



# **Sustainable Information Technology at ALBA II: New Opportunities**

Presented by:

Manuel Valvidares

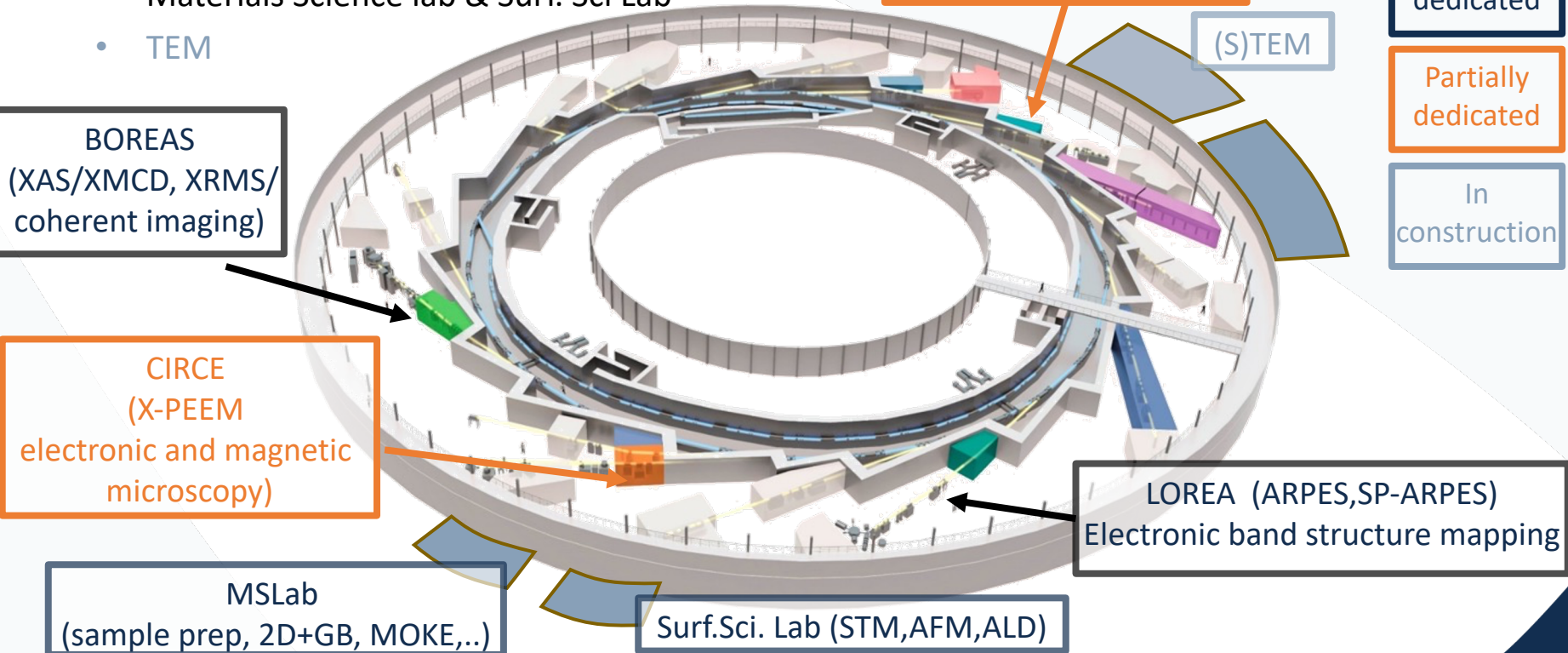
(Section Head)

# Existing tools E&MS at ALBA



Current facilities for Sustainable Inf. Tech.&QMs:

- 2+2 BLs
- Materials Science lab & Surf. Sci Lab
- TEM



Resolving and Manipulating the Electronic and Magnetic States, and its Spatial and Dynamic Characteristics in Quantum Materials.

using a suite of techniques and services enabling the catalytic role of ALBA

## Focused on scientific fields

- Materials discover
- Device physics
- Spintronics and Spin-Orbitronics
- 2D VdW Materials
- Topological states and other emerging states in quantum materials (Dirac/Weyl,...)

