



M. Valvidares

E&M-SM Section beamlines, group and science

- Beamlines overview
- Beamlines detail
- The people (main contacts)
- Science highlights
- Access modes, productivity
- One proposed framework
- Possible work flows

Staff & Associate Staff:

MISTRAL:

Pereiro, E. (LBS)
 Perez, A (BS)
 Sorrentino, A (BS)
 Aballe, L (BS)
 BL Postdoc (in hire)
 iNext Postdoc (i.h.)
 Groen(PhD)
 Valcarcel, R (tech)
 Serra, X (elect)
 Rosanes, M (ct)
 Oliete, R (FC)
 S. Ferrer (coll.)

BOREAS:

Valdivares, M (LBS)
 Gargiani, P (BS)
 Herrero, J (BS)
 Guillemard, Ch.(post.)
 De Melo, L (PhD)
 Enrique, AE (tech)
 Moldes, JM (ct)
 Serra, X (elect)
 Carballedo, A (eng)
 Pedreira, P (FC)

CIRCE:

Niño, MA(LBS)
 Perez, V (BS)
 Foerster, M (BS)
 Villar, I (postdoc)
 Ruiz, S (Mineco)
 Waqas, M (PhD)
 *Mandziak, A (PhD)
 Martinez, A(tech)
 Becheri, F (ct)
 Camps, A (elect)
 Alvarez, JM (eng)
 Pedreira, P (FC)

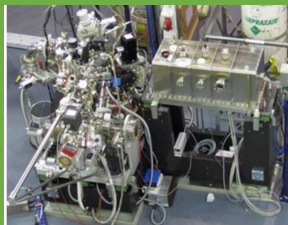
External Funding: (running and new)

- Mineco projects : 4+2 (Mistral (SF, EP), PEEM (LA,MF), BOREAS (MV), NOTOS/ LOREA/NCD (CE,MT,ES), 2 Ext (JH, Niño-IMDEA)
- EU projects: 2+2* (TNSI (Boreas), Flag-Era/PCI SOGRAPHMEM `20, *INEXT,CoCID (Mistral-bio)
- Applied: MyC IF (p), COST, 3 Mineco (BOREAS, ext-CIRCE) (p)

Instruments: 4 (+1* mid 2021)

Operating beamlines: 3 (+1* mid 2021)

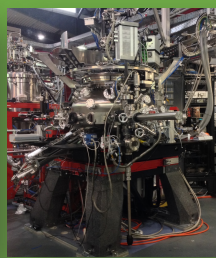
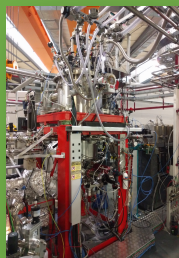
**CIRCE
-PEEM**



MISTRAL (MAG)



**BOREAS
-XMCD BOREAS
-XRMS**



*Under construction:

Lab infrastructure:

