

Macom RF switches radiation-test results

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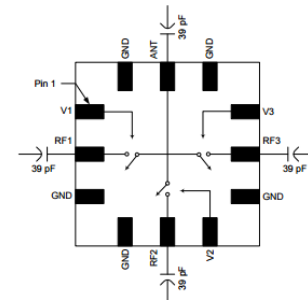
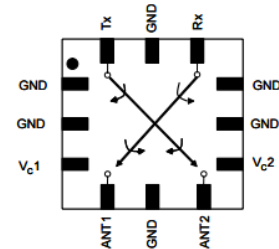
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Introduction

- The MASW-007587 & MASWSS0144 RF switches from Macom where irradiated at the Paul Scherrer Institute (PSI)
- 200MeV Proton beam
- Up to 750Gy
- DUTs used on the DOROS equipment from BE/BI
- Their role on DOROS: Switch signals, few 10mVpp up to few Vpp amplitude @ 1GHz
- Controlled by negative voltage: 0/-5V

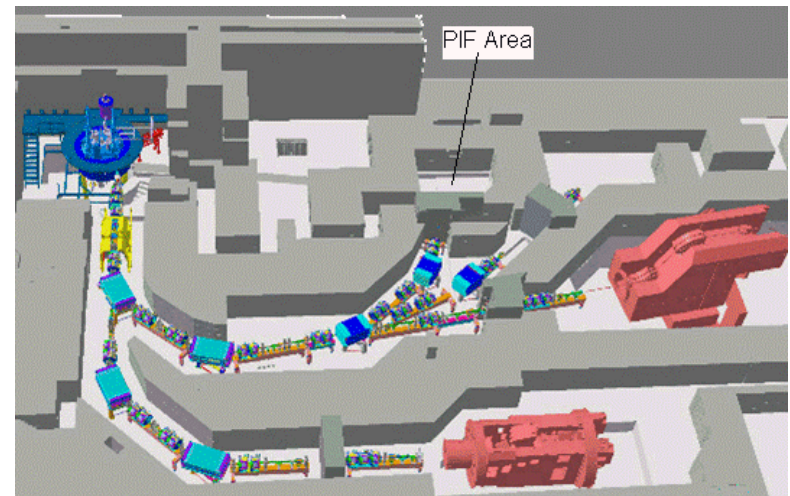
DUT description

- Two RF switches produced by Macom
- 0.5 micron gate length GaAs process
- 3 mm 12-lead PQFN package
 - MASW-007587 is a dual pole, dual throw (DPDT), operates from DC to 4GHz
 - MASWSS0144 is a single pole, three throw (SP3T), operates from DC to 3GHz
- Positive control voltages require external DC-blocking capacitors on all ports



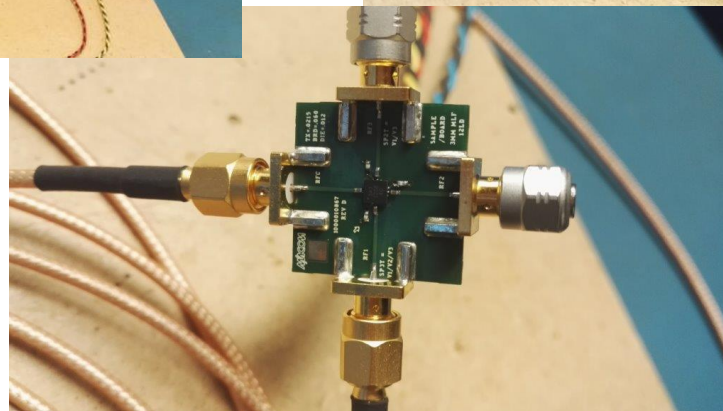
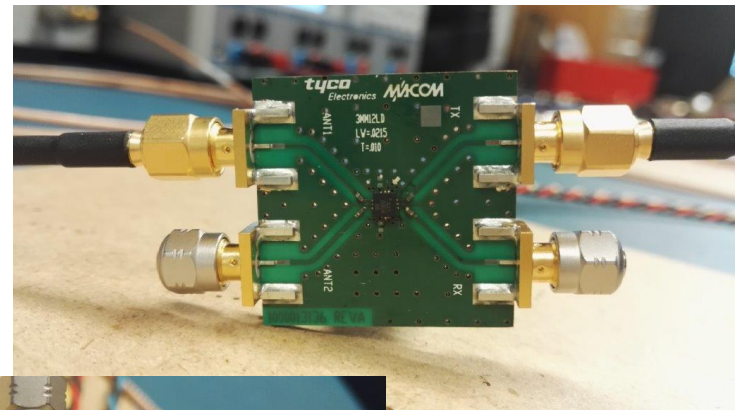
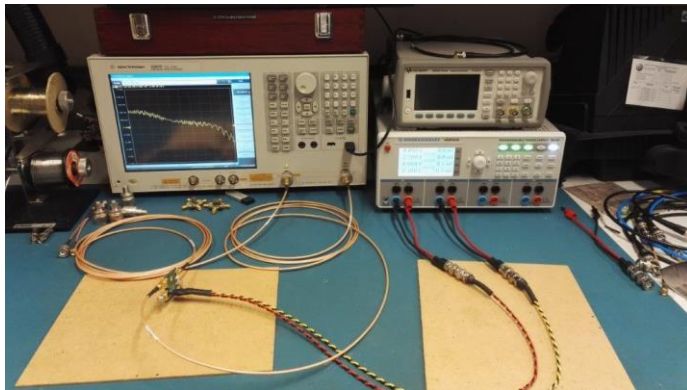
Challenge

