

Small PMT system



Oct 2022 EU-AM collaboration meeting

C.Cerna

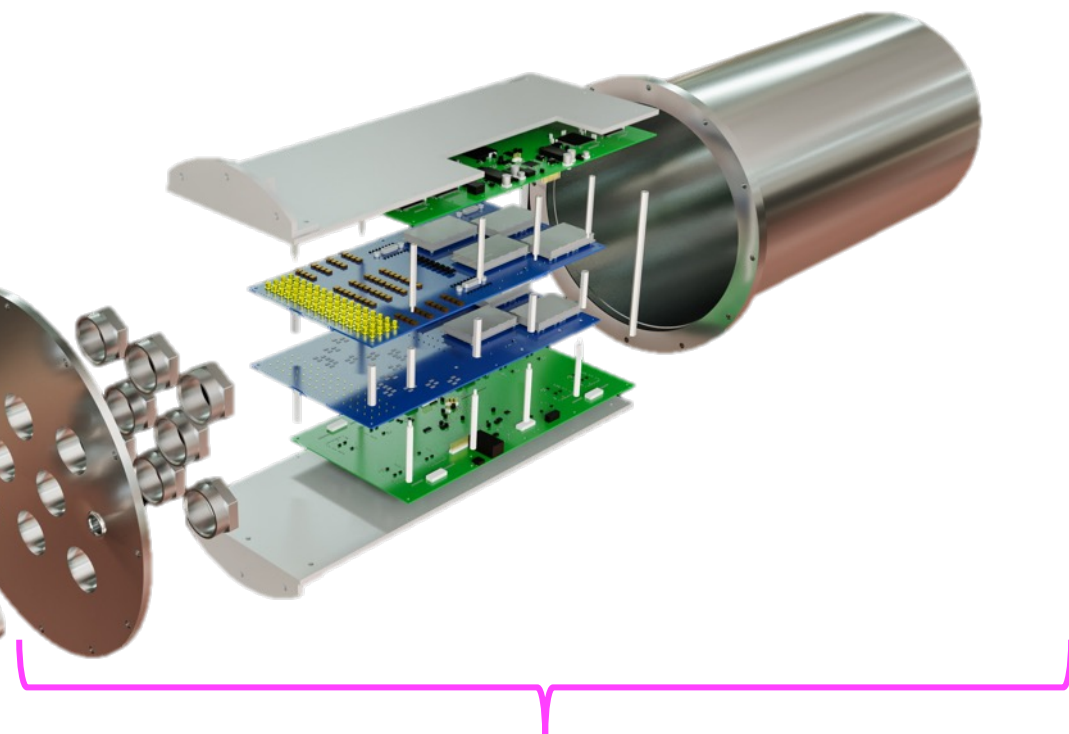
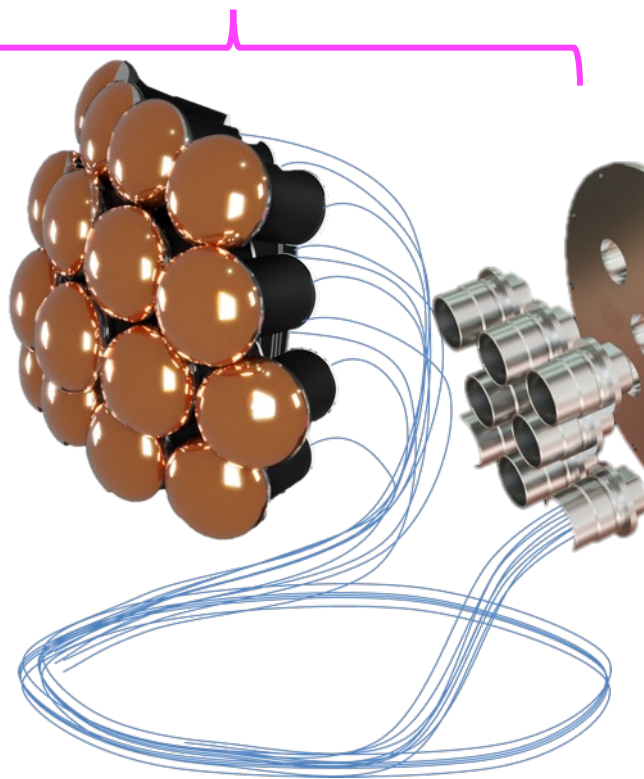
On behalf of the SPMT dream team



Status overview

- ❖ Each subsystem handle 128 3" PMTs + Electronics
- ❖ 200 subsystems = 25,600 channels on CD

