



# Test Infrastructure for Radiological /Nuclear Threats and Hazards: METU Defocusing Beam Line

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II. INTERNATIONAL CBRN CONGRESS

27 – 29 November, 2019

Ankara, TURKEY

# METU-IVMER

**FUNDAMENTAL SCIENCES**

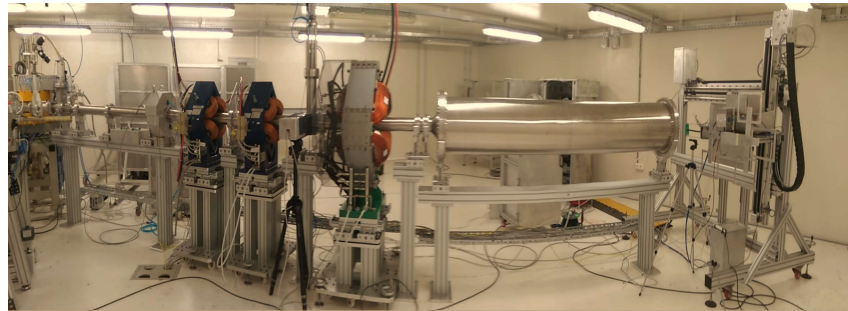
**APPLIED RESEARCH**

**TECHNOLOGY DEVELOPMENT**



## AMS-02

- Measurement of Cosmic-rays
- Search of a Dark Matter Signal



## METU-DBL

- Radiation Dose Predictions For National Satellites
- Single Events Effects

For Radiation Areas

- Radiation Detectors
- Cooling Systems
- Shielding Materials

**Domestic Radiation Monitor Project**

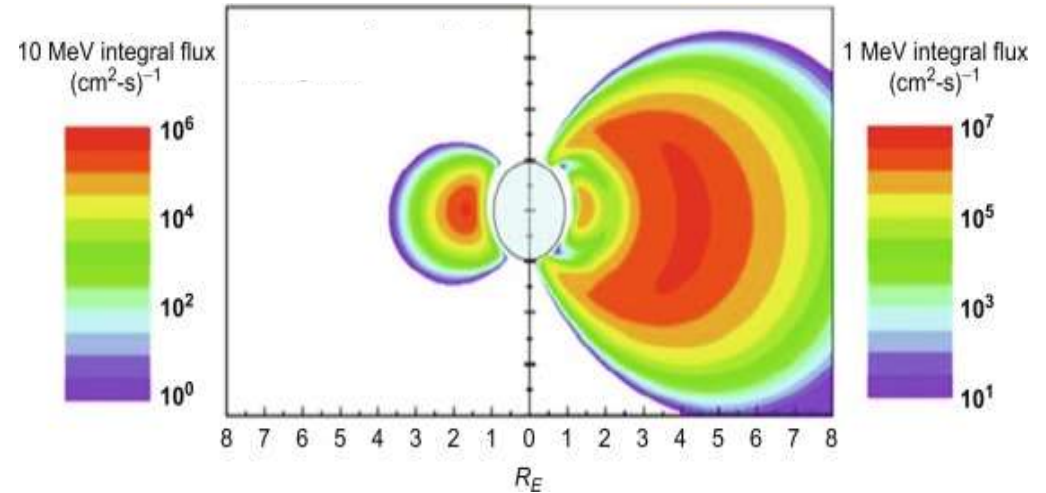
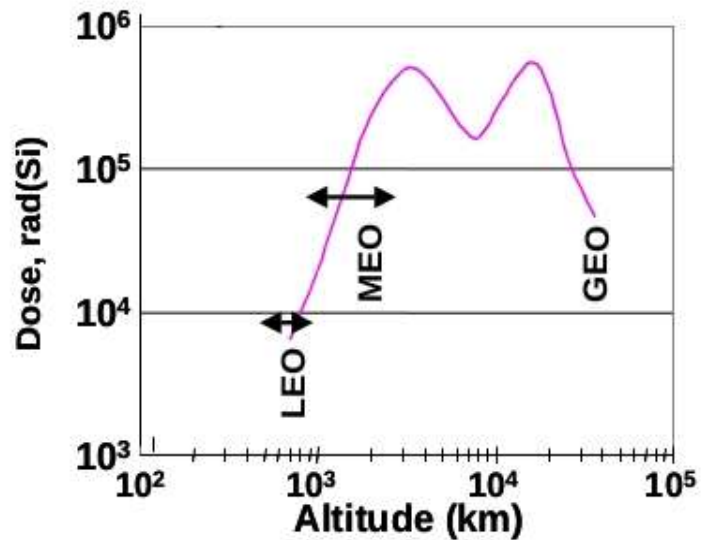
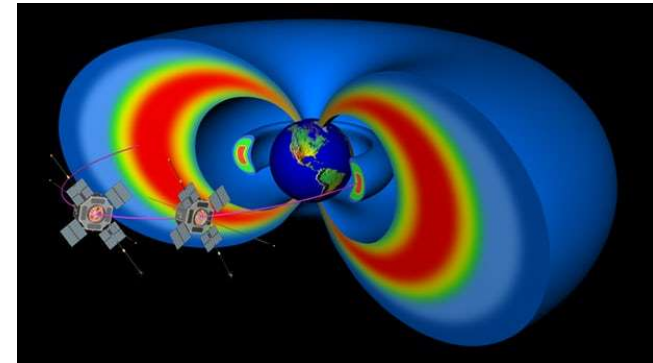
# Space Radiation Environment