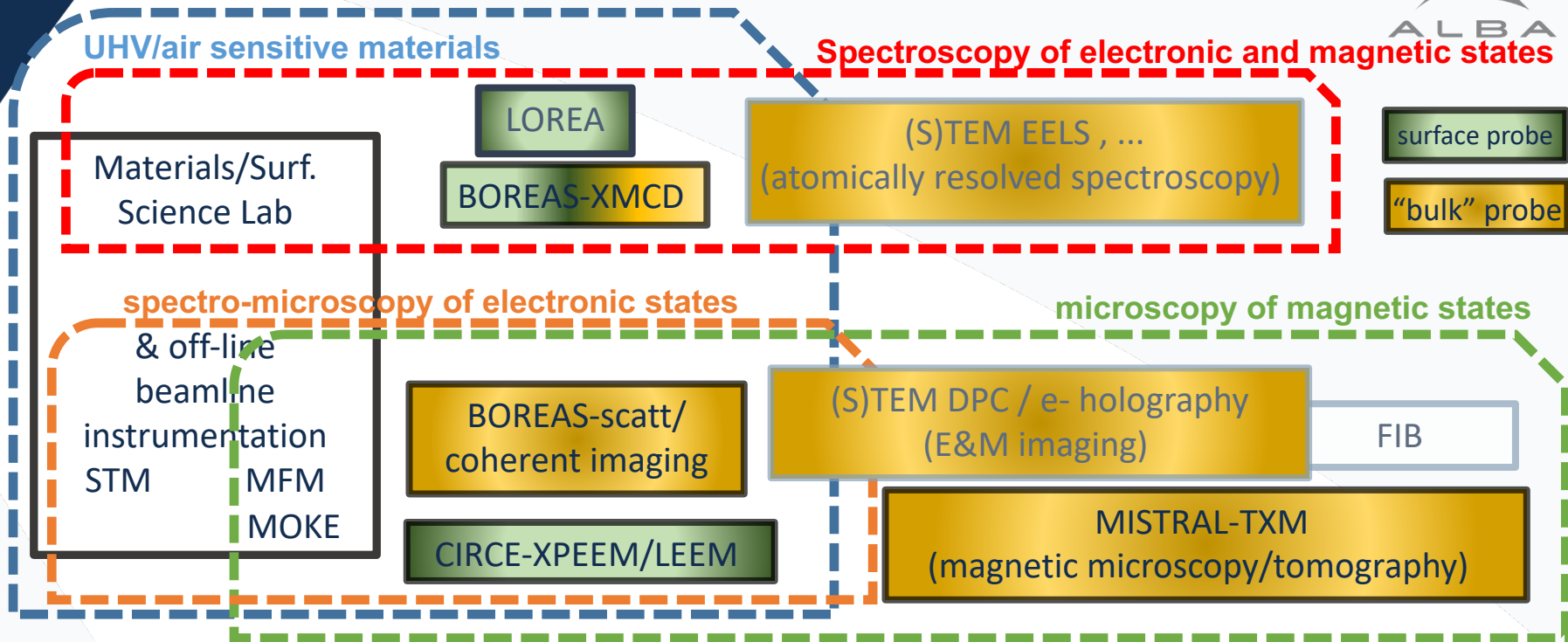
## Techniques

- Materials growth and device fabrication
- XAS, XMCD, XMLD, XLD XRMS
- ARPES (including spin-resolved)
- X-ray microscopy and coherent imaging with chemical, magnetic contrast
- High-resolution TEM
- Lab characterization (LEED, LEEM, SPMs, MOKE, Raman)

