In-Situ Total Ionizing Dose Tests of SSPA Components

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Outline

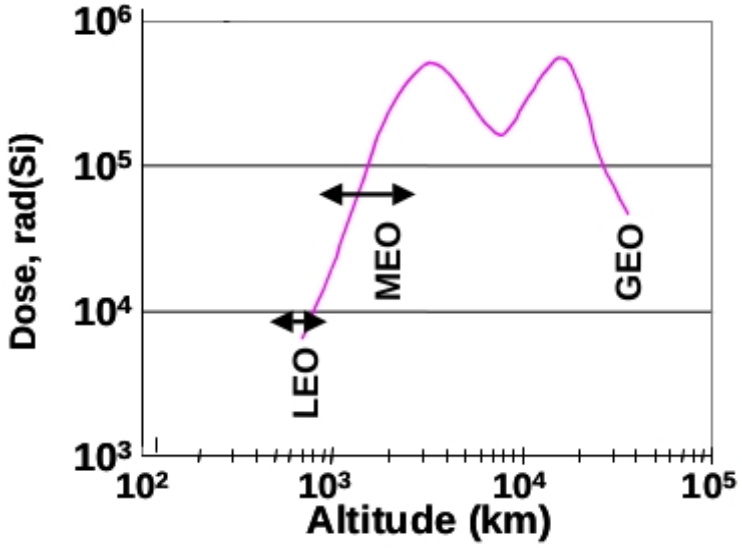
- ❑ Space Radiation Environment
- ❑ Single Event Effects testing Project
- ❑ Total Ionizing Dose Testing Project
- ❑ Test Techniques and Setup
- ❑ Test Results
- ❑ Conclusion

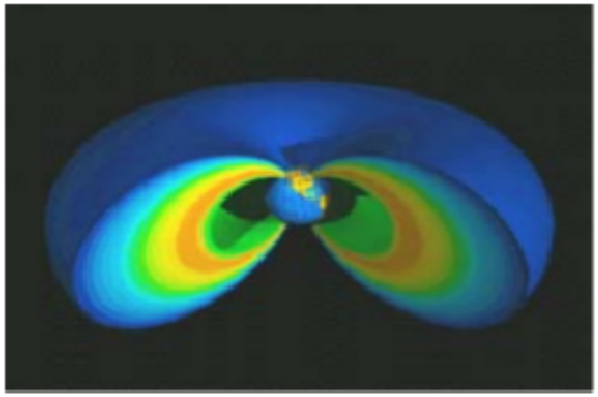
Space Radiation Environment

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

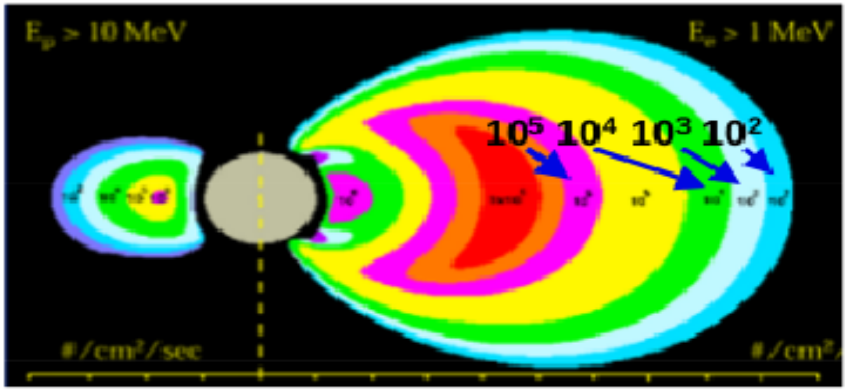
MEO (1000 – 3000 km) ~ 100-1000 krad (Si) / year