PMTs, cables, connectors, potting



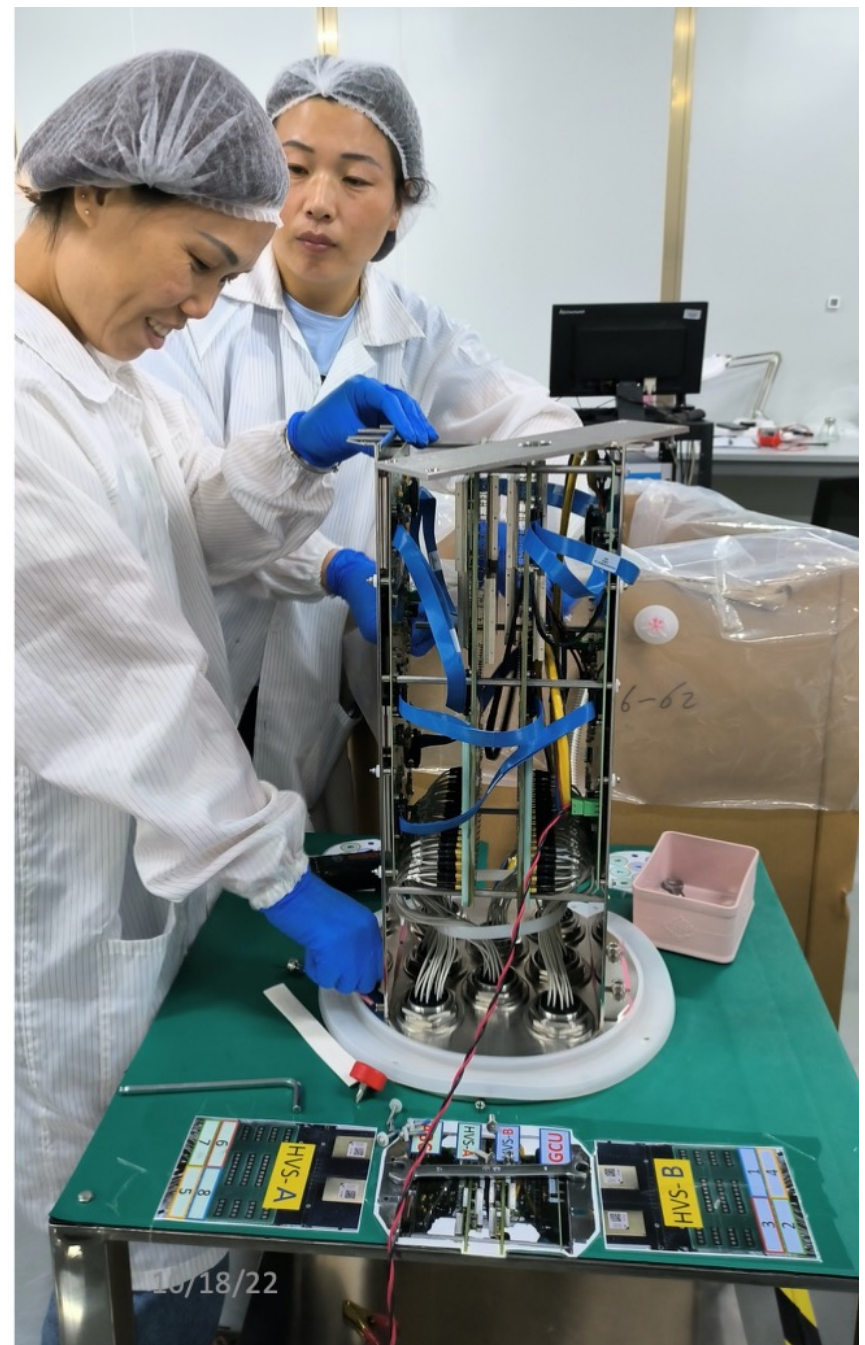
Front-End Electronics + UnderWater Box



Production are (almost) done...