## Services

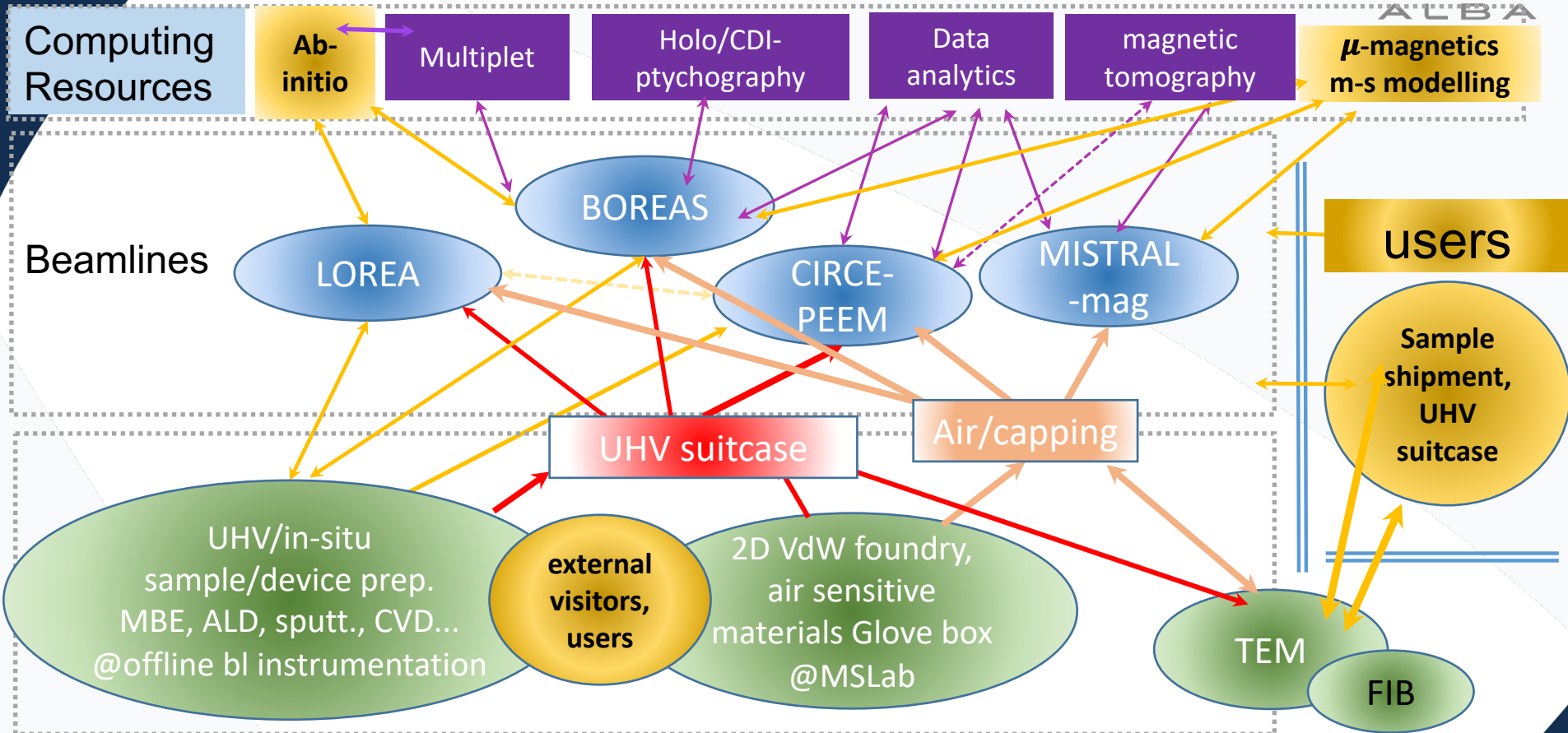
- Sample preparation tools allowing off-line and in-situ sample preparation prior and during experiments +efficient approaches such as automatized structure preparation, wedges, combinatorial approaches
- multi-modal pipelines and access modes for providing solutions for main focus area applications
- Computational modeling tools

