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MATHEMATISCH-
NATURWISSENSCHAFTLICHE FAKULTÄT
Kepler Center for Astro and Particle Physics

Commissioning Report and Status Update of the PMT Mass Testing Container System

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presented by

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together with
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Abstract

- Very short reminder about the system and milestones from the last few months
- Commissioning report (June 1st – July 14th, 2017)
- Status of the container system now and some first preliminary results
- Status update of the 2nd/other container system(s)

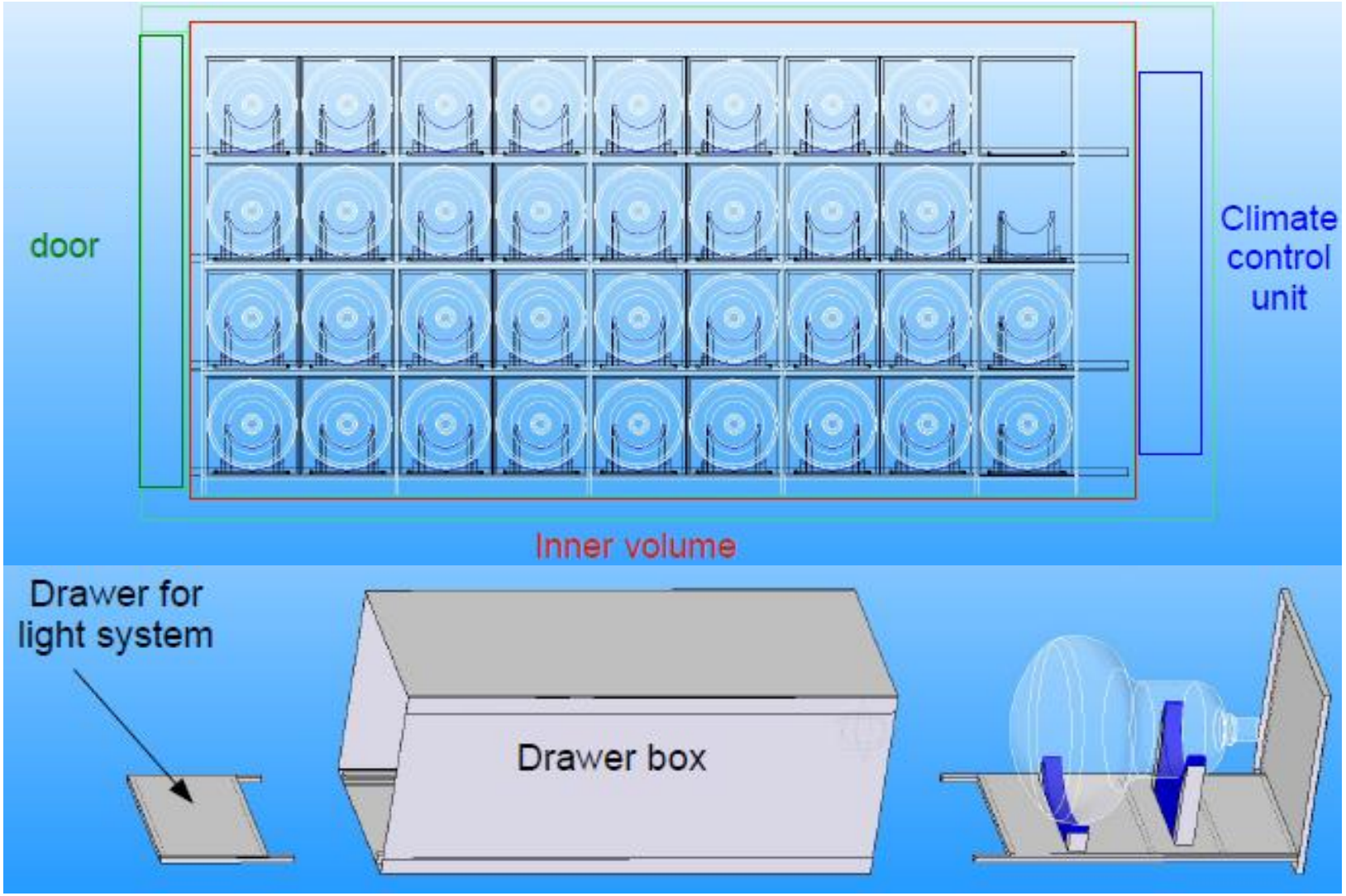
Short Reminder about the System and Milestones from the last Months