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

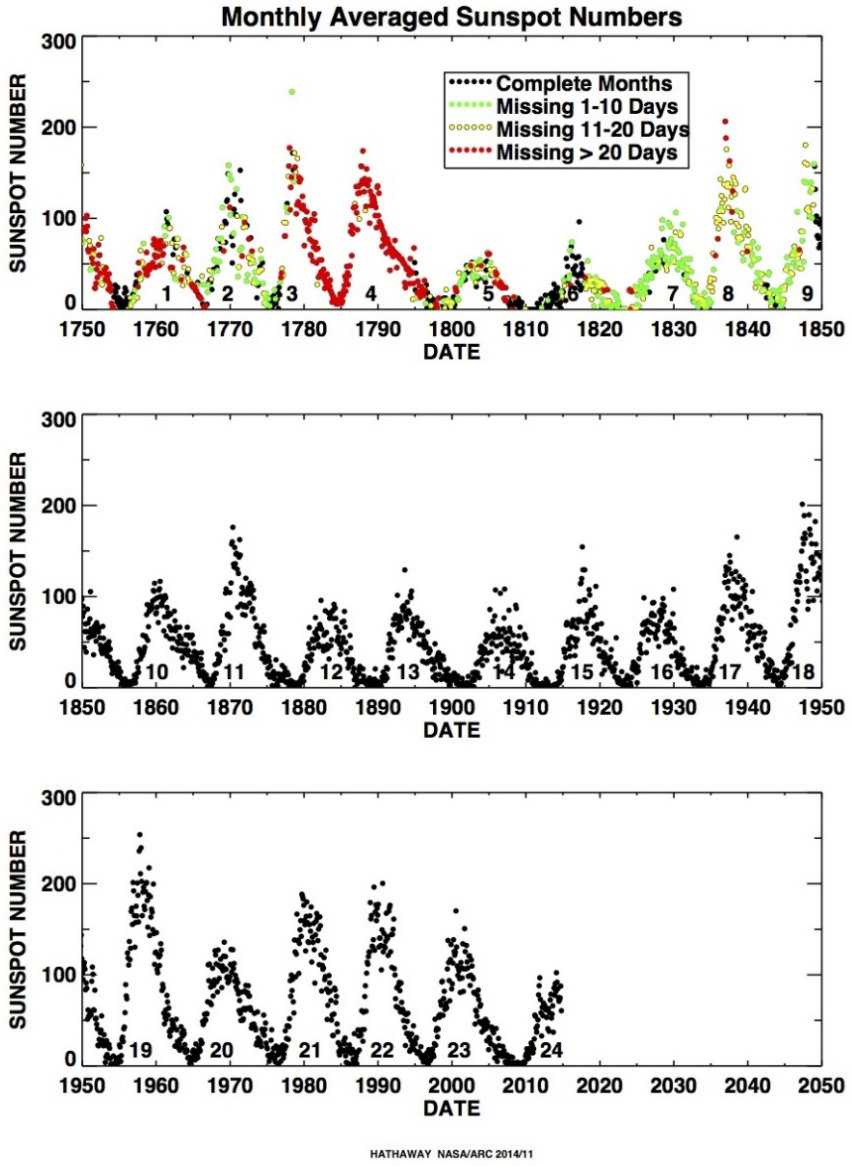


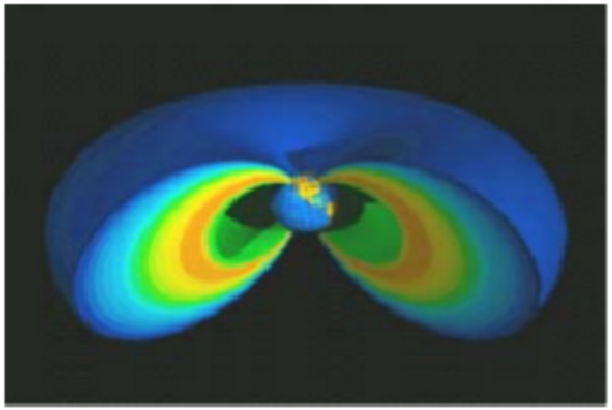


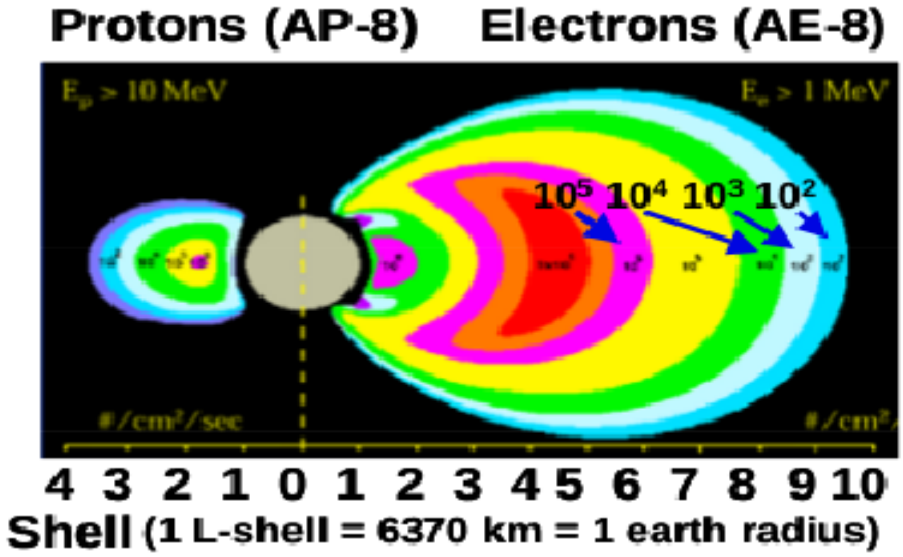
Protons (AP-8) Electrons (AE-8)



