



X-Ray Detector Array for Spatial and Temporal Diagnostic at the LANSCE Linac

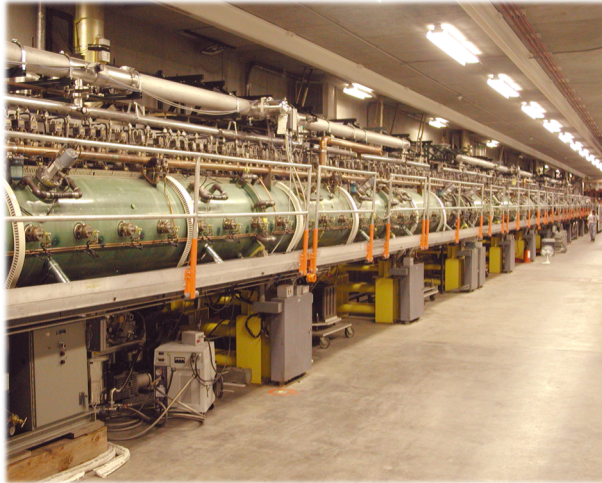
Maria Sanchez Barrueta, NAPAC 2019
2 September 2019

LANSCe Accelerator

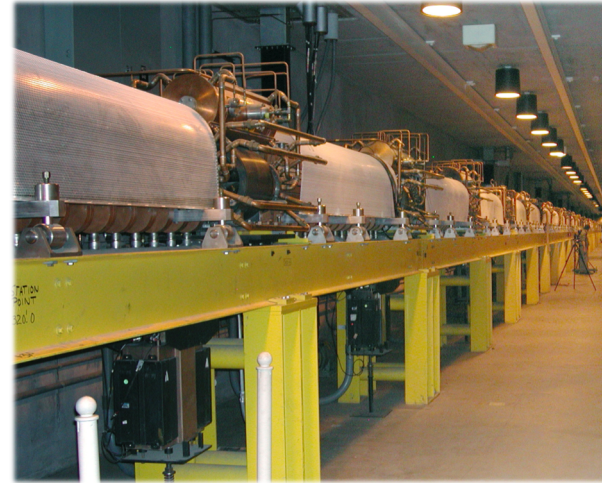
- LANSCE Accelerator
- Module 3 fault issue
- X-Ray detector
- First tests
- Diagnosis
- Solution



LANSCE Accelerator



0.75 MeV - 100 MeV
Alvarez Drift Tube Linac



100 MeV - 800 MeV
Coupled Cavity Linac

LANSCe Accelerator

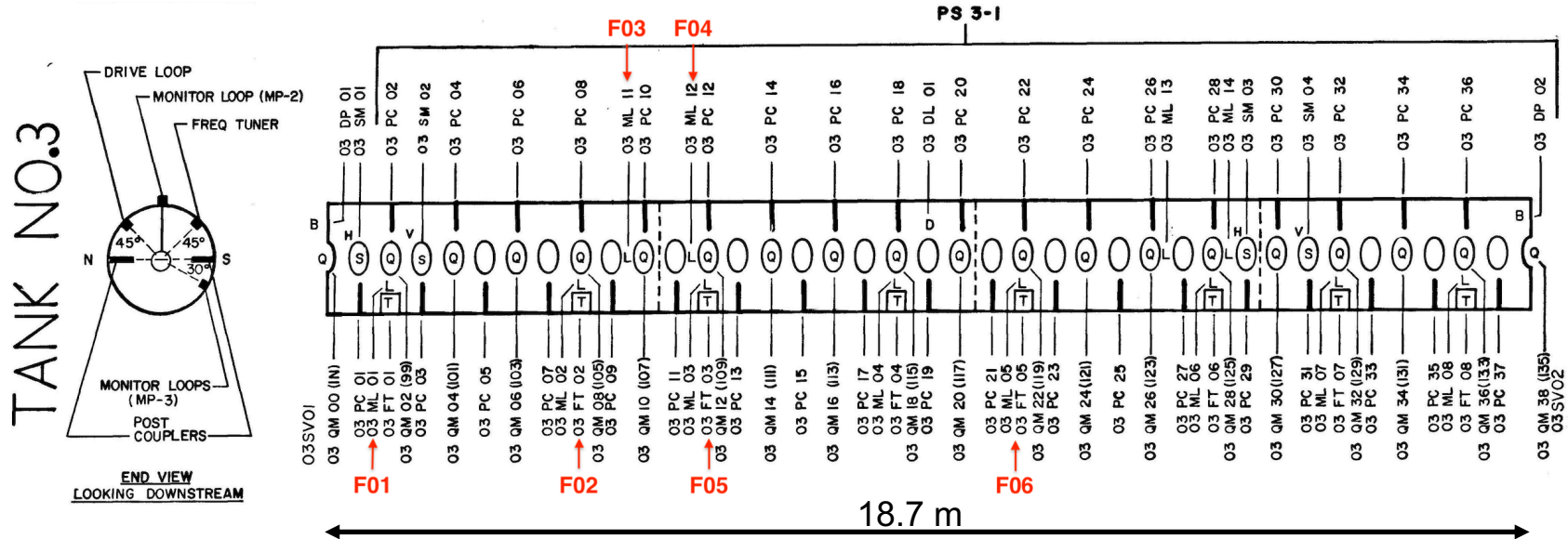
- Alvarez Drift Tube Linac (201 MHz) from 1972
- Cavities 1-4 originally powered by 7835 triodes
- 2014-2016 upgrade to TH628L Diacrode[®] for M2-M4
- 120 Hz 1010 μ s operation until November 2017
- 120 Hz 800 μ s operation until September 2018
- 60 Hz 1010 μ s operation for the rest of 2018