Parameters of 20“-PMT to test

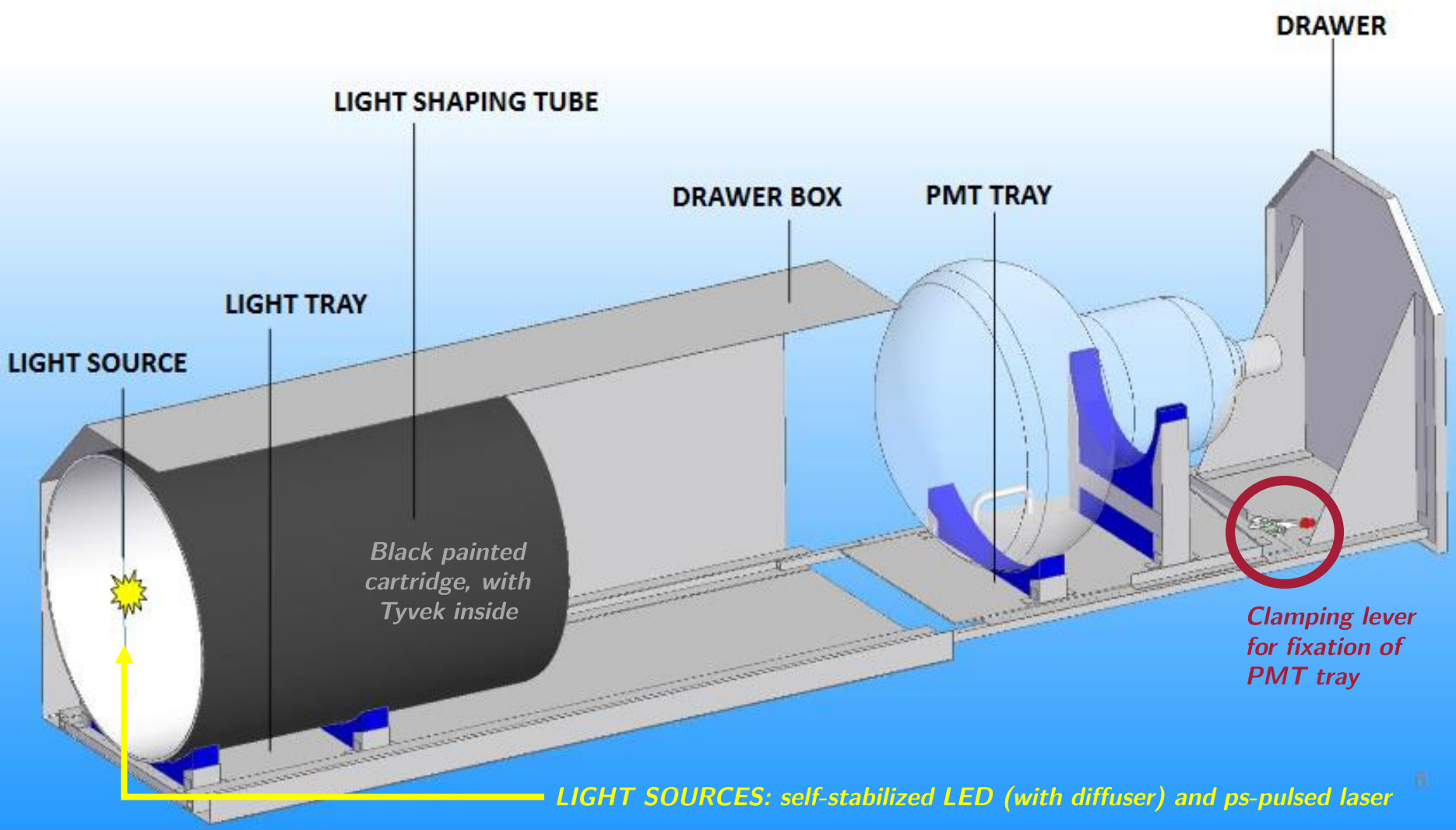
✓	**Detection efficiency @ 420nm**	**(av. 27%, > 24%)**
✓	**TTS of Single Photon Events**	**(< 12 ns)**
✓	**Rise time / fall time**	**(< 8 ns / < 16 ns)**
✓	**HV applied to reach gain of 10^7**	
✓	**Dark Rate**	**(< 50 kHz)**
✓	**P/V ratio**	**(> 2.5)**
✓	**Pre- and after-pulse ratio**	**(< 5% / < 10%)**

- Reliable measurement of ~20000 20” PMTs within comparable and stable conditions
- Acceptance tests for crucial parameters with naked PMTs right after delivery
- Later maybe again full test of all PMTs after potting (depending on electronics scheme...)

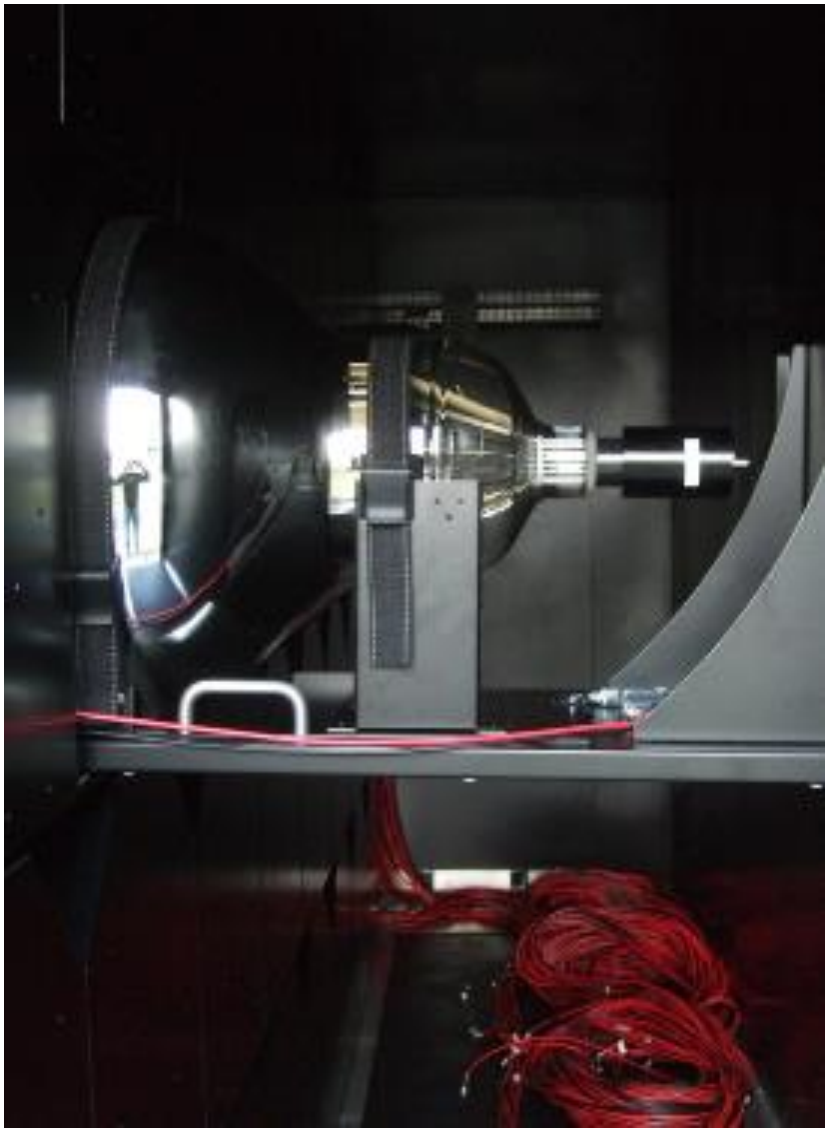
Design of the Mass Testing Container System