Space Radiation Environment

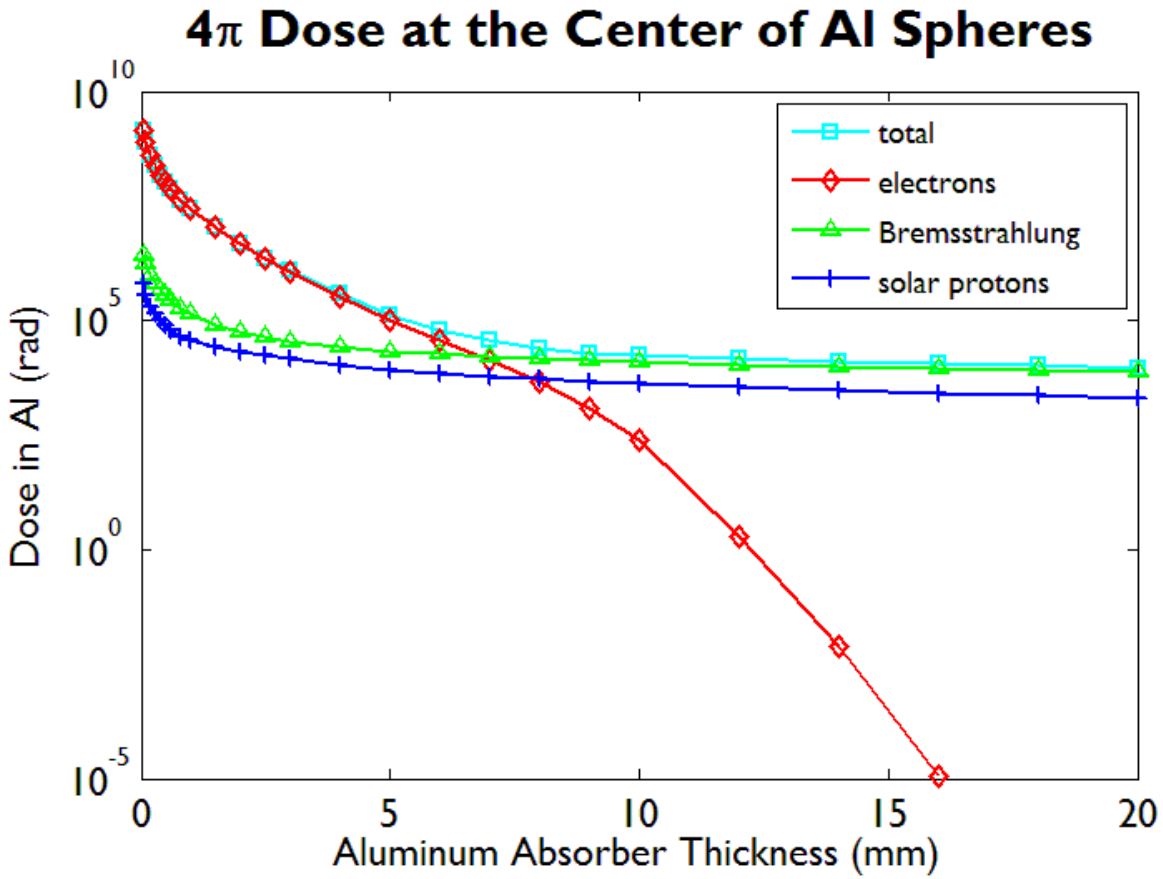






Nikkei Science, Inc. of Japan, by K. Endo

Space Radiation Environment

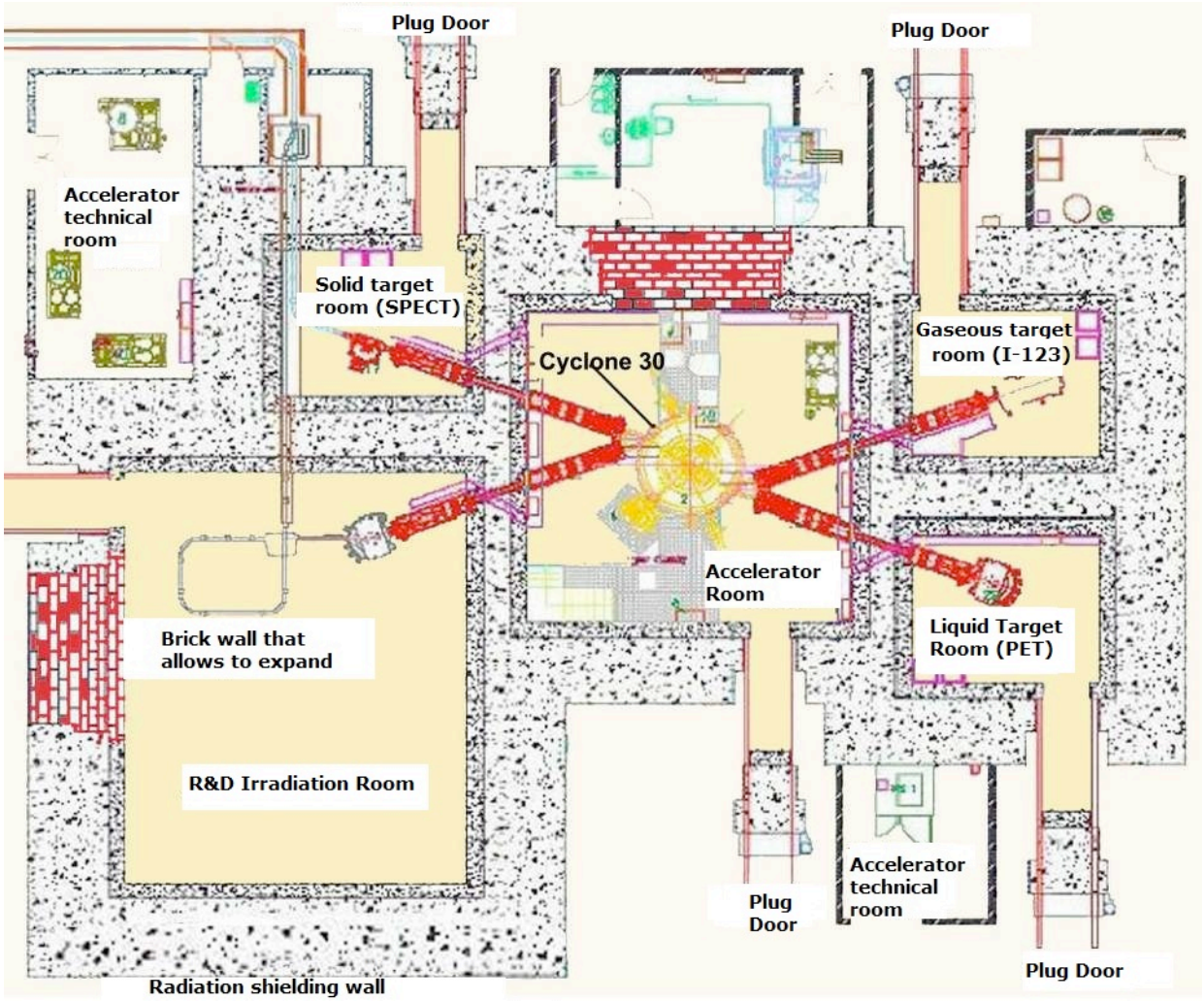


Based on the mission specifications, an analysis reveals that the SSPA is expected to absorb ~100 kRad(Si) of total dose during its orbital lifetime.

Proton Irradiation Test Facility in Turkey

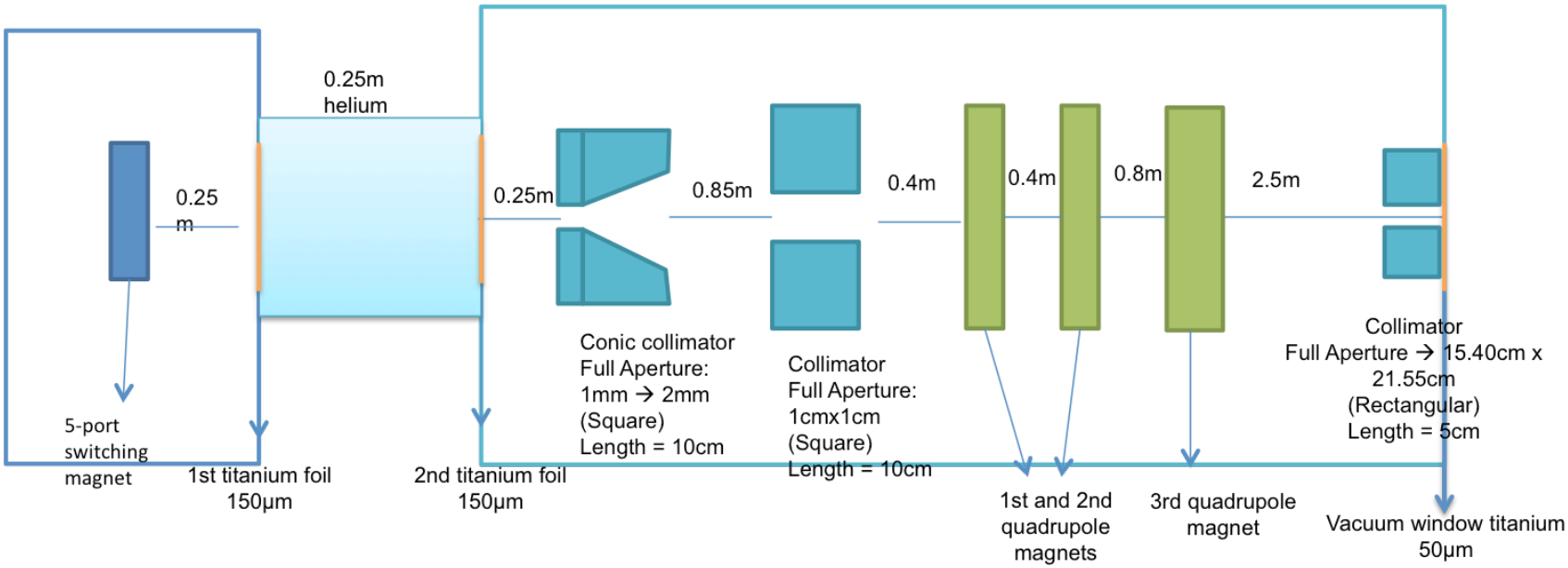
TAEK SANAEM Proton Accelerator Facility

Beam Energy	30MeV
Beam current	10μA to highest 1.2mA
Beam size at the R&D room	1cm in diameter.



