PMT Cascade Implosion Test
Preliminary Results

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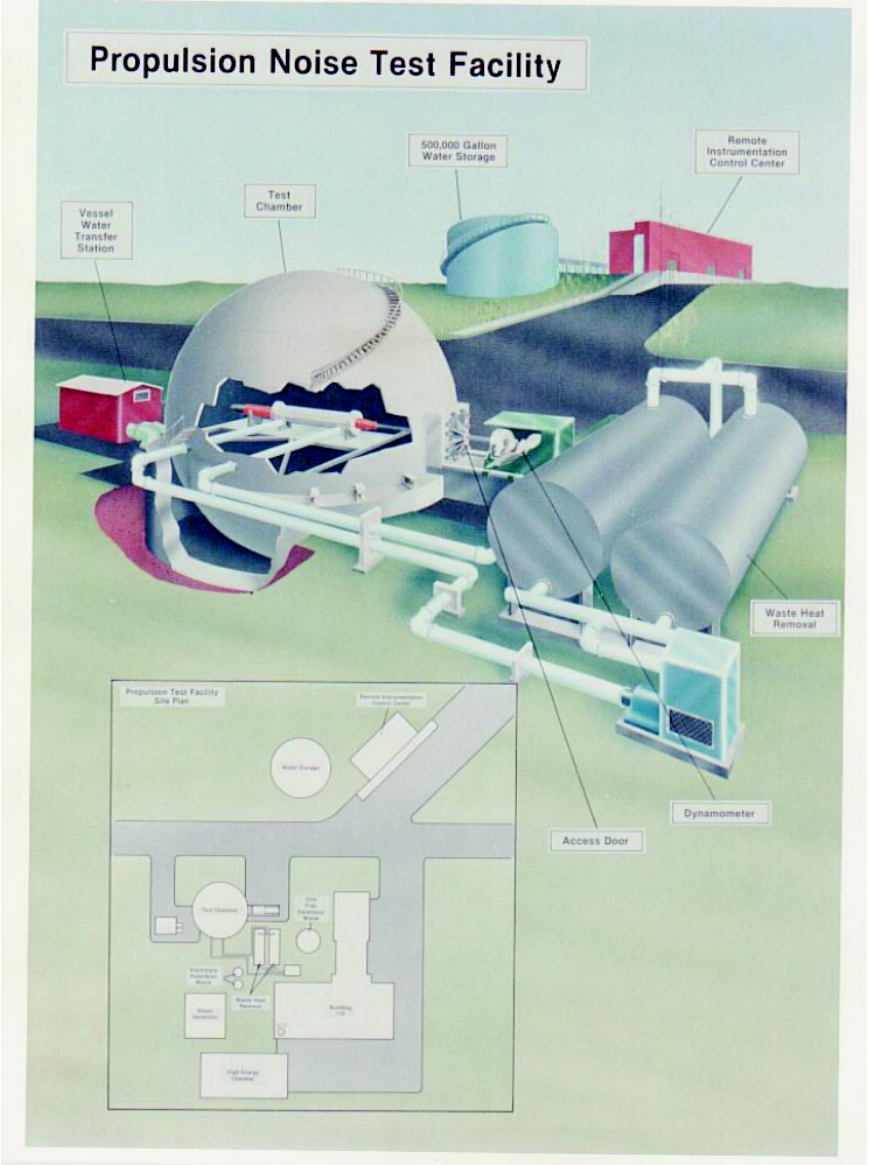
11/21/2011

Introduction

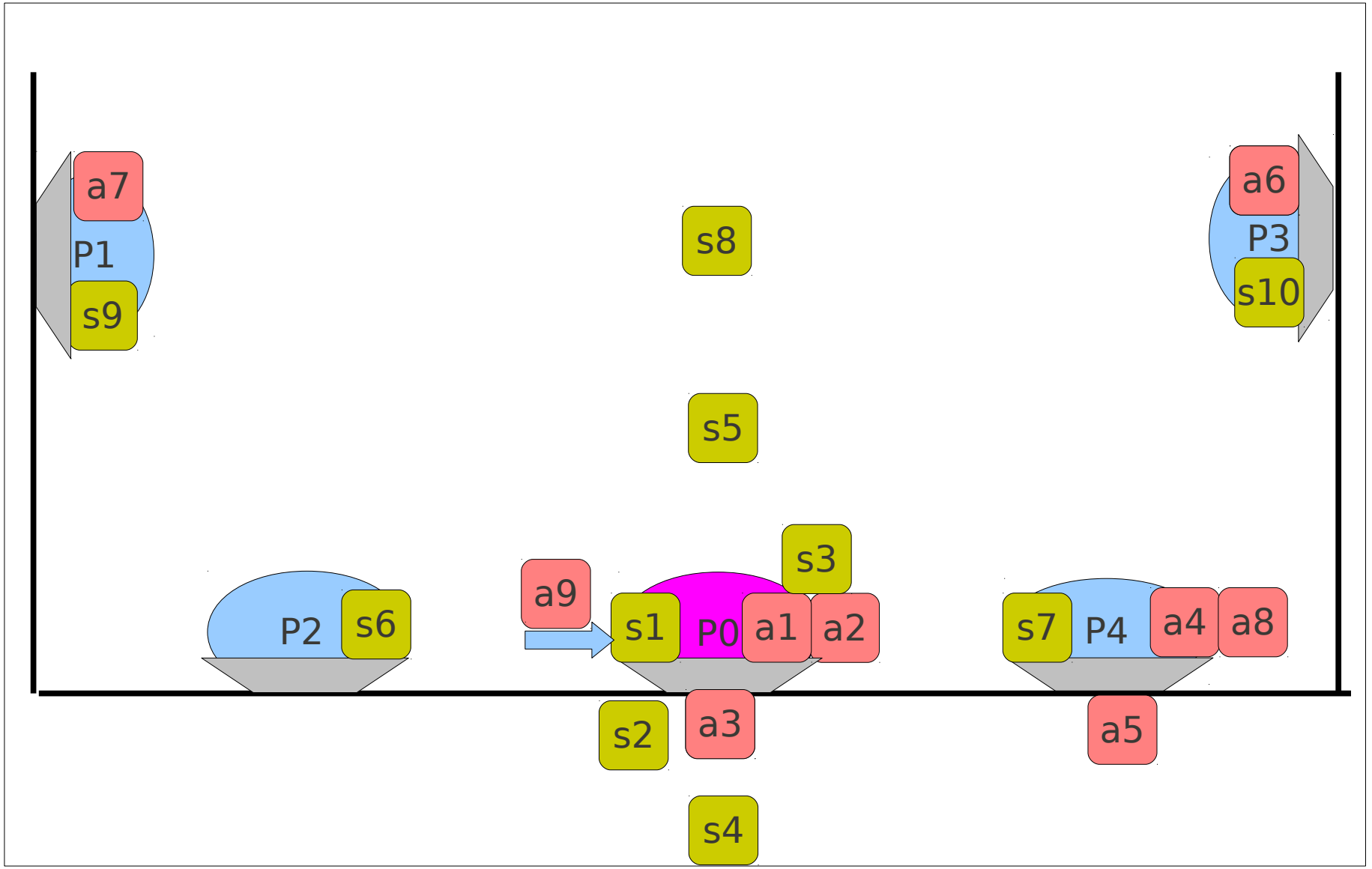
- 3 identical PMT cascade implosion tests @NUWC from Nov. 16th to Nov. 18th , 2011
  - 100Kton WCD baseline design (bucket only)
- One single PMT implosion @ NUWC on Nov 4th , 2011
  - bucket and dome are included
- Experimental setup
- Shock wave pressure results

PNFS Pressure Tank

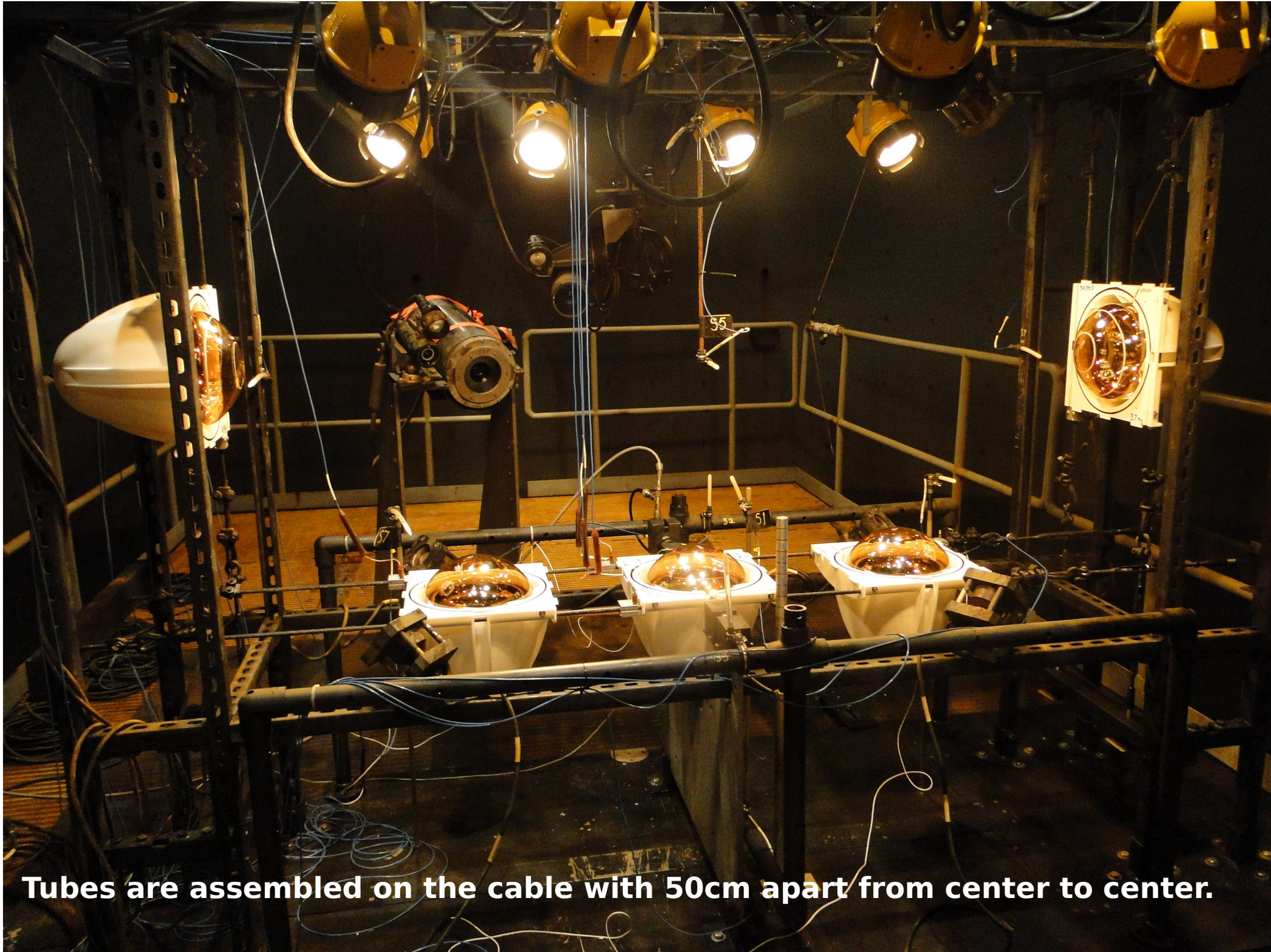


- 15m diameter
- 500K gallons of water
- Filling ½ of the tank ~ 13.5hrs
- Dumping ½ of the tank ~ 4hrs
- Top rated pressure up to 110 psi

Baseline Design (Bucket Only)