Design of the Mass Testing Container System II



Design of the Mass Testing Container System III


Milestones

- Sent by ship on ***March 24th*** (delay of ca. 2 months w.r.t. original schedule)
  - → no climate control during shipment, but enough drying agent inside
  - → humidity max. 70% during shipment, max. acceleration of ~15G (!) recorded
- Container arrived Huangpu Port in China on ***May 19th***
- Started commissioning on ***June 1st***
- Had two on-site workshops in June
- Finished mechanical commissioning on ***June 27th***
- Data taking in "expert mode" (selected measurements) started on ***July 1st***
- In-depth testing and calibration phase of electronics and DAQ from mid July to now

Commissioning Report

Overview of commissioning

- On-site commissioning started on June 1st, first simple functionality tests of electronics all successful, only some minor damages found and quickly repaired

Overview of commissioning II (mechanics)

- Removed all drawers and light slides from inside for ongoing work, realigned light shaping tubes (disturbed by transportation)
- Planed re-routing of the LED cabling finished after 1.5 weeks due to some noise problems
  - → invested ~ 1 week of very hard work in reducing the noise level
  - → successfully controlled all 36 LEDs in parallel for the first time



Overview of commissioning III (mechanics)

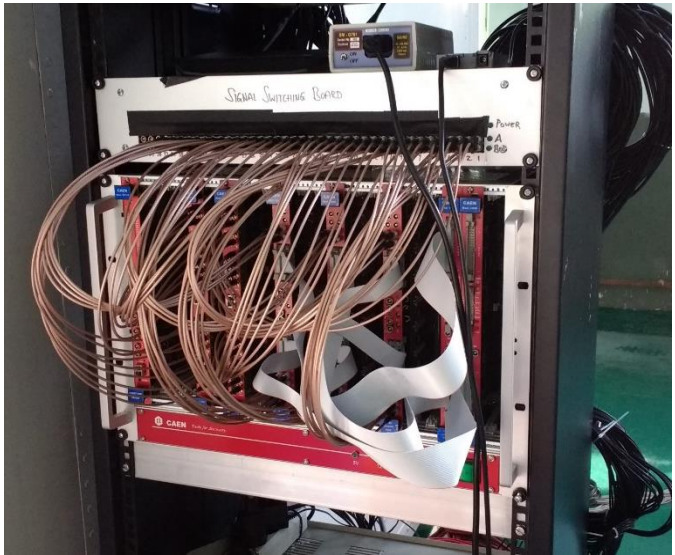
- Installed fiber splitter system into container in 3rd week of commissioning (last missing part)
- Checked container system a lot for light tightness and tried to remove sources of residual light inside the container
- Re-installed all mechanical parts, fixation of all cables, closed cable feed through

Mechanical installation fully completed since June 27th!




Overview of commissioning IV (electronics)

- Start commissioning of electronics and DAQ on **June, 18th**
- Climate remote control unit and temperature monitoring system running properly
- Connection to server farm established
- Removed several different sources of noise (removed some ground loops, using clean ground for all read-out electronics now, external "quiet" power supply for LED controller, ...)



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- Connection to server farm established
- Removed several different sources of noise (removed some ground loops, using clean ground for all read-out electronics now, external "quiet" power supply for LED controller, ...)
- Successful test of all channels (HV, data cables, LEDs, fibers)
- Only a few MCX cables left for trigger recording (small change in plan)

Electrical installation fully completed since July 14th!

Overview of commissioning V (DAQ)

- Some sub-parts of DAQ showed up to still have some bugs (some minor, but also some larger ones: after-pulse, dark noise and TTS measurement)
- Also found some unexpected problems, like larger ADC jitter than needed for good TTS measurement (invisible in our lab tests, because of comparable LED jitter → missed problems with ADC in our tests...)
- Full measurement sequence was never concludingly tested before
  - → it took a lot of time for debugging with real system
  - → data taking is buggy but was possible in principle (in **EXPERT MODE** at the moment)
  - → important to make everything convenient for shifters!
- Started with calibration phase in expert mode, while working on DAQ from remote (fixing all open issues, improve flexibility for calibration, add some new ideas...)

Final DAQ version was not ready on July 14th,
but now in final testing and maintenance phase!

Problems during commissioning

- Tried to reduce **residual light inside the container** as much as possible, but still observed a slightly increased dark count (~10 kHz w.r.t. values given by vendor, depending on illumination)