Module 3 fault issue

- The E field is monitored with pick up loops inside cavity for control purposes
- Amplitude of waveform is Cavity Field
- Derivative circuit detects rapid drop ($< 20 \mu\text{s}$)
- Resulting digital signal is Cavity Field Fault
- Module 3 had 100s of CFFs per day in 2018

Module 3 fault issue

Fiber optic detectors in place



Module 3 fault issue

Fiber Optics

- FO2 (small signal)
- FO3 & FO4 (large signal)

Problems

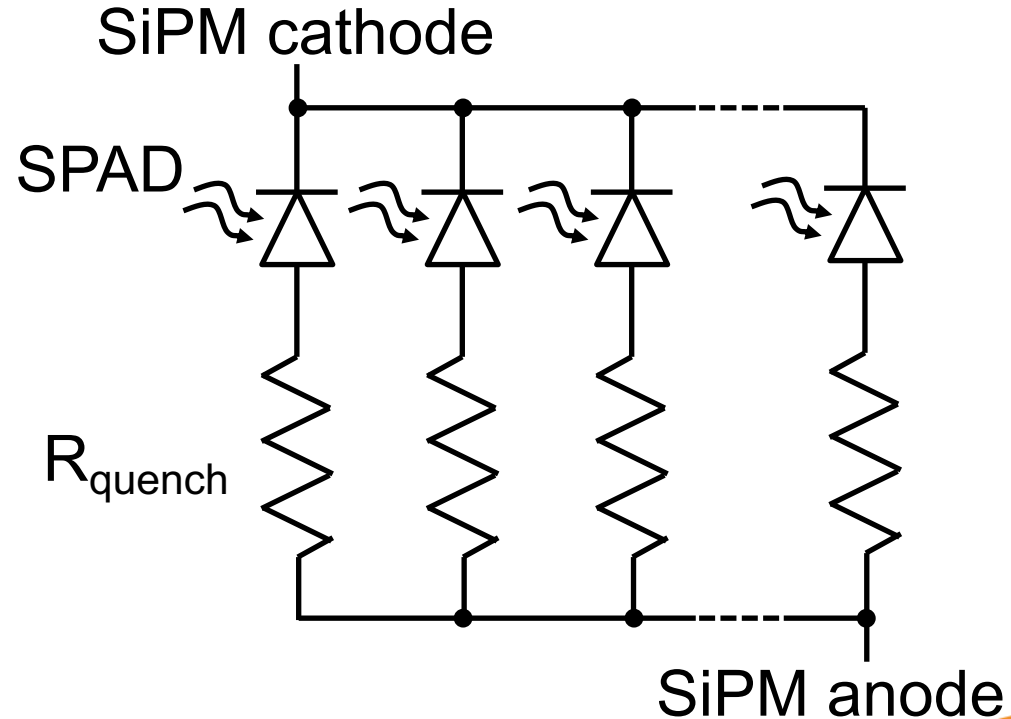
- Physical line of site
- Needs aperture in the cavity
- Can be blocked
- Can capture reflections



X-Ray detector

SiPM

- Microcell (SPAD + R_{quench})
- A high enough electric voltage across the depletion region will trigger an ionization cascade when an SPAD receives a photon and cause the diode to conduct
- R_{quench} will cause the voltage on the diode to be reduced and the conduction to stop
- The diode will recharge to nominal voltage (recovery time)
- The amount of current relates to the number of photons intercepted by the whole sensor