...we are fully switching the activities to integration

...and soon installation





Electronics Architecture

Surface Electronics

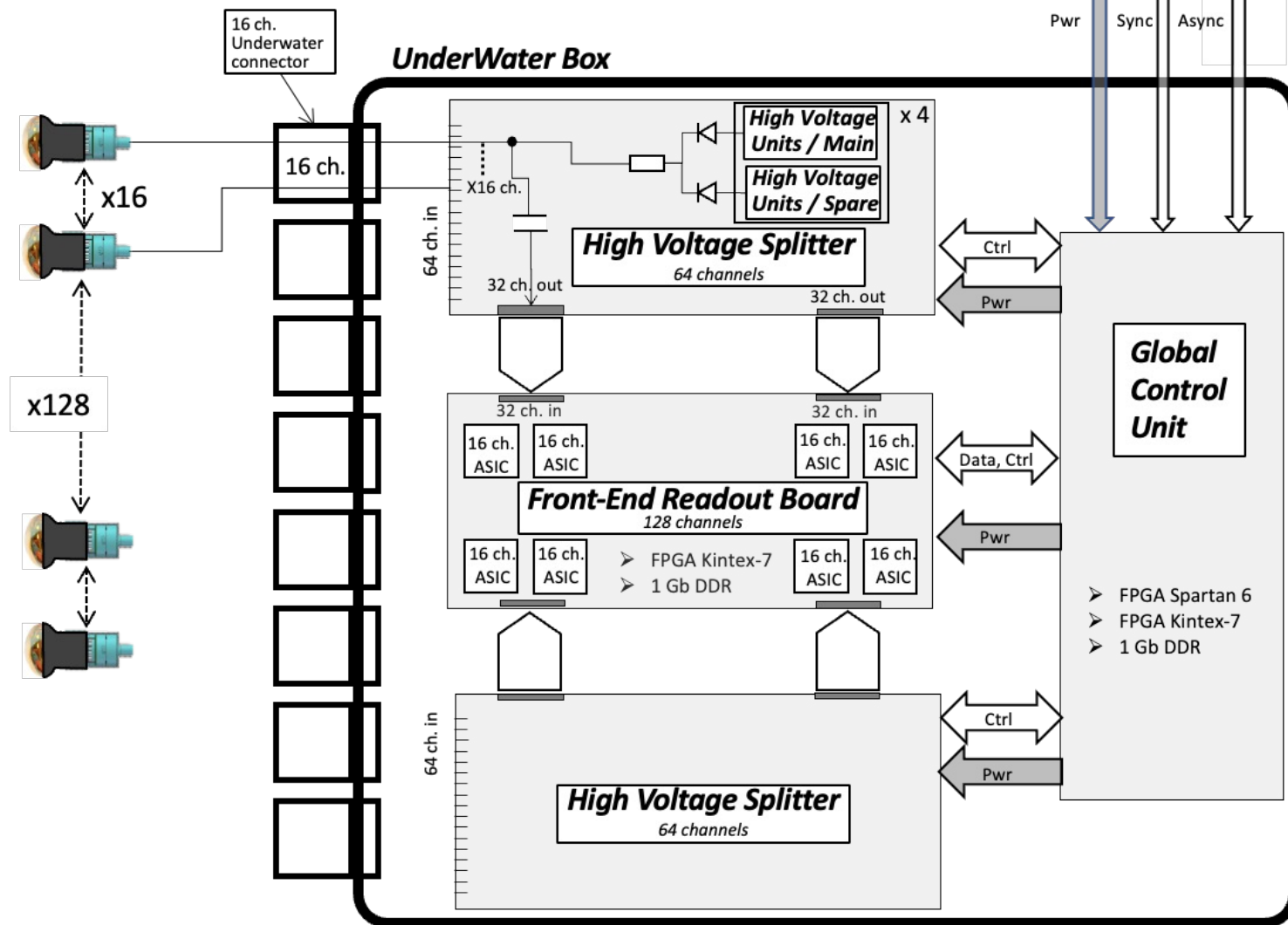
- Low Voltage
- DAQ
- DCS

Pwr

Sync

Async

UnderWater Box





Status of deliveries for integration

- ◆ All received components are stored in SAB so far
- ◆ May move some UWBs to a warehouse in Jinji town later



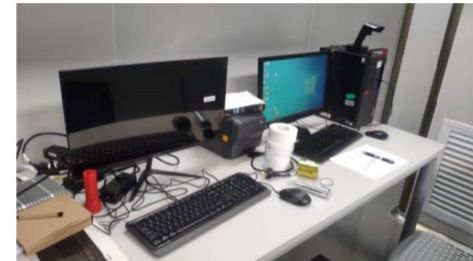
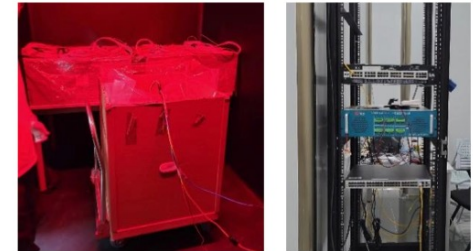
Components	Requirement for JUNO	Requirement for TAO	Received/Produced	Spares
Receptacle	1600	0	1650/1650	3%
ABC	200	3	214/214	5%
GCU	200	3	220/220	8%
HV splitter	400	6	425/435*	7%
Heat sink	200	3	220/220	8%
UWB	200	3	83/210**	3%
Cable and screws	200	3	220/220	8%

* 8 more from Chile and Zsipak.