  → light leaks in the container are excluded as source by several tests

  → found, that glue to fix Tyvek inside of the light shaping tubes is the source

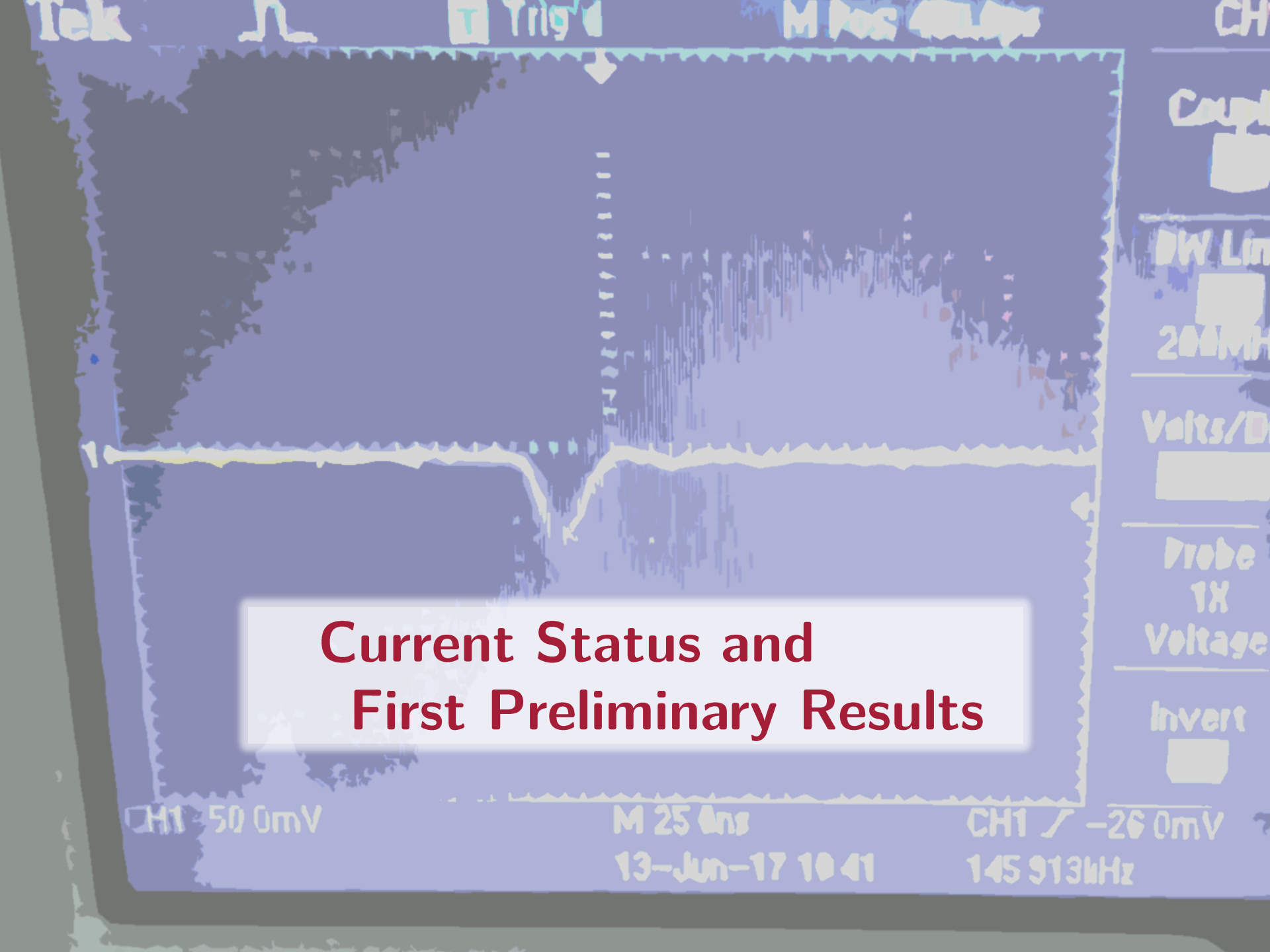
  → **not removable source of a weak and homogeneous background light source**

  → **try to measure excess with reference PMT in each box as offset ("residual light field calibration")**

  → **avoid same problem for 2nd container by using staples instead of glue fot Tyvek fixation**

Problems during commissioning II

- Magnetic field measurement inside showed a field strength of ~ 10 % of EMF (some few boxes exceed the 10% level, up to 12 % of EMF).
  - → **Measurement from Hamburg showed an average of ~ 6%!** Container is slightly magnetized, most likely from stress during transportation
  - → Plan to demagnetize container (at least hot spots) to reduce residual magnetic field inside **(not done/finished yet)**
- **Delay in schedule** due to some unexpected problems (custom troubles, problems with light tightness, increased noise level,...)
  - → Main impact was on automated DAQ, couldn't finish this before we had to leave
  - → Try to fix all these things remotely, accompanied by some additional lab tests in Tübingen
  - → **Major problem: Very bad remote connection from Germany to China (very time consuming, almost unfeasible)**
  - → **A lot of hard work here, but now almost finished**



Current Status and First Preliminary Results

Current Status and Tasks

- Since working in expert mode is possible, ***calibration*** of the whole container system started
- ***Test all DAQ parts in depth*** to better understand interplay between electronics and DAQ, and look for errors and unknown bugs
- ***Work on*** the last sub-parts of ***DAQ*** are on the way to get finished (including some demands and ideas from onsite)
- ***Data taking with new PMTs*** to learn more about the PMT behavior, compare results from container with scanning station results
- Some maintenance on software left for ***shifter convenience*** (improve user interface, file naming convention, adjust LOG summary outputs...)
- Re-adjustment of some cables on the electronics due to changes in DAQ sequence
- Prepare ***shifter manual*** (for both regular and expert shifters)

Current Status and Tasks

- Since working in expert mode is possible, calibration of the whole container system started — ongoing work
- Test all DAQ parts in depth to better understand interplay between electronics and DAQ, and look for errors and unknown bugs — ongoing work
- Work on the last sub-parts of DAQ are on the way to get finished (including some demands and ideas from onsite) — ongoing work
- Data taking with new PMTs to learn more about the PMT behaviour, compare results from container with scanning station results — ongoing work
- Some maintenance on software left for shifter convenience (improve interface, file naming convention, adjust LOG summary outputs) — very soon
- Re-adjustment of some cables on the electronics due to change sequence — very soon
- Prepare shifter manual (for both regular and expert shifters) — very soon

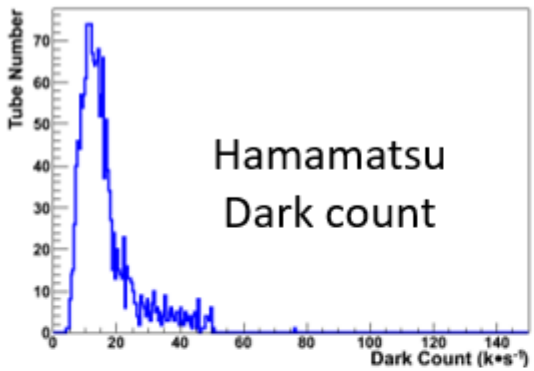
Container Calibration

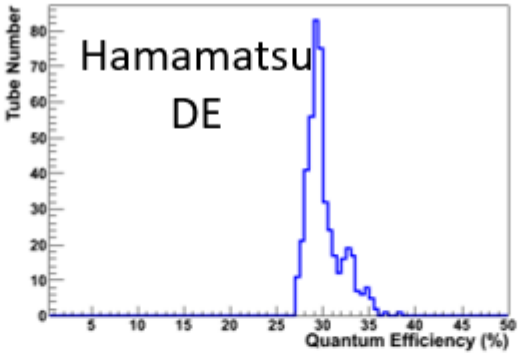
- **Calibration Plan (minimum):**
  - ✓ LED-calibration: adjust all LED setpoints with reference PMT to produce different light intensities (0.1/0.2/0.5/0.7/1.0 p.e.)
  - ✓ Laser-calibration: adjust Laser tuning to produce an average $\sim$ 0.1 p.e. intensity at all fibers
  - ✓ Residual light field calibration: subtract contribution of light shaping shaping tube to "dark" noise rate
- $\sim$ 2/3 of calibration measurements done
- Some more measurements could also be helpful to better understand the system (additional electronics test / "statistical calibration")
  → ***ongoing discussions***