Proton Irradiation Test Facility in Turkey

Defocusing Beam Line Layout



	1st quadrupole magnet	2nd quadrupole magnet	3rd quadrupole magnet
Magnetic field (kG)	3.3	-1.2	6.5
Length(m)	0.3	0.3	0.3
Aperture(cm)	11.0	11.0	16.0

Proton Irradiation Test Facility in Turkey

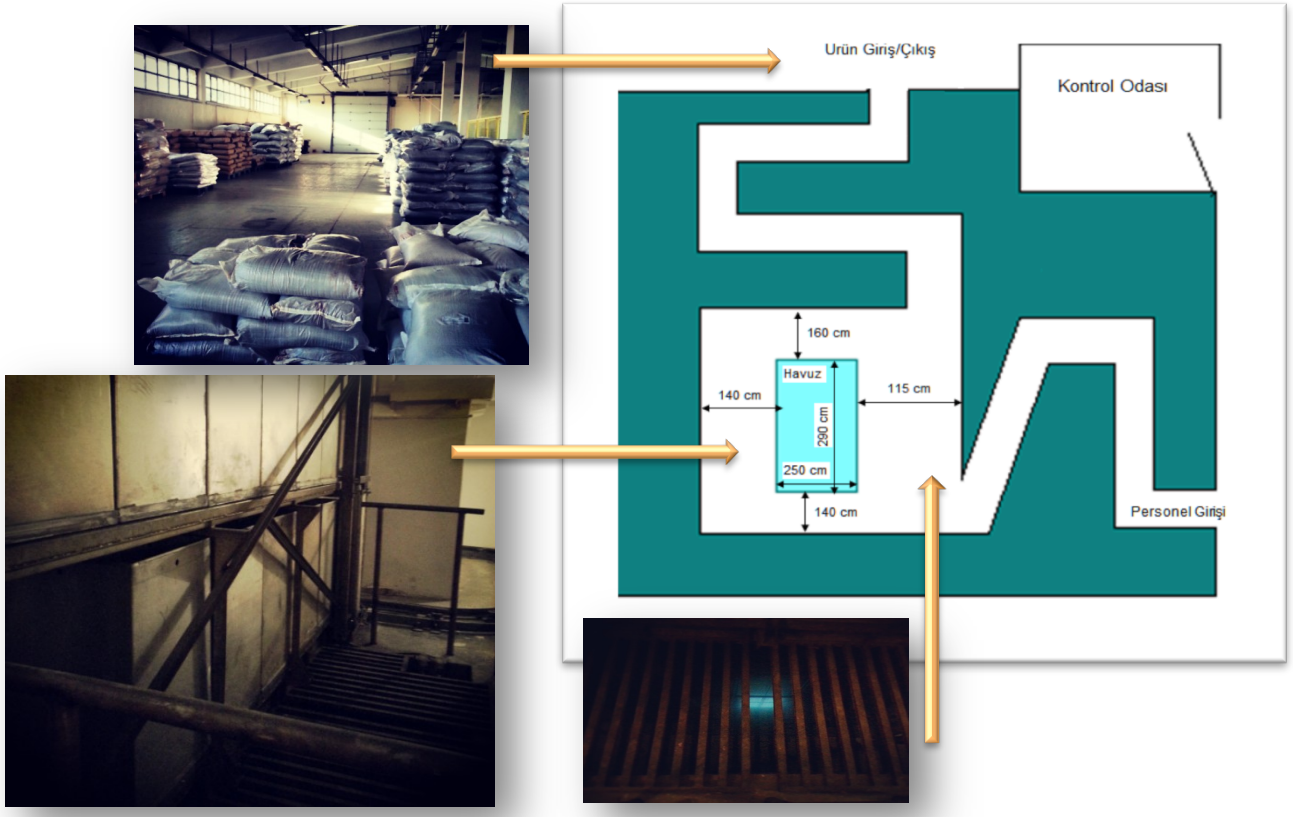
- The project
  - started in August 2015.
  - Funded by Ministry of Development in Turkey.
  - Has approximately 2 million Euro budget.
- The facility will serve space community in 2018.

In-Situ Total Ionizing Dose Testing Project

- The project
  - started in December 2014.
  - collaboration between Aselsan and METU.
  - funded by Ministry of Science, Industry and Technology in Turkey.
  - aims to qualify in-house developed Solid State Power Amplifers.