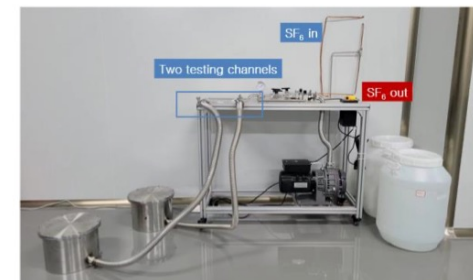
** Plan to receive all in November.

Work station

- ◆ Was planned in Kunshan. Moved to **JUNO site** in May to avoid transportation and lockdown due to pandemic.
- ◆ Set up a new laboratory in the clean room of the surface assembly building (SAB).



PMT+electronics testing



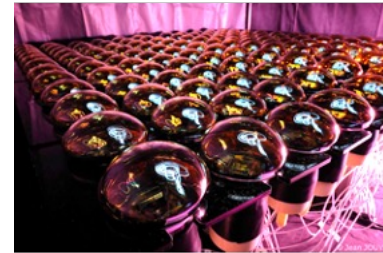
SF6 leakage test system



Main status

- Combined test stations with the full chain of instrumentation and electronics

- LP2i Bordeaux and IHEP Beijing
 - 128 PMTs + full chain of electronics



- Integration

- 3 UnderWater Boxes (UWB) training in January in IHEP
 - ~ 30 UWB integrated since Sept. in JUNO site
 - Integration PRR passed Oct. 18th
 - Bellow length in the order of underground installation



Manpower, Schedule and storage

◆ Manpower

- ⇒ **Ziliang Chu + Beizhen Hu + 2** → 4 workers from AnDeYuanTong company
- ⇒ Shifters from November
- ⇒ Local or remote support by IHEP, GXU, Wuyi, LP2i, PUCC, UCI, NTU ...

◆ Schedule

- ⇒ 2 → 4 electronics per day
- ⇒ Plan to finish by Chinese New Year

◆ Storage

- ⇒ ~50 in SAB
- ⇒ The rest in a warehouse in Jinji Town, ~4 km from SAB (need better packaging with N₂ protection)



SAB



Jinji warehouse



Main steps of integration

See docdb 8947

Receptacle
assembly



ABC
assembly



Two HVS
assembly



GCU
assembly



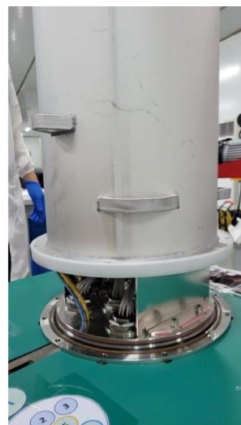
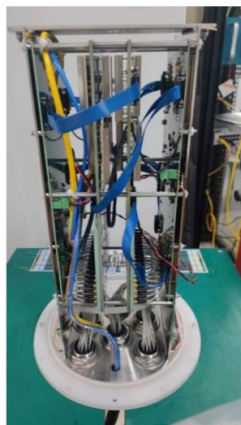
Closing
UWB



