activities.

R&D Project for the Isolde Superconducting Recoil Separator

Funding from Spain

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I. Bustinduy, J.L. Muñoz
Consorcio para la Construcción, Equipamiento y Explotación de la sede Española de la Fuente Europea de Neutrones por Espalación ESS-Bilbao, 48160 Derio, Bizkaia, Spain

ISOLDE SUPERCONDUCTING RECOIL SEPARATOR

History

- Presented at 84th Meeting of the ISCC, 2019.
- First paper on ISRS beam dynamics published: C. Bontoiu et al., Nucl. Ins. Meth. A 969 (2020)
- Letter of Intent INTC-I-2283 (the LOI) approved in February 2021.
- December 2021, Spanish Ministry of Science and Innovation grants 6 M€ to the Spanish Institutions participating in CERN experiments: ATLAS, CMS, ISOLDE, LHCb and n_TOF. Funding: EU/RRF.
- ISOLDE ISRS: 3 M€ for R&D activities, deadline: December 31, 2025.
  - ✓ University of Huelva (UHU, Coordinator)
  - ✓ University of Valencia (UV)
  - ✓ Instituto de Estructura de la Materia, CSIC, Madrid (IEM/CSIC)
  - ✓ Consorcio para la Construcción, Equipamiento y Explotación de la sede Española de la Fuente Europea de Neutrones por Espalación ESS- Bilbao (ESSB)
- Administrative procedure expected to be completed before the end of July 2023.

→ ISRS R&D Project

PHYSICS OPPORTUNITIES

Physics working group

- Coulomb breakup/dissociation
- Direct transfer reactions in inverse kinematics
- Multinucleon transfer reactions
- Fusion-evaporation reactions in inverse kinematics
- Low energy transfer, breakup and fusion reactions

Minimum spectrometer requirements	
Parameters	Values
Momentum acceptance	±10%
Resolving power $p/\Delta p$	2000
Angular acceptance	±10°
Angular resolution	0.1°
Solid angle	100 msr
Charge resolution $\Delta Q/Q$	1/70 (FWHM)
Mass resolution $\Delta M/M$	1/250 (FWHM)
Rotation	0 – 70°

- ✓ Nuclear structure studies around N≈ 82, 126.
- ✓ Reactions relevant for the *s, p* and *rp* process nucleosynthesis around Z ≈ 50 and Z ≈ 82.
- ✓ Neutron-rich nuclei in Terra Incognita (^{78}Ni, r-nuclei ~N=126).
- ✓ Shell-quenching and the r-process.
- ✓ Reaction dynamics studies, collective phenomena, nucleon-nucleon correlations.