LEO (550 – 1000 km) ~ 1-10 krad (Si) / y

MEO (1000 – 3000 km) ~ 100-1000 krad (Si) / y

GEO (36,000 km) ~ 10-100 krad (Si) / y

1 krad = 10 Gy



# Radiation Effects

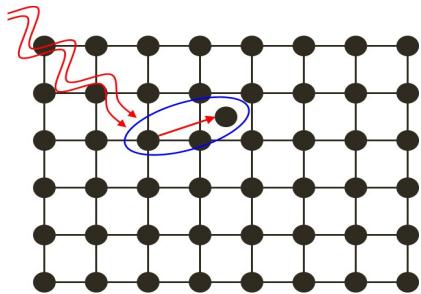
## 1) Ionising Effects

Total Ionisation Dose (TID)

LET: Linear Energy Transfer

$$LET = -\frac{1}{\rho} \frac{dE}{dx'}$$

## 2) Non-ionising Effects(DD)



## 3) Single Event Effects (SEE)

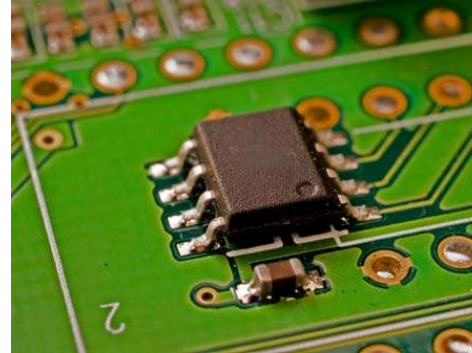
Single Event Latchup (SEL)

Single Event Burnout (SEB)

Single Event Upset (SEU)

Single Event Transient (SET)

Single Event Gate Rupture (SEGR)



# TAEA DRAT Proton Accelerator Facility



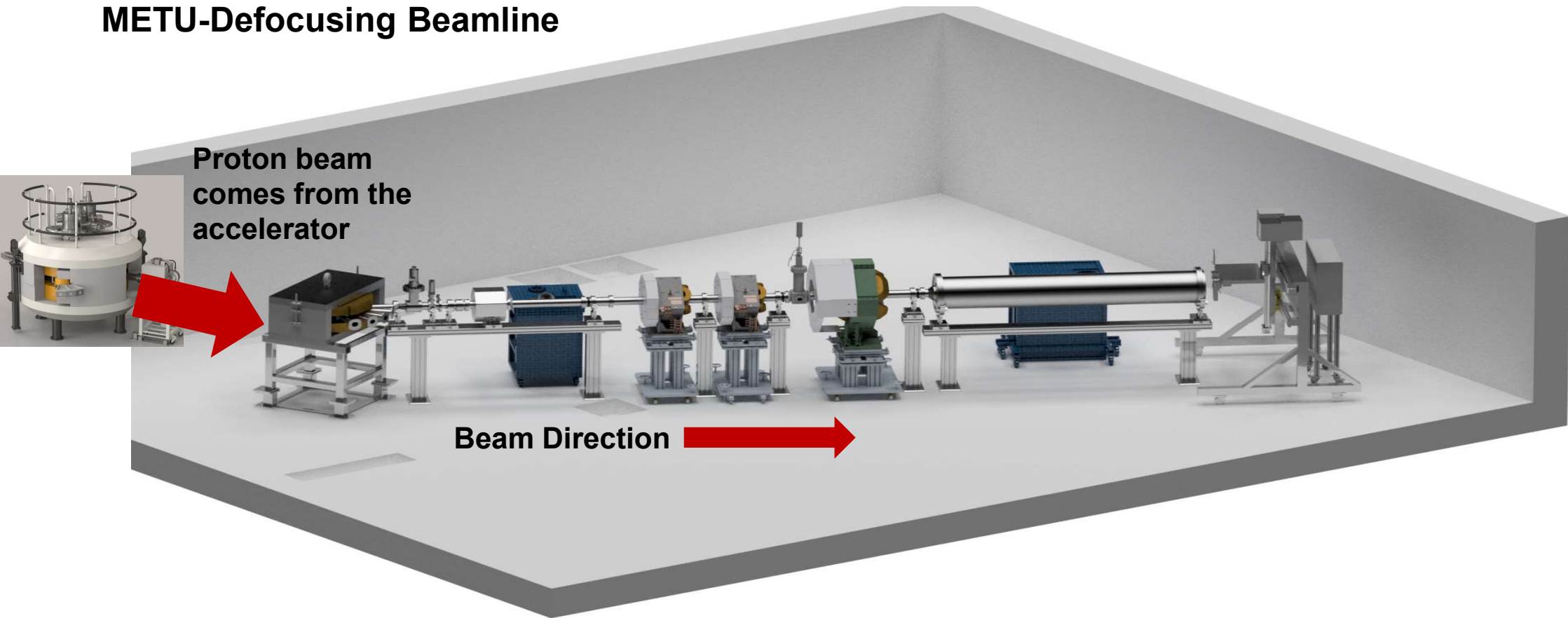
<b>Purpose</b>	Radioisotope Production and R&D Studies
<b>Accelerator</b>	Cyclone 30
<b>Energy Range</b>	15 – 30 MeV
<b>Beam Current</b>	0.1 $\mu$ A - 1.2 mA
<b>Beam Width</b>	1 cm