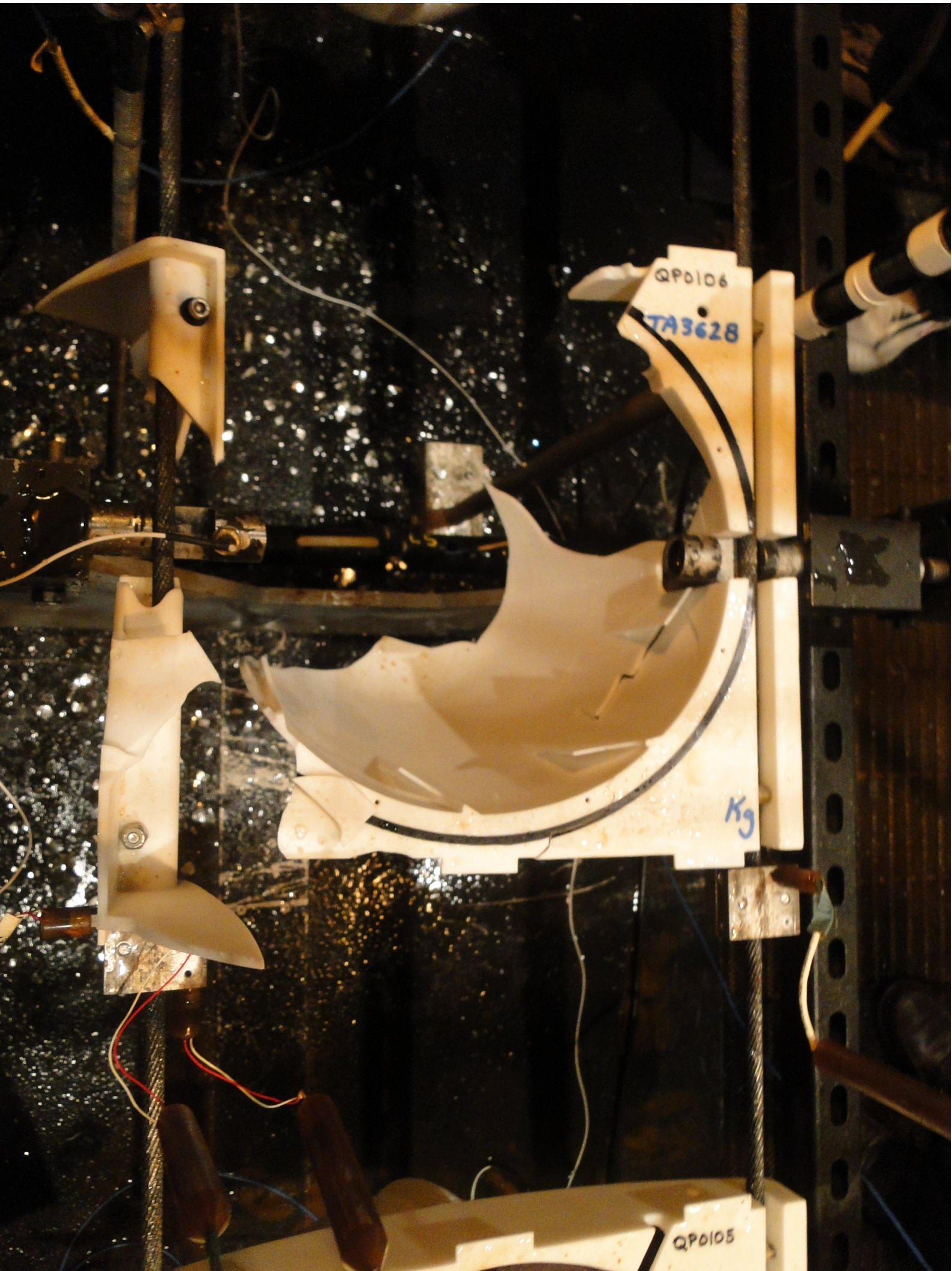


Blast sensor S6 and S9, Accelerometer A7 broken / shorted



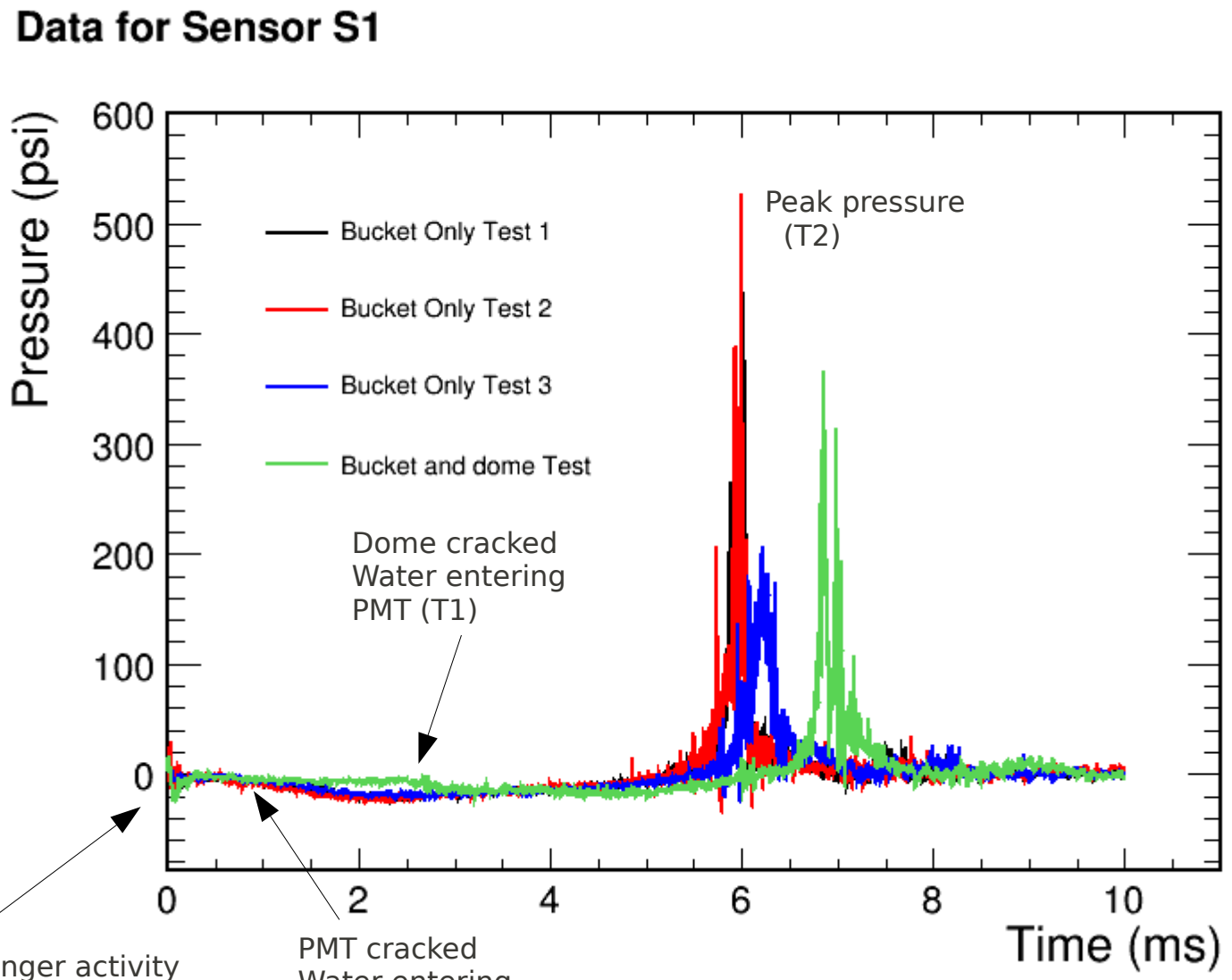
Tubes are assembled on the cable with 50cm apart from center to center.

All nearby tubes survived.


QP0106
TA3628
Kg
QP0105

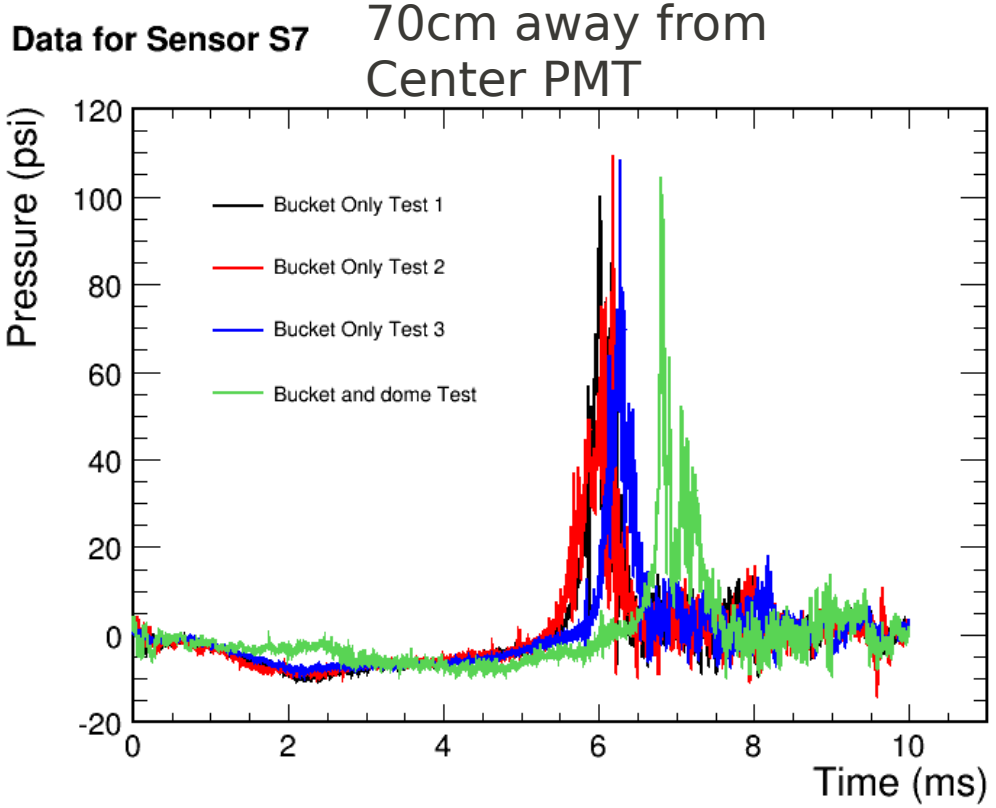
Blast Sensor Data

Blast Sensor S1 (28cm from Center PMT)



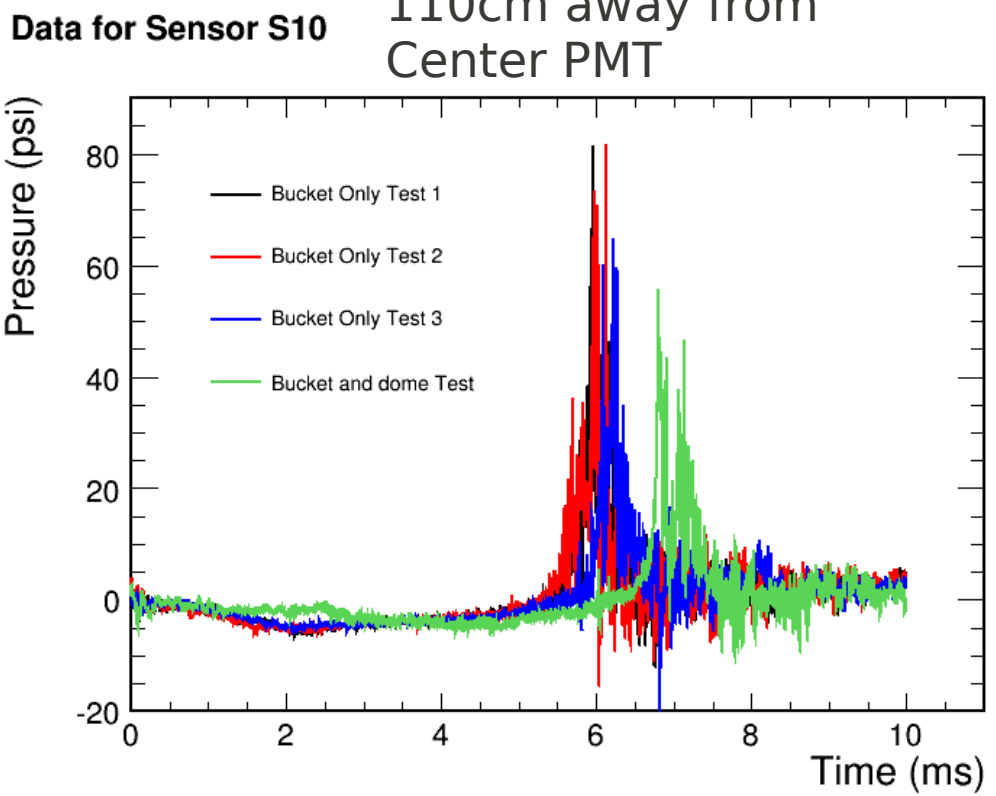
Other Sensors (Near Side PMT)