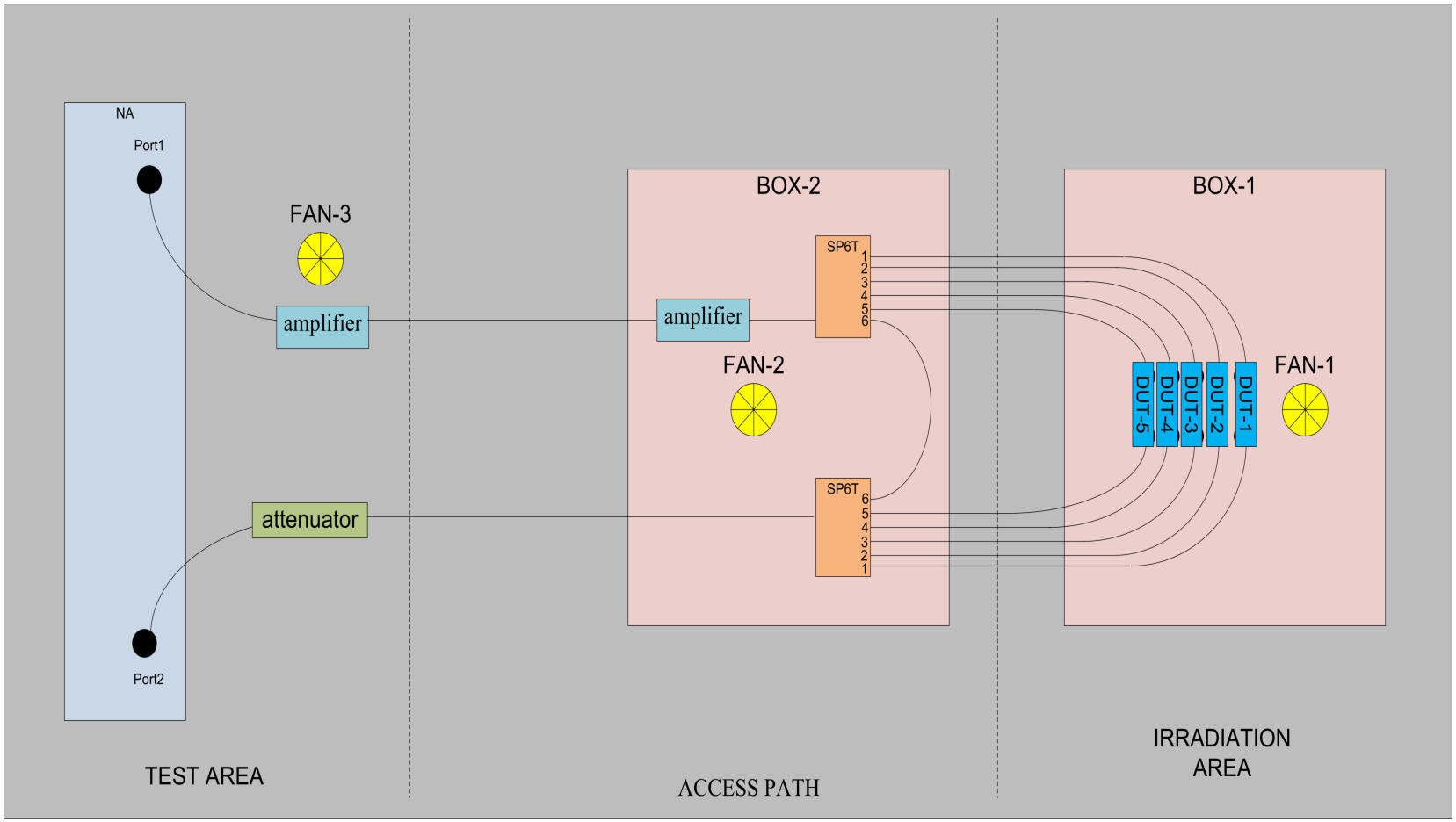
Total Ionizing Dose Test Facility in Turkey

TAEK SANAEM Gamma Irradiation Facility

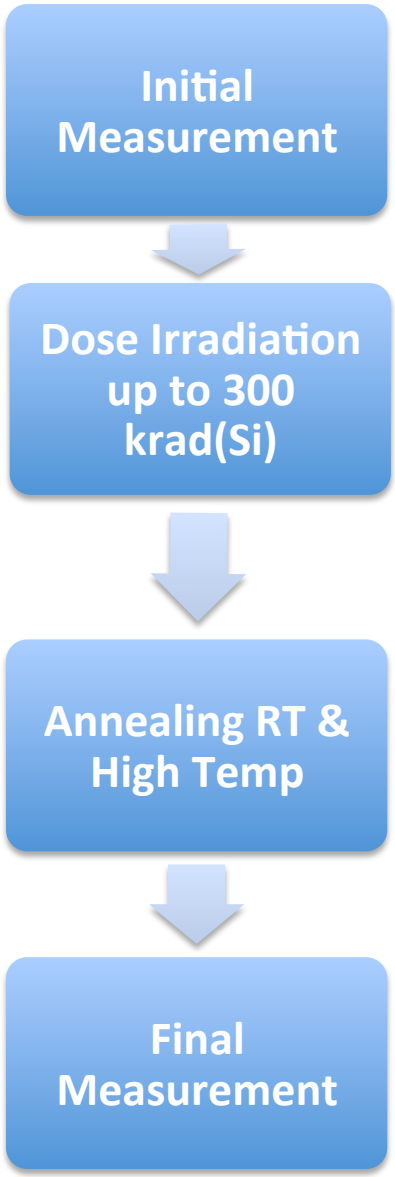


Source	Co^{60}
Activity	300 kCi

Test Techniques and Setup



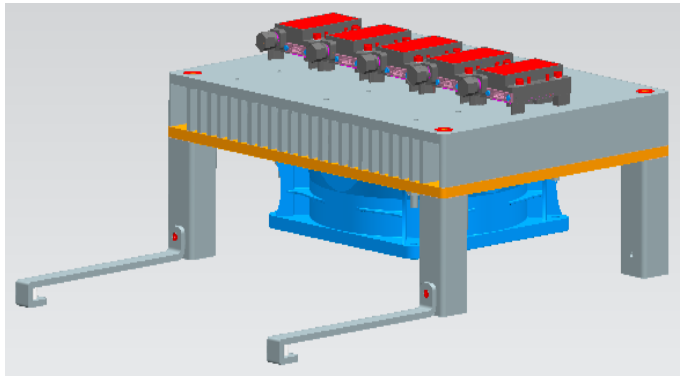
Test Techniques and Setup

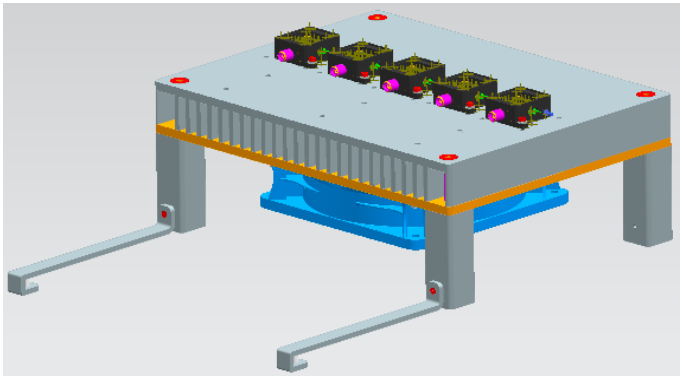


- Test Samples;
  - Solid State Power Amplifier and its components;
    - High Power Amplifier
    - Attenuator
    - Phase Shifter
    - Amplifier
- Measurement Units
- Power Supplies
- Dosimetry (Alanine)