- Instrumentation has to be located 15-meters away from the DUTs to protect it from radiation
- Perform 1GHz measurements with 2x15-meter cable length
 - Insertion loss in on state
 - Insulation in off state
 - Signal bandwidth



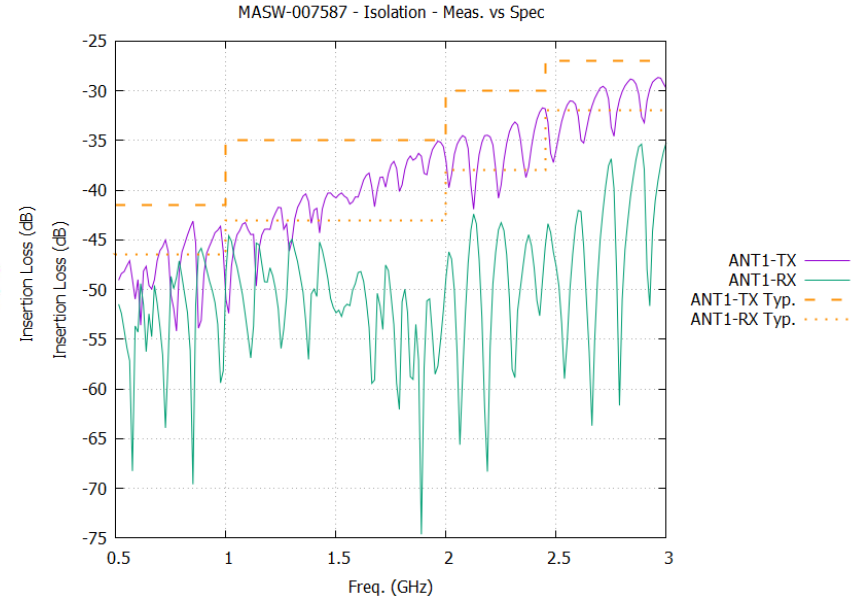
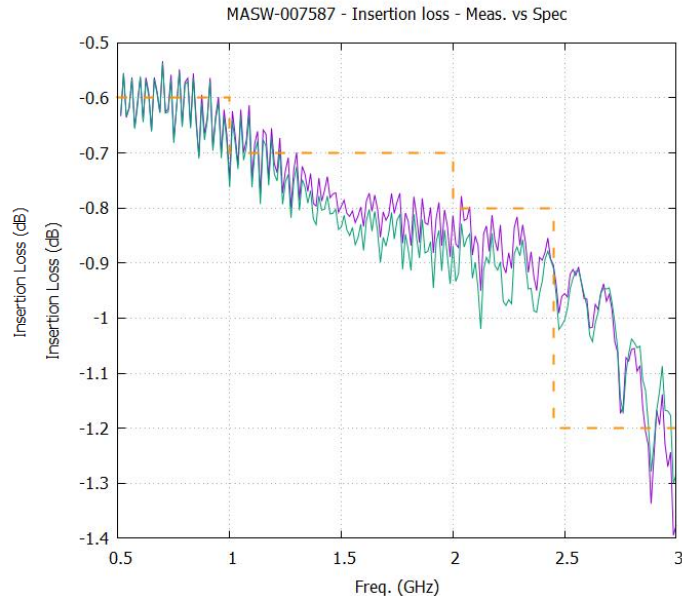
Long-cable measurement feasibility