Leakage
test

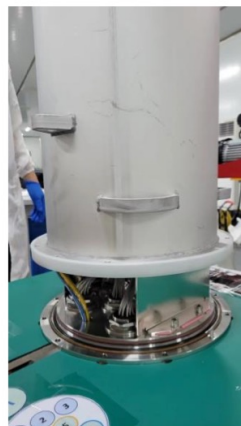
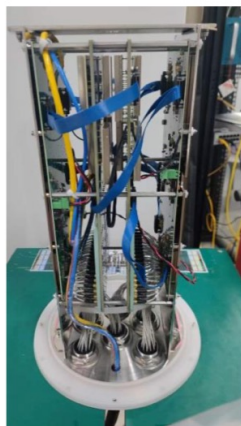
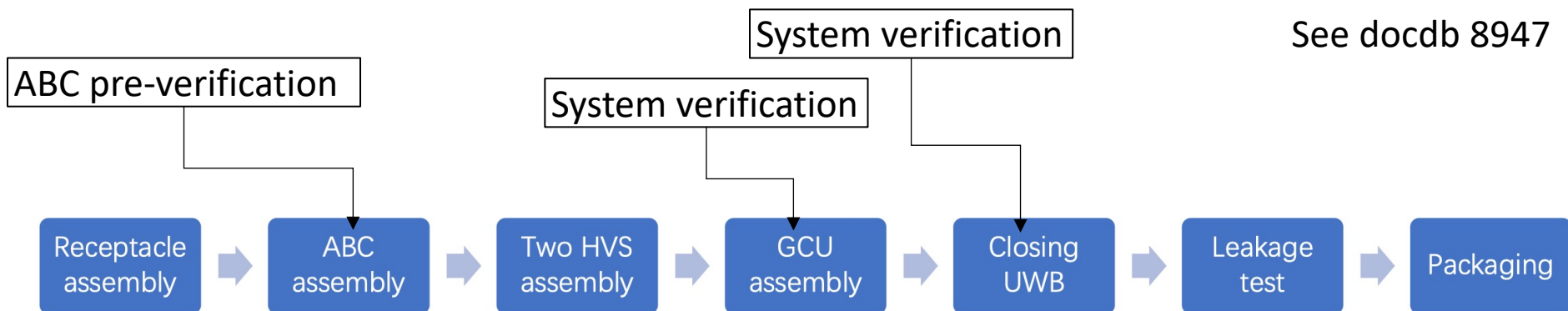


Packaging



Main steps of integration

See docdb 8947



HV Splitter verification
➤ Mapping/Cabling
➤ Functional

Leak verification

Main steps of integration

See docdb 8947

ABC pre-verification

System verification

System verification

Receptacle
assembly

ABC
assembly

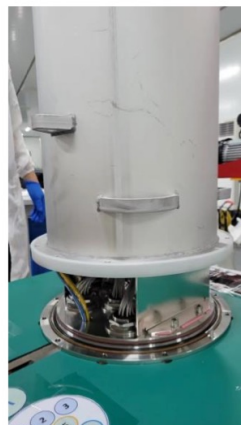
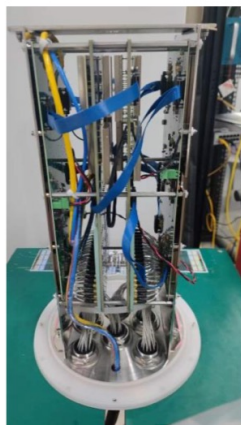
Two HVS
assembly

GCU
assembly

Closing
UWB

Leakage
test

Packaging



HV Splitter verification

- Mapping/Cabling
- Functional

Leak verification

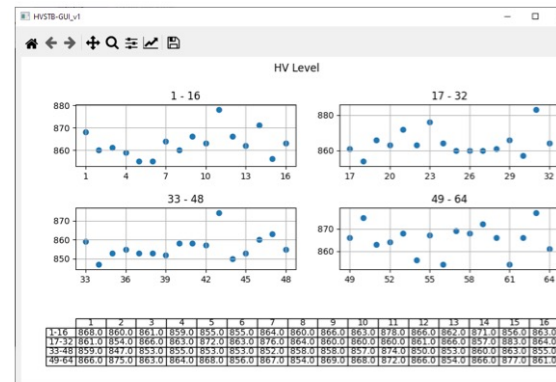
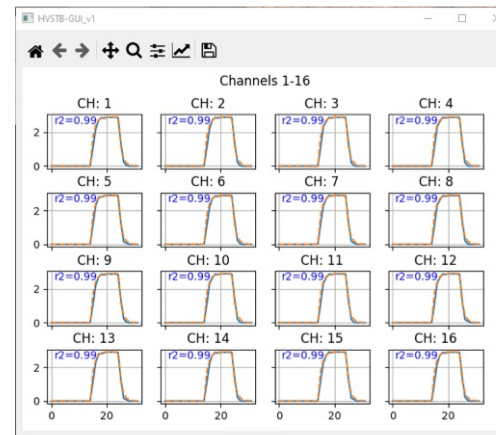
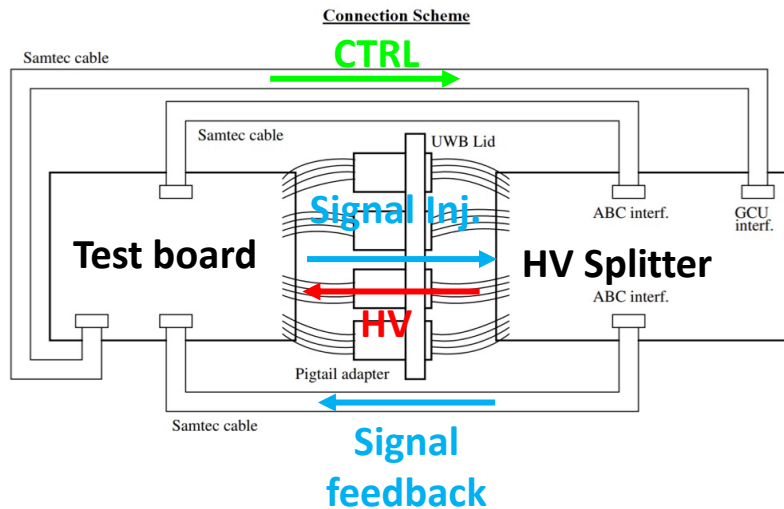
High Voltage Splitter verification

