This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 730871.

Status of Task 17.2

ARIES WP17 2nd Annual Meeting,
14 July 2020 – Video meeting

Alessandro Bertarelli (CERN)

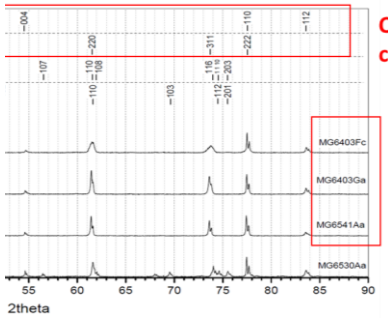
Task 17.2: Overview

Materials development and characterization

- Research, investigation, development and characterization of novel CMC and MMC based on graphitic, carbide or diamond reinforcements and dopants (in collaboration with Task 14.4).
- Study and development of electrically conductive coatings, resisting the impact of high intensity particle beams.
- Characterization of thermophysical and outgassing properties, microstructural analyses, study of phases and of their change under various environments …

Participants: CERN, GSI, NIMP, POLIMI, POLITO, UM (plus Brevetti Bizz, RHP-Technology through WP14)

Task 17.2: Overview



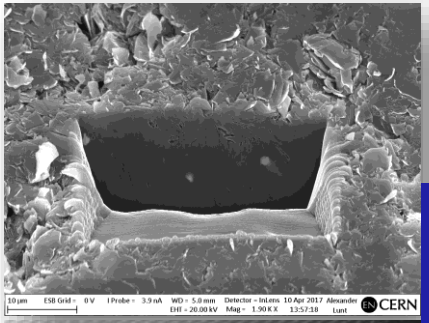
Only one carbide phase

Cubic: More isotropic properties

With Ti

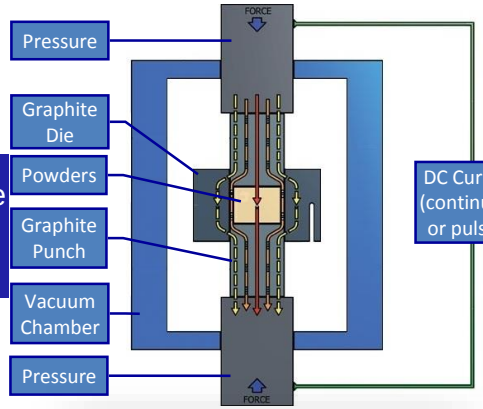
Data analysis, investigation, new proposal …

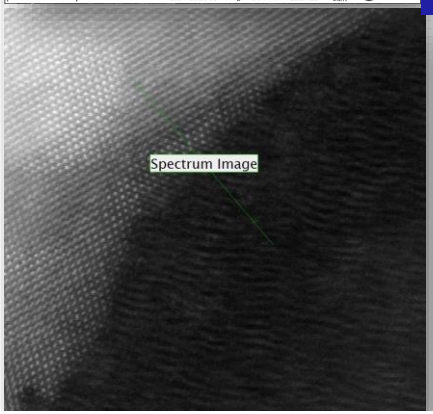
Choice of components (materials, topology, dopants …)



Microstructural characterization (SEM, FIB, XRD, EDS, TEM …)

High-temperature manufacturing (SPS, RHP …)





Thermophysical characterization (DIL, LFA, DSC …)

Task 14.4

in collaboration with University of Zaragoza (SP)