**METU-DBL**  $\longrightarrow$  Proton Irradiation Tests

- Hi-Lumi LHC
- Space Applications
- Radiological/Nuclear Applications



# METU-Defocusing Beamline



ESA/ESCC No: 25100 Standard Single Event Effects Test Method and Guideline				
Kinetic Energy	Radiation Area	Flux	Homogeneity	Fluence
20 – 200 MeV	15,40 cm x 21,55 cm	$10^5 - 10^8$ p/cm <sup>2</sup> /s	±%10	$10^{11}$ p/cm <sup>2</sup>

# Subsystems of METU-DBL



Beam Optics



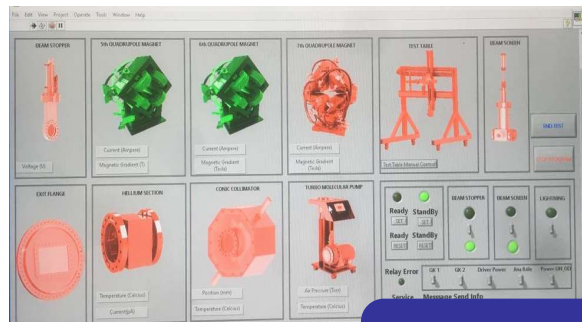
Vacuum



Robotic



Test and Measurement



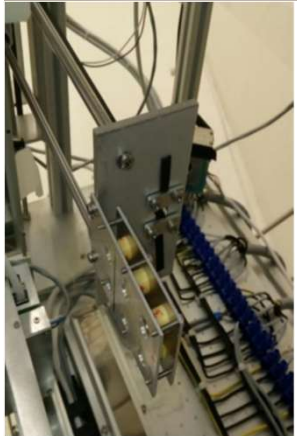
Control



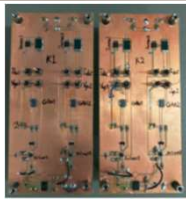
Cooling

**Simulation Programs**  
 Beam Optics → MAD-X and Transport  
 Particle Tracking → Turtle and G4beamline  
 Cooling Calculations → ANSYS Fluent  
 Dose and Radioisotope Studies → FLUKA and MCNP