LOREA



X-ray Resonant ARPES-BL

Materials&Surf Science Lab

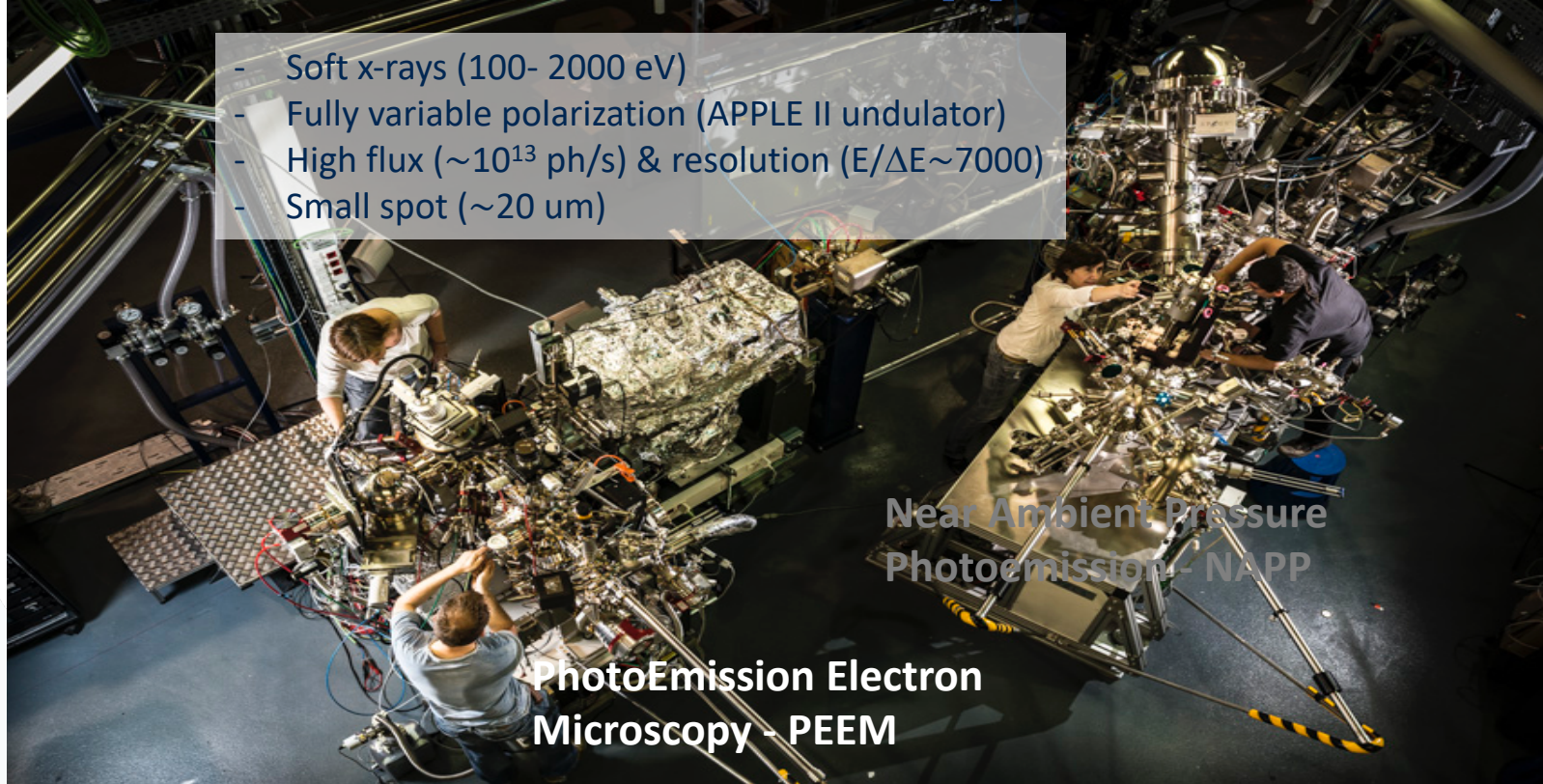


CIRCE: Photoemission spectroscopy and Microscopy

- Soft x-rays (100- 2000 eV)
- Fully variable polarization (APPLE II undulator)
- High flux ($\sim 10^{13}$ ph/s) & resolution ($E/\Delta E \sim 7000$)
- Small spot (~ 20 μm)

Near Ambient Pressure
Photoemission - NAPP

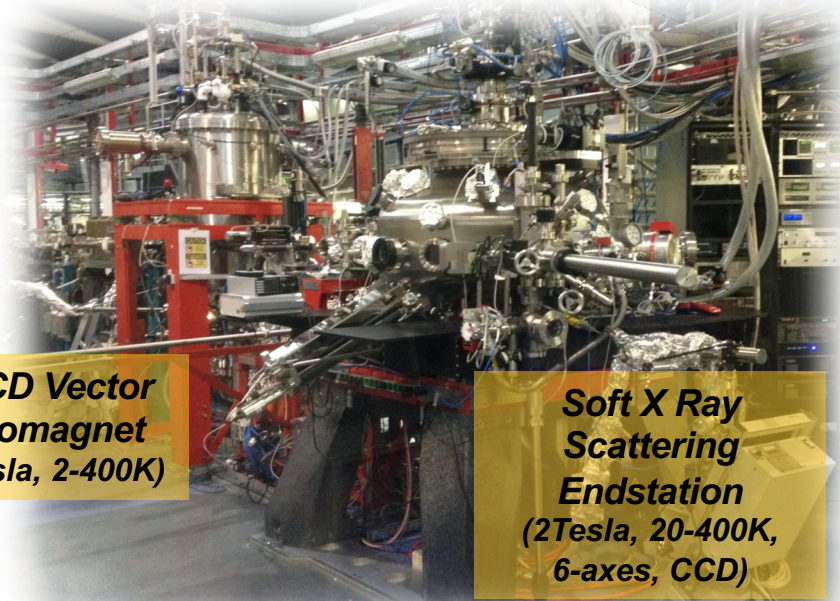
PhotoEmission Electron
Microscopy - PEEM