# Correlation between (soon-to-come) program tools



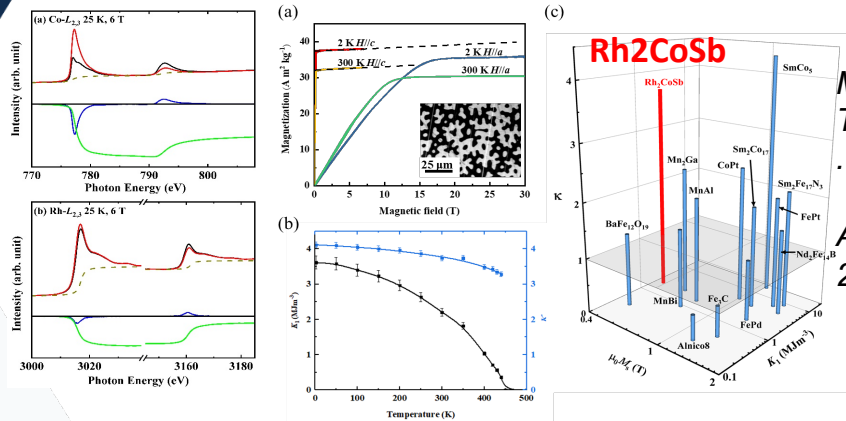
- Section instruments have an integrated program with well defined roles, complementarity scope & capabilities
- Section program to be correlated with TEM additional structural characterization capabilities, explore opportunities for TEM-imaging of electronic and magnetic states in solids
- Enhancement of MSLab and Surf Science equipment (Raman, ARPES/XPS), FIB capability

# The Roles/Flows of all Tools



# Multi-modal opportunities at ALBA: novel materials, characterization techniques and in-operando environments for imaging and manipulating states in IT materials

## New Highly-anisotropic Rh-based Heusler Compound for Magnetic Recording @Boreas



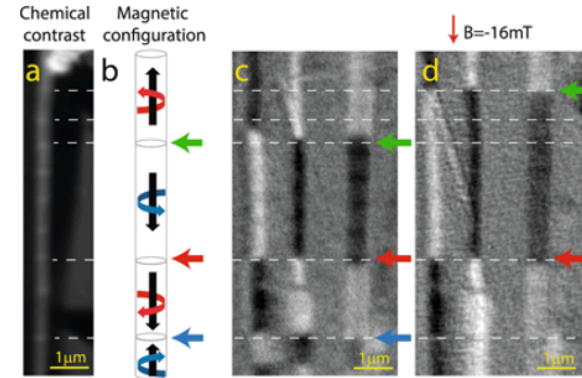
MPI Halle,  
Trinity College,  
...

Adv. Mater.  
2020

## Helical Magnetic Domain Configurations In Nanowires

@Peem+mistral

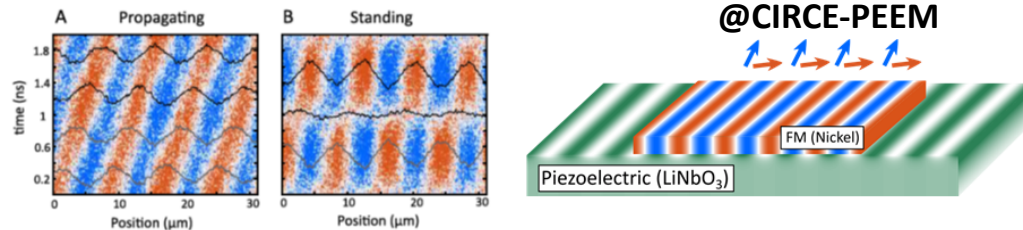
Full 3D – configuration measured by TXM and XMCD-PEEM