# METU-DBL Pre-Tests (December 2017 – March 2018)



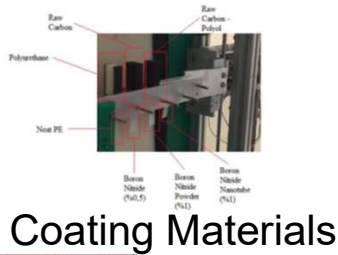
Pin Diodes



GaN-FET



Solar Cells



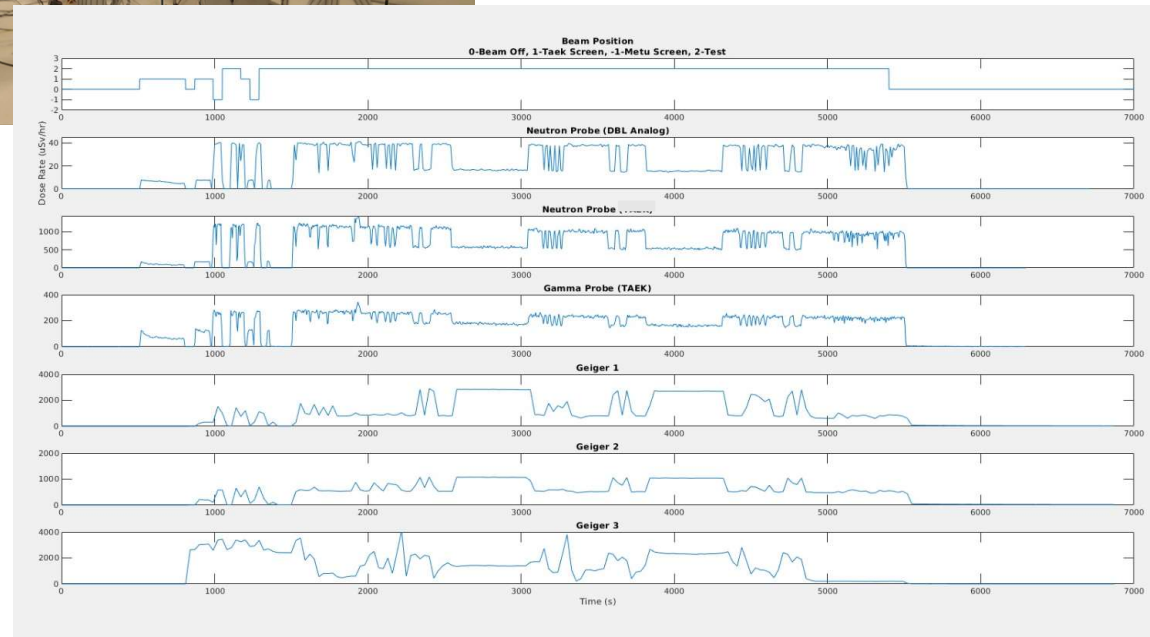
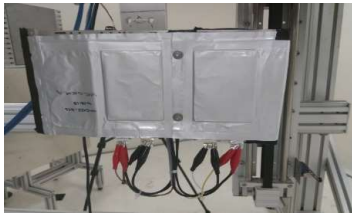
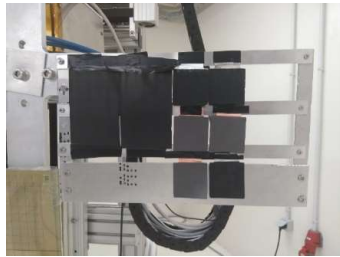
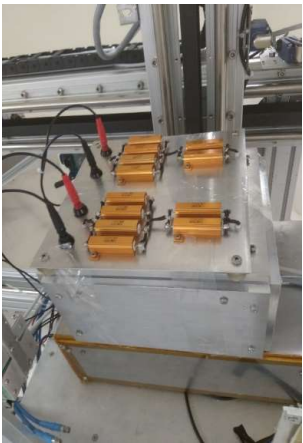
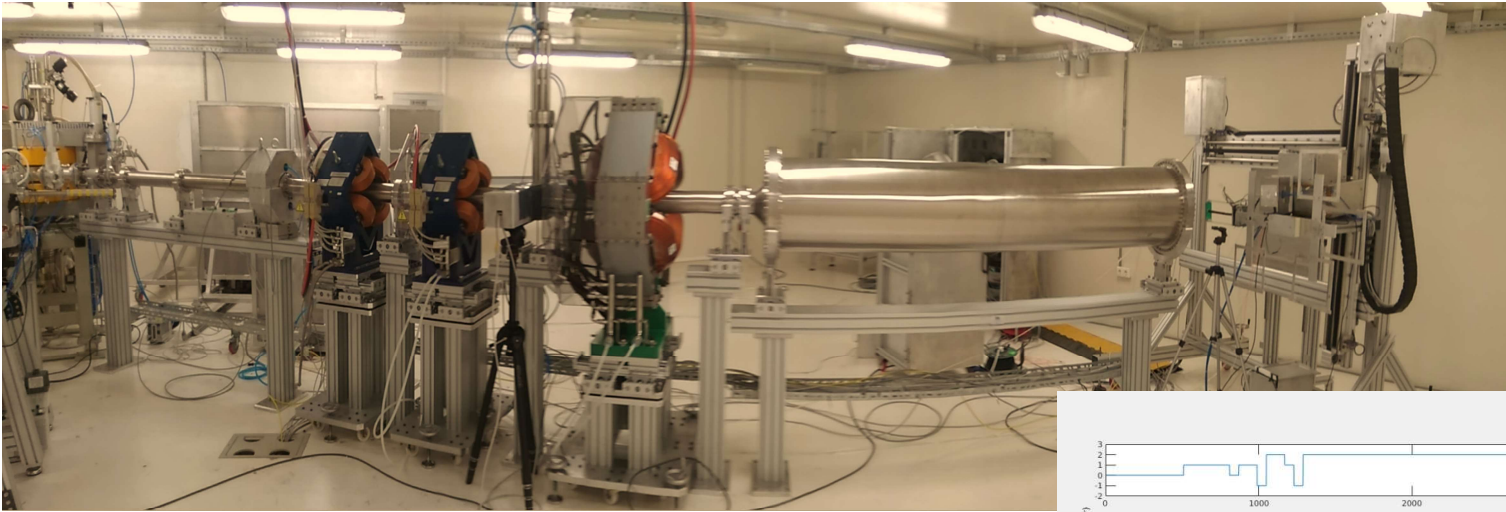
Coating Materials

Institutions	Material
METU	PIN Diodes
TUBITAK MAM	Solar Cells
TUBITAK MAM	Shielding Glasses
TUBITAK MAM EE	Battery, Anode-Cathode
TUBITAK Uzay	Buffer
TUBITAK Uzay	GaN-FET
Sabancı University	Coating Materials
METU	Metallic Glasses