Task 17.2 – Material Development

Molybdenum Carbide – Graphite (MoGr) from R&D to industrialization …

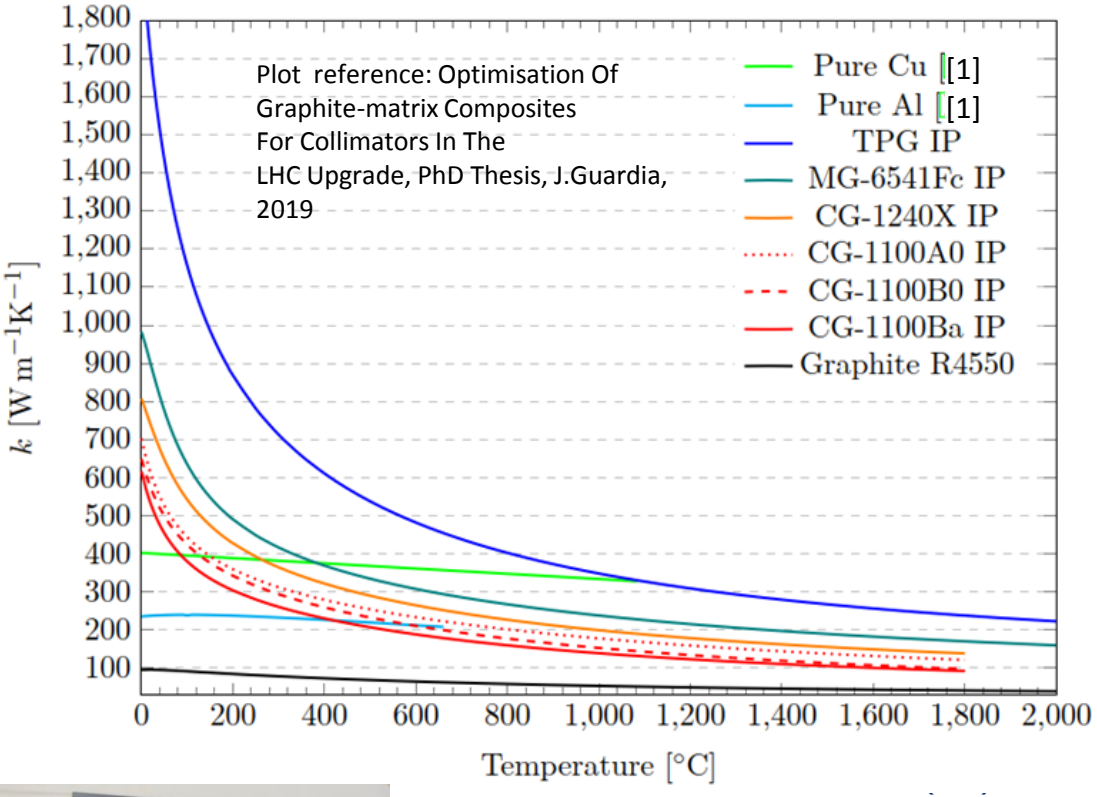
- After extensive R&D (CERN, Brevetti Bizz), MoGr **was successfully industrialized**
- Large contract for the production of MoGr blocks for 5 primary and 10 secondary **HL-LHC collimators. Total of 380 bloc**
- **Main challenges highlighted by th** **e**: tight tolerances (require a multi-stage machining process) and UHV **trol of the cycle parameters)**
- **Material production completed in** **collimators already installed in the machine!**
- Blocks for secondary collimators **c** **denum** layer to further **increase electrical co**

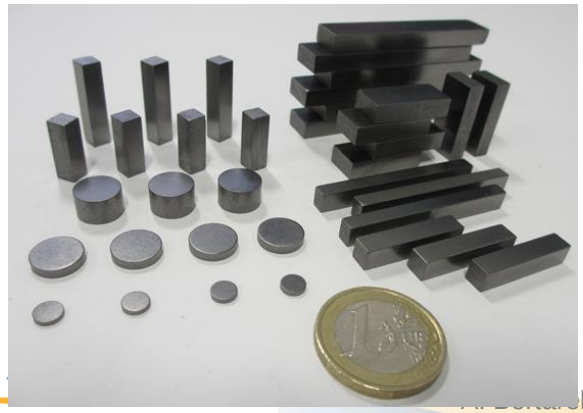
Thanks ARIES, EuCARD2, EuCARD!!

