



Welcome to the 2nd Annual Meeting of ARIES WP17 (PowerMat)

Virtual Section 14/07/2020

Minutes and Actions

PowerMat WP in a nutshell

- Develop and characterize novel composite materials based on graphitic and metal matrices with carbide and diamond reinforcements
- Test and online monitor materials behaviour under thermal shock (particle- or laser-beam induced) and irradiation
- Investigate radiation damage using numerical and experimental approaches.
- Identify and test novel materials for broader accelerator applications for high power targets, beam catchers, beam windows and luminescence screens
- Explore societal applications of these novel materials such as advanced engineering, medical imaging, quantum computing, energy efficiency, aerospace, and thermal management

Introduction to the meeting (A. Bertarelli, M. Tomut)

- Presentation summary:
 - Objective: review of the past months activities and planning of last months of ARIES
 - Number of activities postponed due to Covid19 emergency
 - Re-planning as a function of the project extension
- Discussion:
 - AL asked if irradiation at GSI/HRTM can be continued in IFAST. AB replied that TA activities are not included in IFAST, but ARIES TA can be extended
 - SR asked if the allocation of resources has been done in view of the extension. AB replied that GSI/CERN extend some PhD contract
- **Actions:**
 - **Ask for MS61 4 months extensions, discuss in October for the other MS/Del.**
 - **Organize online “light” meeting of WP for September/October**

ARIES WP17 PowerMat: Timetable

- 4 sessions
 - Task 17.2 combined with 14.4
 - Task 17.3
 - Task 17.4
 - Task 17.5
- 27 attendees
- Participant list: C. Accettura, A. Bertarelli, F. Carra, J. Guardia-Valenzuela, A. Lechner, M. Losasso, S. Redaelli, N. Solieri, M. Portelli, A. Waets, P. Drechsel, P. Bolz, M. Tomut, J. Potoine, M. Beghi, M. Scapin, L. Peroni, M. Kitzmantel, P. Simon, T. Asavei, C. Trautmann, V. Toto, A. Galatanu, O. Frutos, N. Sammut, P. Mollicone, S. Bizzaro

Status of task 17.2 (A. Bertarelli)

- Presentation summary:
 - MoGr development completed and industrialized. Production for LS2 collimators almost completed.
 - Good progress in other materials.
- **Actions:**
 - Complete thermo-mechanical and UHV characterization of graphite-carbide composite. (CERN)
 - MS61. Start preparing and ask for deadline extension

Status of task 14.4 (F. Carra)

- Presentation summary:
 - Deliverable completed in 2018 with the material production
 - Mechanical test of CuCD, assessment of anisotropy
 - Paper submitted by M. Portelli containing this info
 - Different luminescent screen tested
 - New development in IFAST (reduce cost)

Status of task 14.4 (F. Carra)

- Actions:
 - New luminescence screen for next year beamtime (avoid graphitization) (GSI/RHP)
 - Check remaining budget from RHP (CuCD production target already reached)
 - Define geometry and test CuCD with Hopkinson bar (POLITO/CERN)
 - Simplified collimator block with Mo-cladded CuCD and samples for dynamic test(CERN/RHP)
 - Update production summary of RHP (all samples, not only the ones shipped to CERN-GSI) (F. Carra)
 - Carbide-Graphite to be manufactured (BREVETTI)
 - 1 MoGr plate with pitch
 - 25 Samples for Hopkinson bar → convert to another material to be defined shortly (Need inputs from WP17.2, CERN)
 - 1 big part to prove industrialization. To be defined shortly. (Need inputs from WP17.2, CERN)

Task 17.2

- **Report from recent material characterization campaigns and new developments (J. Guardia)**
- Presentation summary:
 - Density of different batched of CuCD for MultiMat
 - Isotropy check of CuCD: new holder production for thermal diffusivity, HT bending test
 - Development of CrGr: promising thermal and electrical properties, thesis publication
- Discussion:
 - MT asked why to use pitch and JG replied that pitch converts into graphite during sintering and this improve the graphite crystallite bonding

Status of task 17.3+Possible scenarios for dynamic tests (L. Peroni)

- Presentation summary:
 - Description of the task and summary of results: irradiation at GSI, MultiMAT, FlexMAT
 - Discussion on the special issue
 - Discussion and overview of laser-induced shock wave: test proposal and planning
 - Understand partner capability
 - Timeline
 - Instrumentation
 - Materials
 - New MultiMAT proposal
- Discussion:
 - AL asked which is the expected intensity for HiRadMat, FC replied that should be the same as before the shutdown. AB added that with the MultiMAT design it is possible to focus and to increase the stress/strain even at lower intensity. Higher temperature reached on the instrumentation (closer to the beam)

Status of task 17.3+Possible scenarios for dynamic tests (L. Peroni)

- Actions:
 - Define laser test for PHELIX (GSI/POLITO/CERN/ELI) → application deadline 27th July
 - Diagnostics (GSI)
 - Stress simulations (CERN/ELI)
 - Additional instrumentation (POLITO)
 - Dynamic test at high temperature (BREVETTI/POLITO). Check with Brevetti about status of Vacuum Chamber manufacturing
 - Call for paper submission for special issue: send reminder to interested authors (STI, RaDIATE, HiRadMat ...) (ALL)
 - 2 more papers coming soon (CERN/GSI)
 - Ask to the editor to postpone the deadline (POLITO) → **DONE (MS will update in the next week on the editor's answer)**