BOREAS : soft X-Ray Spectroscopy (XMCD, XMLD) & Scattering



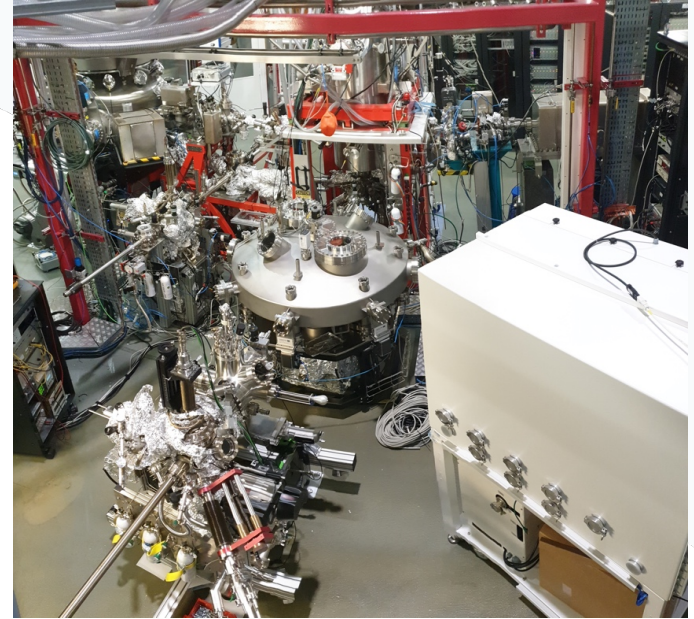
- Variable polarization APPLE-II source, 80-4000eV energy range
- KB mirror with adjustable focusing (about 80x30 μm @ES1, 250x150 μm @ES2)



**XMCD Vector
Cryomagnet
(6 Tesla, 2-400K)**

**Soft X Ray
Scattering
Endstation
(2Tesla, 20-400K,
6-axes, CCD)**

- ☐ HECTOR High-field (6T-2T) vector magnet endstation for XAS/XMCD with TEY, TFY, transmission detection modes
- ☐ MaReS double circle UHV reflectometer for magnetic resonant scattering, with HTS magnet (2T), CCD+diodes

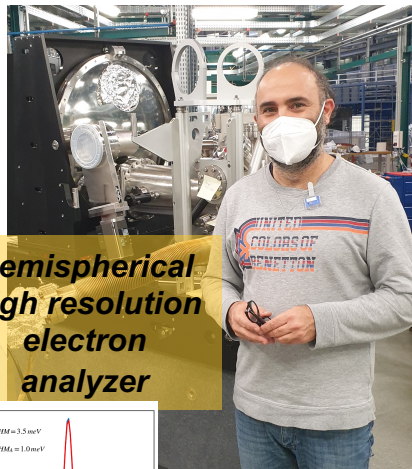


- ☐ Full MBE off-line preparation
- ☐ LT STM/Q-plus
- ☐ Glove box to be connected to beamline

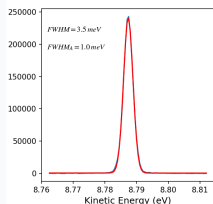
LOREA : soft X-Ray Photoemission Electron Spectroscopy (ARPES)



- Variable polarization APPLE-II source, 10-1000eV energy range
- KB mirror "nano-bender", with adjustable focusing (about 15x15 μm)

