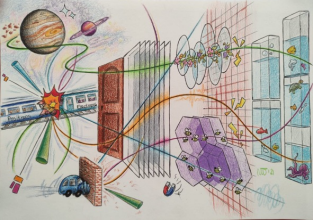

WG 6: Wide Bandgap Materials

Diamond, Silicon Carbide, Gallium Nitride, 2D

Plan for deliverables/milestones

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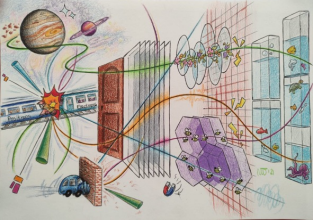
on behalf of the DRD3 proposal writing team

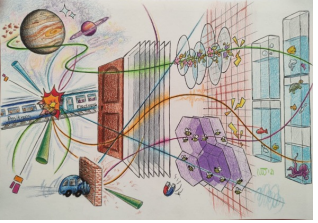
with help of Thomas Bergauer, Alexander Oh, Thomas Koffas, Giulio Pellegrini



Milestones - Diamond

DRD3

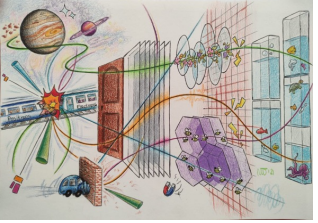
	2024	2025	2026	2027-2029	> 2030
CVD diamond wafers, CCD > 500µm, variation < 2%			x	x	x
Rate capability, verify scaling in planar and 3D geometries		x	x	x	x
Radiation hardness, > $10^{17}cm^{-2}$ in planar and 3D		x	x	x	x
3D diamond detectors, cages/interconnects, base length <25 µm			x		
3D diamond detectors, fabrication up-scaling and processing speed				x	x
Modelling, develop refined simulation models with trapping and grain boundaries			x	x	
Investigating of charge multiplication with high-field electrode designs (3D)				x	x
Fast timing detector (<30ps) via charge multiplication or electrode designs (3D)				x	x



Milestones - SiC

DRD3

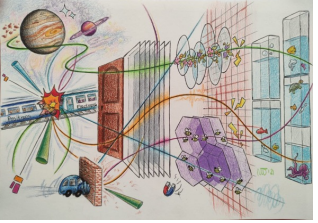
	2024	2025	2026	2027-2029	>2030
Large area sensors	*1x1cm²*		*5x5cm²*	*10x10cm²*	
active epi thickness	100µm	200µm	300µm		
epi resistivity		100 Ω cm	>kΩ cm		
SiC-LGAD (gain layer)		x	x	x	
Radiation hardness			>1E15	> 1E16	> 1E17
timing capabilities	80ps?		20ps?		
TCAD model	bare material	1E14	1E15		
Study microscopic defects	x	x	x	x	
investigate 3D geometry				x	x



Milestones - GaN

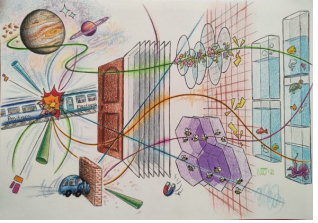
DRD3

	2024	2025	2026	2027-2029	> 2030
Improve material quality; GaN growth on bulk GaN substrate; increase thickness of epitaxial GaN layer			x		
Improve existing infrastructure for TCAD modeling				x	
Establish radiation hardness to protons/neutrons at >10^{16} neq/cm^2			x		
Establish radiation hard HEMT fabrication process; electron mobility			x		
Monolithically integrate HEMTs and Schottky diodes on same substrate				x	
Assess GaN devices as high-rate, high timing precision devices			x		
Industrial partnerships – large scale production					x
Demonstrate LGAD GaN device(?)					x



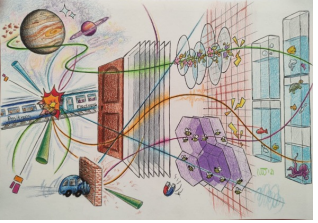
Milestones – 2D materials

	2024	2025	2026	2027-2029	> 2030
Apply graphene and other 2D materials in radiation detectors, readout electronics and signal formation. TRL2		x			
Evaluate radiation hardness of graphene with high energy particles. TRL1				x	

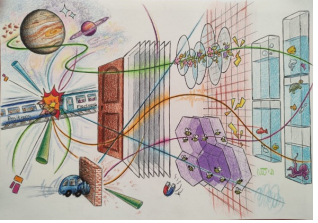


Founding and FTE for WBG

Funding (kEUR) 2024-2028		Capital budget (kEUR)		New strategic (kEUR)	FTE/year	
Total	Av. Institute/year	Total	Av. Institute/year	Total	Fix	Temp
948	11.4	495	6	567	8.9	14.1

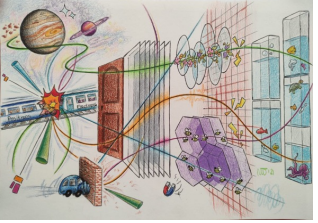


Open to discussion



DRDT 3.3 – Extend capabilities of solid state sensors to operate at extreme fluences

- To evolve the design of solid state sensors to cope with extreme fluences it is essential to measure the properties of silicon and diamond sensors in the fluence range 10^{16} n_{eq} cm^{-2} to 10^{18} n_{eq} cm^{-2} and to develop simulation models correspondingly including microscopic measurements of point and cluster defects. A specific concern to address is the associated activation of all the components in the detector. Exploration is desirable on alternative semiconductors and 2D materials to further push radiation tolerance.



Detector Readiness Matrix

DRD3

- Radiation tolerance NIEL
- Radiation tolerance TID
- LHCb (>= LS4, 2030-2035)
  - Vertex: NIEL 6e16, TID 1Grad
  - Tracker: NIEL 0.3e16, TID 0.25Grad
- ATLAS & CMS (>= LS4, 2030-2035)
  - Vertex: NIEL 2e16, TID 0.5Grad
  - Time of flight
- FCC-hh (> 2045)
  - Vertex: NIEL 100e16, TID 30Grad
  - Tracker: NIEL <=1e16, TID <= 1Grad
  - Calorimeter: NIEL >= 100e16, TID ~ 50Grad
  - Time of flight: NIEL >= 100e16, TID ~ 30Grad