- We purchased evaluation boards from Mocom for both switches



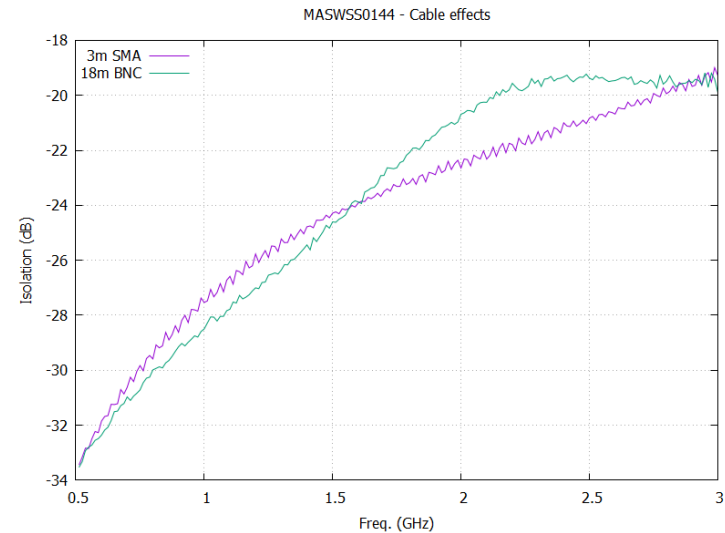
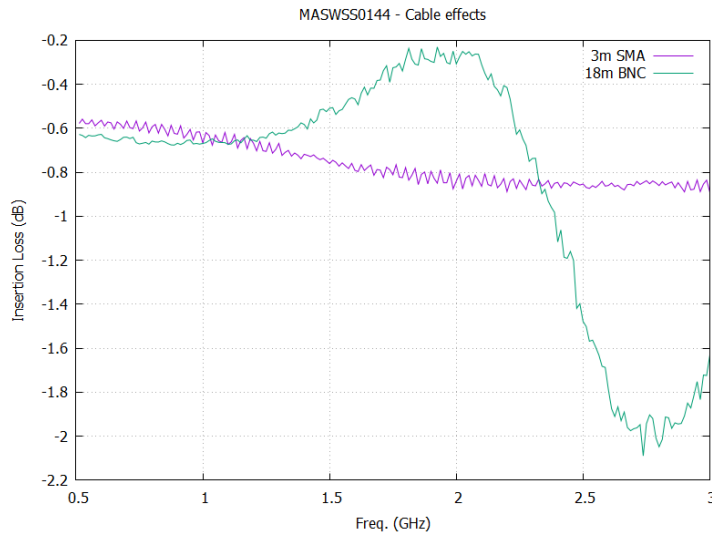
Measurements vs. Macom Specifications

- Verification of our measurement setup against the manufacturer specifications using 3-meter SMA coax cables



18-meter BNC coax cable measurements

- Performed the measurements with two different cables:
 - 3-meter SMA cable from Radiall (Specified up to 3GHz)
 - 18-meter BNC cable from Radiall (Specified up to 1GHz)