70cm away from Center PMT



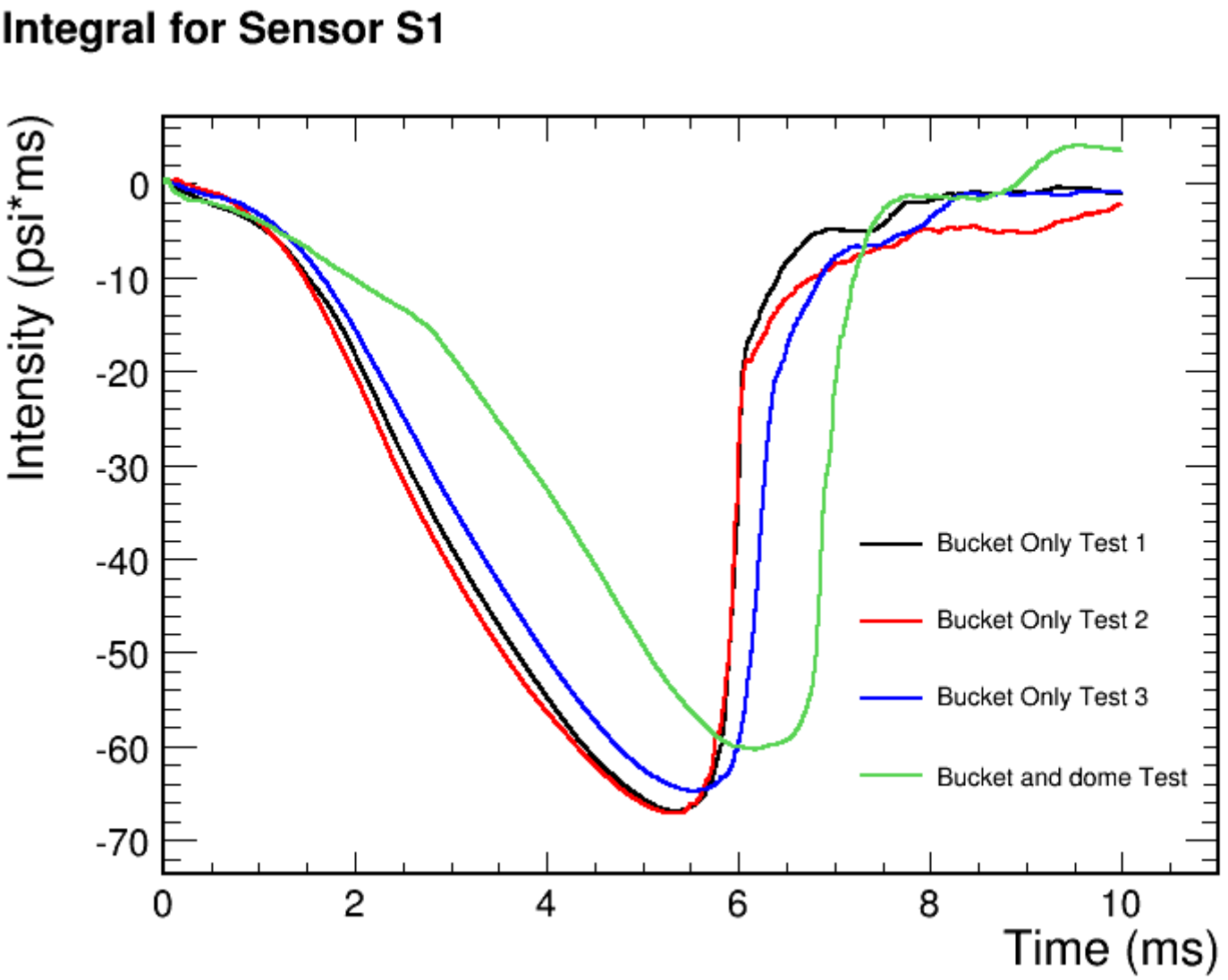
The impact on the side PMT is about 100 psi

110cm away from Center PMT

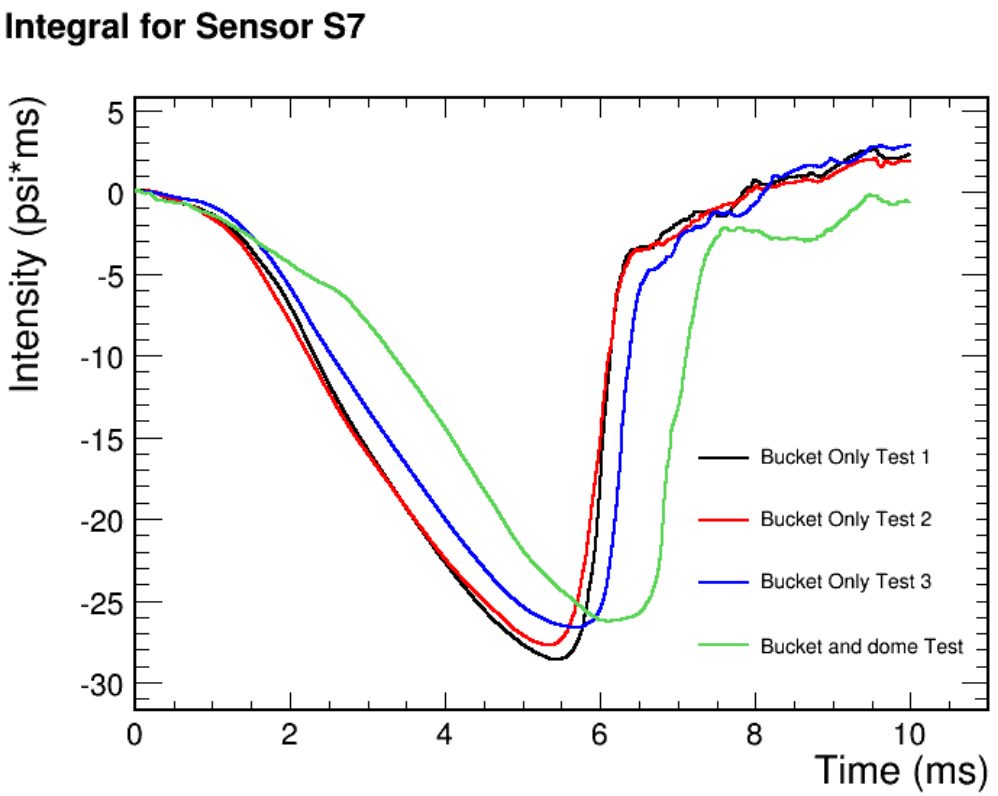


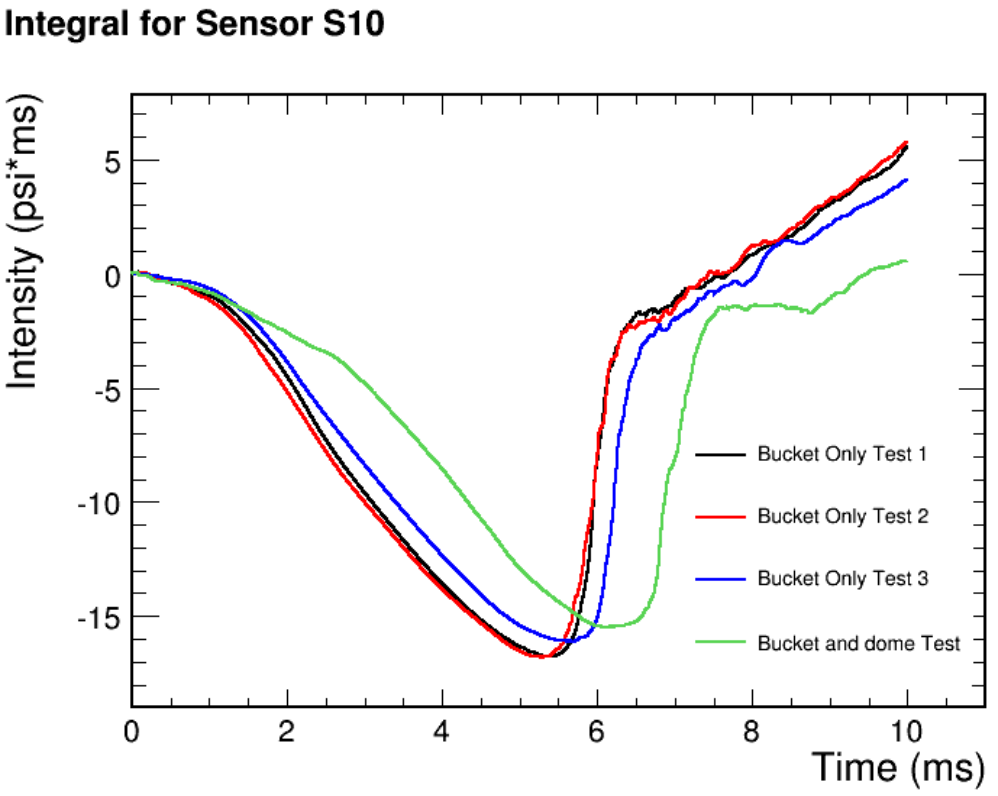
The impact on the side vertical PMT is about 80 psi

Pressure Integration S1



Pressure Integration for Other Sensors





General Information

12/16/2010 Single PMT implosion W/O bucket 10” S/N RA0249

Sensors	distance(mm)	T0 (ms)	T2(ms)	T2-T0 (ms)	Peak (psi)	Intensity (psi*ms)
ACC11	152	0.000	5.570	5.570	801.6	150.0
ACC5	482	0.260	5.800	5.540	300.2	37.8
ACC1	521	0.260	5.785	5.525	426.9	38.0
ACC2	521	0.245	5.780	5.540	488.3	43.2
ACC3	521	0.235	5.830	5.595	287.2	35.8
ACC4	521	0.245	5.825	5.580	410.0	36.3
ACC6	991	0.560	6.150	5.590	169.2	20.3

11/16/2011 Single PMT implosion bucket only 10” S/N TA3068

Sensors	distance(mm)	T0 (ms)	T2(ms)	T2-T0 (ms)	Peak (psi)	Intensity (psi*ms)
S1	279	837.143	843.161	6.018	437.22	67.21
S2	546	837.313	843.332	6.019	200.23	37.51
S3	508	837.151	843.331	6.180	123.61	37.69
S4	508	837.215	843.269	6.054	136.43	39.30
S5	508	837.298	843.333	6.035	199.24	31.95
S7	711	837.350	843.371	6.021	100.18	31.22
S8	1016	837.653	843.647	5.994	107.80	18.59
s10	1143	837.709	843.662	5.953	81.37	22.36