Task 17.2 – Material Development

Novel **Chromium – Graphite** (CrGr) composite under development as **lower cost** alternative to MoGr

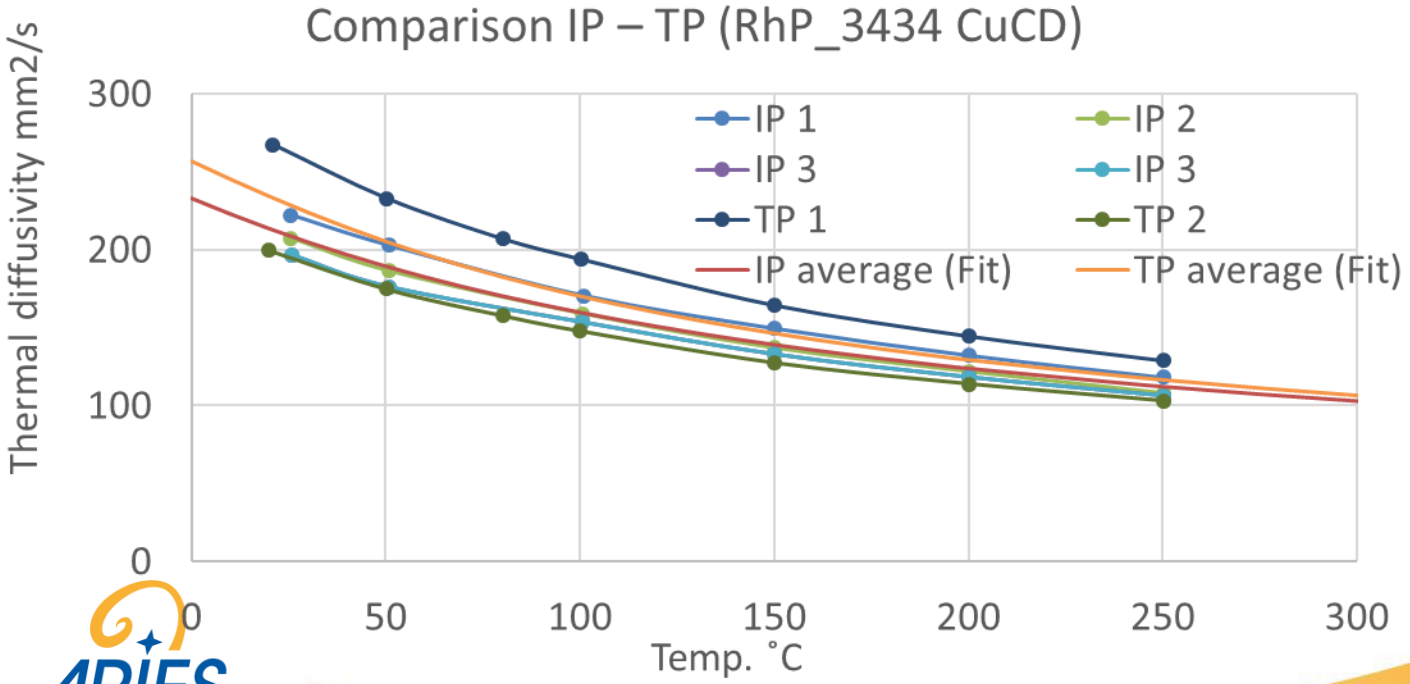
- 4 different CrGr grades, produced by Brevetti Bizz, investigated
- Thermo-physical analyses performed
- Microstructural characterization
- XRD in-situ up to 600 °C: phase stability and CTE
- **Record high thermal conductivity** measured in grade CG-1240X: 739 $Wm^{-1}K^{-1}$ at 20°C. Almost as high as best MoGr grade.





WP14.4 contributions to WP17 – recent highlights

- **Copper – diamond (CuCD) anisotropy test**
  - **3 new samples measured** with tailor-made sample holder (non-standard dimensions). Samples with in-plane (IP) orientation, opposite to usual through-plane (TP) samples.
  - **No relevant differences observed** between IP and TP directions. **The material can be considered isotropic** despite being produced under uniaxial pressing load.



Custom-made graphite sample holder for square samples with 5 mm-long sides

Task 17.2: What's next (excerpts) …

- Prepare MS61 (Compendium of Materials Developed), due in August 2020!!!!
- Complete optimization of carbide – graphite materials (MoGr and CrGr) and their characterization (thermophysical, UHV, radiation resistance, microstructure …)
- Integrate results from experimental tests at POLITO, GSI and ELI-NP
- Prepare for final report …

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Thank you and enjoy the (short) session!