# METU-DBL : November 2019 -

Tested  
Anode - Cathode and Battery  
developed by TUBITAK MAM EE  
on 18.11.2019



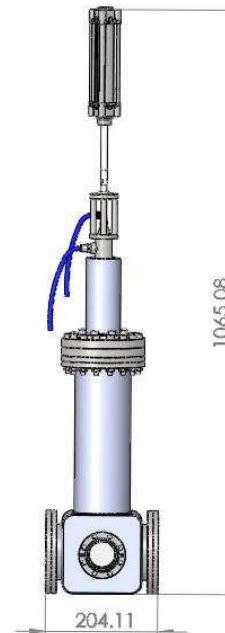
# METU-DBL Technologies



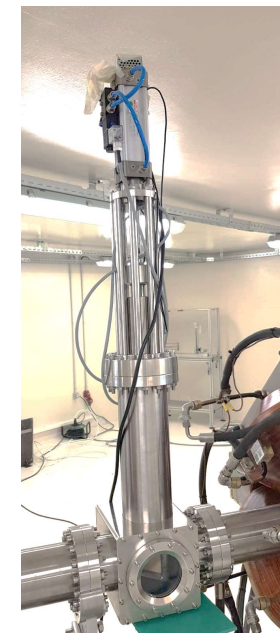
Radiation Tolerant Water Treatment Unit



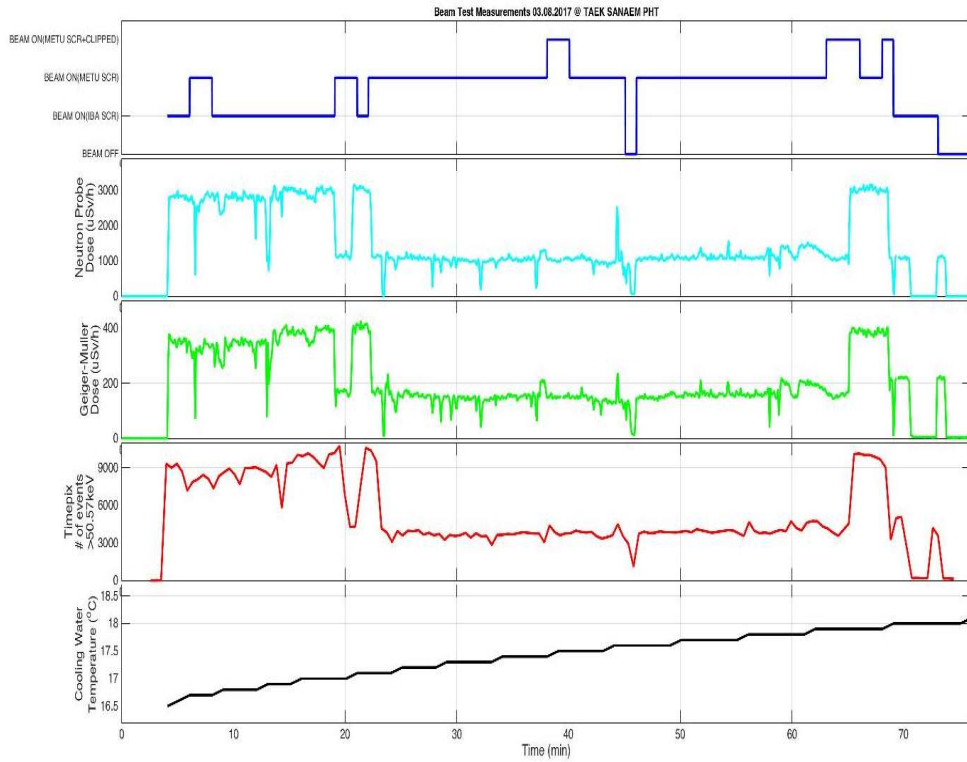
First Turkish Industrial Size Accelerator Magnet