X-Ray detector

Scintillator

- LYSO
- 40 ns decay time

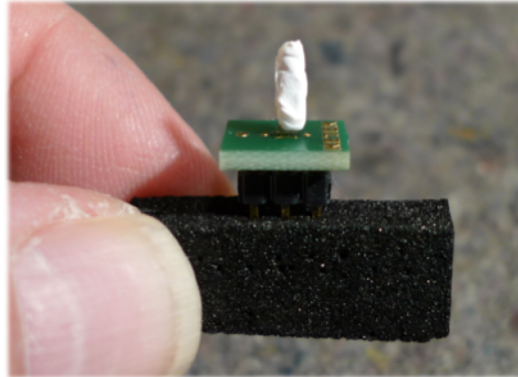
Detector

- SiPM, PM1125-WB
- 28 VDC breakdown voltage
- 1600 microcells
- 30 ns recovery time

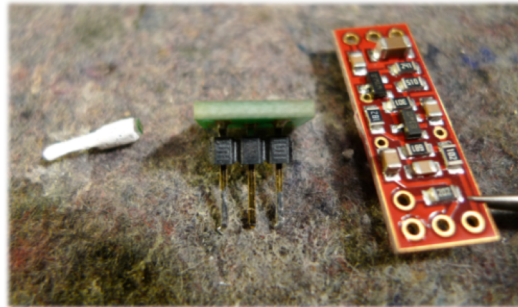
Amplifier

- Advatech AMP-0611
- 9 VDC

This detector can be placed anywhere alongside the cavity and can measure the X-rays from a specific gap



From PM1125-WB datasheet (Ketek)



First Tests

8 detectors constructed
Initial test conditions

- 3 lead bricks
- Front brick with collimator
- 2 rolling supports
- Placed in front of cells
- X-rays on all detectors



First Tests

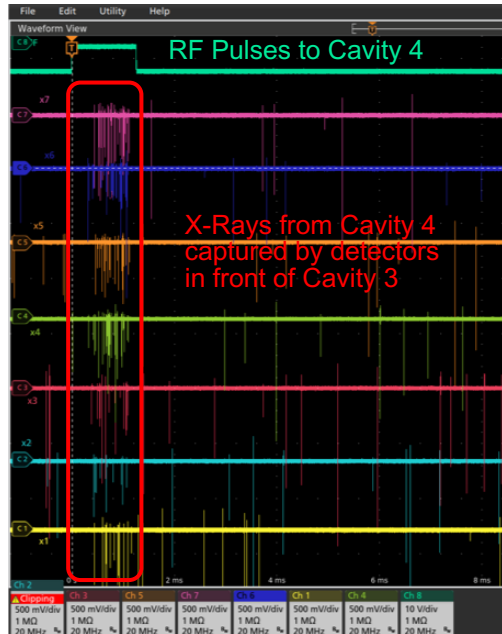
Increased shielding

- 14 lead brick box
- 1 lead brick with collimator
- Collimator lined up with the scintillator
- Hole in the back for cables (9 VDC, 28 VDC)