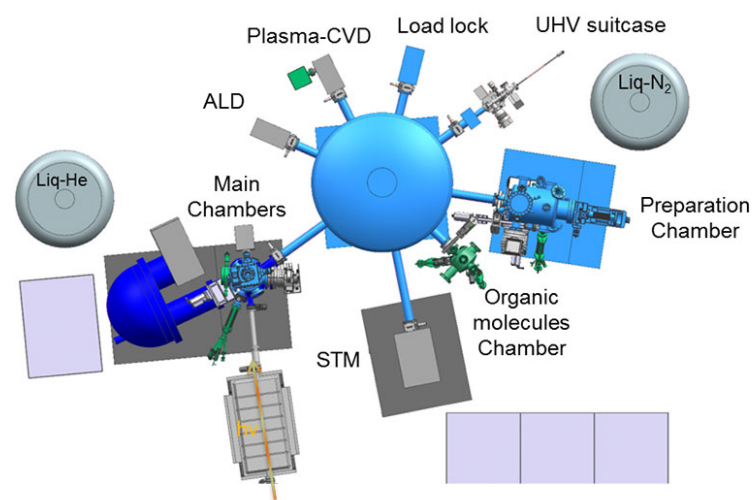


**Hemispherical
High resolution
electron
analyzer**



1 meV !

- ❑ State-of-the-art electron analyser with high resolution, electronic lenses and 2D-detector for electronic band images
- ❑ Surface preparation at low temperature on endstation manipulator in retract mode to prep chamber
- ❑ Dedicated, noise-free, control room for experiment control and real time data analysis (also remote operation)



***Multi-technique cutting-edge surface
science preparation environment***

- ❑ Full MBE in-situ preparation
- ❑ Radial distribution chamber
- ❑ ALD and other capabilities will be implemented
- ❑ UHV suitcase docking

BOREAS



Pierluigi Gargiani
pgargiani@cells.es



Javier Herrero
jherreo@cells.es

CIRCE-PEEM



Miguel A. Niño
mnino@cells.es



Michael Foerster
mfoerster@cells.es

The people: LOREA



Massimo Tallarida
mtallarida@cells.es



Federico Bisti
fbisti@cells.es

MISTRAL



Manuel Valvidares
mvalvidares@cells.es



Charles Guillemard



Sandra Ruiz



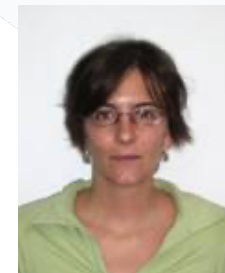
Waqas Kalig



Lucia Aballe
laballe@cells.es



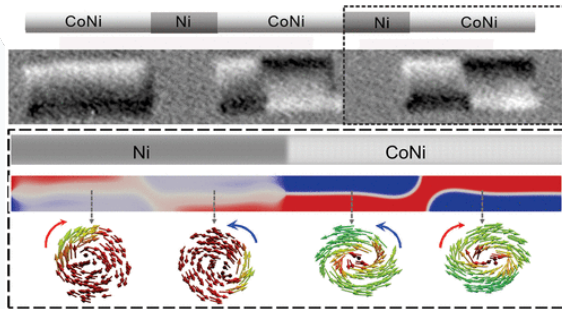
Andrea Sorrentino
asorrentino@cells.es



Eva Pereiro
epereiro@cells.es

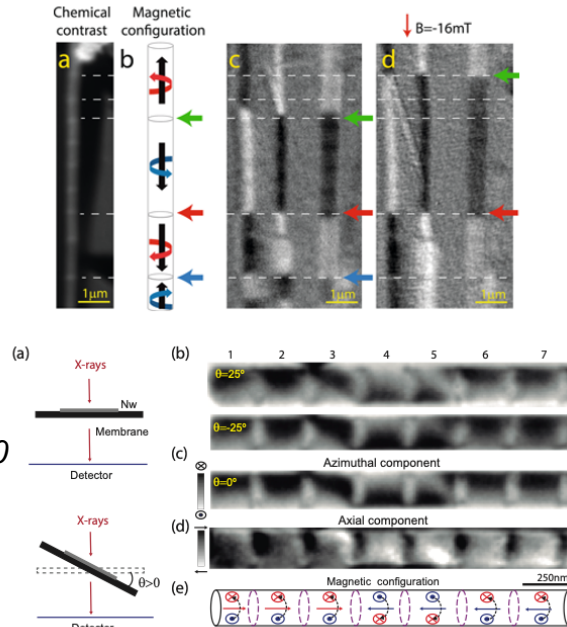
CUTTING EDGE STUDIES OF CHIRAL MAGNETIC DOMAINS IN NANOWIRES UNVEILING THE ORIGIN OF GEOMETRICAL CONTROL OF MAGNETIC CHIRALITY@PEEM+MISTRAL MULTIDOMAIN STRUCTURES IN COMPOSITIONALLY MODULATED CYLINDRICAL MAGNETIC NANOWIRES@PEEM