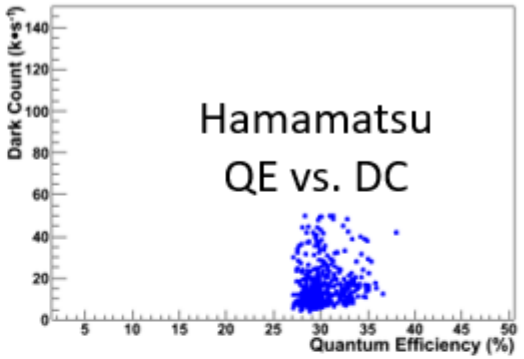
PMT Delivery Status

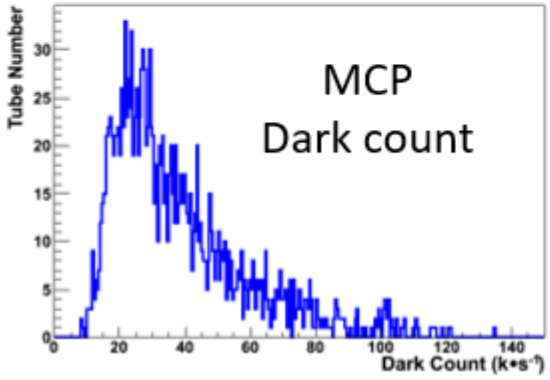
- Totally received PMTs at Pan-Asia warehouse (last week):
  3440 tubes (1760 Hamamatsu tubes, 1680 NNVT MCP tubes)

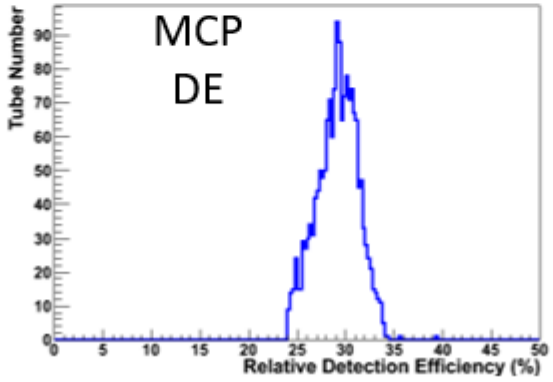
- Vendor data:

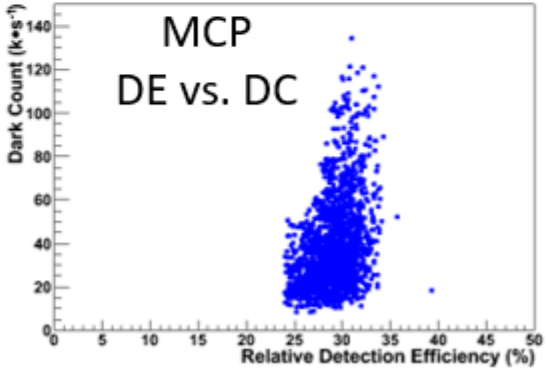








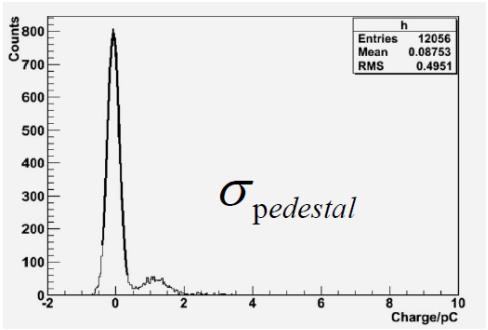


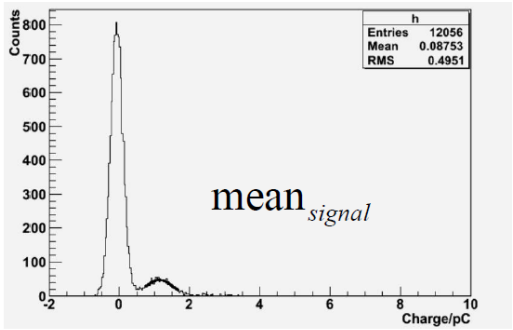


All plots from *Haiqiong Zhang* and *Zhimin Wang* (see talks from weekly PMT Instrumentation Phone Meetings → corresponding DocDB conferences)

Some *PRELIMINARY* Results: S/N

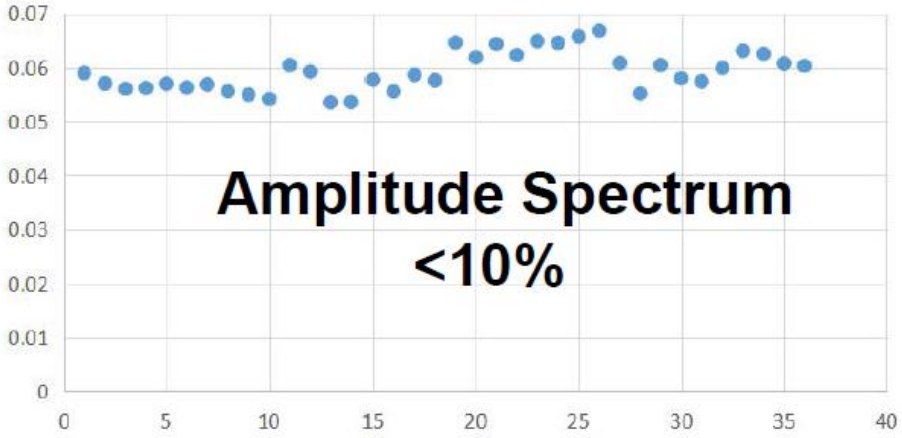
- Signal-to-Noise ratio of container system ***better than 10***