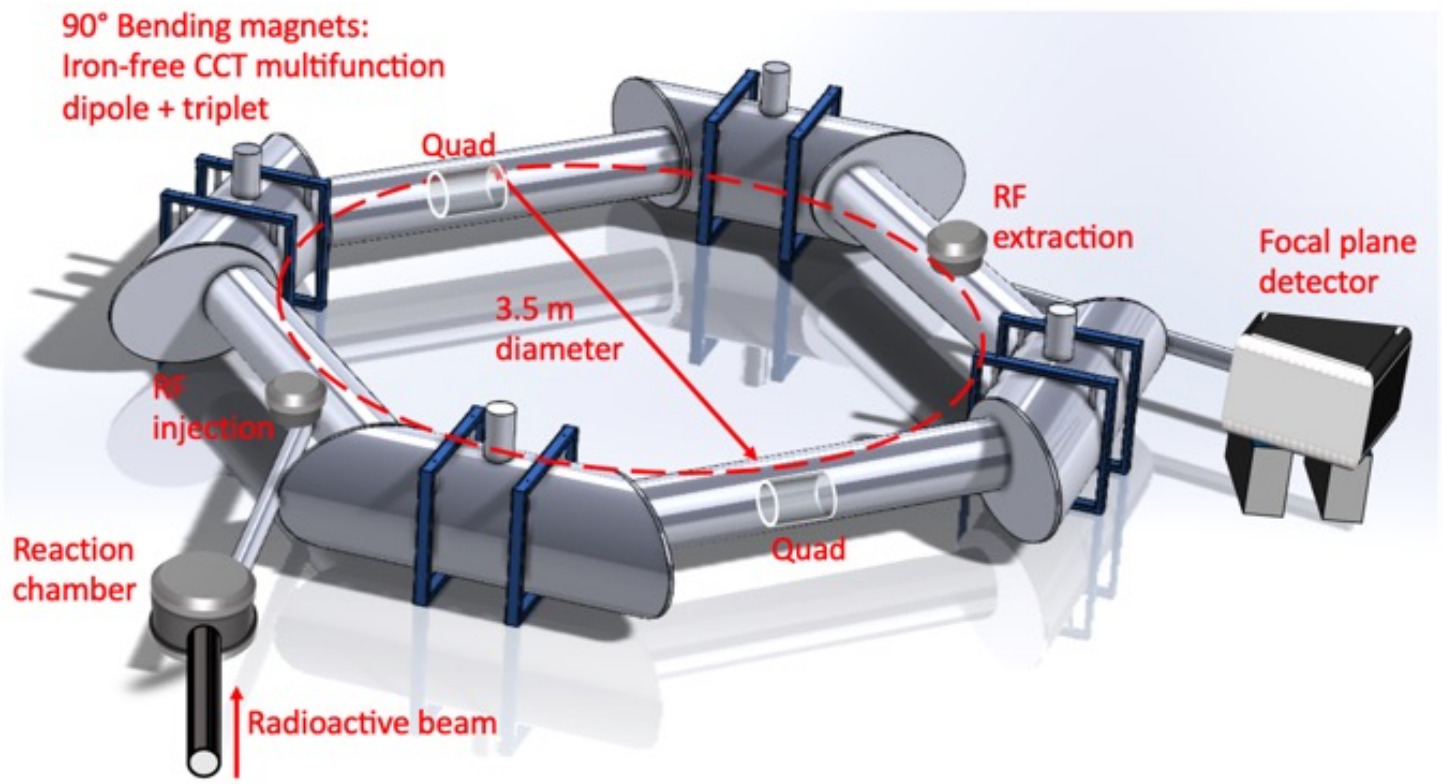
ISRS – coupled to detector arrays

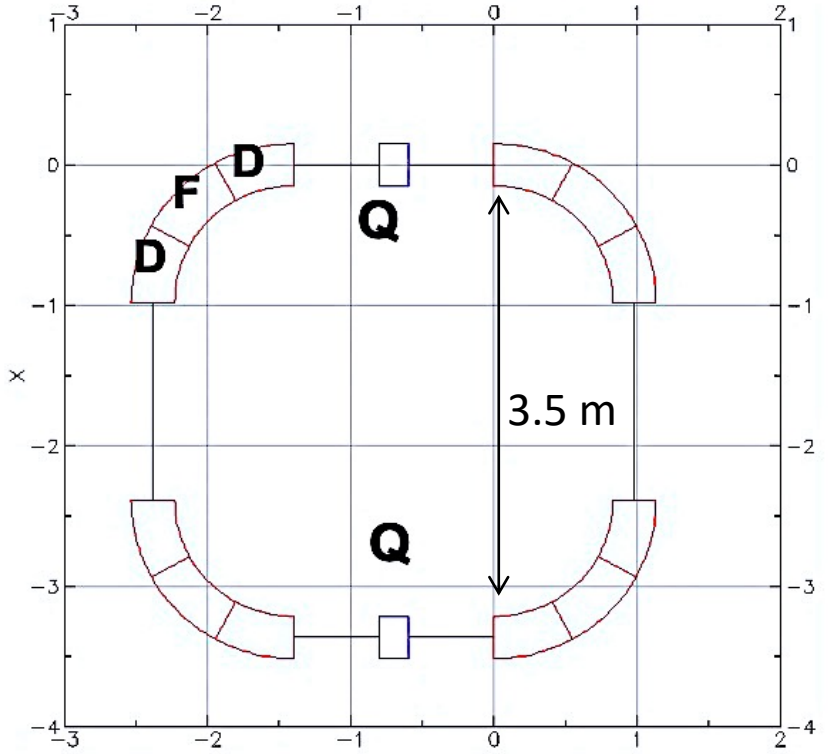
- ISS
- MINIBALL
- SEC
- SAND

- AGATA

Andrea Gottardo presentation

ISRS CONCEPT

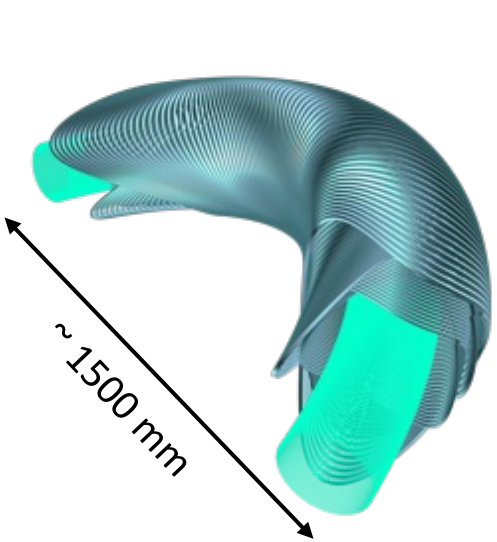


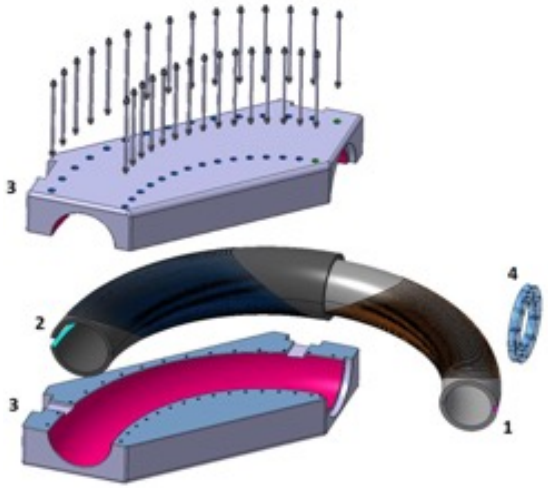


- Fixed Field Alternating Gradient → accepts large divergence and momentum spread
- Superconducting magnets → reduced size, mass, large fields
- Multifunction magnets (dipole, quad., sextup.) → compact magnets
- Canted Cosine Theta (CCT) → reduce field errors, easier design/ fabrication
- Iron free (magnetic shield) → reduced thermal mass, weight, non-linearities
- Cooling by cryocoolers → easier operation, displacement (rotation)