11/04/2011 Single PMT implosion with bucket & dome 10” S/N ZT0007

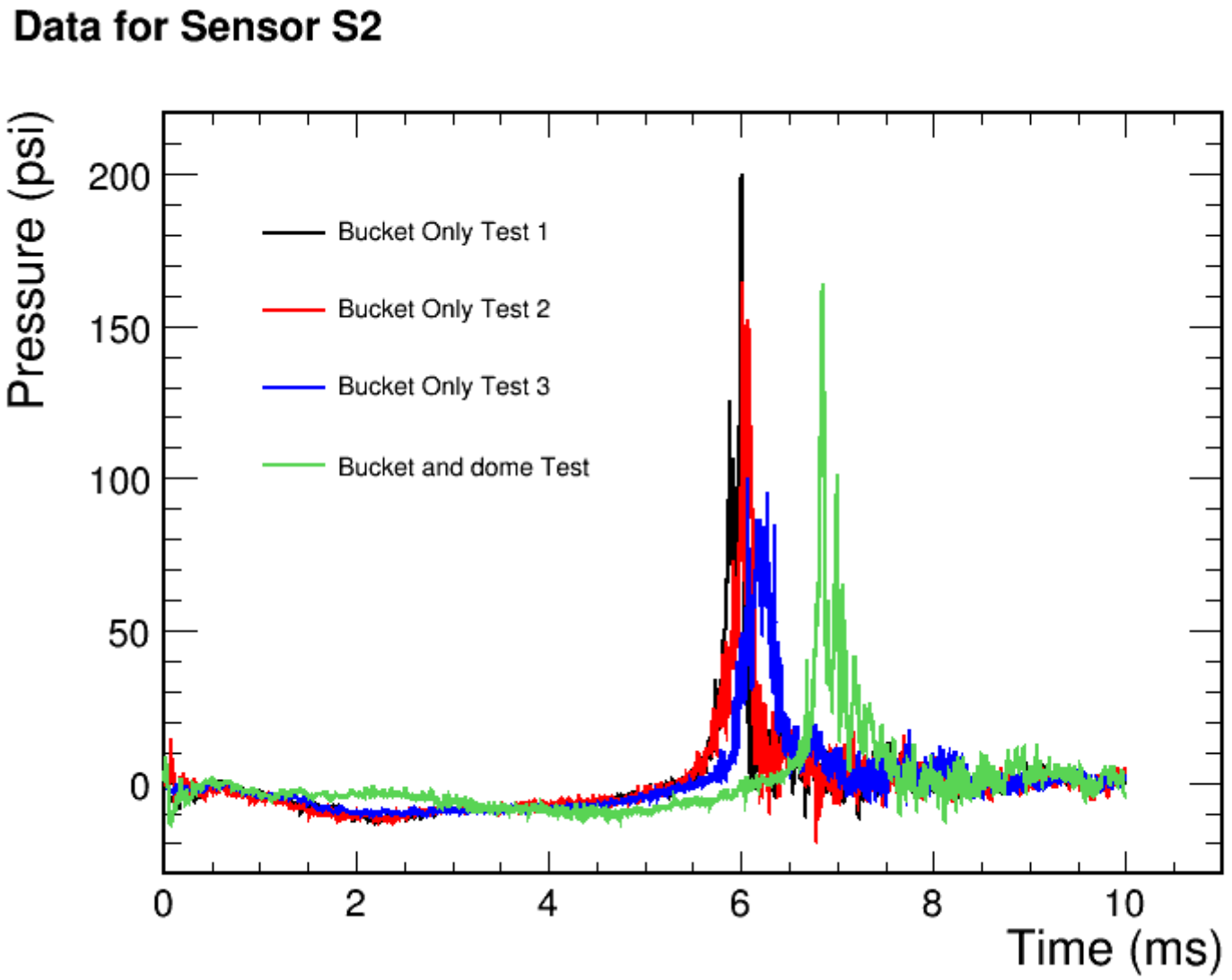
Sensors	distance(mm)	T0 (ms)	T2(ms)	T2-T0 (ms)	Peak (psi)	Intensity (psi*ms)
S1	279	299.994	306.854	6.860	366.95	64.37
S2	546	300.150	307.004	6.854	164.09	35.73
S3	508	300.004	307.144	7.140	116.98	36.45
S4	508	300.075	307.150	7.075	134.58	36.26
S5	508	300.136	307.317	7.181	252.12	45.33
S7	711	300.247	307.053	6.806	104.38	26.36
S8	1016	300.493	307.507	7.014	101.44	17.15
s10	1143	300.543	307.346	6.803	55.82	16.05

Observations

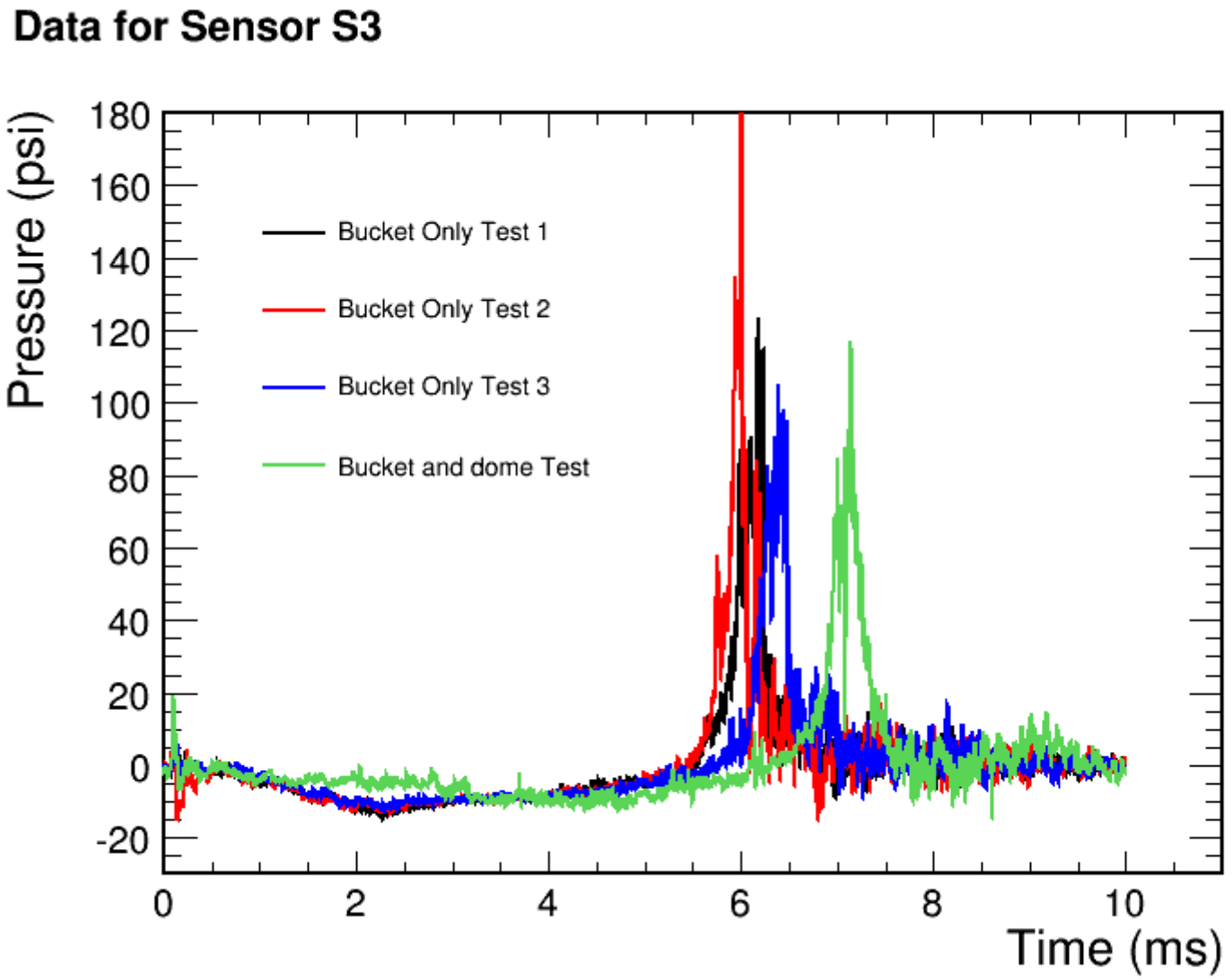
- Bucket protection can effectively reduce the shock wave peak pressure by roughly 50% - 75%.
- Dome has a small effect on reducing the shock wave pressure, however it slows the whole implosion process due to the dome cracking.
- The integrated shock wave pressure intensity is consistent with all the tests due to the energy conservation.
- All the nearby 10” tubes survived in all three tests.
- Extrapolation of this result to the current baseline design will be the subject over the next year.