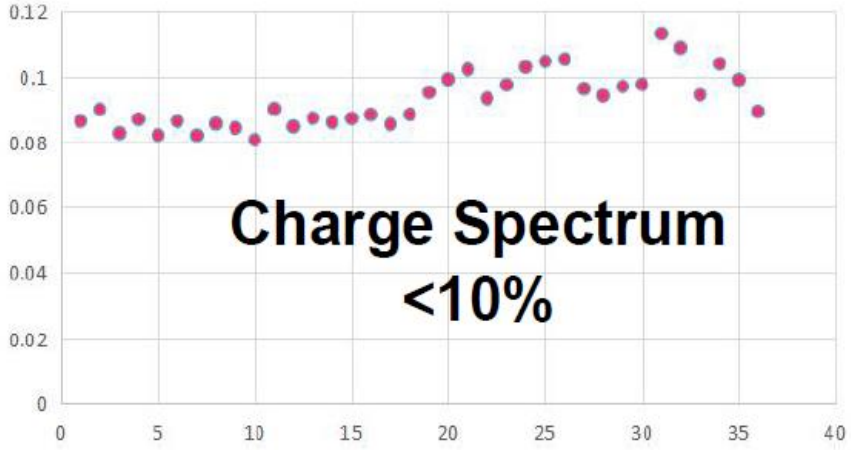


$$S/N = \frac{\sigma_{pedestal}}{mean_{signal}}(HV@1*10E7)$$

S/N



S/N from Charge Spectrum



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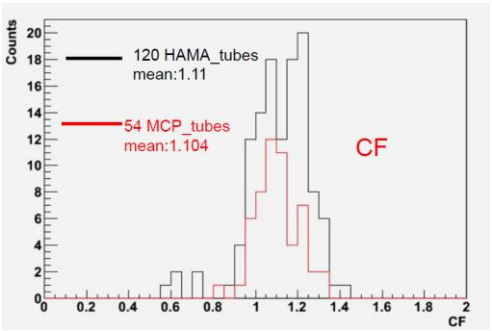
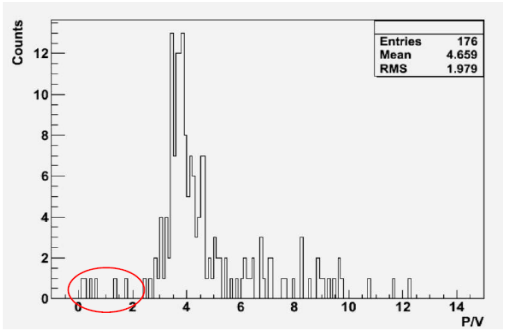
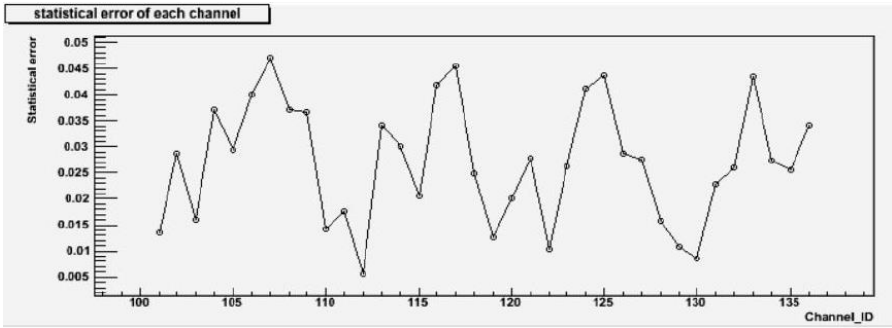
Some *PRELIMINARY* Results II: PDE

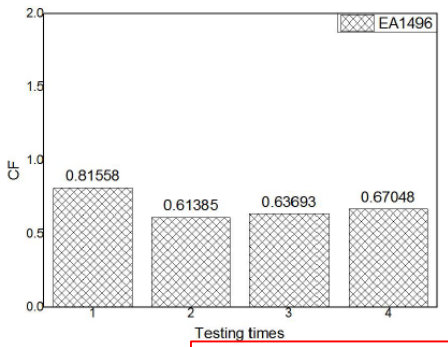
- Conversion factor (CF): factor between PDE of measured PMT to reference PMT (mostly Hamamatsu EA1578)
- P/V and PDE CF values from ~ 170 PMTs measured
- Statistical errors of PDE measurement acceptable for all channels (< 5%)