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



ACS nano, 2020

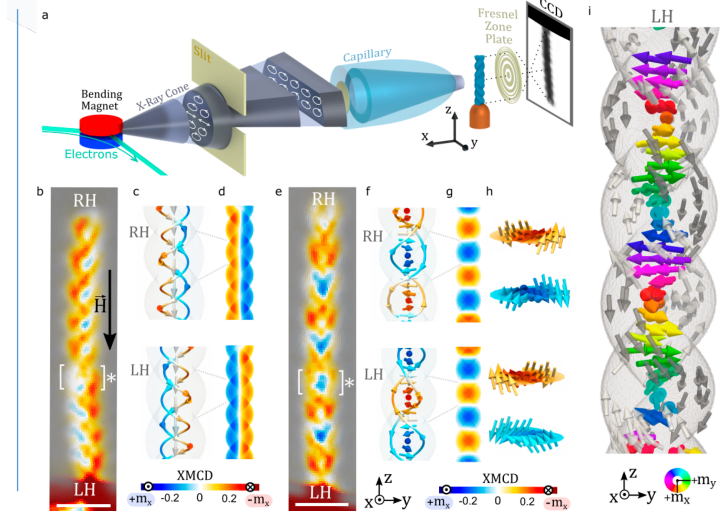
- CoNi/Ni multisegmented cylindrical nanowires with chiral vortex state
- Potential for high-speed multipurpose applications



Sandra Ruiz, et al,
Nanoscale, 2020

WORD-CLASS 3D MAGNETIC TOMOGRAPHY

ARTIFICIAL DOUBLE-HELIX FOR GEOMETRICAL CONTROL OF MAGNETIC CHIRALITY@MISTRAL

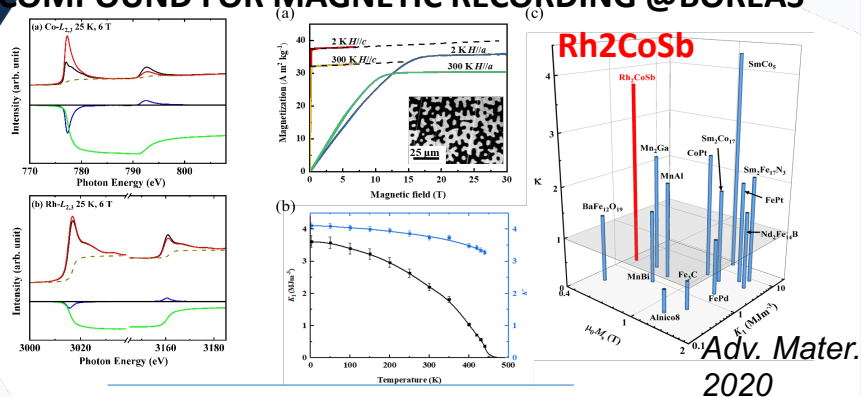


- Novel 3D FIB “printed” magnetic structures
- Oxford, LBNL, and Mistral Magnetism team

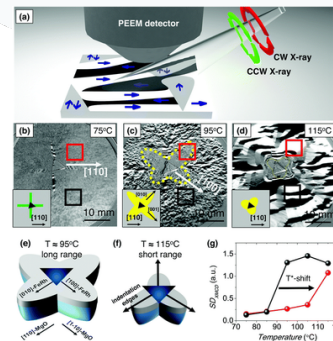
ACS Nano
2020

ENABLING NOVEL MAGNETIC MATERIAL ADVANCES IN INFORMATION TECHNOLOGY

NEW HIGHLY-ANISOTROPIC RH-BASED HEUSLER COMPOUND FOR MAGNETIC RECORDING @BOREAS



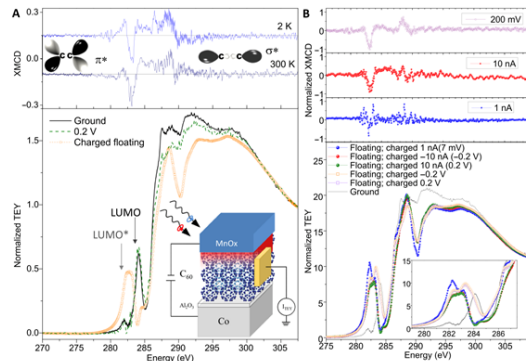
LOCAL MANIPULATION OF METAMAGNETISM BY STRAIN NANOPATTERNING@CIRCE-PEEM



- nano-needles approach to magnetic memories
- 100% local collaboration: ICMAB, ICN2, UB and ALBA