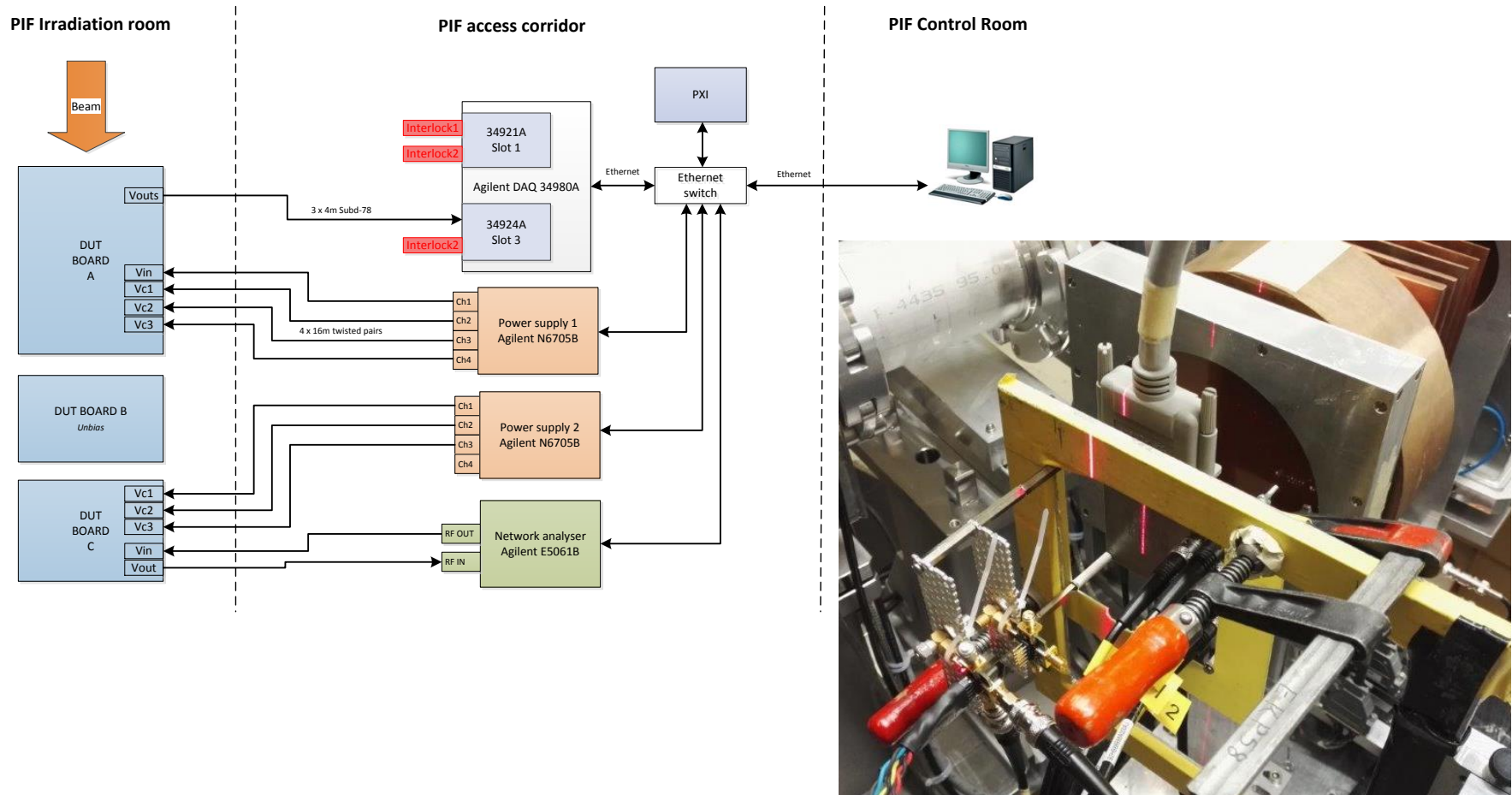


=> Measurements with 18-meter BNC cables are possible up to 1.2GHz

PSI test setup

- Limitation: VNA can monitor only one DUT at a time
- Monitoring several chips under radiation would require as many runs as the number of DUTs to be tested. One run up to 750Gy requires about 2 hours => not acceptable, it is too long!
- Solution: run several tests in parallel
 1. DC tests: Several chips can be monitored in parallel. Objective: monitor the switching functionality
 2. RF test: One chip is monitored during irradiation up to 1GHz
 3. Unbias test: An additional chip is placed in the beam while being unbiased. A characterization is performed before and after irradiation. Objective: confirm the degradation observed during the HF test.