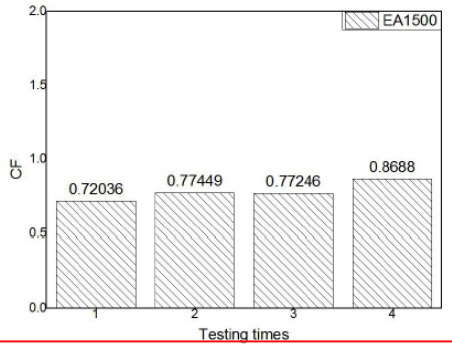


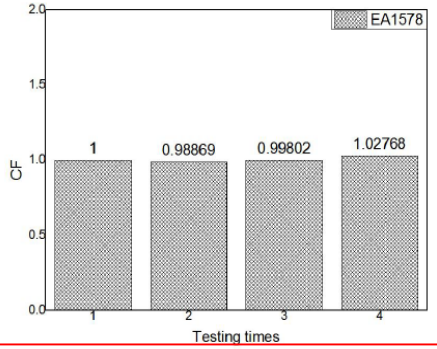


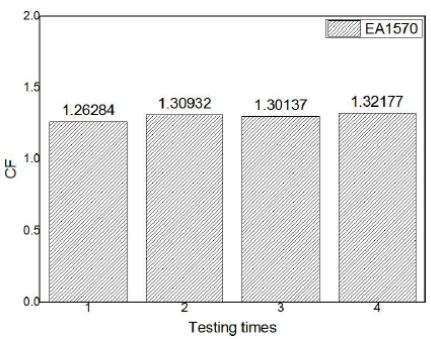


- Stability over time checked for some PMTs





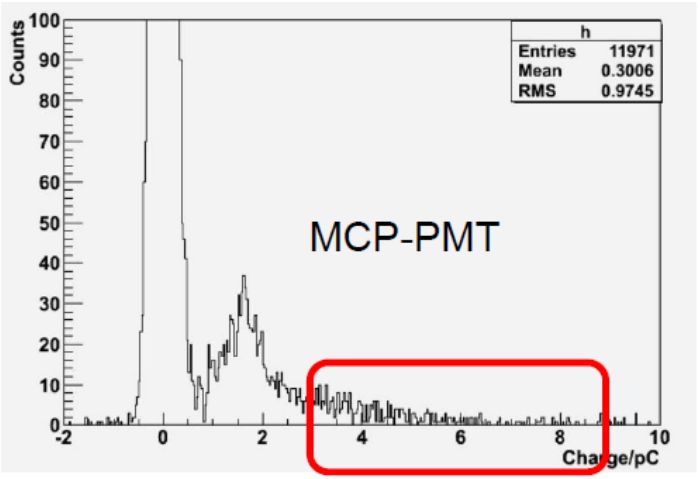


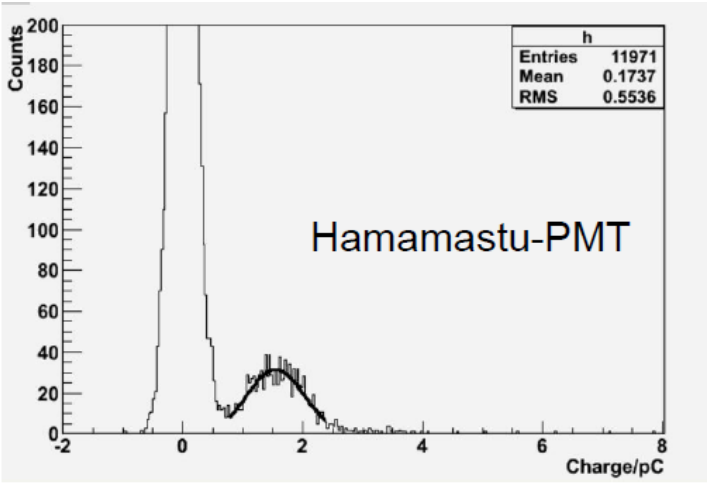


All plots from *Haiqiong Zhang* and *Zhimin Wang* (see talks from weekly PMT Instrumentation Phone Meetings → corresponding DocDB conferences)

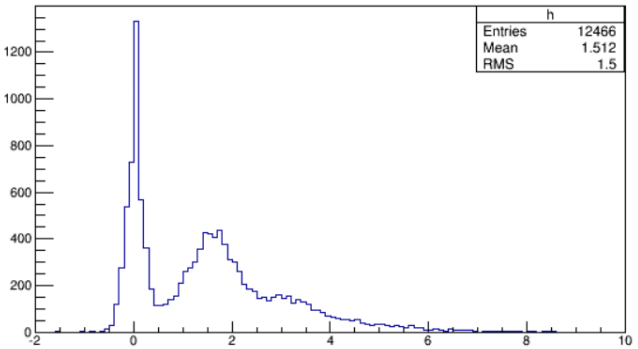
Some *PRELIMINARY* Results III: PMT types

- Observed differences in charge spectra between Hamamatsu PMTs and MCP PTMs (long tail in single p.e. spectrum for MCP PMTs)





For comparison: Hamamatsu charge spectrum with higher light intensity (multi p.e.)



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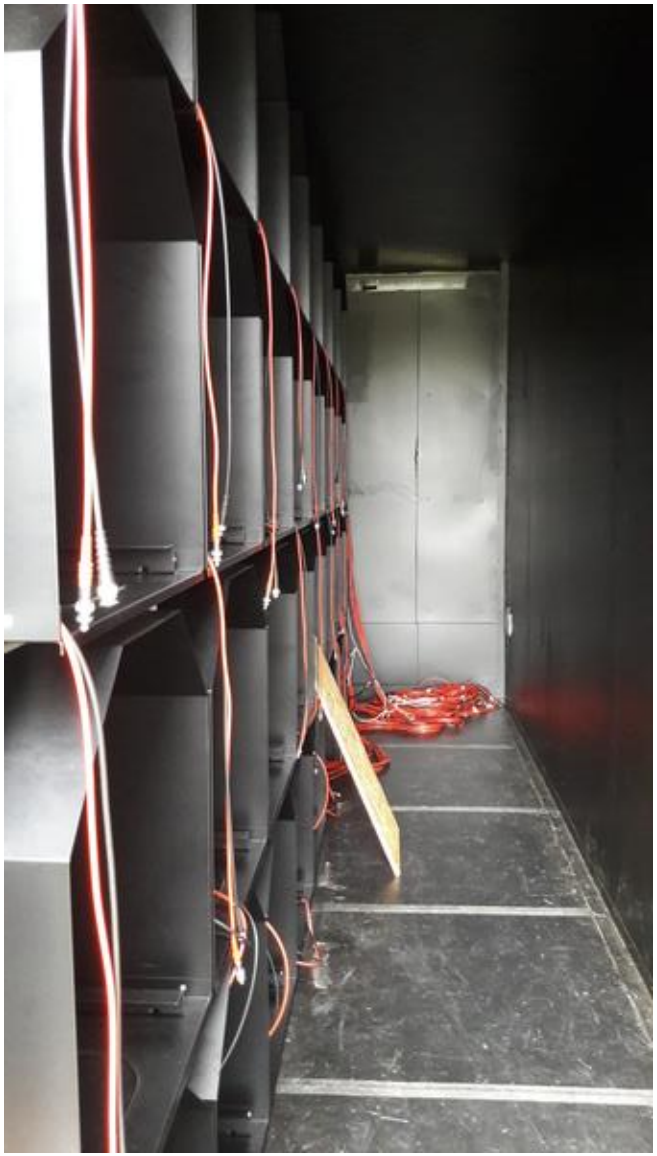
Update on Next Container Systems