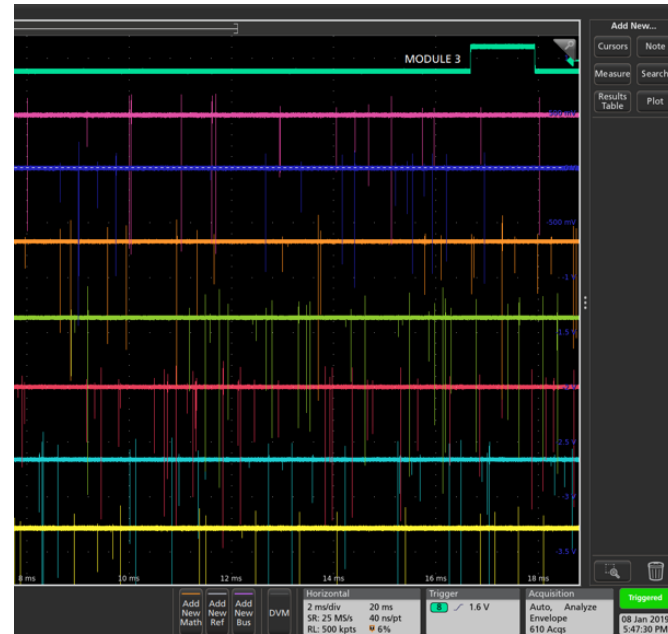


First Tests

No back shielding



Back shielding



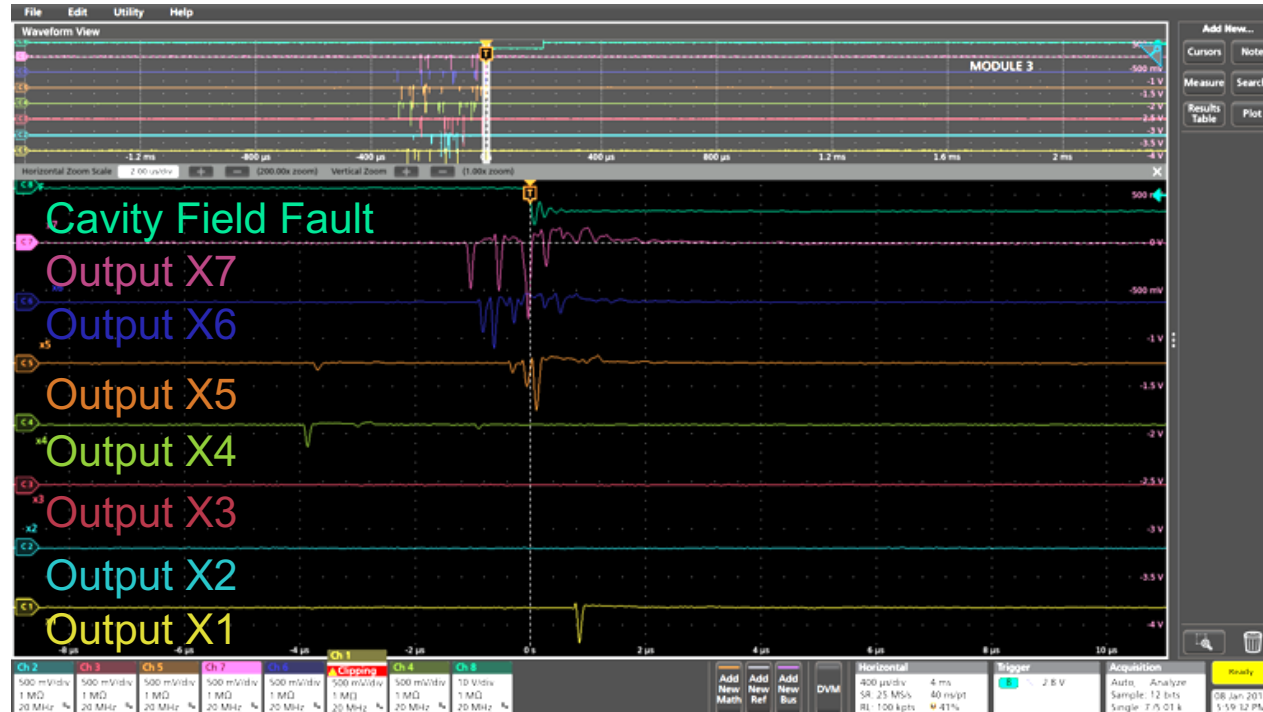
First Tests

Increased shielding

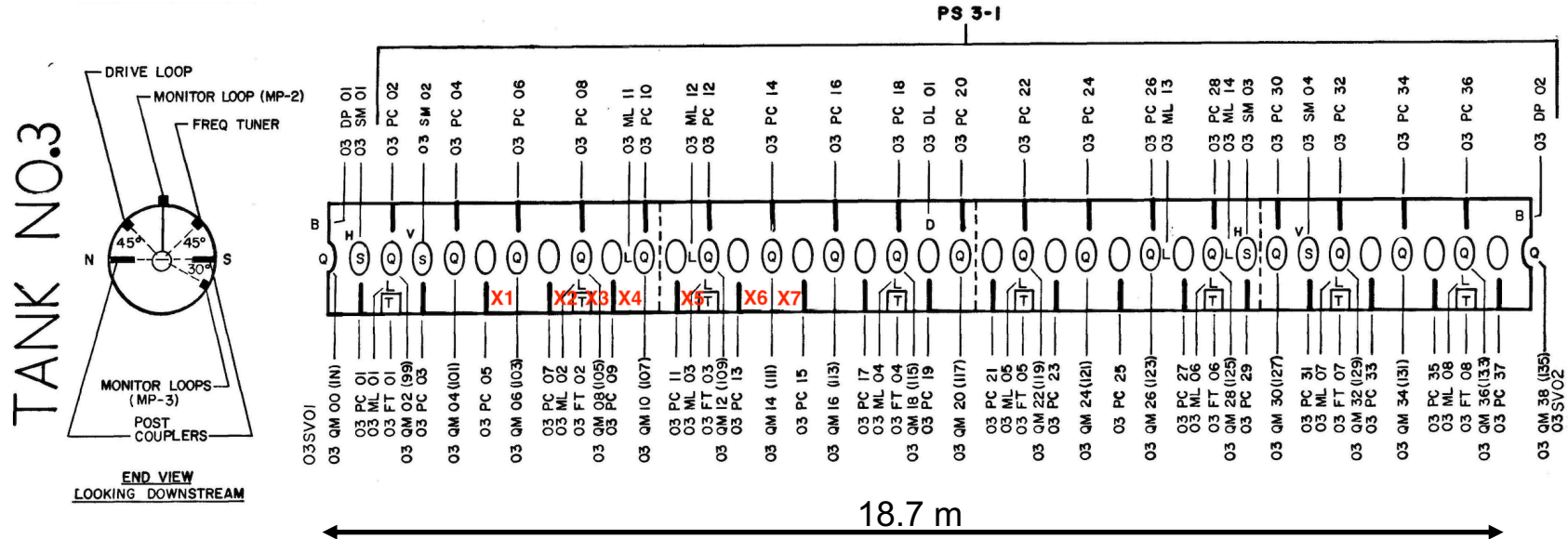
- Lead blanket on the back
- More supports (more weight)
- Reduced crosstalk
- Reduced influence from other cavities