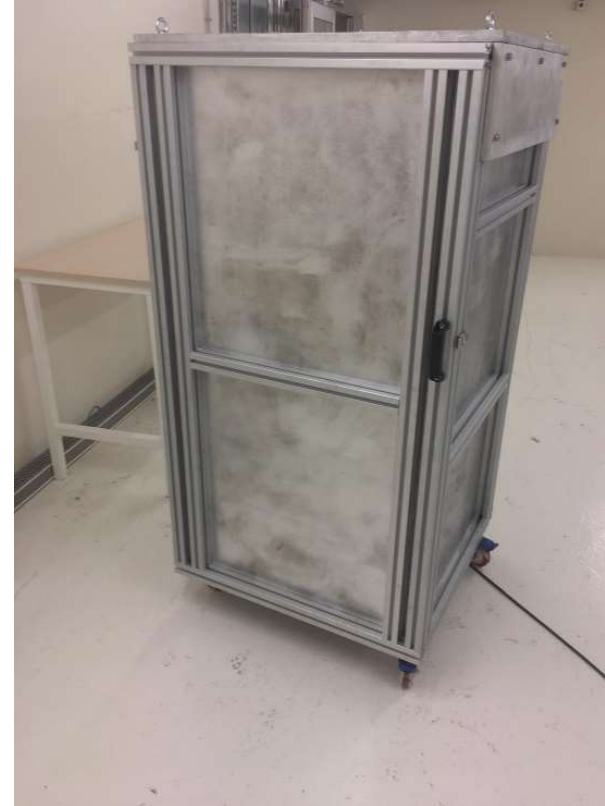
Movable Beam Screen



# METU-DBL Technologies



Real Time Radiation Monitoring System



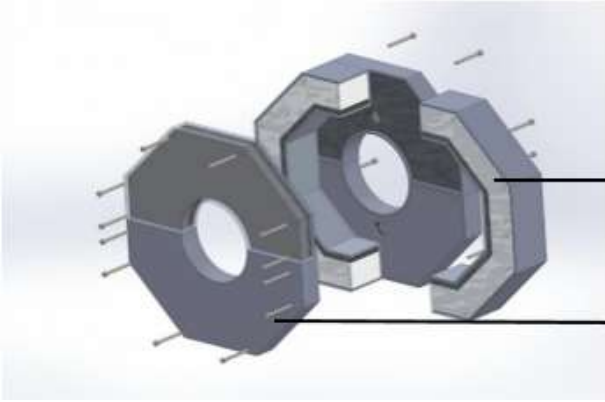
Shielding against gamma, electrons and neutrons in METU-DBL





# METU-DBL Technologies

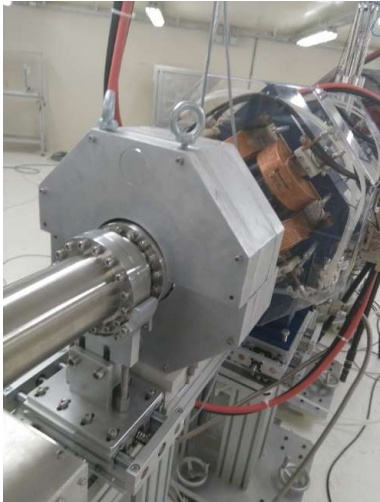
## Shielding Calculation



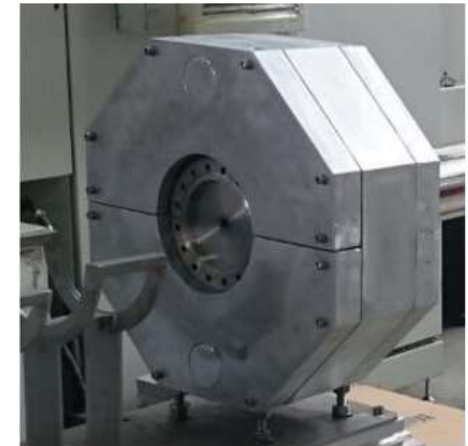
1\* From inside to outside Al:0,5 cm – Pb:1,0 cm – PE:0,5 cm – Al: 0,5 cm

2\* From inside to outside Al:0,5 cm – Pb:1,0 cm – PE:2,0 cm – Al: 0,5 cm

1\* Side parts of the Shield 2\* Cover parts of the Shield



Dose rate **with shielding** 80  $\mu\text{Sv/h}$   
Dose rate **without shielding** 3000  $\mu\text{Sv/h}$

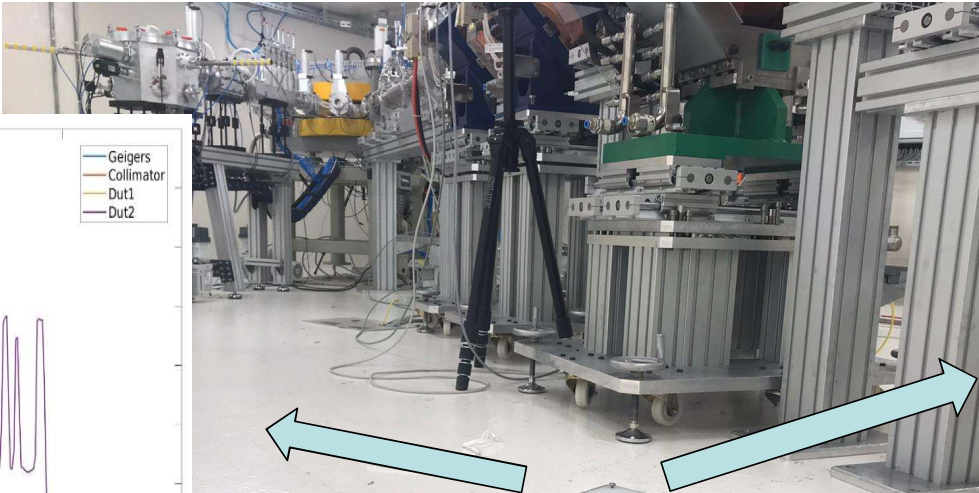
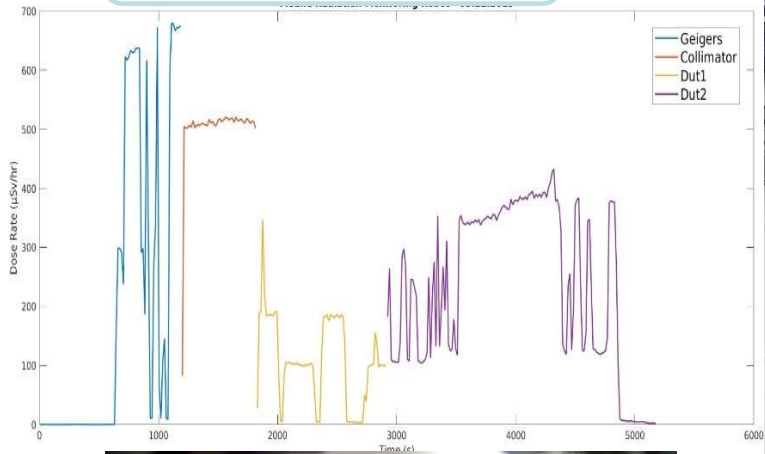