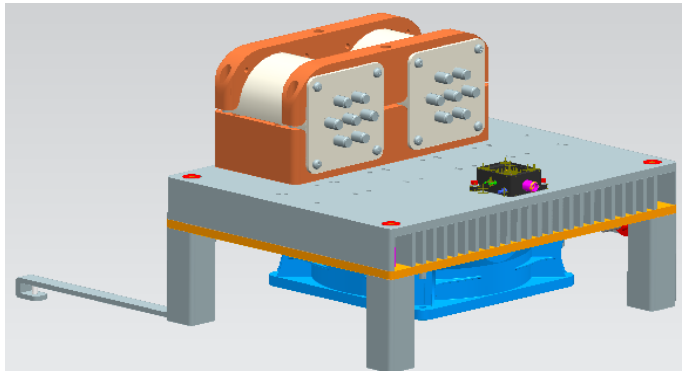
Test Techniques and Setup

Layout of SSPA Modules and its components placed in Al-Pb Box during irradiation

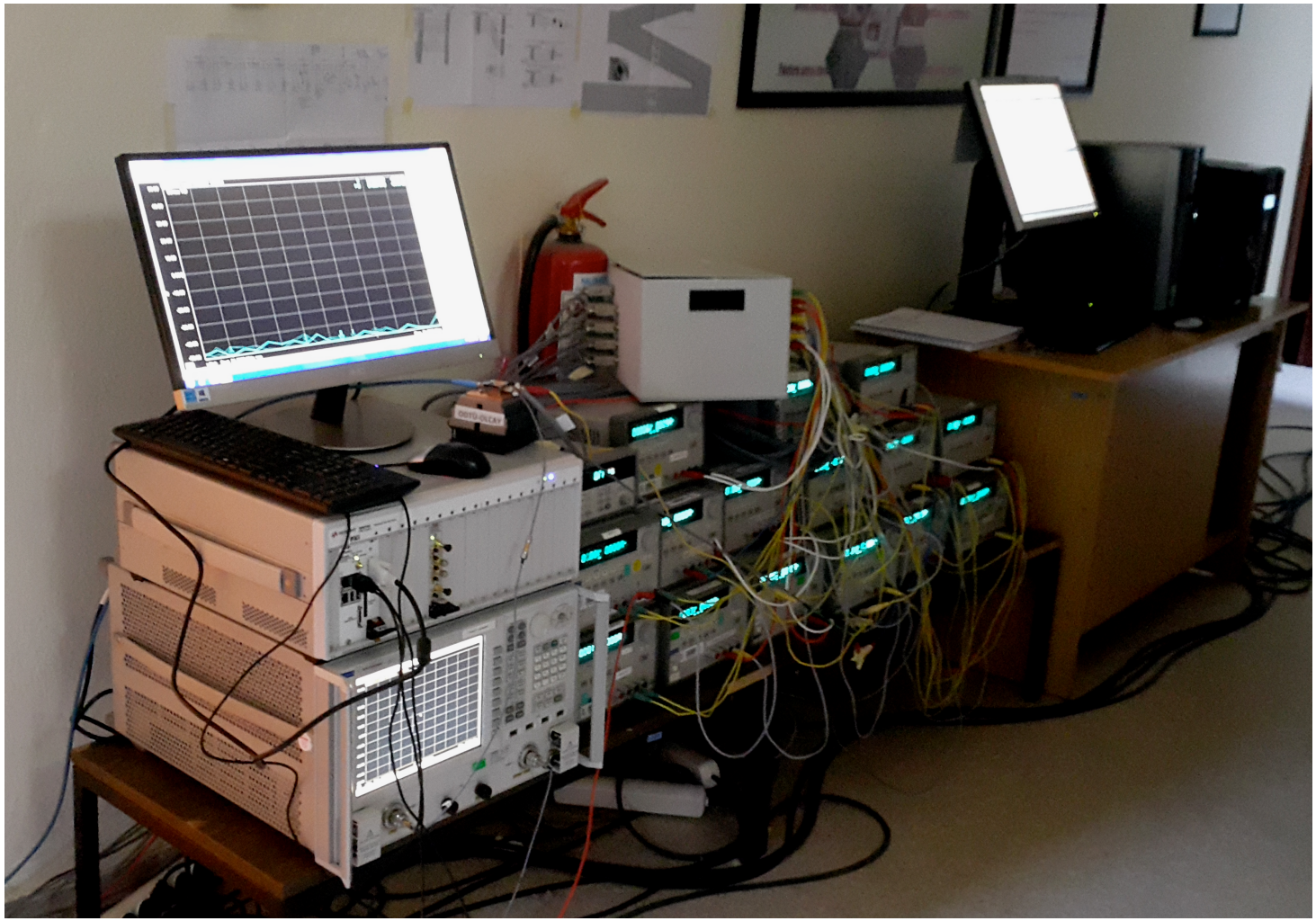




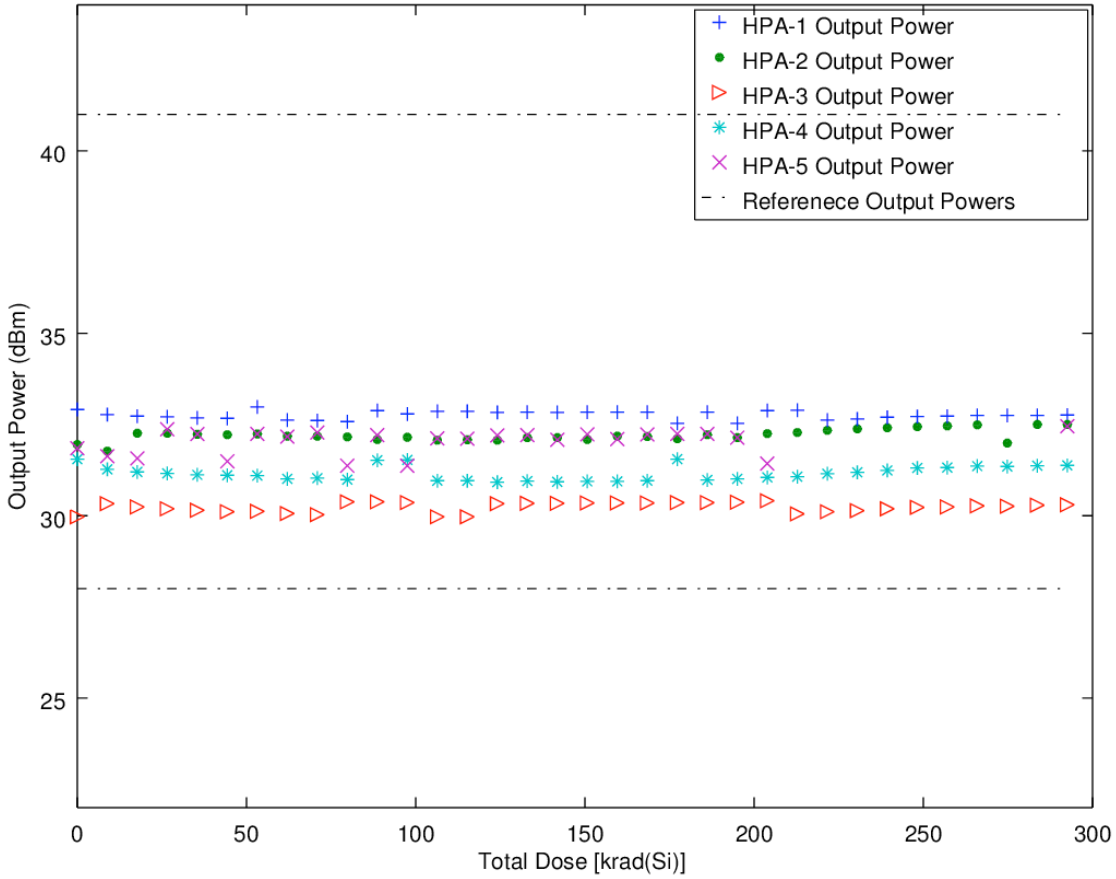
Layout of RF Switch in Al-Pb box on the access path