- Key critical board: 64 channels, High Voltage, Signals
- 2 boards / UWB
- 16 HV Units

See docdb 8946

a) HVS functional testing & cable mapping

- To confirm HVS functionality and check correct cable mapping
- Using HVS test board and software, details DocDB 8621-v2
- This procedure is operated by workers



Ping and configure HVU

- Check HVU functionality

Inject and readout AC

- Check AC continuity
- Check cable mapping

Measure DC high voltage

- Check HV output
- Check leakage

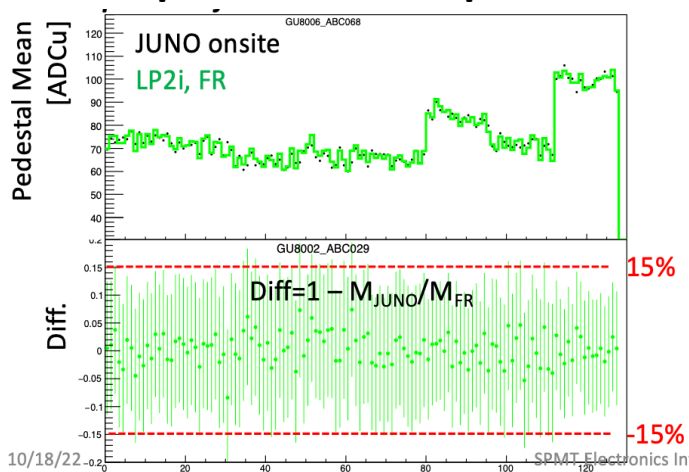
Check for shorts

Functional Testing with SPMT @dark room

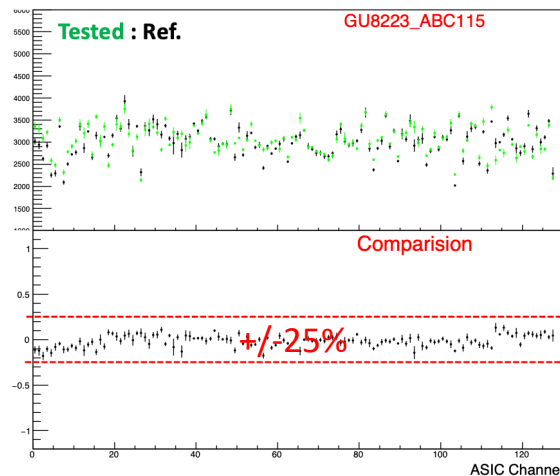
128 PMTs

- Pedestal and Single Photon Spectrum comparison
- 30 min. / UWB
- Comparison with ABC production performances