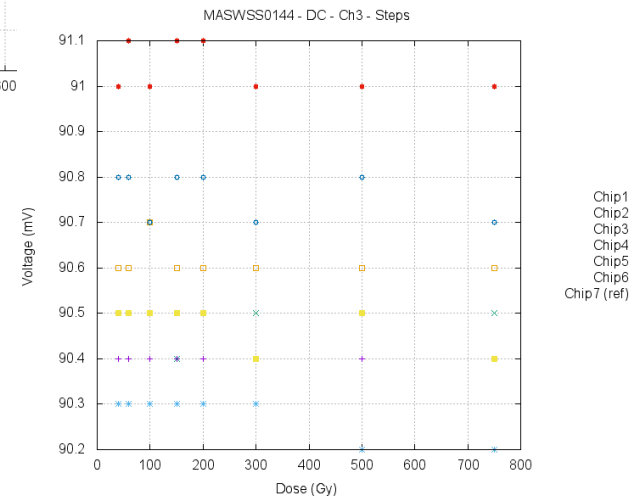
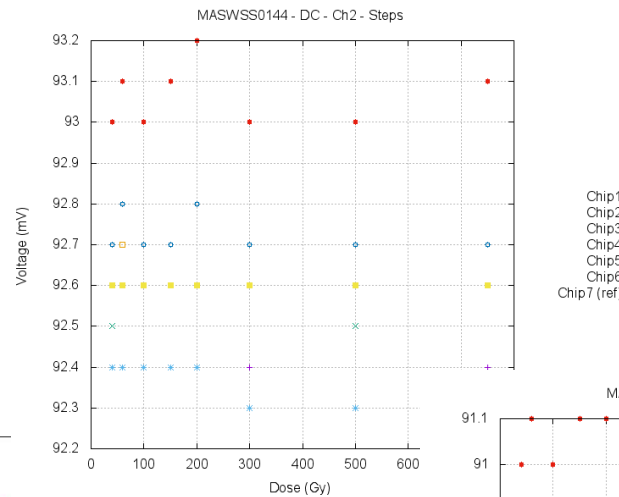
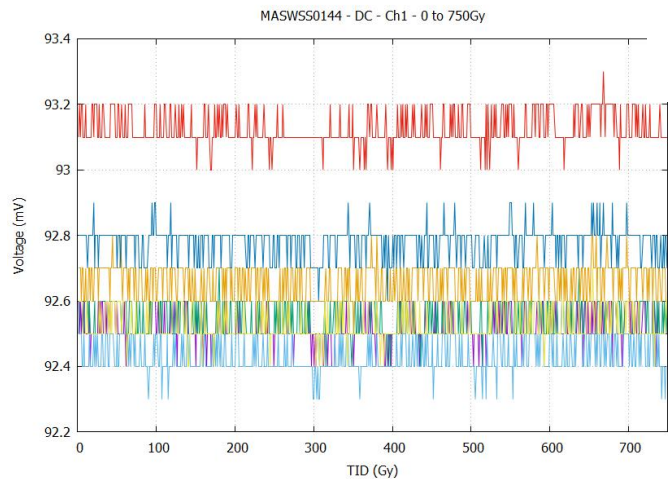
PSI test setup diagram



MASWSS0144 DC test results

- Channel 1 was monitored during the whole irradiation period
- Beam stop performed periodically to operate the switch (change channels)