- **Multi-harmonic buncher** → adapt HIE-ISOLDE beam structure for ISRS operation

ISRS MAGNETS: Canted Cosine Theta (CCT) coils

Single 90° sector



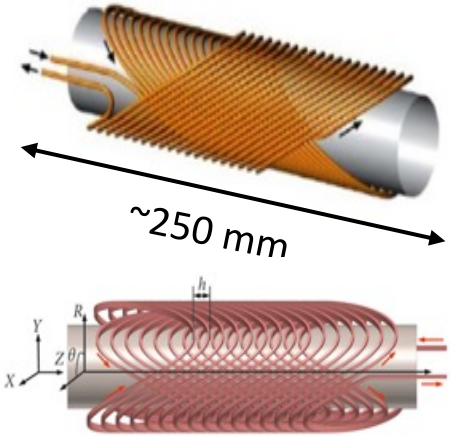


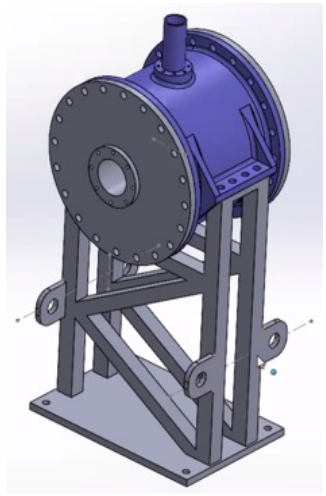
G. Kirby et al., IEEE Tran.App.Sup. 23(2022)1-5

- Single unit for 90 degree bending
- Being develop at CERN
- Technology development
- Collaboration with ISRS (beam dynamics, specifications, …)

Glyn Kirby presentation

Straight solenoids





L. Zhou et al., Hindawi Shock and Vibration 2021, 8895136

- Three (or more) units for 90 degree bending
- Accessible to industry
- Setup collaboration with APC, INFN, CERN,…

Present project using Spain funds
→ Discussion “Straight solenoids and cryostats”