Backup slides

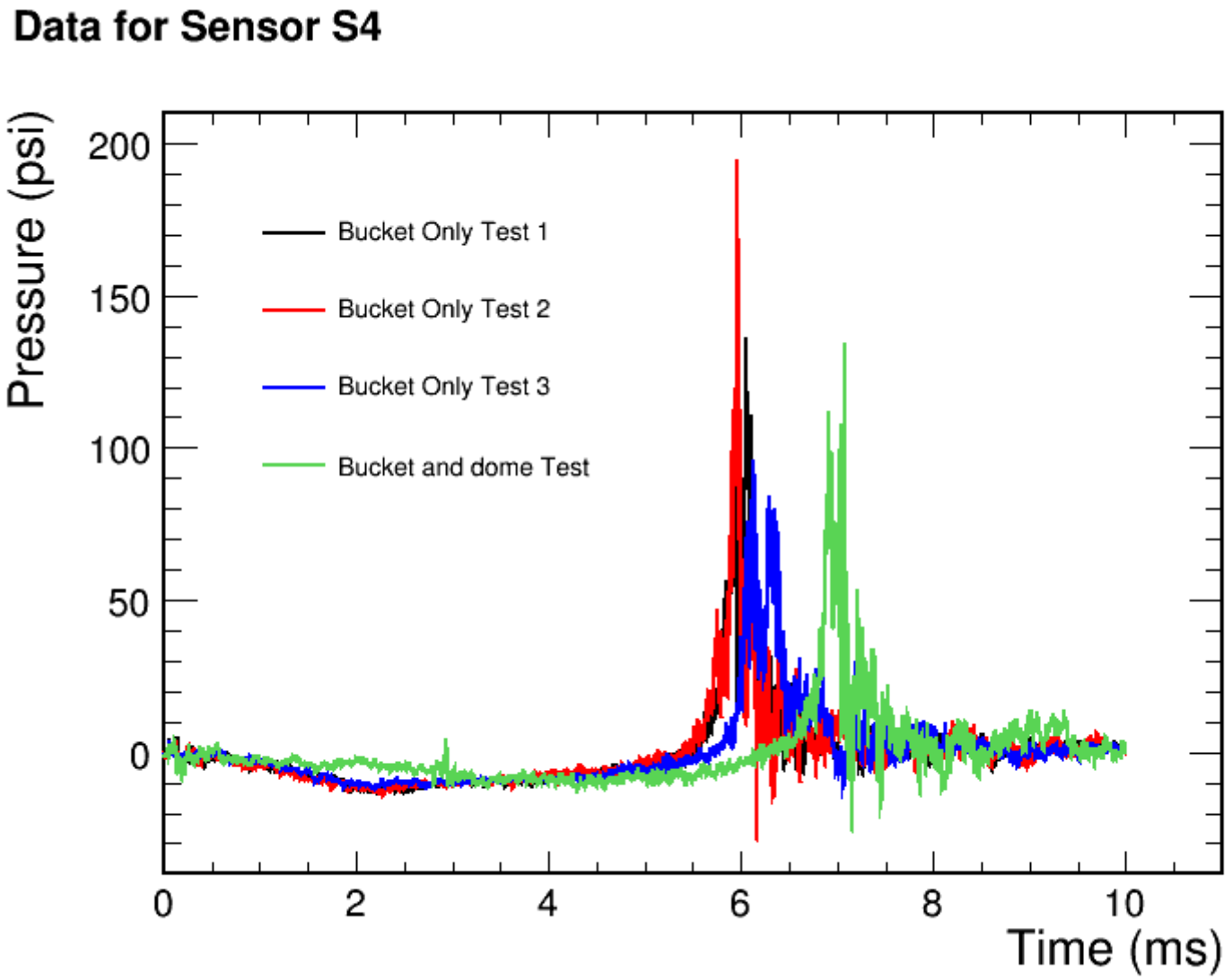
Blast Sensor S2



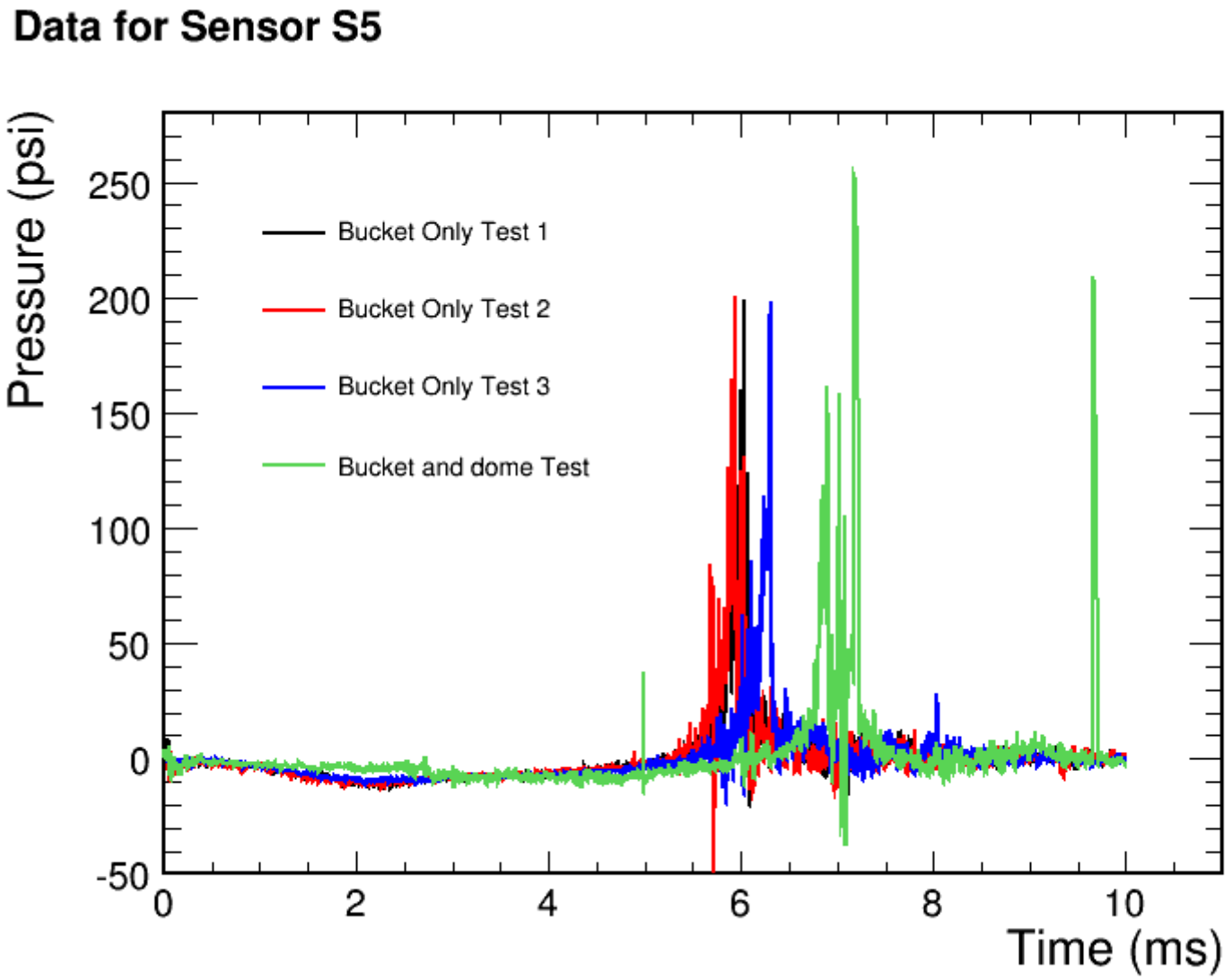
Blast Sensor S3



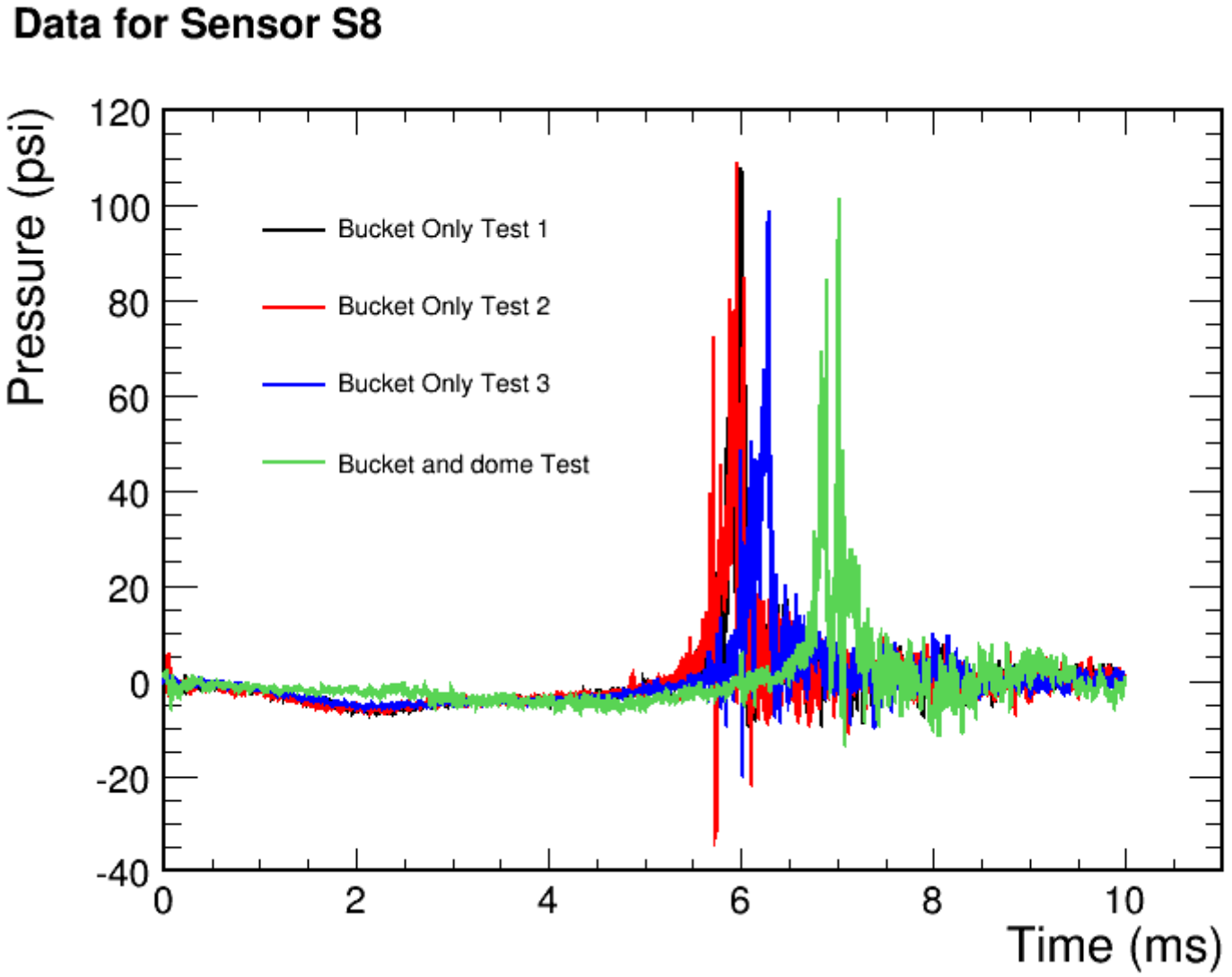
Blast Sensor S4

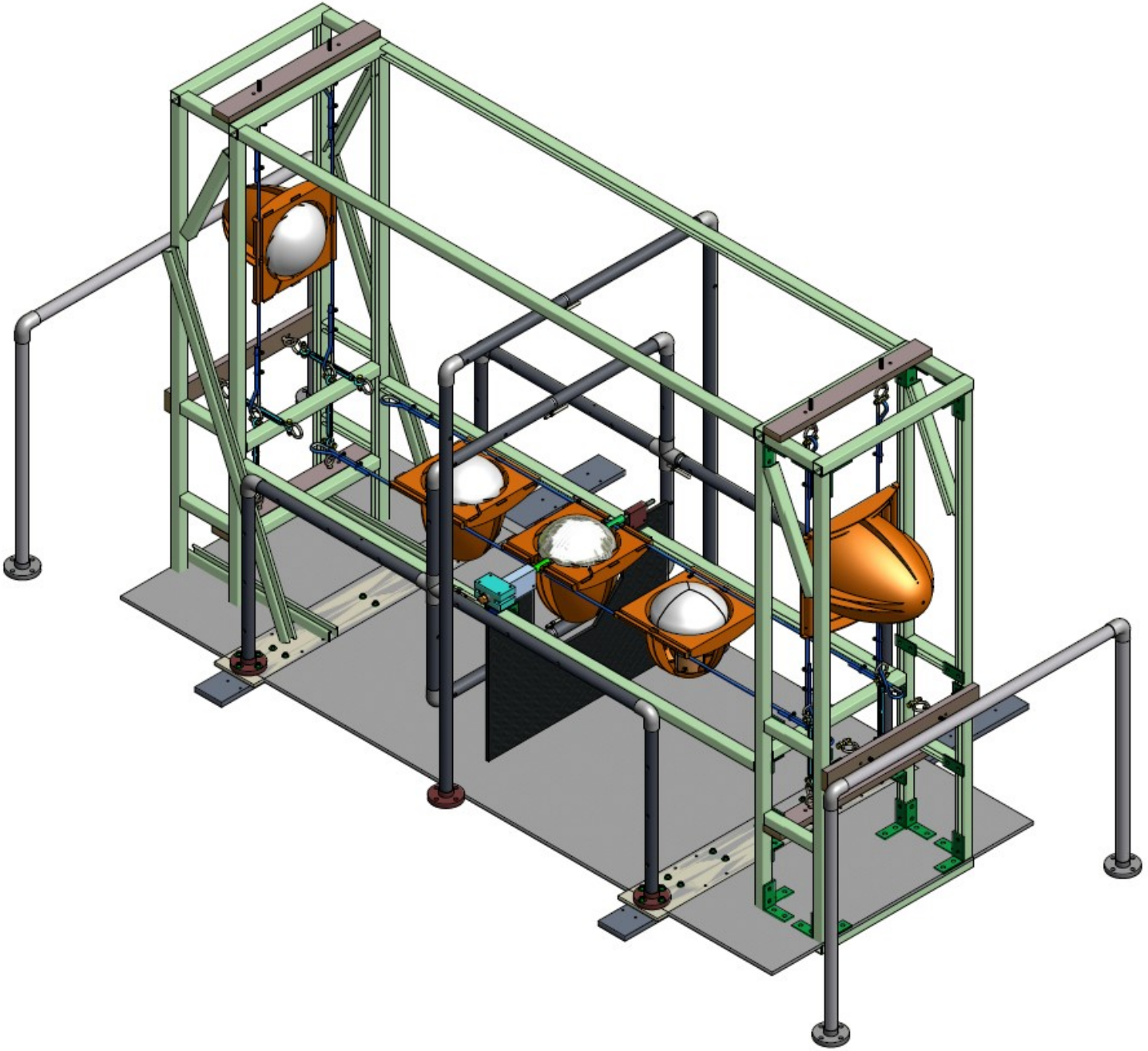


Blast Sensor S5



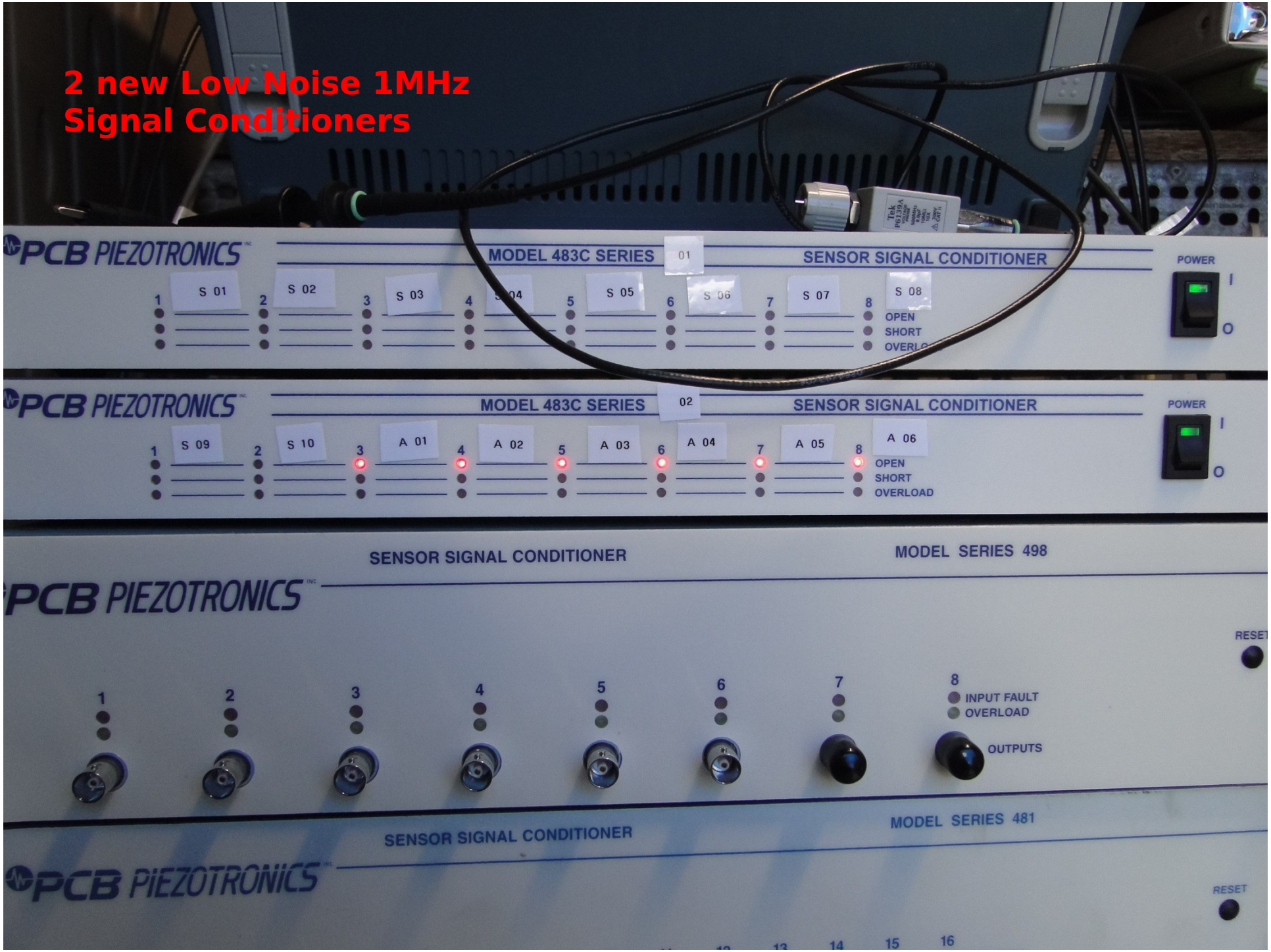
Blast Sensor S8

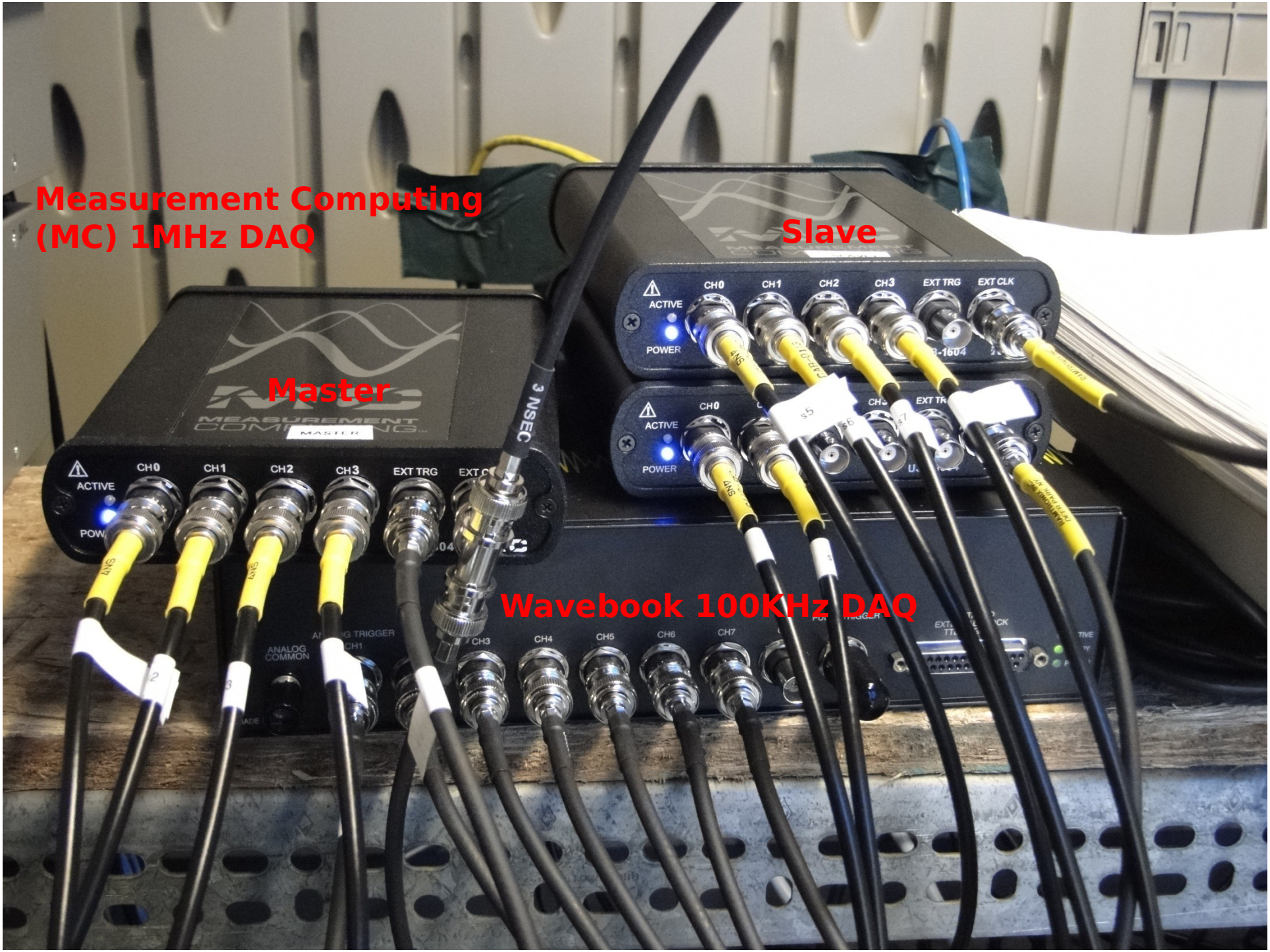




Trigger and DAQ System

Small DAQ
Shed


2 new Low Noise 1MHz
Signal Conditioners
PCB PIEZOTRONICS
MODEL 483C SERIES
01
SENSOR SIGNAL CONDITIONER
POWER
S 01
S 02
S 03
S 05
S 06
S 07
S 08
OPEN
SHORT
PCB PIEZOTRONICS
MODEL 483C SERIES
02
SENSOR SIGNAL CONDITIONER
POWER
S 09
S 10
A 01
A 02
A 03
A 04
A 05
A 06
OPEN
SHORT
OVERLOAD
SENSOR SIGNAL CONDITIONER
MODEL SERIES 498
PCB PIEZOTRONICS
RESET
INPUT FAULT
OVERLOAD
OUTPUTS
SENSOR SIGNAL CONDITIONER
MODEL SERIES 481
PCB PIEZOTRONICS
RESET


Measurement Computing
(MC) 1MHz DAQ
Slave
Master
Wavebook 100KHz DAQ
ACTIVE
POWER
CH0
CH1
CH2
CH3
EXT TRG
EXT CLK
3 NSEC
4NS
ANALOG
COMMON
CH3
CH4
CH5
CH6
CH7

