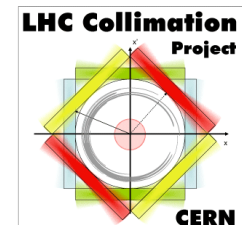


EuCARD-2 WP11 Topical Meeting Collimator Materials for Fast High Density Energy Deposition

EuCARD-2 WP11 Topical Meeting, MALTA, April 28-29, 2016

Adriana Rossi on behalf of



- The material work package in EuCARD-2 supports progress with material developments for collimators and targets, where requirements for material shock resistance, electrical and heat conductance, in conjunction with radiation hardness push research onto challenging grounds.
- This topical annual meeting aims at a comprehensive review on
 - Applications of collimator materials to LHC and HL-LHC,
 - Progress on material development and characterisation,
 - Outlines of production techniques,
 - Results of irradiation tests (ions, protons and high-energy impact protons)
 - Comparison with FLUKA estimation of DPA to predict radiation induce degradation.

Programme

THURSDAY 26th April 2016		
9:30	Introduction and scope (15'+5')	A. ROSSI – CERN
9:50	Overview of scenarios where new materials are required (20'+10')	R. BRUCE – CERN
10:20	Progress on material development and characterisation (30'+20')	J. GUARDIA VALENZUELA – CERN
11:10	COFFEE	
11:40	Material characterisation (30'+20')	L. PERONI – POLITO
12:30	CuCD production and novelties (20'+10')	M. KITZMANTEL – RHP
13:00	MoGr production and novelties (20'+10')	S. BIZZARO – BREVETTI-BIZZ
13:30	LUNCH (free)	
14:30	The HiRadMat 23 Experiments : results and analysis (30'+20')	F. CARRA – CERN
15:20	Studies of energy deposition for a proton absorbers for crystal collimators (30'+20')	S. GIBSON – RHUL
16:10	COFFEE	
16:40	Proposal of upgrade scenarios based on tracking simulations with new materials (30'+20')	E. QUARANTA - CERN
17:30	Status and perspectives of proton irradiation tests at RRC-KI (30'+20')	A. RYAZANOV – RRC-KI
20:00	WP11 DINNER @ Michael's at the Civil Service Sports Club	
FRIDAY 27th April 2016		
9:10	Status of proton irradiation tests at BNL and DPA estimation (30'+20')	N.SIMOS – BNL
10:10	Ion irradiation results: variation of material properties with irradiation (30'+20')	M. TOMUT – GSI
11:00	COFFEE	
11:30	FLUKA estimation of DPA for ion irradiation and update on IR7 DPA calculations for LHC operations (30'+20')	L. SKORDIS – CERN
12:20	Presentation of the ARIES (after EuCARD2) programme for materials (30'+20')	A. ROSSI and M. TOMUT
	Wrap up and future plans	
13:00	LUNCH (free)	

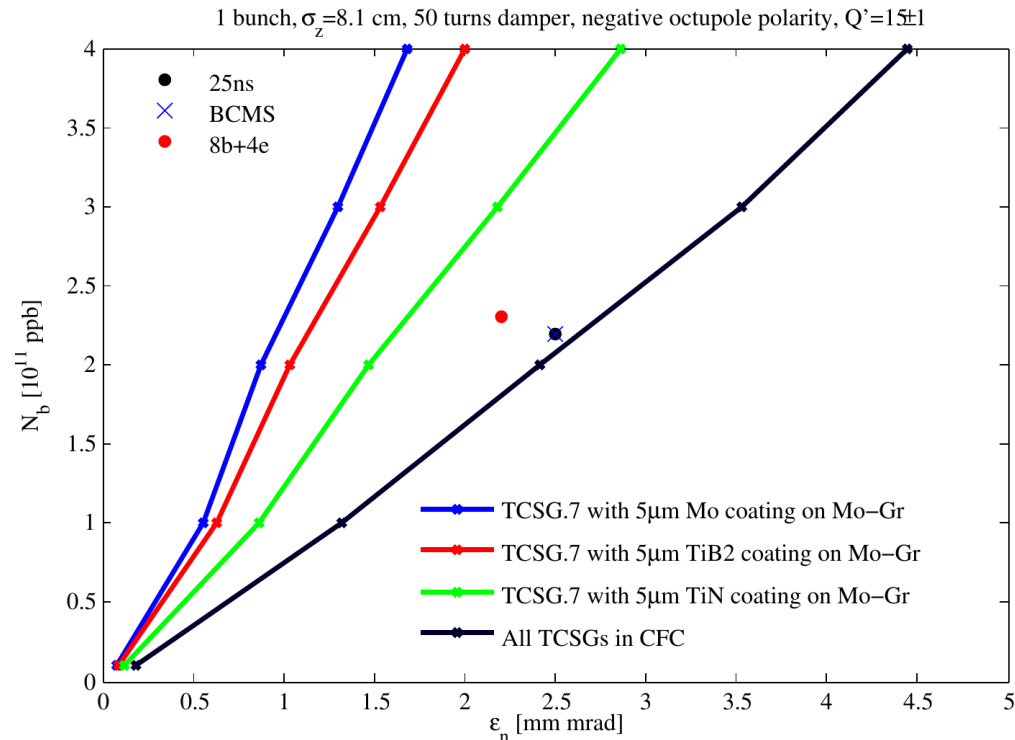
- Roderik gave a nice overview on the reasons why we need new materials for LHC and HL-LHC:

- Already in 2015 octupoles were used at max current → concern with collimator impedance that will be even worse for higher intensities and smaller emittance.

- MoGr seem to fulfill impedance requirements, provided vacuum compatibility

- Tertiary collimators robustness concern

- CuCD could work if increased transparency acceptable.

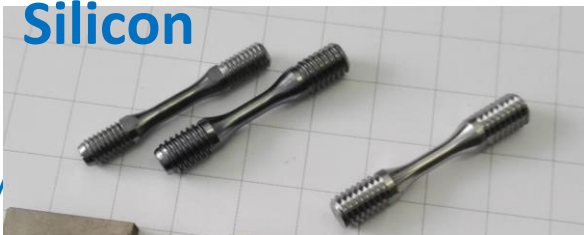


- Jorge gave an update on material development, MoGr in particular:
 - Carbide content related to material stability (better thermo-mechanical properties)
 - > Temperature of annealing important because can help in carbide formation
 - > Ti addition seem to increase catalytic efficiency and stabilises phase structure of MoGr, maintaining a good electrical conductance
 - Postprocessing under vacuum improves outgassing by a factor of 5. New tests foreseen with vacuum group.
 - TiGr should be the next step.

Summary

- Lorenzo showed capabilities in POLITO for investigating mechanical properties of refractory materials:
 - At high temperature and very high strain rate.
 - Yielding higher than fracture point
 - Low temperature neutron irradiation effects on microstructure and tensile properties of molybdenum seem to follow same trend as with high temperature and high strain rate > to be investigated further

Silicon



Graphite



MoGr



- Federico showed results with HighRadMat tests:
 - Very promising since MoGr jaws resisted to an impact equivalent to injection misfire. Can be used in IR7
 - And CuCD jaw could withstand an impact equivalent to asynchronous beam dump, necessary if used as TCT materials

- Stephen has presented preliminary results for energy deposition in a possible absorber downstream crystals.
 - Study just started
 - Details to be sorted : normalisation factor
 - Iterations necessary to find geometry and material sequence.
 - Maximum leakage of impacting proton to be given as input parameter.

- Elena showed where and why we could use novel materials
 - MoMG not only for secondary, but also for primary collimators in IR7 with ~30-50% impedance reduction, and small cleaning efficiency improvement.
 - TCDL improve cleaning efficiency and 15-12 sigma should be a good compromise between efficiency and risk to damage to TCDL.
 - Improved robustness against large beam losses (failure scenarios) for tertiary collimators and DS collimators could be provided by Cu-CD

Summary

- Alexander presented latest results on SiC using TEM prior irradiation. Highly anisotropy advantage under irradiation.
- MoCuCD after irradiation

- Nick presented results on irradiation of MoGr at BNL
 - Old grade (2012/13) of MoGr exhibited extensive structural failure highly ($5E21\text{p/cm}^2$)
 - PIE analysis ongoing. Evidence of embrittlement also at lower fluences $1E18\text{ p/cm}^2$
 - To be completed with NSLS-II XRD analysis and macroscopic thermo-physical analysis
 - Analysis to understand if behaviour dominated by graphite content: swelling observed could be the same as graphite after high level of irradiation and could be due to gas transmutation.
 - New MG grades (6403, 6530) started and reached $5e19\text{ p/cm}^2$

WP11 Milestones and deliveries

... a busy year ahead!

Milestones :

MS69 Irradiation of first samples	M12
<i>MS70 Present results on material damage from irradiation</i>	<i>M24</i>
MS71 Show new material development status	M24
MS72 Present results on material damage from simulation and compare to experiments	M45

Deliverables :

11.1 Result on simulations of new materials and composites	M36
11.2 Report on comparative assessment of beam simulation codes	M40
11.3 Irradiation test results	M46
11.4 Results on characterisation of new materials and composites	M46