Materials Horizons, 2020

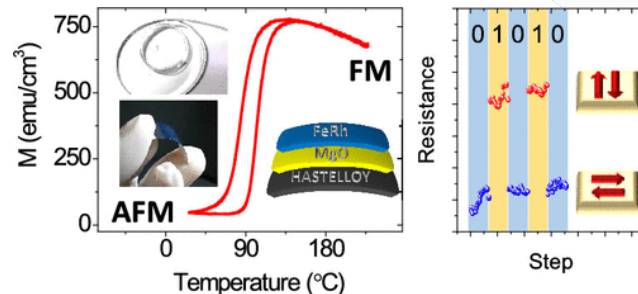
REVERSIBLE SPIN STORAGE IN METAL OXIDE-FULLERENE HETEROJUNCTIONS @BOREAS



Brings the possibility of light-actuated spin capacitors for low-energy consumption technologies

Science Adv. 2020

FLEXIBLE ANTIFERROMAGNETIC FeRh TAPES AS MEMORY ELEMENTS



ACS Appl. Materials&Interfaces, 2020

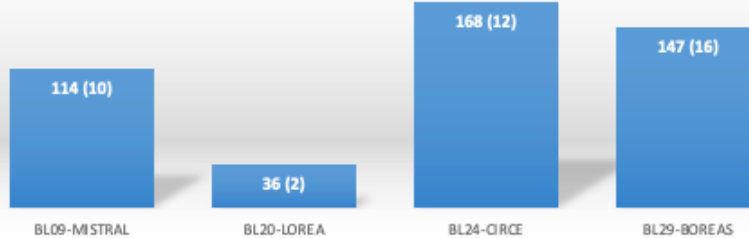
Access mode: user facility access



- 2 user proposal rounds per year
- external international proposal evaluation panels
- since 2019 FCT ALBA agreement, researchers at Institutes with Portuguese affiliation benefit of experiment funding similar to Spanish institutions

- Summary
- Approaching 50 publications per year in the area of electronic and magnetic structure of matter, and 20 of high impact.
- Average publication factor > 7.0
- Publication number still on slight grow
- Illustrates ALBA E&M section **strong, world-class capabilities to impact topics in the area of Quantum Informatics and Quantum materials**, and boost quality of research by groups in Universities and research centers by addition of synchrotron radiation experiments at the section beamlines

2021-I Awarded shifts (proposals) by beamline

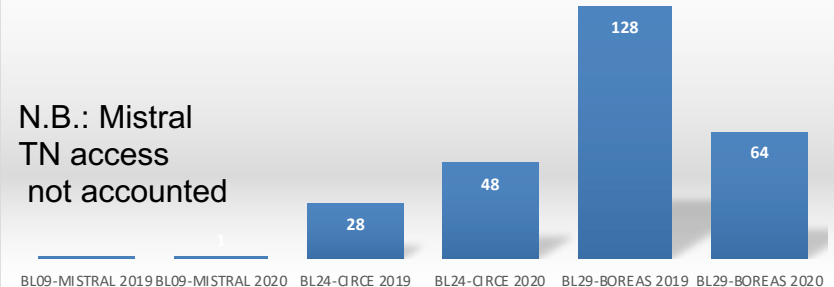


Development of Peer Reviewed Publications*:

Year	PEEM/CIRCE	Mistral (mag)	Boreas	Total
2020	13(6)/26(10)	3(2)/12	28 (9)	44(17) /64
2019	14/23	1/10	23	38 /56
2018	10/17	3/6	17	30/40
2017	8/13	2/11	14	24/38
2016	9/12	0/9	8	17/29
2015	5/6 (5*)	1/4	5	11/15
2014	0/2	0/1	5	5/8