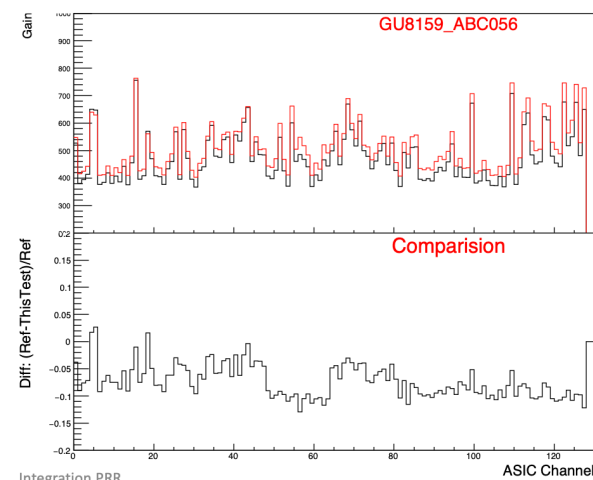
Example of Ped. comparison



Example of Gain comparison



Example of DCR comparison



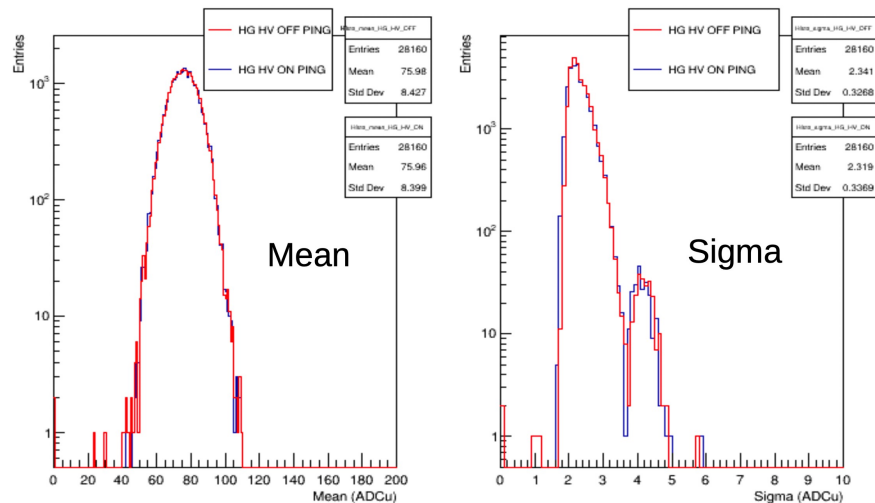


ABC readout front-end board performances from production

See docdb 8946

Reminder 1 P.E. = 0.5 pC
for PMT gain @ 3E6

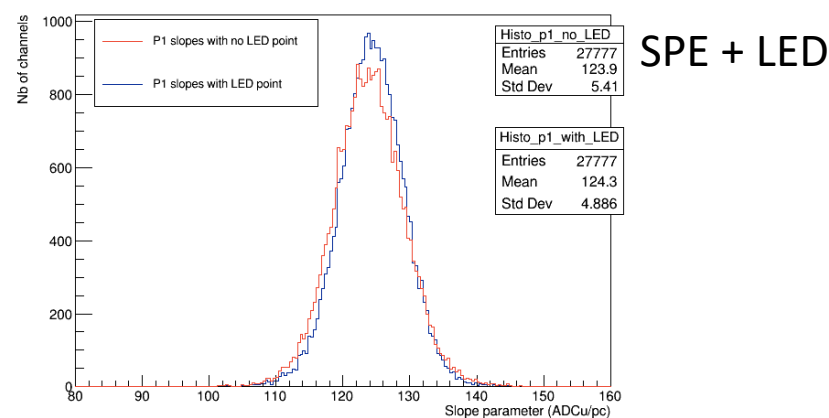
Mean and sigma pedestal distributions



- Low noise achieved
~4% PE / <1% PMT resolution

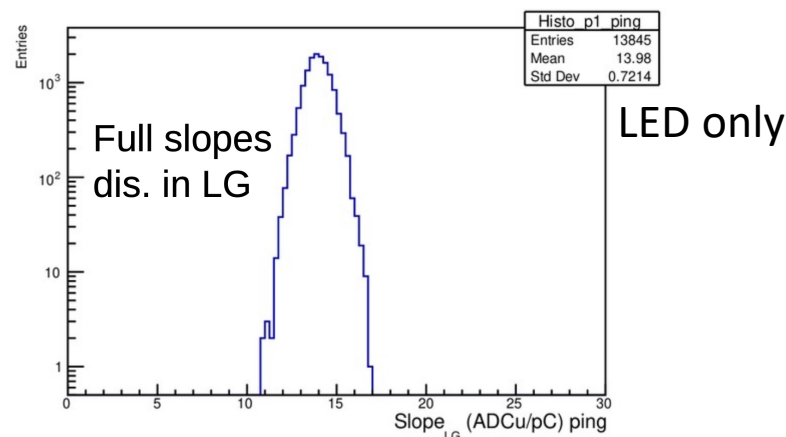
➤ Front-End boards parameters delivered for integration