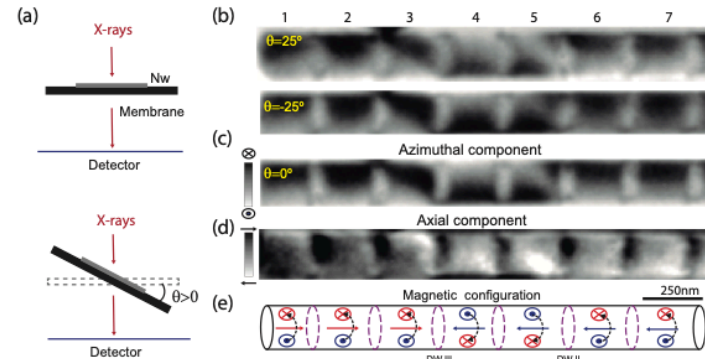
IMDEA, ALBA,  
...  
Nanoscale,  
2020

## Manipulating magnetic domains via surface acoustic wave

@CIRCE-PEEM



ALBA, ICMAB-CSIC, PDI Berlin, Phys Rev. Lett. 2021



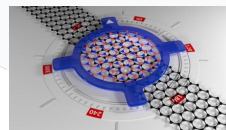
## example: 2D-VdW materials

## Our Goal at a Glance

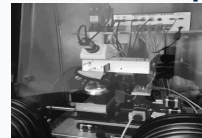
MBE, 2D Materials and VdW Foundry at MS Lab, offline bl equipment, as a complement & bridge to user facilities

Challenges addressed and advantages:

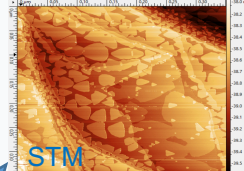
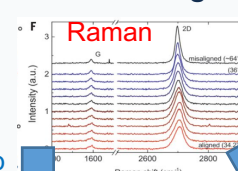
- air sensitive / short duration
- repeatability / efficiency / on-the-go experiment adjustments
- Deeper partnership (projects, shared PhDs, short and mid term stays related to experiments and projects)



twistronics



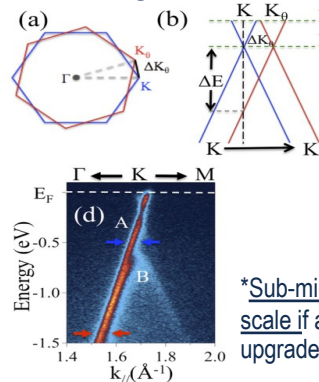
VdW transfer setup



STM

### Microscale\* averaged electronic & magnetic properties

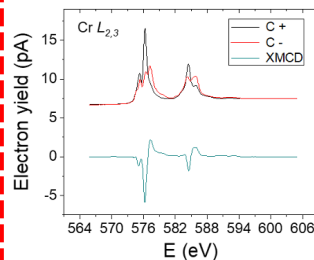
#### LOREA: ARPES



ARPES in twisted BLG, *Soleil, Sci Reports 2016*

\*Sub-micron to nano scale if a nano-focusing upgrade is considered

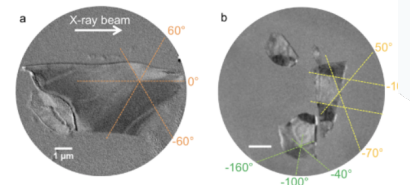
#### BOREAS - XMCD



Cr XMCD in CrCl<sub>3</sub> sl, *ArXiv 2020*

### Micro to nanoscale imaging

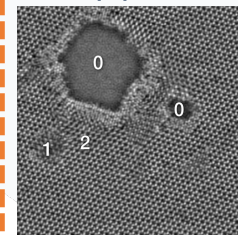
#### CIRCE, MISTRAL & BOREAS



PEEM, Multilayer flakes of CrTe<sub>2</sub> VdW, *ACS AMI 2020*

### Atomic imaging

#### HR-(S)TEM



Defects in a MoS<sub>2</sub> imaged with high-resolution STEM *Spectra, ThermoFischer*

-ALBA to provide the X-ray & electron- tools, enhanced sample preparation capabilities enabling pre-experiment preparation, mid-term visitor /missions and stronger collaborations and partnerships

-Aiming at a multi-modal approach from meso to nanoscale, from surface to bulk-like

	Resolution	complementary x-ray + SPM, TEM imaging capabilities
XTM MISTRAL	20-30 nm	fast ; 2D imaging ; <b>3D tomo</b> ; bulk (only C+ BM)
PEEM CIRCE	20-30 nm (<10nm possible)	fast; 2D; part 3D (shadow tech.) ; <b>surface, mod. Field &amp; LN temp</b>
Coh. Imag. BOREAS	25 nm (3-5 nm possible)	slow (reconst. or scanning) 2D ; 3D possible; <b>LHe ; Hig field</b>