SRS Pulse Generator
STANF D RESEARCH SYSTEMS, INC. MODEL DG535 FOUR CHANNEL DIGITAL DELAY/PULSE GENERATOR
Single Shot (Exc)
s
ms
µs
ns
ps
TRIGGER
TRIG
BUSY
RATE
INT
50Ω
EXT TRIG
MENU
TRIG
DELAY
OUTPUT
GPIB
STORE
RECALL
NUM
REM
BSP
7
8
9
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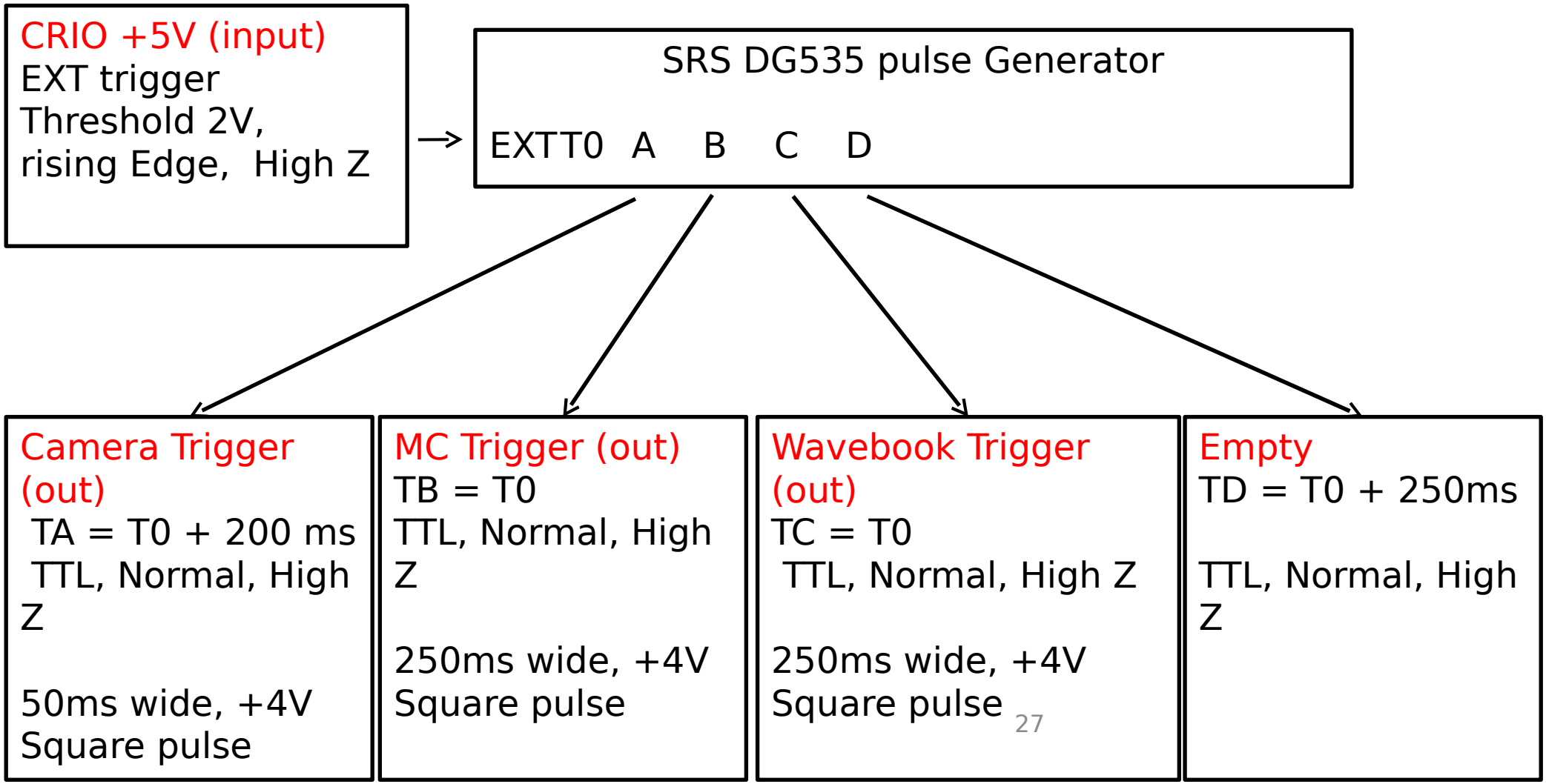
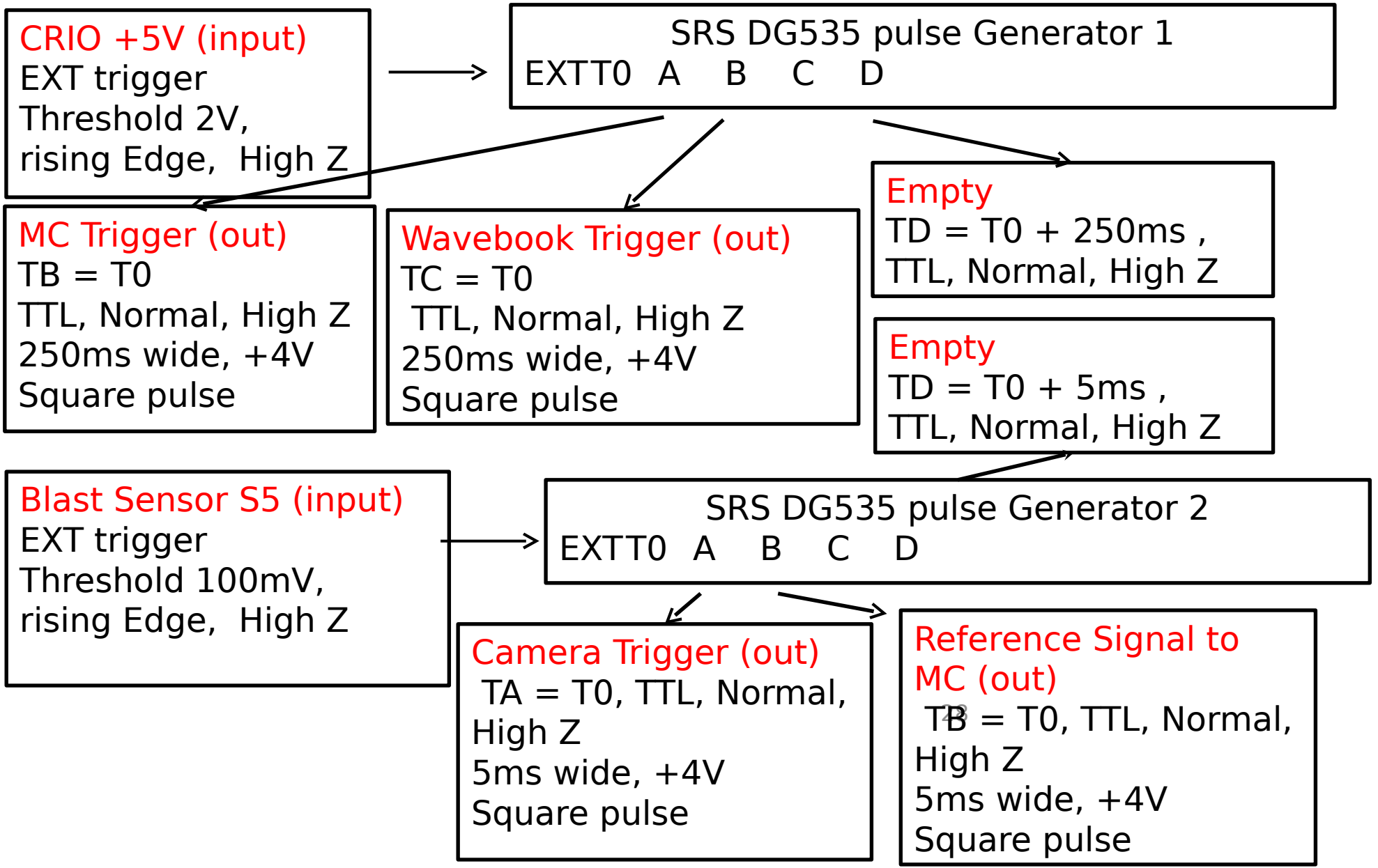
4
5
6
EXP
0
1
2
3
EXC
LCD
POWER
ON
OFF
A
B
A⎍B
A⎍B
C
D
C⎍D
C⎍D
Trigger

Trigger Setup 1



Trigger Setup 2



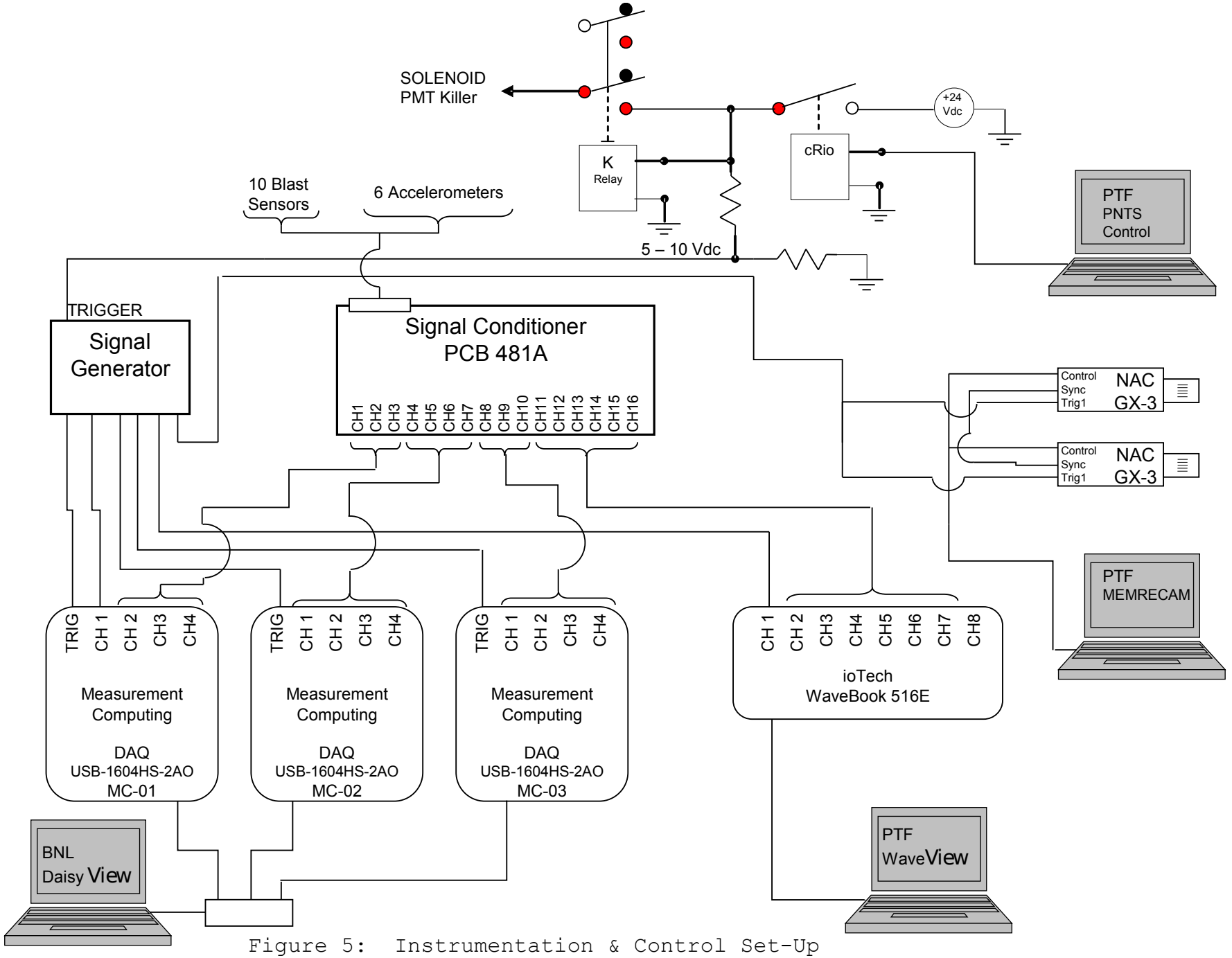
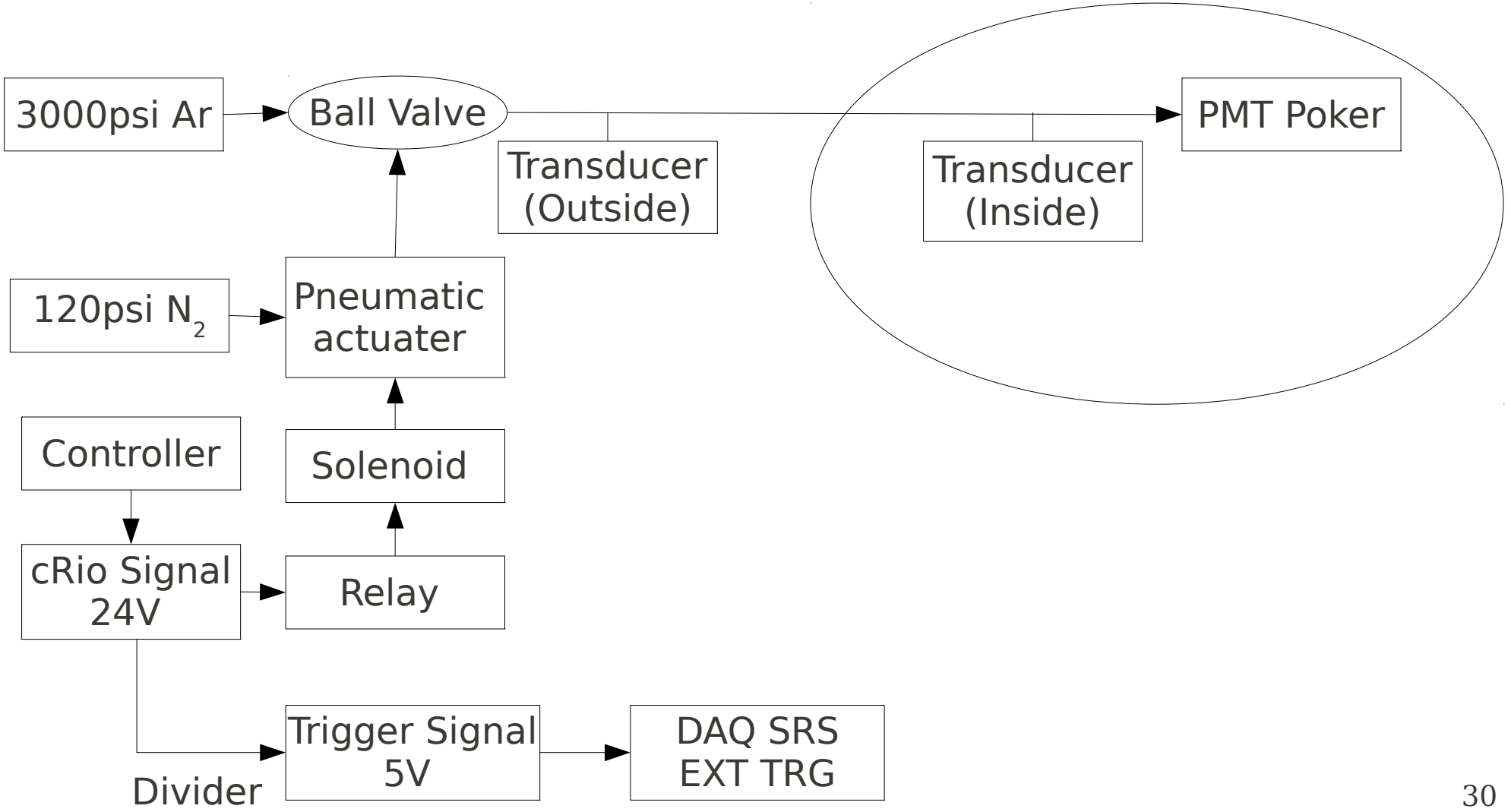