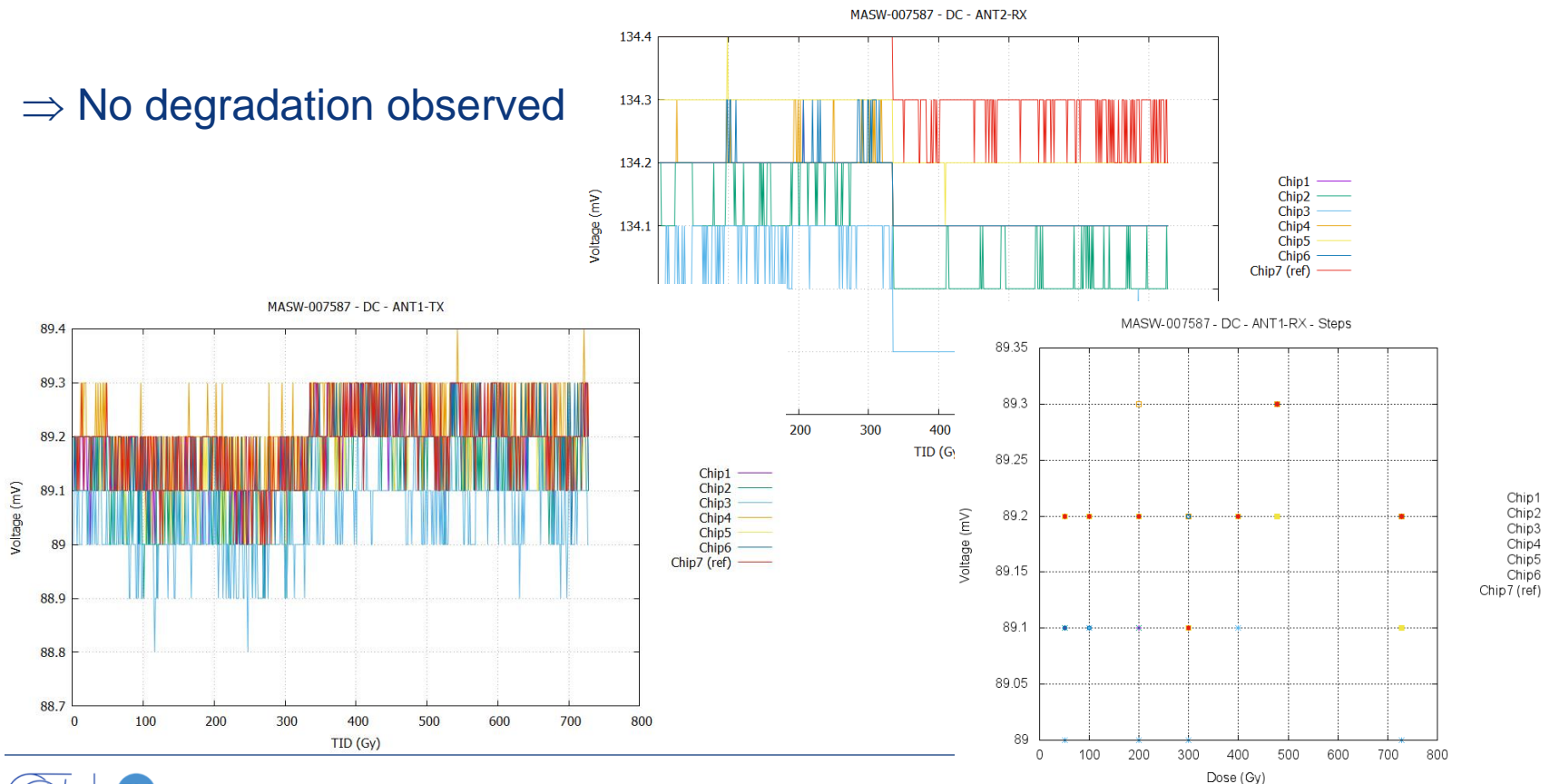
⇒ No degradation observed



MASW-007587 DC test results

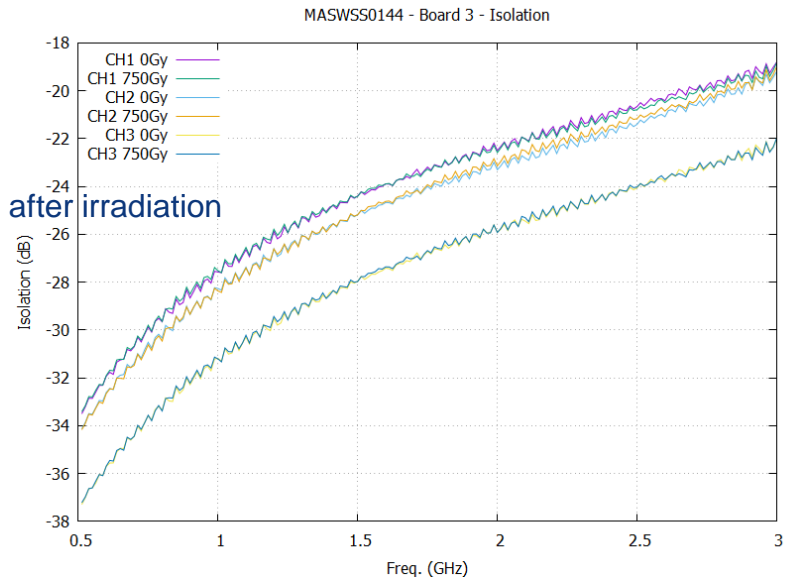
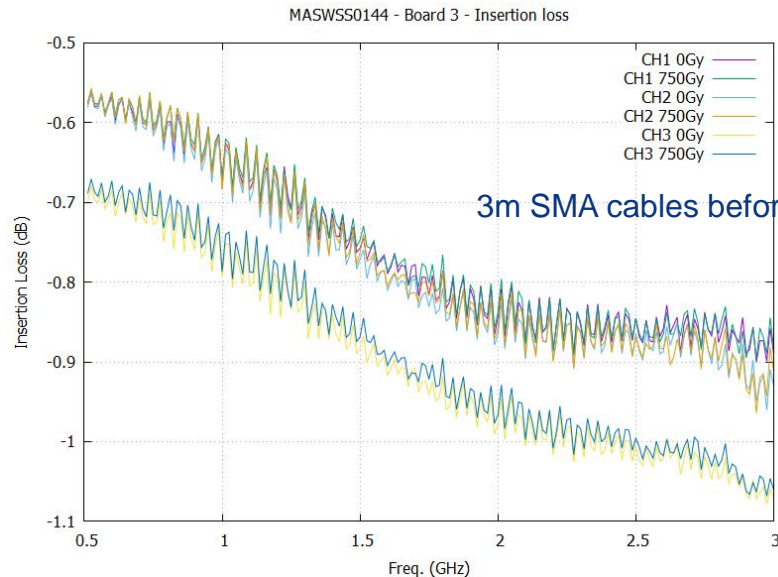
- Paths ANT1-TX & ANT2-RX were monitored during the whole irradiation period
- Beam stops performed periodically to operate the switch (cross channels)