COMPREHENSIVE DESIGN STUDY

- Physics cases
  - Selected cases for simulations
  - Reaction calculations
- Beam dynamics
  - Prove A/Q resolution
    - ✓ High-momentum acceptance
    - ✓ Isochronous
  - High order corrections
  - Best configuration
  - Buncher
  - ISRS prototype (RRF)
- Injection/extraction system
  - Fast RF ~ ns / Slow RF ~ us
  - SuShi (solenoids), kickers
  - Others
- Beam diagnostics (prototype)
  - Interceptive
  - Non-interceptive
- Protype of a section of the ISRS ring (MAGDEM)
  - 90 degree, straight CCTs, Cryocoolers, active shielding
  - Separate Cryogenics/beam vacuum
  - Reconfigure for mass separation
  - Future tests/experiments
  - Design/fabrication/integration
- Magnetic measurement system (prototype)
  - Field map of straight CCT units
  - Monitoring for MAGDEM
- Focal plane detector (prototype)
  - In-ring/external
  - Gas/silicon/DPSA
  - Coupled to MAGDEM
- Multi-harmonic buncher
  - Operational system for HIE-ISOLDE
  - Based on SSPA

  (Chopper not included)

WORK PACKAGE BREAKDOWN

- Reordering of LOI WPs in only three: WP1, WP2 and WP3
- In RED, Spanish institutions receiving funding and responsible of deliverables

WP1: Beam dynamics and injection extraction systems. Valencia

- TASK1.1: Selec. Phys. cases — Huelva — HIE-ISOLDE collab
- TASK1.2: Nucl. React. Calc. — Huelva — HIE-ISOLDE collab
- TASK1.3: Beam dynamics — Valencia
- TASK1.4: High ord. correct. — Madrid
- TASK1.5: Injection/Extract. — Valencia — Liverpool — Prototype
- TASK1.6: Beam diagnostics — Valencia — Liverpool — Prototype

WP2: CCT solenoids and cryostats Huelva

- TASK2.1: CCT solenoid — Huelva — CERN, INFN* — Prototype
- TASK2.2: Solenoid + cryost. — Huelva — APC, CERN — Prototype
- TASK2.3: Magnetic meas. — Huelva — Cockcroft — Prototype
- TASK2.4: Focussing system — Madrid
- TASK2.5: Focal plane det. — Prototype — Madrid — Lund, Milan, West-Scotland

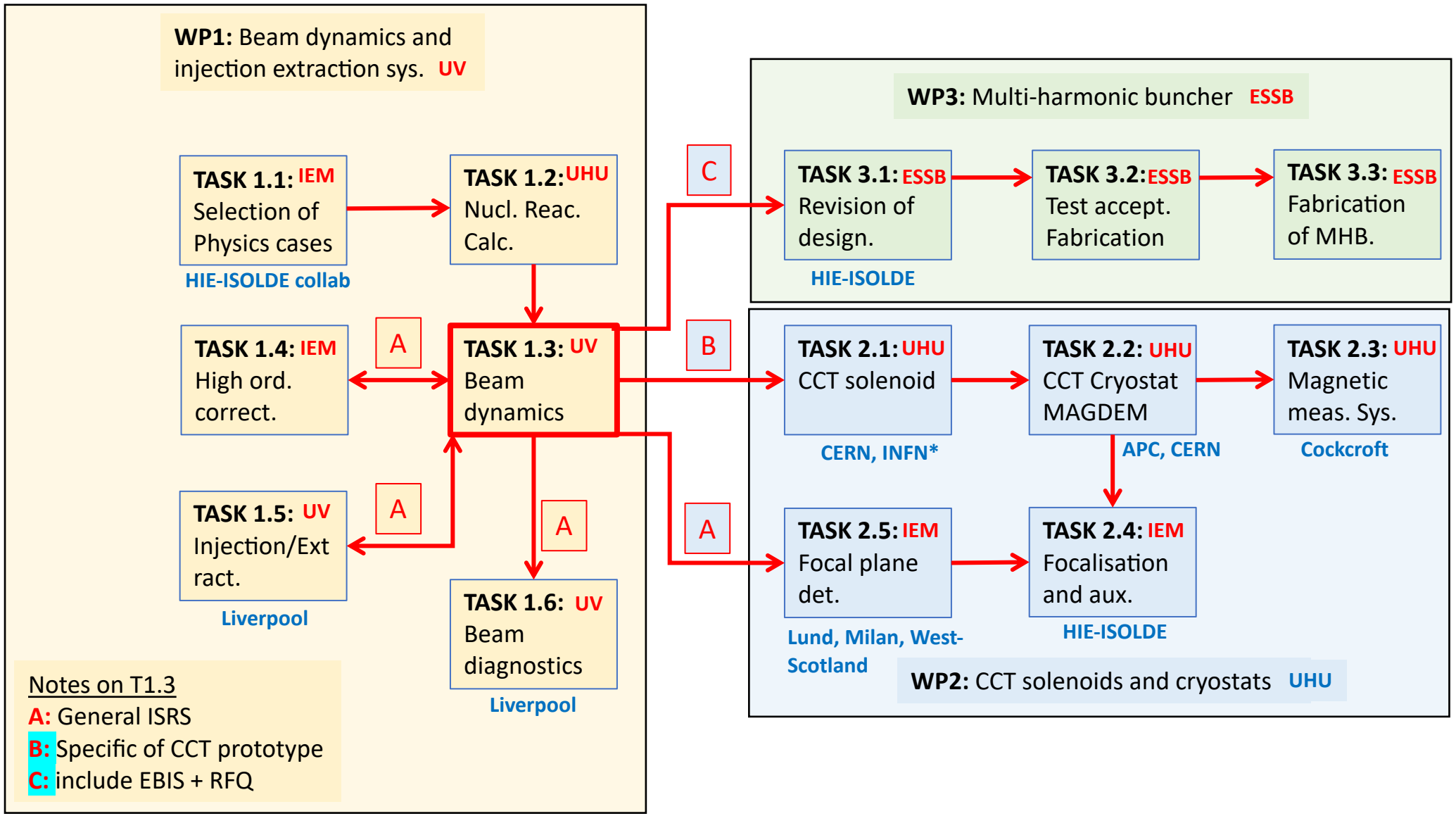
MAGDEM: prototype of one ISRS bending section