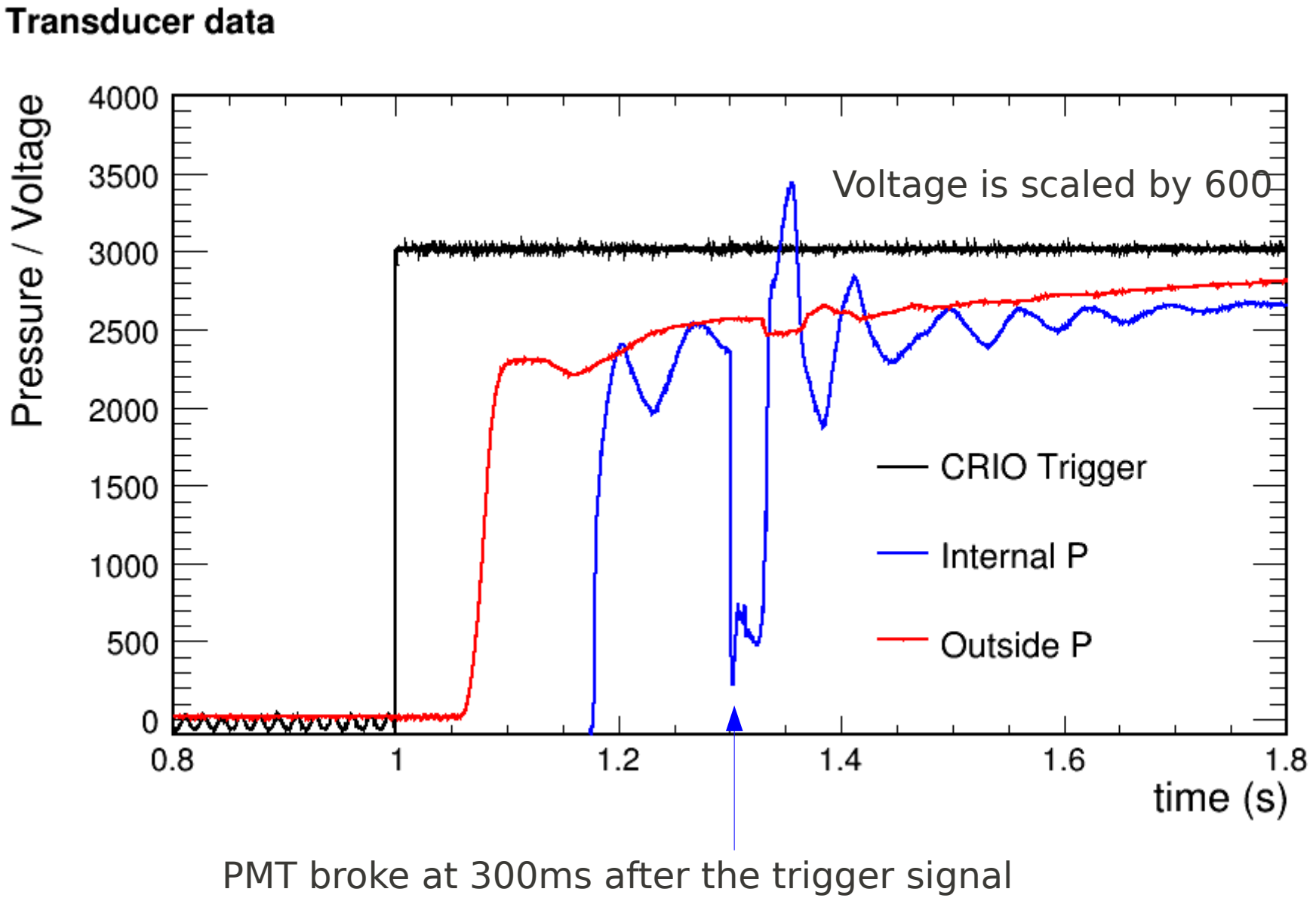
Figure 5: Instrumentation & Control Set-Up

Out of date. The concept is still valid.

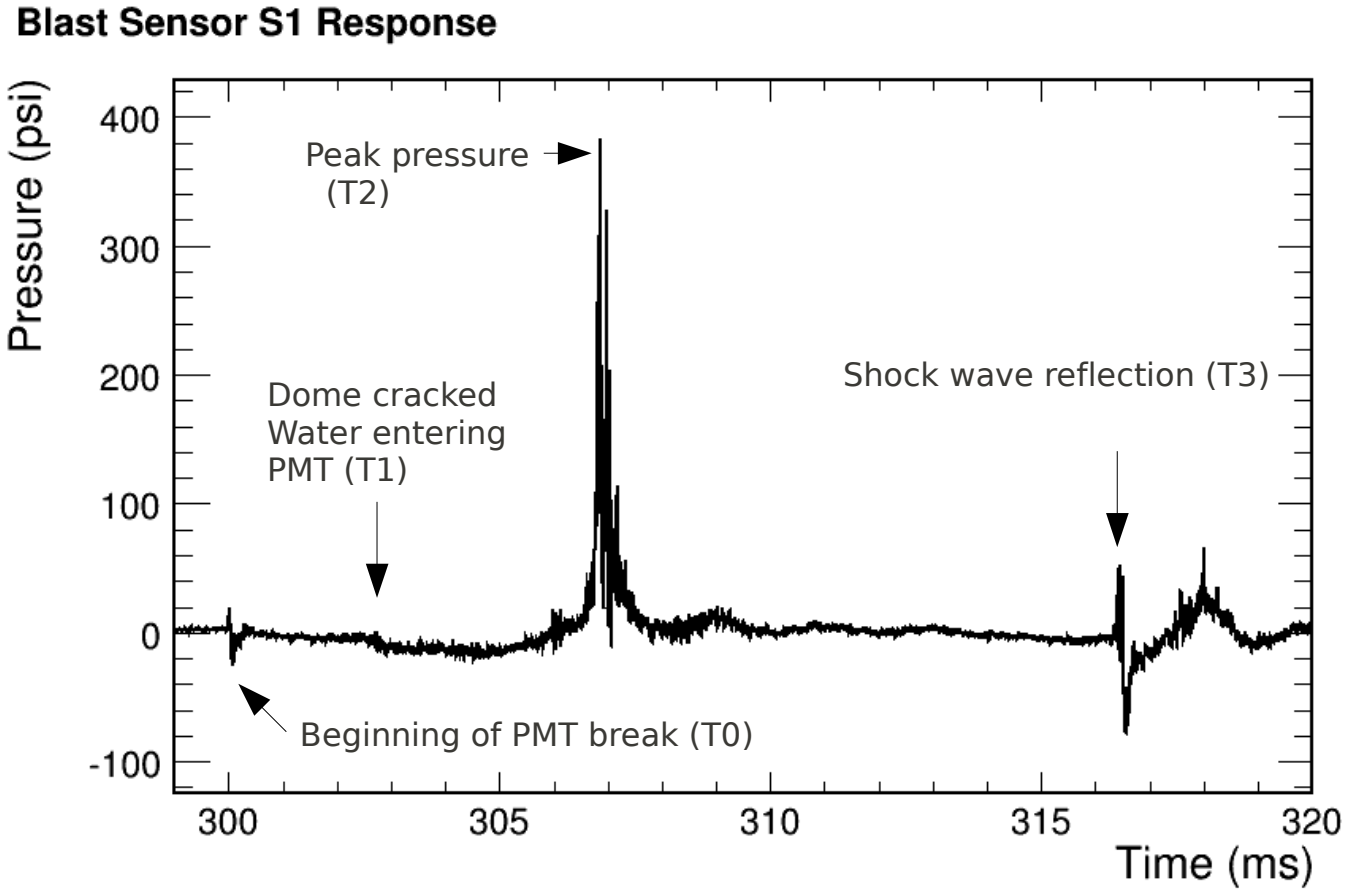
Pneumatic PMT Breaking System



Time Scale of the Pneumatic System (Daisy Data)



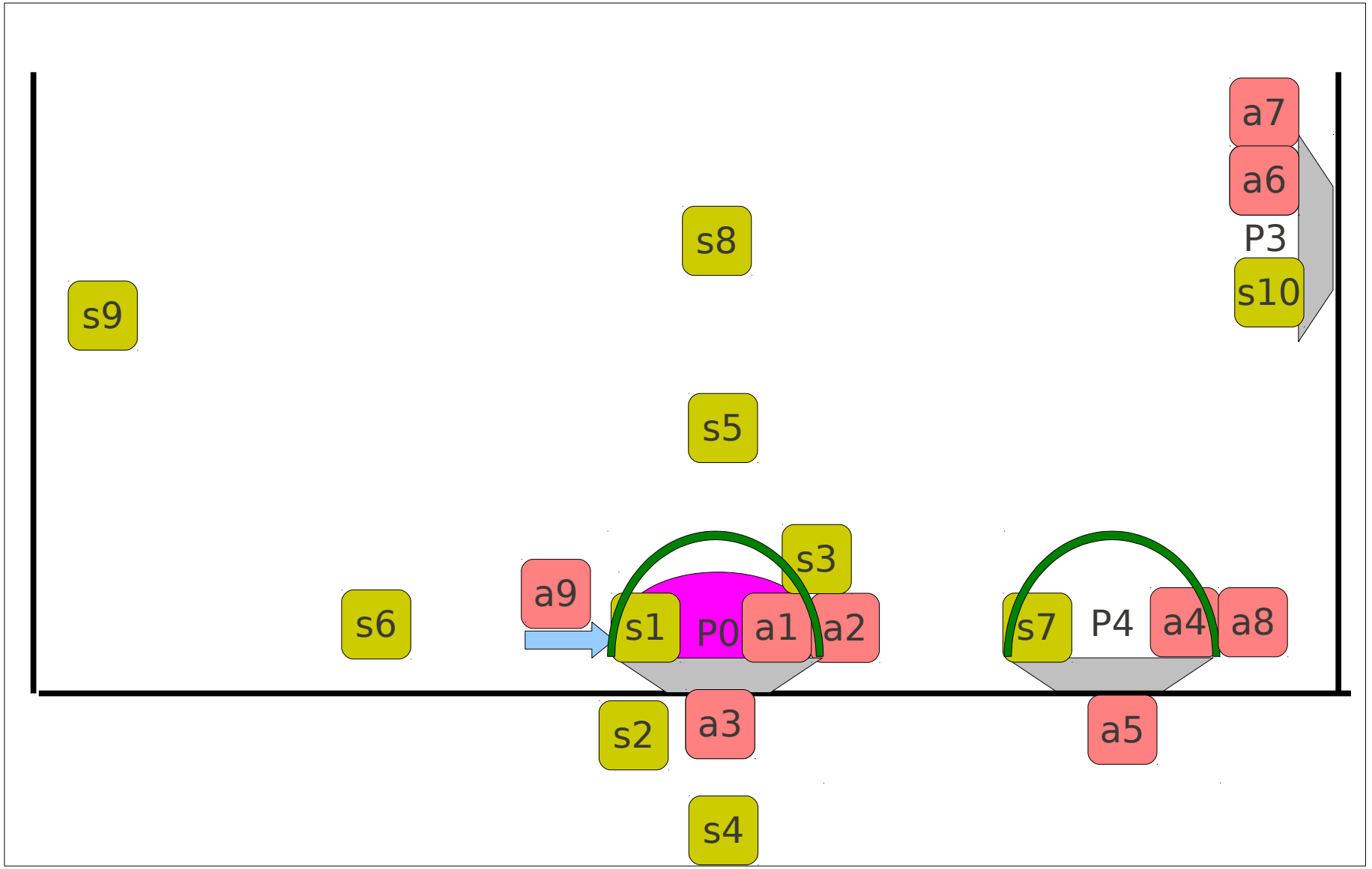
Blast Sensor Pulse Structure



Even with the current bucket and dome design, we can not get rid of the shock wave.

T1 – T0 ~ 2.7ms (use to be ~ 1ms; Bucket and dome does slow the implosion process)
T2 – T1 ~ 4.2ms
T2 – T0 ~ 6.9ms (use to be ~5.6ms)

PreTest Setup (Dome Included)



Only one PMT is installed in the PreTest setup.