Task 17.3

- **ELI-NP activities updates (T. Asavei)**
- Presentation summary:
 - Installation of 3 vacuum chambers completed
 - Experiment planned at the end of 2020 with proton beam
 - Spectroscopy to study phase-evolution during shock waves planned for end of 2021
- Discussion:
 - MT commented that the p beam will be very divergent and difficult to control

Task 17.3

- **Discussion on shock experiments on accelerator materials with lasers and high energy beams**
- AB asked the feasibility of laser-induced shock wave studies at ELI-NP within next 6-8 months, but the laser commissioning and testing requires more time. Keep open the possibility of ELI if ARIES extension 12months.
- MT proposed to focus on PHELIX (ns pulse laser). Deadline for the proposal 27th of July. Usually 5 days of time allocated to the experiment, 6 shot/days → need to choose carefully parameters and materials. The spot size is in the order of microns but can reach up to 1 mm if particular phase plate is inserted.
- LP proposed to confine the materials to increase shock intensity, MT suggest to do it at the end because difficult to test different geometry within 1 week time.

Task 17.3

- **Investigation of dynamic effects in targets by GeV U ions impact (P. Bolz)**
- Presentation summary:
 - Motivation and method
 - Summary of the results focusing on 2 materials: one that survived irradiation and one that was severely damaged
- **Dynamic Response of Tantalum Rods Embedded in Graphitic Shells Impacted by High Energy Particle Beams in the HiRadMat 38 "FlexMat Experiment"**
- Presentation summary:
 - Test and material overview
 - Benchmark of experimental data and simulation
- Discussion:
- AB asked why the dependence from the CTE of graphite, if the energy is deposited mainly in Ta → not clear, to be further investigated
- MT commented that the test bench is still at CERN, but a PIE is planned for this year

Task 17.4(A. Lechner)

- Presentation summary:
 - Overview of the activities:
 - HL-LHC dpa simulation
 - PhD thesis of E. Skordis successfully discussed (to be published) on this topic
 - GSI irradiation
 - BLIP irradiation
- Discussion:
 - AL asked which is the expected intensity for HTRM, FC replied that should be the same as before the shutdown. AB added that with the MultiMAT design it is possible to focus and to increase achieved stress/strain comparable to LIU beam even at lower intensity. Pay attention to higher temperature reached on the instrumentation (closer to the beam)
- Actions:
 - Preparation of new irradiation campaign at GSI (if approved)
 - Analysis of BLIP 2018 irradiation campaign (CERN)
 - Preparation of BLIP 2020 irradiation campaign (CERN)
 - Development of molecular dynamics simulation (POLIMI)

Task 17.3

- **Radiation damage and gas production simulations for HL-LHC collimators (A. Waets)**
- Presentation summary:
 - Motivation and overview of possible application (HL-LHC, GSI, BLIP)
 - Modeling of radiation damage
- Discussion:
- AB asked how to infer the threshold energy for displacement of MoGr. AL replied that the same of Gr is assumed. Complex and long simulation chain so influence of this <10-20%
- **GSI irradiation tests results and future test plans (C. Accettura)**
- Presentation summary:
 - Overview of the test
 - Electrical resistivity and Raman spectroscopy
 - Future plan
- Discussion:
- AL commented that it may be useful to report both max and average dpa when discussing the properties degradation

Task 17.3

- **Modelling of defects in graphite (M. Beghi)**

- Presentation summary:

- Motivations
- Overview of MD simulation for defects in graphite (excluding the way these are created)
- Procedure and validation

- Discussion:

- AB asked the timeline for this study, MB replied that the system has been set up, now will be validated with literature comparison
- MT proposed to try different simulation with different defects distribution

- **Update on BLIP irradiation tests and RaDIATE activities (N. Solieri)**

- Presentation summary:

- Overview of RADIATE activities
- Planning for PIE of BLIP 2018 and new irradiation in 2020 for collimators

- Discussion:

- AB asked if the max temperature on the CERN 2 capsule is simulated or measured. NS replied that so far it is only simulated but discussion are ongoing to measure the temperature in the next tests.

Task 17.5 (M. Tomut)

- Presentation summary:
 - Overview of the activities:
 - Optimization of diamond-metal composite for luminescence
 - Graphite foil for NUMEN target
 - IFAST: graphene membrane development and studies
- **Actions:**
 - Irradiation of new luminescence screen with different element (not N)
 - Dissemination of R&D results on novel materials for accelerator and societal applications (month 46)
Planned initially as a Workshop “Extreme Beams meet Extreme Materials” • To be replaced by an online workshop or by a Special Issue in an open access journal (“Materials”- IF 3.4)
- **New results on beam- induced colour centres in nitrogen containing diamonds(P. Simon)**
- Presentation summary:
 - Irradiation campaign overview, new measurements and results
- Discussion:
 - AB asked if we can still consider this material even if they lose luminescence. MT replied that their higher robustness encourage further development to optimize their luminescence.