⇒ No degradation observed



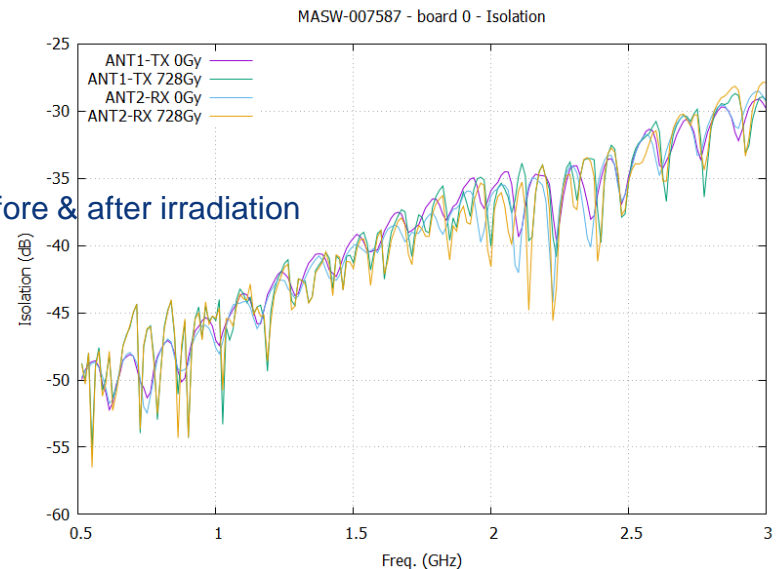
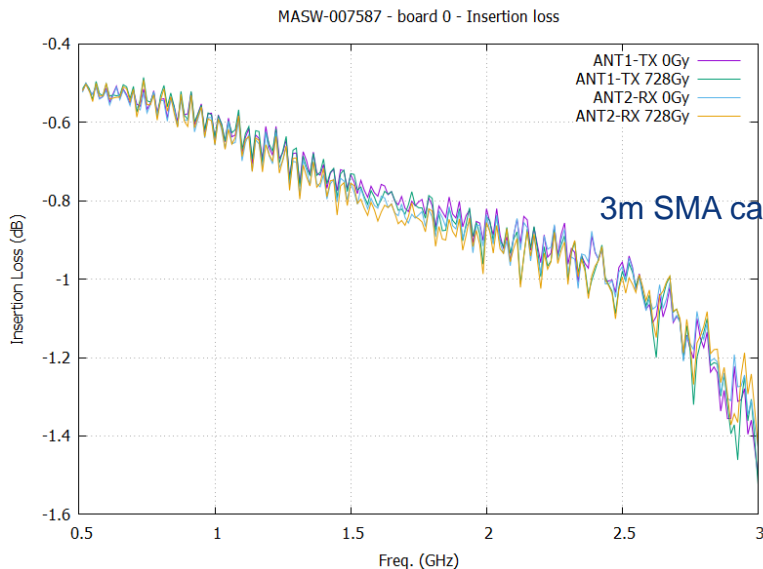
MASWSS0144 HF test results

- Channel 1 was monitored during the whole irradiation period
 - Beam stops performed periodically to operate the switch (change channels). Insertion loss and isolation were recorded for all three channels up to 1.2GHz
- ⇒ No degradation observed
- ⇒ Measurements were performed after irradiation with 3m SMA cables up to 3GHz