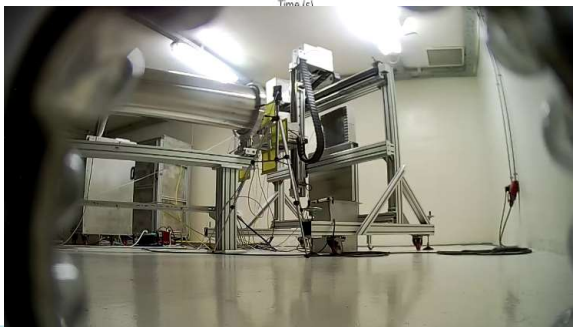
# METU-DBL Technologies

## Mobile Radiation Measurement Robot

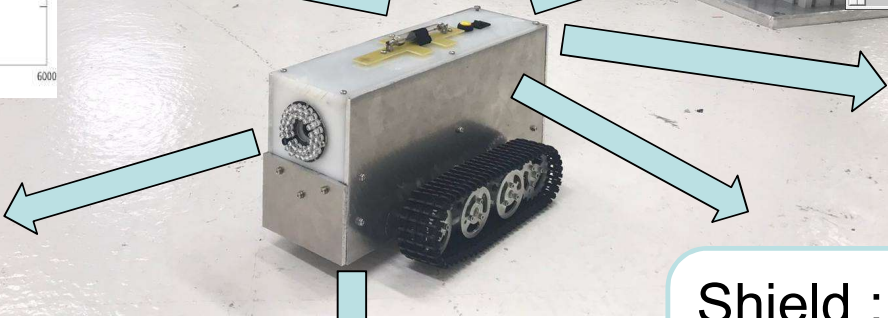
Geiger Counter



The control interface includes a 'Killswitch' (192.168.1.161), directional buttons (Left arc, Forward, Right arc, Standing Left, Stop, Standing Right, Rear Left arc, Reverse, Rear Right arc), and a 'Reset Counter' button. It features radio buttons for 'Geigers', 'Collimator', '3rd Magnet', '4th Magnet', '5th Magnet', and 'DUT'. There are also checkboxes for 'Data Flow: True' and 'Turn On/Off Data Flow'. A 'Speed control' slider is set to 40. A log window on the right displays a list of timestamped dose rate measurements, such as '10.47.34: Dose Rate: 0.0324800 uSv/h'.