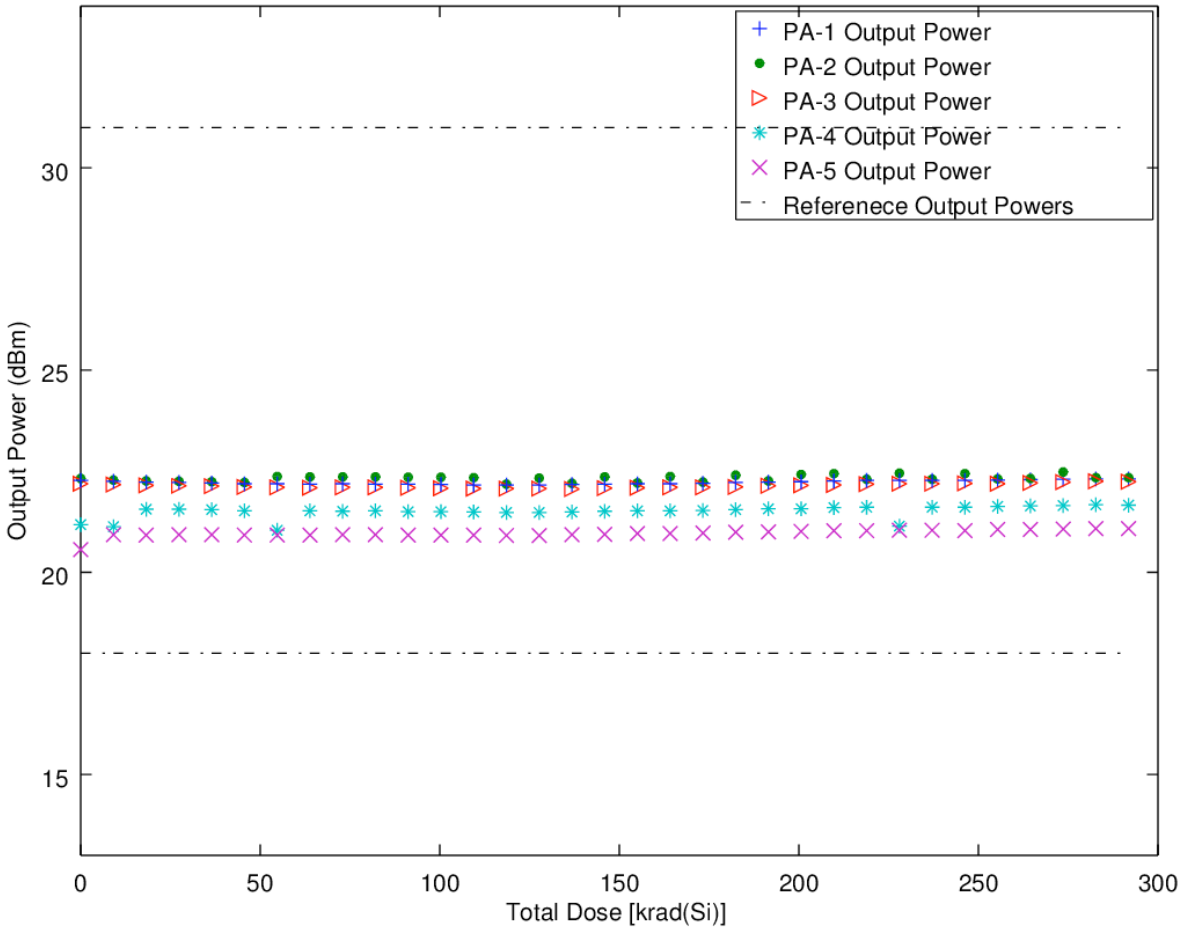
Test Techniques and Setup



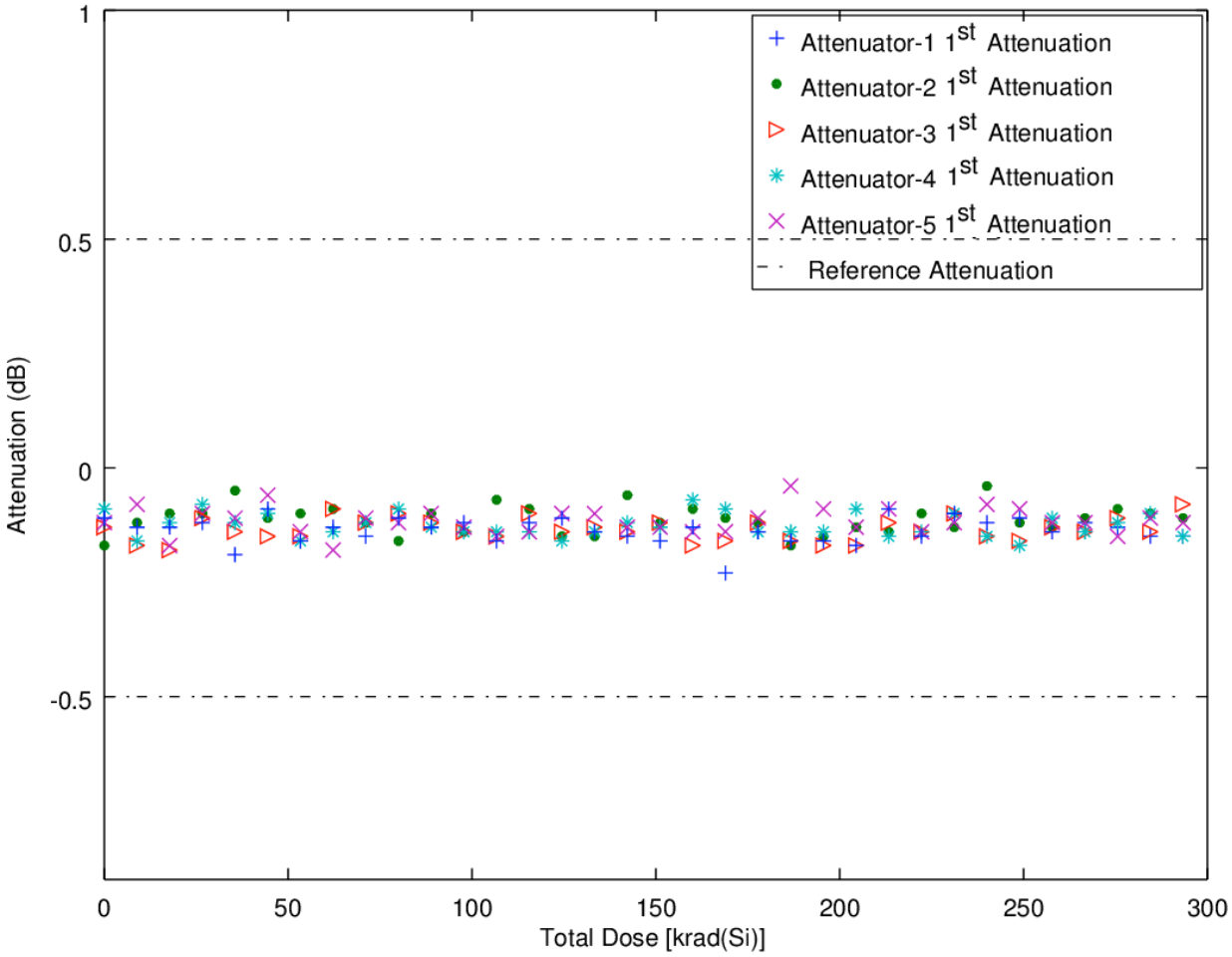
Output power characteristics of GaAs High Power Amplifier MMICs



Output power characteristics of GaAs Power Amplifier MMICs



Attenuation characteristic of Analog Attenuator



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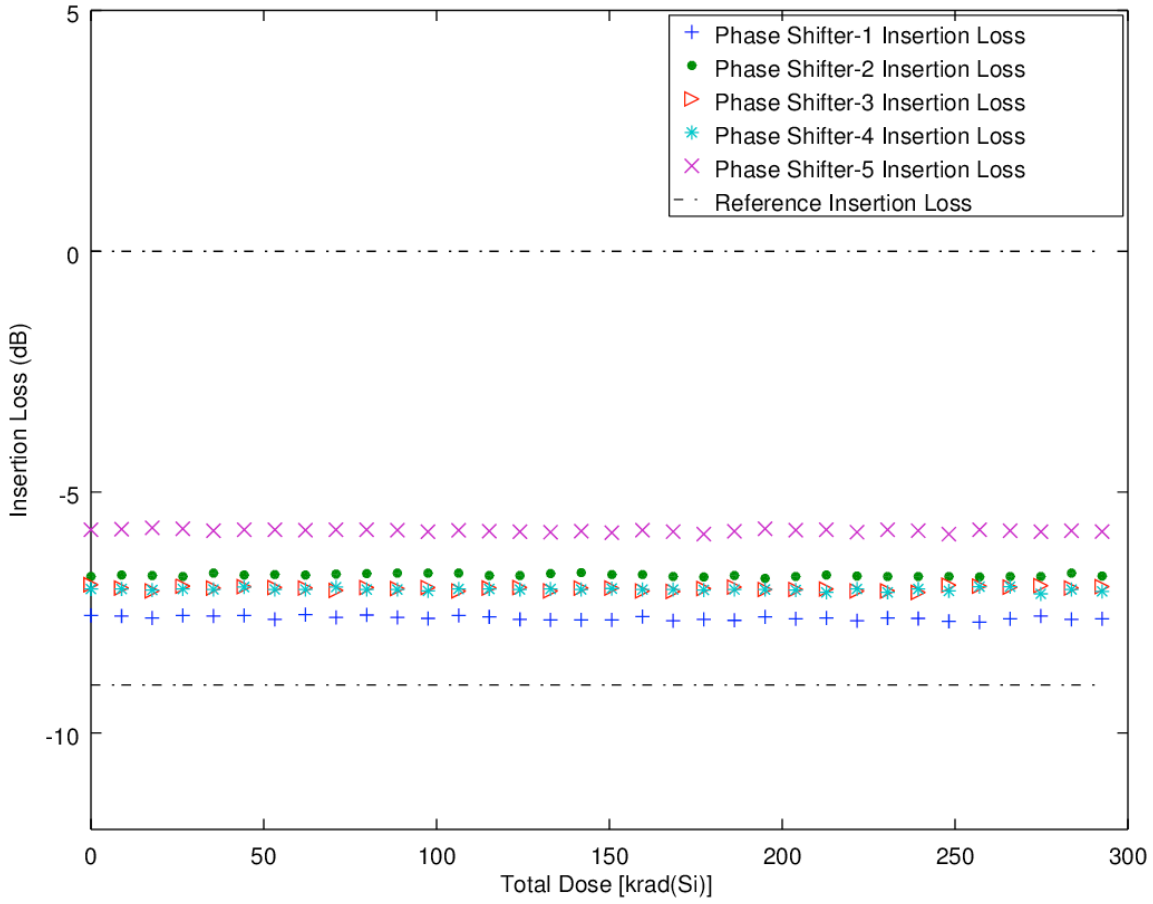

Conclusion

- The test results exhibit excellent hardness characteristics under irradiation.
- Test results suggest that components of SSPA will operate successfully against gamma ray irradiation.
- Although, GaAs MMICs that are components of in-house developed SSPA modules are immune to total ionizing dose effects according to test results, radiation effect studies and tests of SSPA module itself will be investigated to insure its performance in the space environment.