WP3: Multi-harmonic buncher Bilbao

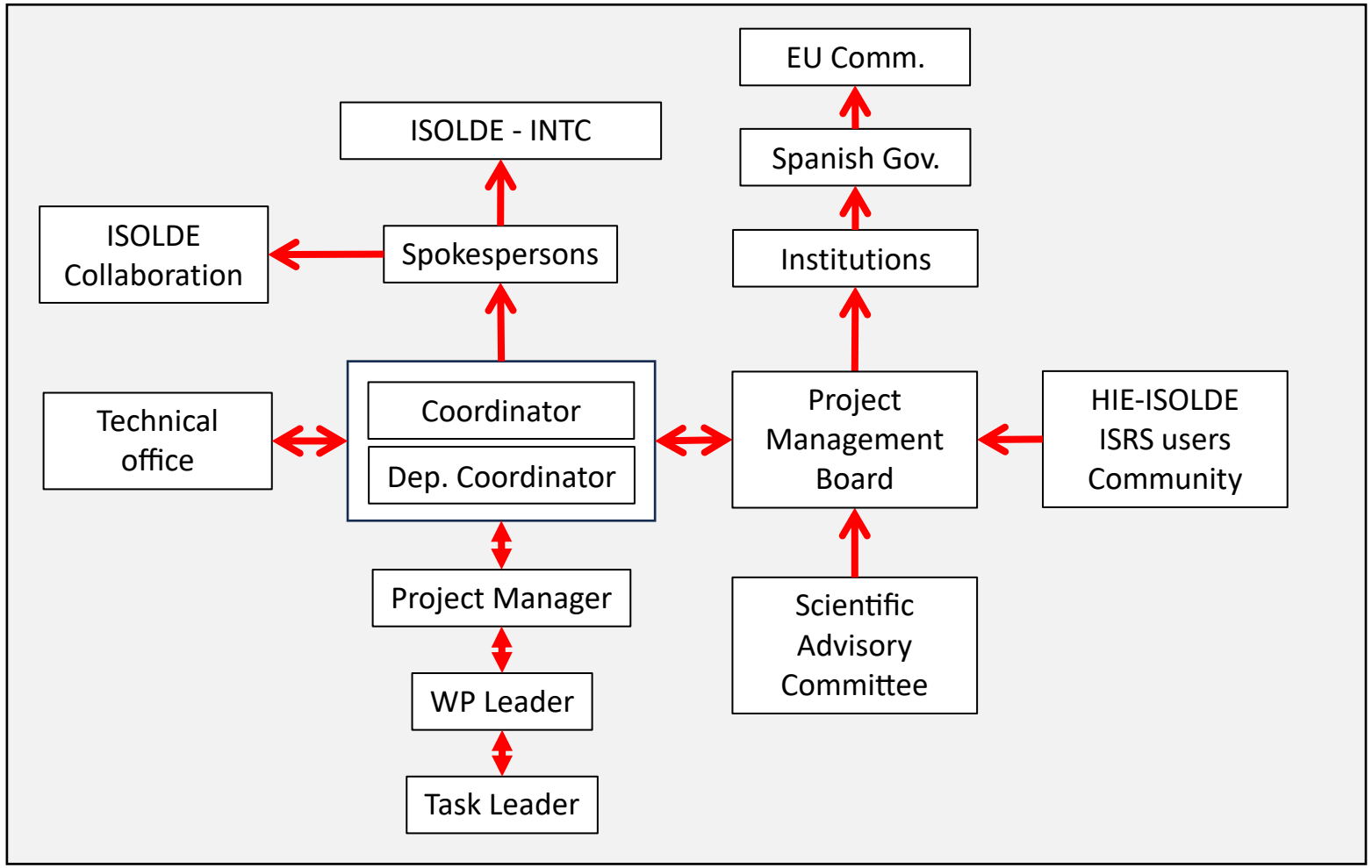
- TASK3.1: Revision design. — Bilbao — HIE-ISOLDE
- TASK3.2: Test accept. Fab. — Bilbao
- TASK3.3: Fabrication MHB. — APC — Bilbao