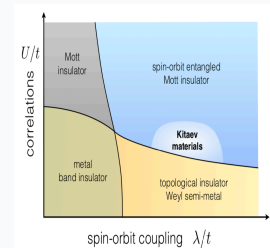
Red: high impact

Industrial usage (hours) by beamline



N.B.: Mistral
TN access
not accounted

Access mode: scientific collaboration program



- FCT– ALBA collaboration goes beyond use access mode: scientist to scientist
- Scientific collaboration between ALBA scientist, Portuguese scientist and eventual additional Spanish partners
- Opportunities for joint projects at EU level and use of in-house research to support joint FCT-ALBA research program

- **E&MSM proposes to led together with Portuguese partners (to be defined by the selection process agreed between FCT and ALBA) a research program in the field of 2D and Quantum materials as an strategic area for one of the 4 areas of collaboration in the framework of FCT-ALBA collaboration**

Alba E&MSM has the instrumentation, know-how and expertise to impact quantum materials/topological electronic and magnetic structure of matter research;

Our assets: cutting edge spectroscopy (BOREAS), world-class spatial resolved properties (CIRCE-PEEM, MISTRAL), soon electronic properties (LOREA); MBE know-how; multidisciplinary skills & staff

- **E&MSM Goal and Strategy is to use this also to acquire leadership at international level**

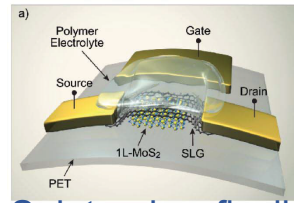
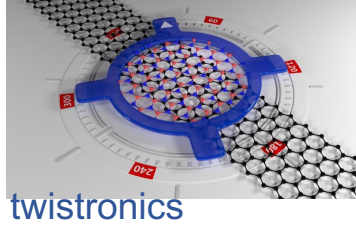
Step1) Identify a strong partner consortium, and agree a close collaboration, topics, funding

Step2) Contact one or more ALBA people

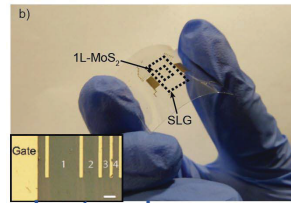
Step 3) Expression of interest

- ENABLING NOVEL MAGNETIC MATERIAL ADVANCES IN INFORMATION TECHNOLOGY
- DEVELOPING S-R “KEY ENABLING TECHNIQUES” FOR INFORMATION TECHNOLOGY

Materials Science with next gen synchrotron source: 2D-VdW materials & spintronics



Spintronics, flexible electronics



Synchrotron characterization

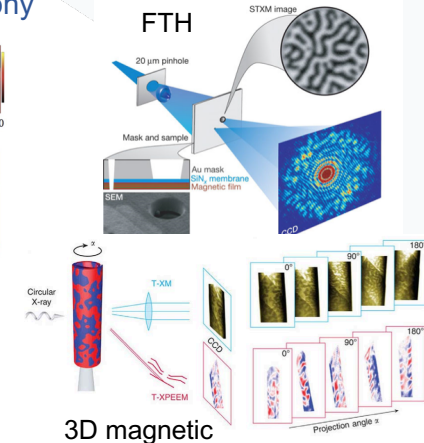
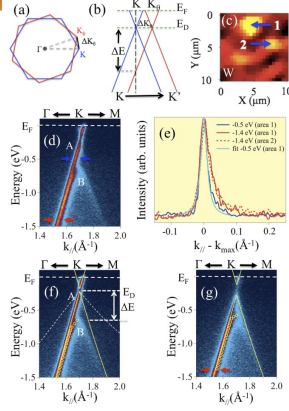
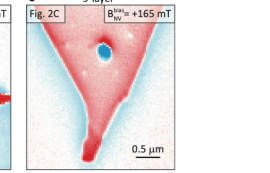
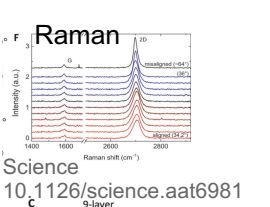
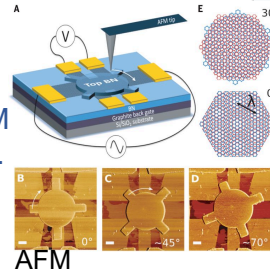
Electronic prop: ARPES, XPS, NAPP, XAS/XANES, EXAFS, RIXS

Structural/morphology: XRD, SXRD, SAXS/WAXS, GISAXS, SXRS, XRMS, XTM, XPEEM

Microscopy: PEEM, STXM, XTM, hard x-ray nanoprobe, tomography, FT Holography, Ptychography, CDI,...