Calibration parameters in High Gain

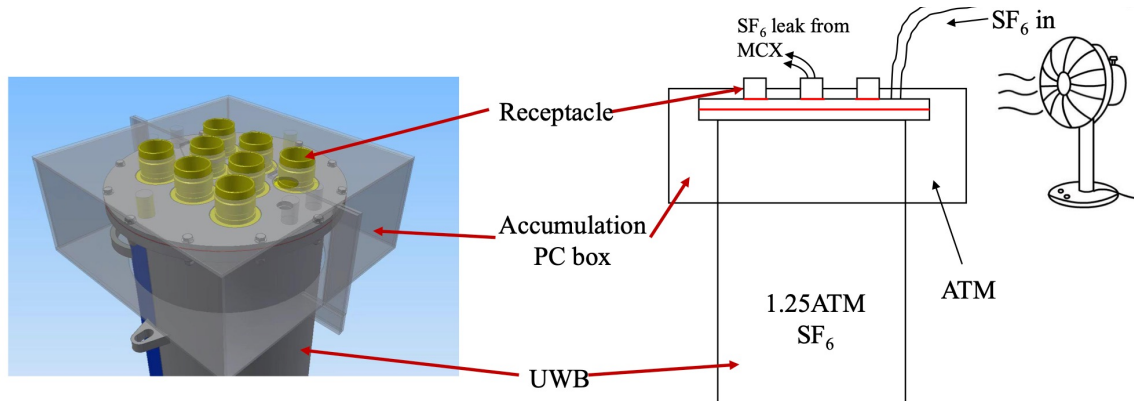


- High Gain range [1/3 - 10] PE @Gain 20

Calibration slope in Low Gain



- Low Gain range [10 - 150] PE @Gain 20



Leakage test method

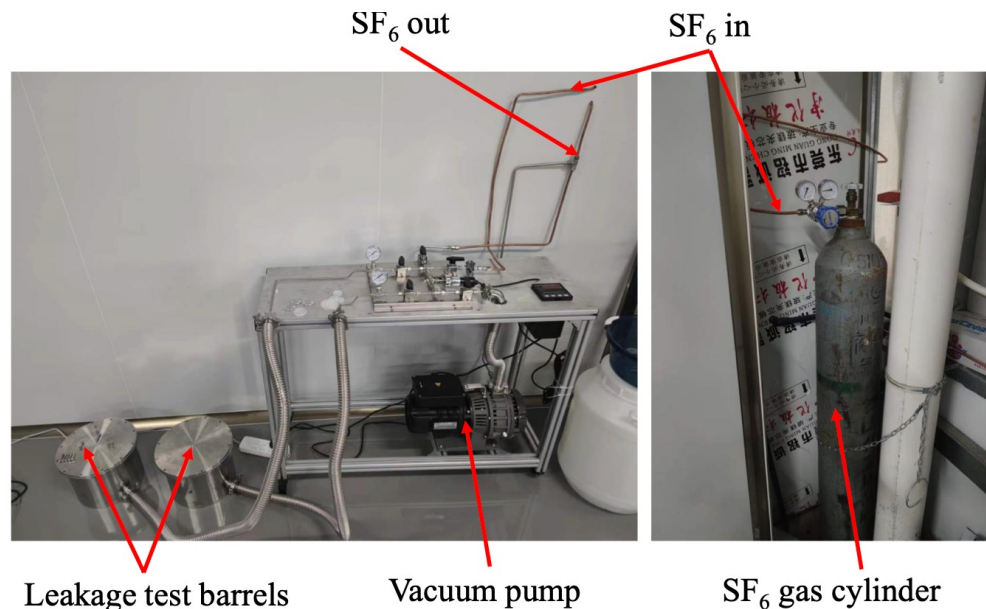
- Detect SF_6 leak and accumulated in the PC box.
- Test flanges between UWB lid and receptacles, flange between UWB lid and body
- Exclude SF_6 leak from the MCX connectors.

Processes

- Pump UWB to vacuum.
- Inject SF_6 to 1.25 ATM
- Set for ~ 8 hours.
- Detect SF_6 in PC box.

Sensitivity

- Volume of PC box : 11375ml
- Sensitivity of SF_6 detector : 0.01PPM
- Accumulation time : ~ 8 hours
- Leak rate of PC box : half SF_6 in 8 hours
- Sensitivity of total leak rate : $\sim 10^{-9} \text{ Pa} \cdot \text{m}^3/\text{s}$



Leakage test barrels

Vacuum pump

SF_6 gas cylinder

PRR passed on Oct. 18th

from then ...

- Better management of the deviations
 - Github issues ticket system
 - Remote experts reactivity
- More tests and verifications
 - More dimensions verifications during assembly
 - More intermediate tests to guaranty the quality of each integration step
 - Soon, implementation of long (hours or days) functional tests



Joint SPMT and LPMT installation will start very soon