Livelihood Camera



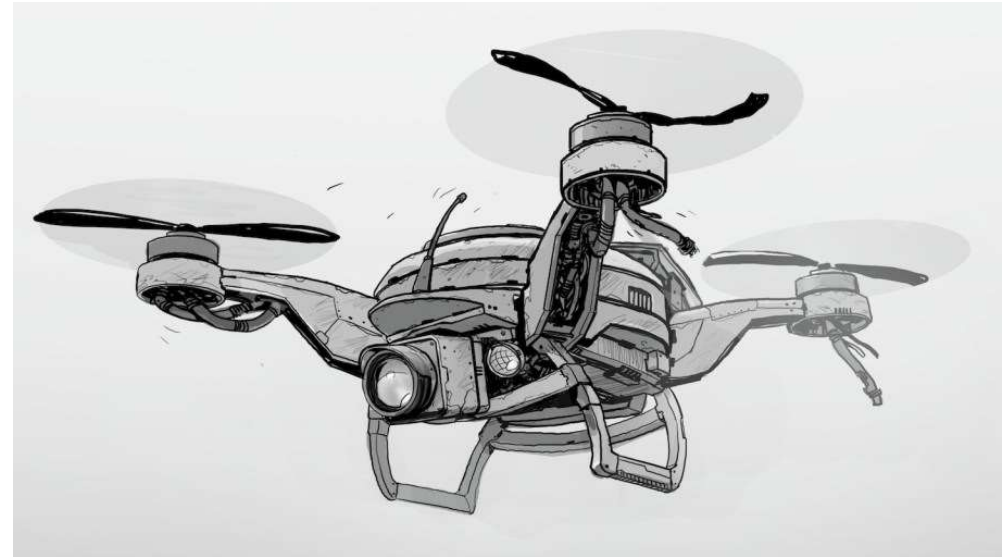
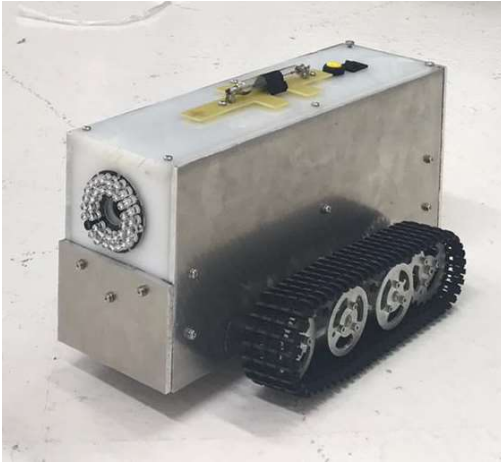
Wireless Control

Ability to locate radiation source

Shield :  
10 mm Polythene  
2.5 mm Al

## Mobile Radiation Measurement Robot

Next Idea :



To find misplaced nuclear sources and/or map radiation after a CBRN event

## Slayt 14

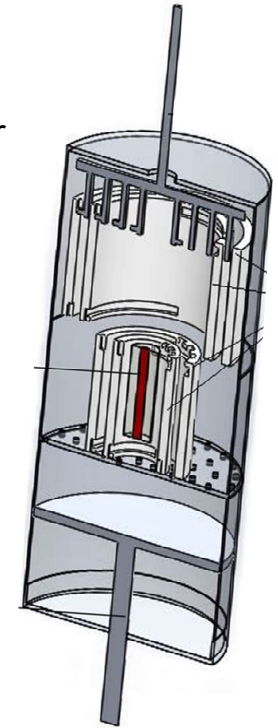
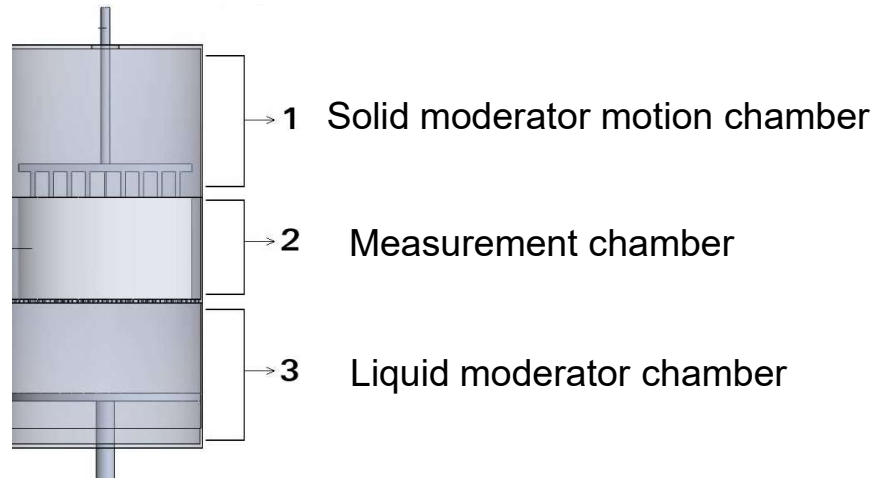
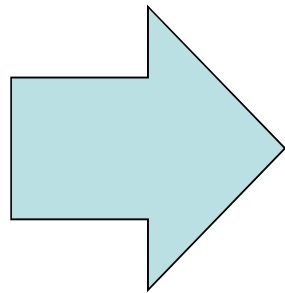
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**BD1**

Bilge Demirkoz; 28.11.2019

## New Patent : Neutron Detector with Solid-Liquid Moderator to Measure Neutron Flux at Different Energies

Bonner spheres



Now working on commercialization of this patent



## Slayt 15

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**BD2** Bilge Demirkoz; 28.11.2019

**BD3** Bilge Demirkoz; 28.11.2019



# Thank You Four Your Attention!

Thanks to

- Presidency of Defence Industries
- Presidency of Strategy and Budget
- TAEA PAF

<http://ivmer.metu.edu.tr/>

## References

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8. Demirköz, M. B., Efthymiopoulos, I., Poyrazoglu, A. B., Seckin, C., Uslu, P., Celik, N., ... & Avaroglu, A. (2019, June). Installation of the METU Defocusing Beamline to Perform Space Radiation Tests. In 2019 9th International Conference on Recent Advances in Space Technologies (RAST) (pp. 355-361). IEEE.

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