Prototype of MHB

INTERACTION BETWEEN WPs



MANAGEMENT



Spokespersons: I. Martel (UHU), O. Tengblad (IEM), J. Cederkäll (LU)

Coordinator: I. Martel (UHU)
Deputy-Coordinator: T. Kurtukian-Nieto (IEM-CSIC)
Project manager: TBA (UHU)

Project Management Board (PMB)

- UHU: I. Martel
- CSIC: O. Tengblad
- ESSB: I. Bustinduy
- UV: J. Resta
- Representative of institutions contributing to the project; CERN, Liverpool, Cockcroft, APC, INFN, Lund, West-Scotland, Milan,…
- Project manager

Scientific Advisory Committee (SAC)

- ISOLDE Spokesperson: J. Freeman
- ISOLDE technical team: A. Rodríguez
- INFN-LNL: G. de Angelis
- GANIL: P. Delahaye

SUMARY AND CONCLUSIONS

- Funding expected (July) for R&D activities, deadline 2025.
- Spanish Institutes: Univ. Huelva, Univ. Valencia, IEM/CSIC Madrid, ESS-Bilbao
- R&D covers the main activities of the LOI, including prototypes.

THANKS!

ISRS COLLABORATION

Inst. de Física, UNAM, ***México.***
Univ. Huelva, ***Spain.***
IJCLab-Univ. Paris-Sud, ***France.***
Dpt. of Physics, Univ. Liverpool, ***UK****.*
Wigner Research Centre for Physics, Budapest, ***Hungary****.*
Inst. de Estructura de la Materia, CSIC, Madrid, ***Spain****.*
ESS-BILBAO, Bilbao, ***Spain.***
Univ. Surrey, **UK.**
CERN, Geneva, **Switzerland.**
Lund University, **Sweden.**
Götenborg University, **Sweden.**
Univ. Edinburgh, **UK.**
LNL INFN, **Italy**
Uppsala Univ., ***Sweden.***
Aarhus Univ., ***Denmark.***
Chalmers Univ. of Technology, ***Sweden.***
CENGB, Gradignan, ***France.***
Univ. York, ***UK.***
Univ. of West Scotland, ***UK.***
ICMUV-Univ. de Valencia, ***Spain.***
The Cockcroft Institute, ***UK.***
Astroparticule et Cosmologie-Univ. Paris Diderot, ***France.***
Univ. Jyvaskyla, ***Finland.***
IMIS Univ. Riyadh, ***Saudi Arabia.***
IFIN-HH, Bucharest, ***Romania.***
Politecnico di Milano-DEIB & INFN, ***Italy.***
HIL-Warsaw University, ***Poland.***

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