Diagnosis



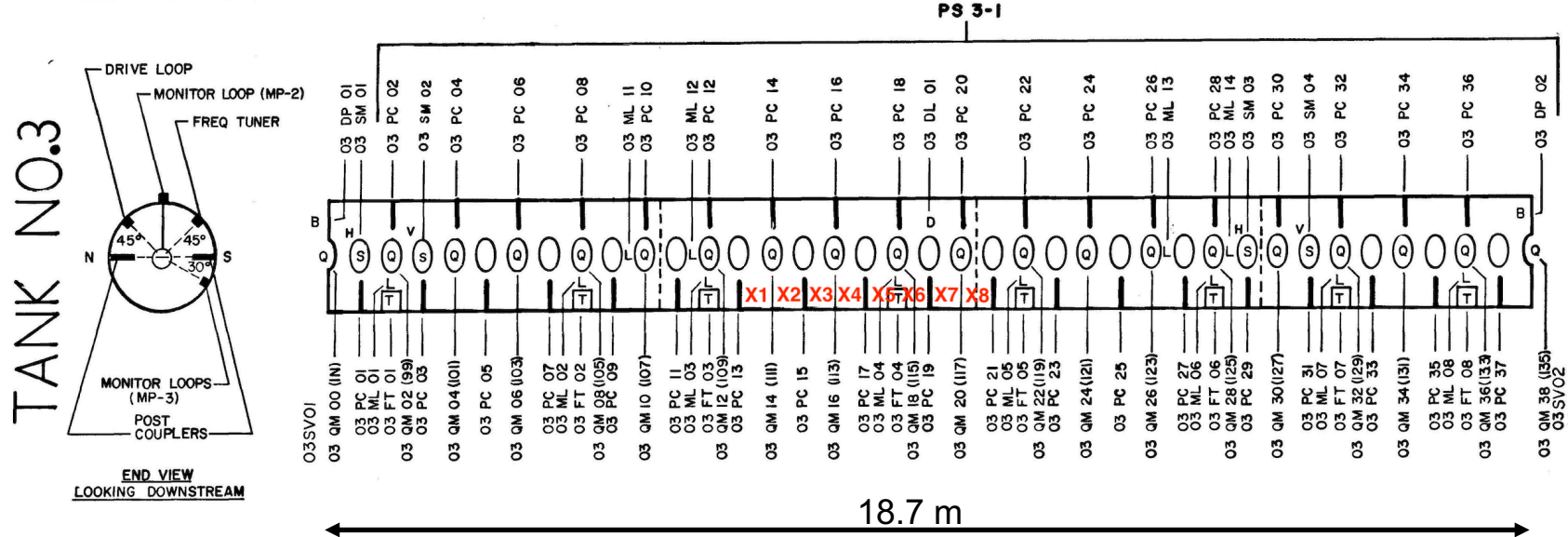
Diagnosis



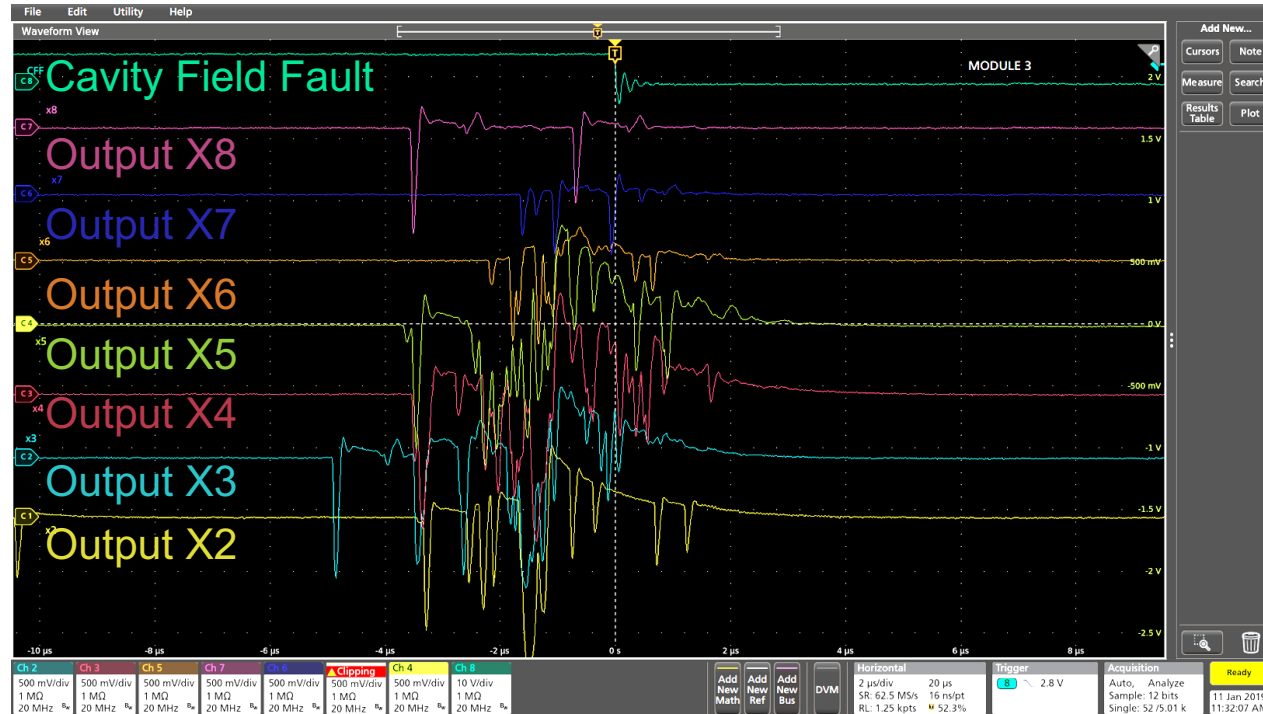
Diagnosis



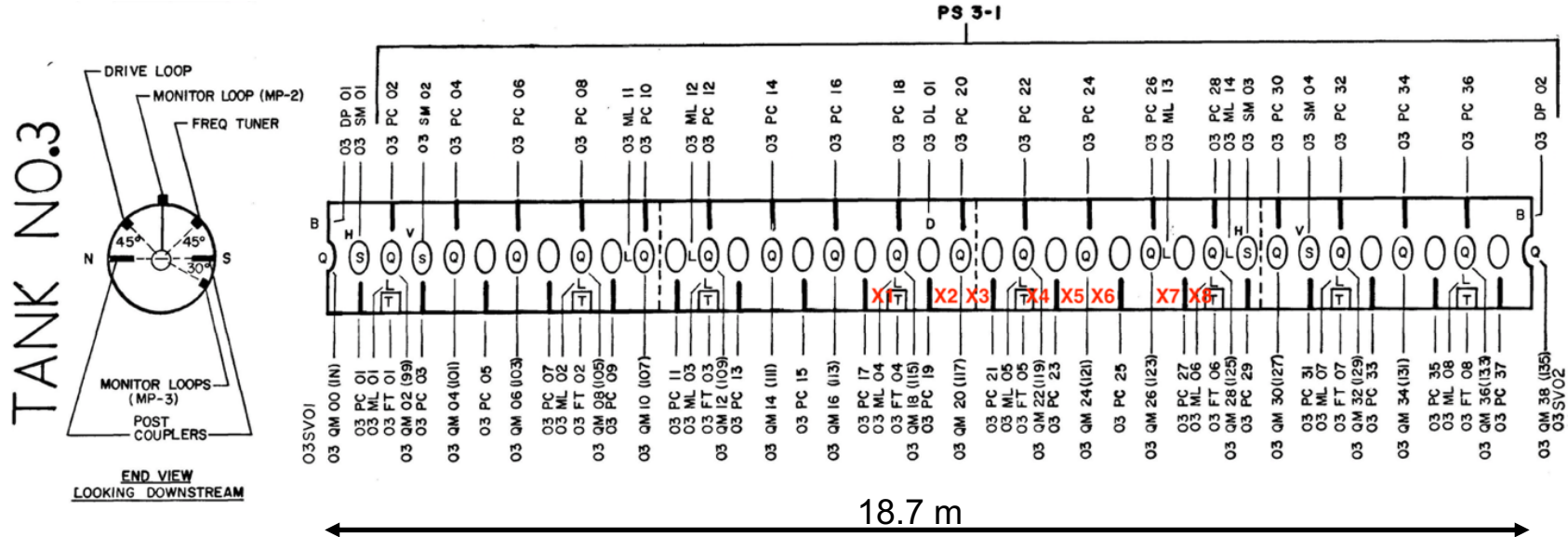
Diagnosis



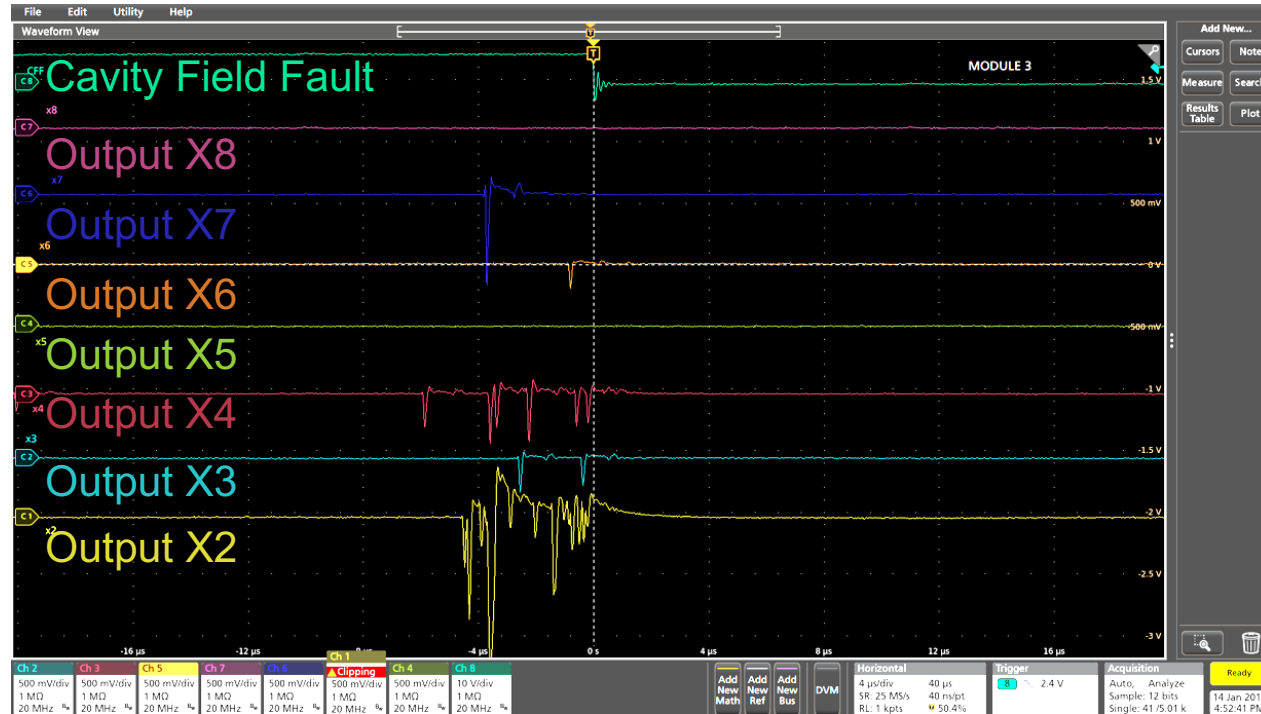
Diagnosis



Diagnosis