# ASTIP: Examples for Strategic Partnerships (in Pre-Proposal Stage)

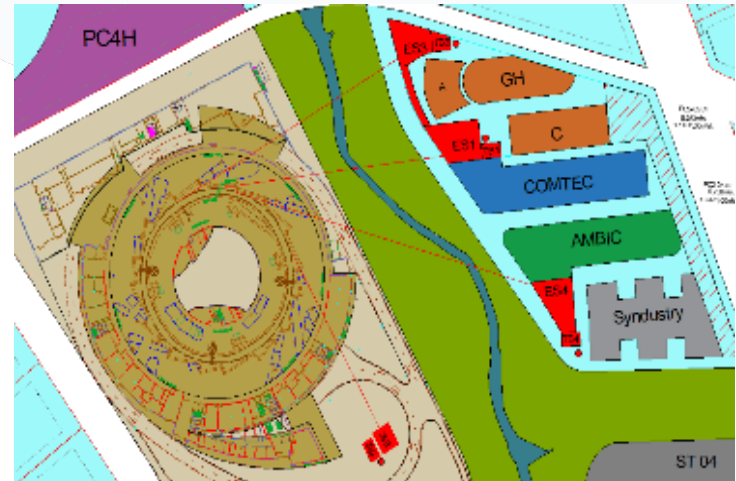


Large partnership with local institutions and opening to other national institutions to form a hub of 4 pillars, being ALBA II in the center. The other three pillars will be:

- AMBIC (life sciences)
- COMTEC (material sciences)
- SYNDUSTRY (Innovation hub for industry)

The materials science center COMTEC could boost :

- 2D, spintronic and spin-orbitronic systems
  - Multifunctional materials
  - Quantum informatics
  - Computational Materials Science
  - Sample Preparation and Support Facility
- COMTEC provides full service building on the strength and expertise of local groups and provides them the full network.
  - ASTIP is in the preproposal stage



# ALBA II a 4th Generation Source

ALBA II will provide complete characterization solutions for the 2 branding areas (2D/QMs, Information Technology) by combining:

- ❑ Enhanced spectroscopic and imaging tools allowing multi-modal approaches.
- ❑ Optimized high-throughput instrumentation.
- ❑ Data handling facilities consistent with big data (including theory, simulation and data analytics for branding areas).
- ❑ Development and implementation of new methodologies.
- ❑ ALBA II will form strategic partnerships\*\* and will be embedded into research supporting infrastructure which provides all non X-ray support to the users (example of the ASTIP proposal). \*\*ALBA II will still provide all current services to all (Spanish) other users.

## Computational resources

Ab-initio

Multiplet

Data analytics

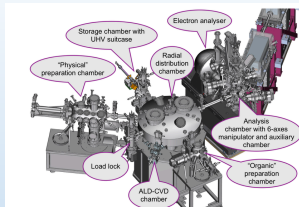
magnetic tomography

Holo/CDI-ptychograph

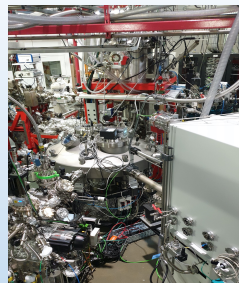
Micromagnetics  
Multi-scale modelling

XPCS

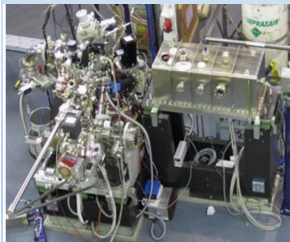
### LOREA-ARPES



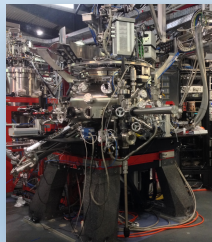
### BOREAS-XMCD



### CIRCE-PEEM



### BOREAS-SCATT



### MISTRAL TXM-(MAG)



## ALBA Core-Business

### HR-(S)TEM

## Materials&Surf Science Lab



# ALBA II a 4th Generation Source



Questions welcome



21/11/2017