Magnetic properties: XMCD, XMCD-PEEM, XMCD-SXTM, XMCD-TXM,

3D magnetic tomography, Magnetic FTH, Magnetic Ptychography, Bragg CDI, Bragg Ptychography



Nano Arpes on twisted bilayer Gr, Sci.Rep. 2016

3D magnetic x-ray tomography

Fabrication

Growth: MBE, PLD, ALD, sputtering, CVD

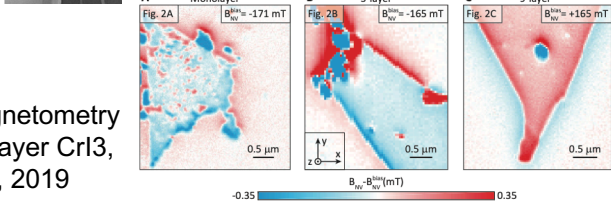
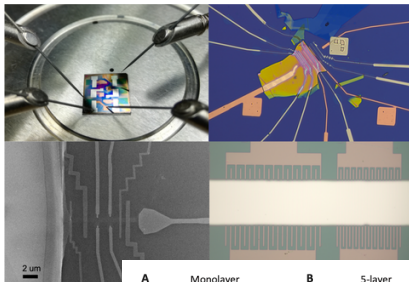
Manipulation: clean, deterministic transfer

Device prototyping: lithography, FIB, RIE,...

Lab characterization

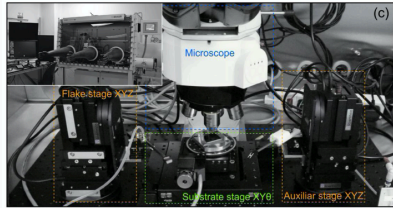
electrical: 4-point, FE-hysteresis, Microscopy: TEM, NV, MFM/AFM

Spectroscopy: lithography, FIB, ..



NV magnetometry on few layer CrI3, science, 2019

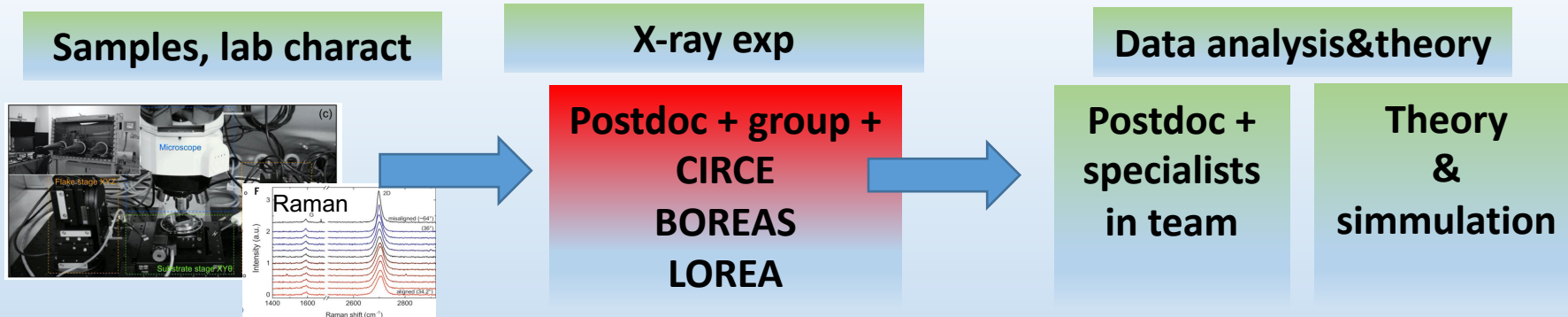
Manchester group, VdW materials transfer setup



Postdoctoral research for experimental synchrotron investigations of 2D Quantum Materials
in a collaboration between Portuguese QM materials institute “X”, ALBA people “Y” and Spanish QM
research group “Z”



Workflow 1 (TRL 1-3) : Sample from Portugal, experiment at ALBA, analysis by postdoc and theory by Portugal/Spanish grup



Workflow 2 (Adv. TRL 1-4,5) : Sample from ALBA, Lab characterization at Portugal, experiment at ALBA, analysis by postdoc, simulations by theorist, device prototyping, patent, application demonstration in lab