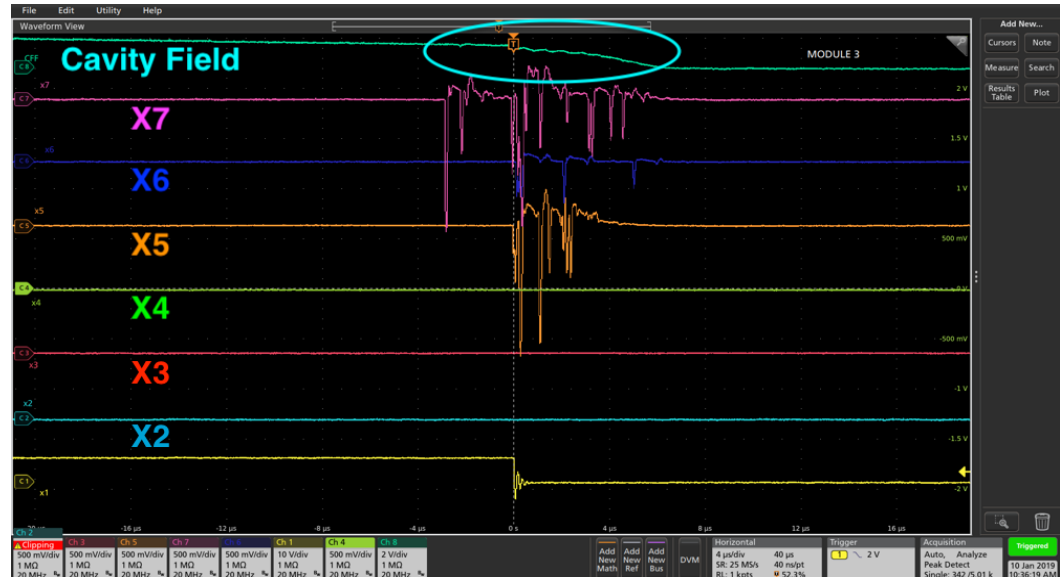


Diagnosis



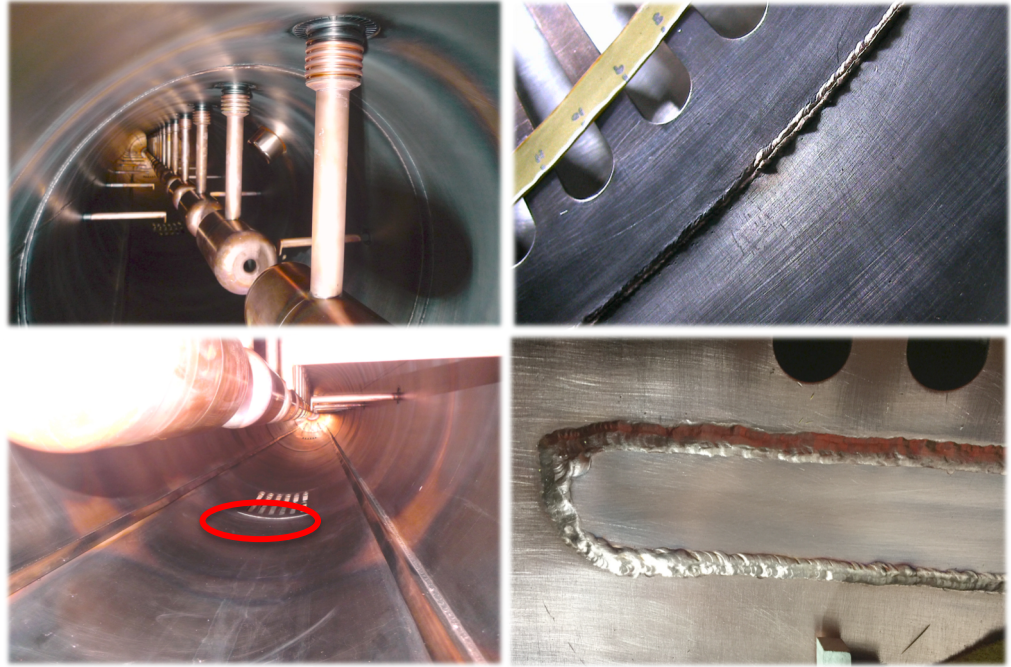
Diagnosis

- Cavity field collapses (electron loading produces an abnormal slope)
- For the duration of the slope, there is X-ray emissions from the second quarter of the cavity



Solution

- Thorough visual inspection revealed gap at pump grating weld in the middle of the 2nd quarter of the cavity
- Weld performed by AOT-MDE
- Cavity returned to operation
- 120 Hz 1060 μ s



Thank you. Any questions?



Detector construction: J. Lyles, J. Zane, G. Bolme, R. Pinsky

Tests: J. Lyles, J. Zane, AOT-MDE

Repair: ALDPS, AOT-DO, AOT-MDE, AOT-OPS, AOT-RFE, DESH-DO, DESH-LFO, E-6, ES-EPD, IQPA-IQ, LANSCE-FO, LASO-O-FR, LOG-MSM and OSH