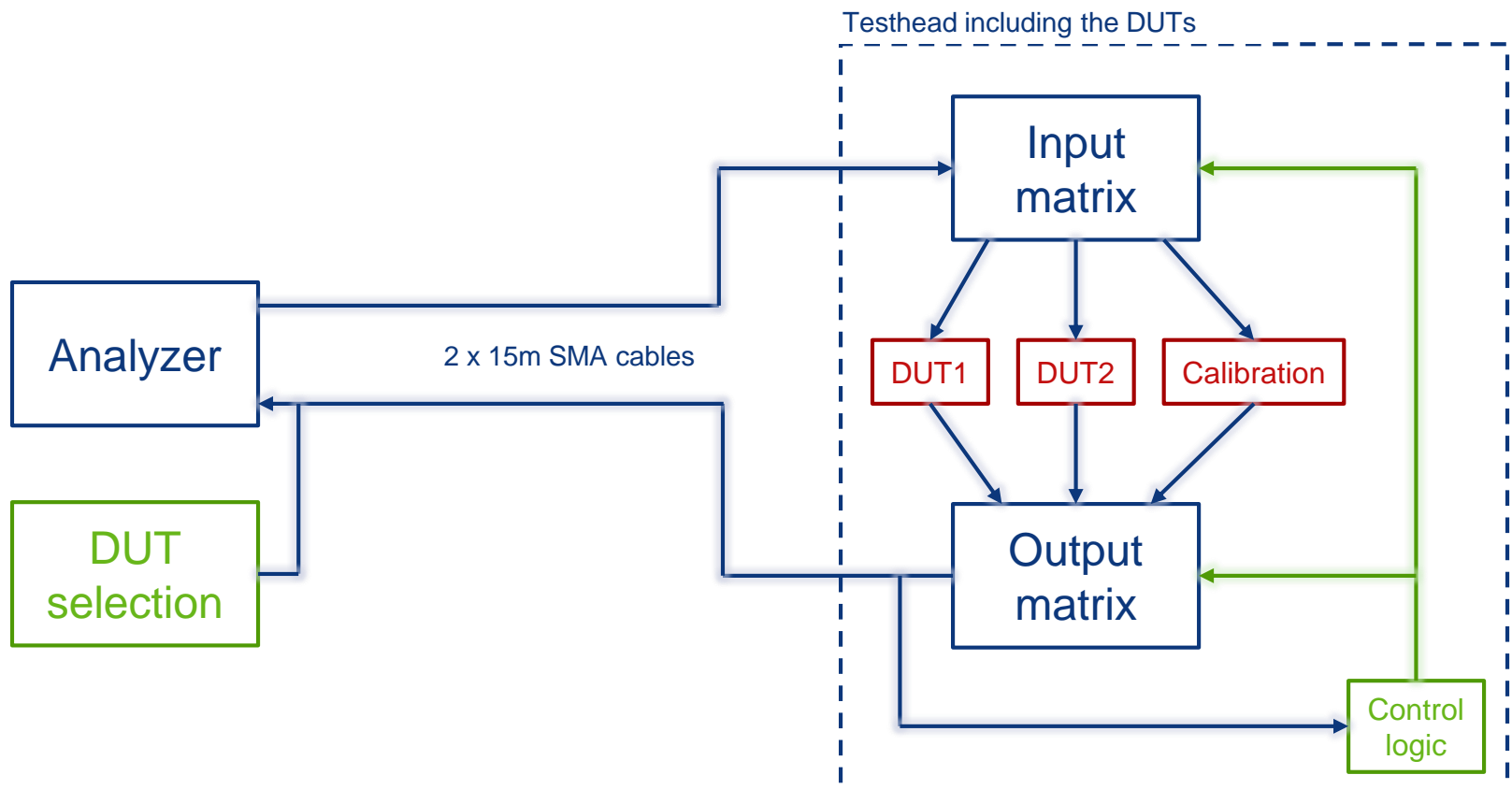
MASW-007587 HF test results

- ANT1-TX channel was monitored during the whole irradiation period
 - Beam stops performed periodically to operate the switch (change channels). Insertion loss and isolation were recorded for all three channels up to 1.2GHz
- ⇒ No degradation observed
- ⇒ Measurements were performed after irradiation with 3m SMA cables up to 3GHz



Project: RF matrix for radiation tests

Objective: develop a low-cost testbench to monitor several DUTs up to 3GHz without cabling modifications and with only 2 cables between the instrumentation and the testhead



Project: RF matrix for radiation tests

Challenges:

- Adding switch matrices on the RF path adds losses => hopefully they should be compensated by the analyser using the calibration path
- Preserving the 50 Ω impedances

Status:

- Simulations were performed to validate the control logic but we are limited in our exploration because the spice models of the switches is not available
- A mock-up was partially built and tested in December. The control logic was validated. Tests with DUTs are yet to be performed in order to validate the principle and the performances. Unfortunately, the project is temporarily in standby due to other priorities

Conclusions

- BE/BI requested the qualification of two RF switches from Macom that are part of their DOROS equipment.
- Important parameters: Insertion loss, isolation and signal bandwidth @ 1GHz.
- Challenge because we've never performed radiation tests at such frequencies.
- Tests were performed at PSI up to 750Gy in DC and from 500MHz up to 1.2GHz (limited by cable performances). The new 3GHz-certified cables arrived too late for this test.
- Both switches showed no degradation of the monitored parameters and were fully operational at the end of the test.
- The good performance of the DUTs gave us the idea to develop a matrix capable of switching RF signals in order to test several DUTs with a single analyser. This project is under development.



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Thank you for your attention
Any questions?