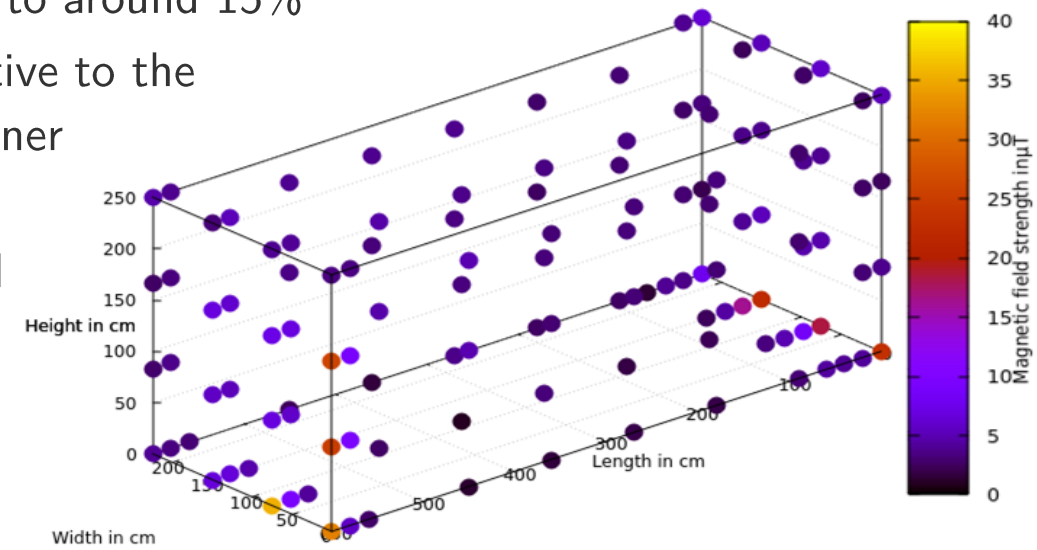
Overview

- Next three container already delivered
- All of them received magnetic shielding
- Already painted black inside and shelf system installed into next container
- HV and signal cables installed



Magnetic shielding

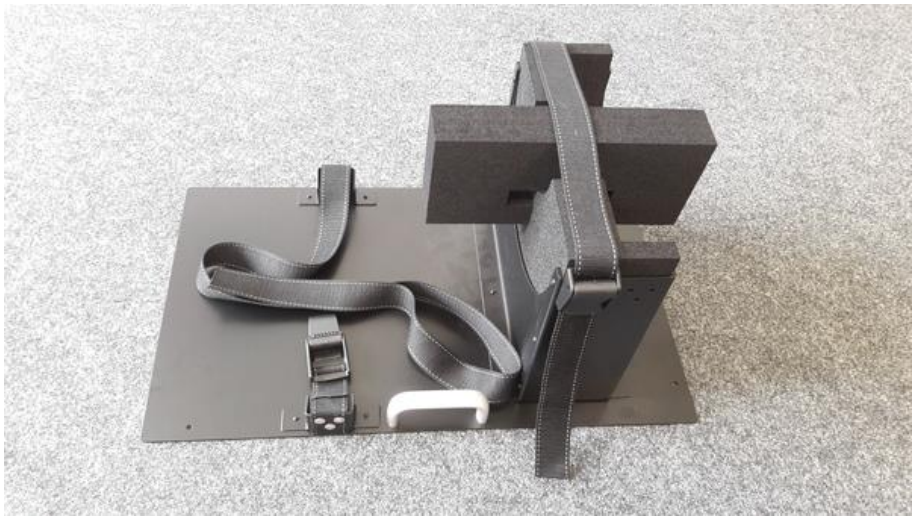
- ***Shielding factor of 2nd container mostly better that 10***
- Weak spots:
  - 2 drawer boxes next to ventilation openings **(expected)**
    → 15 % of EMF in two drawers, got an extra shielding with Finemet
  - Some weakness close to doors **(unexpected)**
    → Shielding factor decreased during transportation from company to DESY from below 10% to around 15%
    → Door seems to be sensitive to the placement of the container
    → Shielded drawers close to doors with additional layers of Finemet

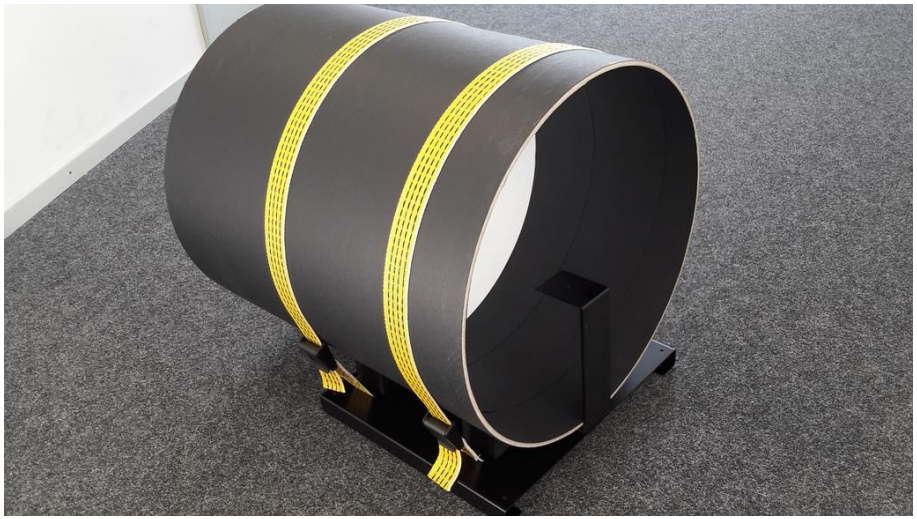


EMF in Hamburg: ca. 48 µT

Acquisition status / other parts of the drawer system

- Mechanical parts:
  - All crucial parts for next container available
  - Also most parts for light system already manufactured
  - 40 new trays and light shaping tubes ready
  - Light shaping tube: Glue used for 1st container to attach Tyvek is emitting a small amount of light **(darkcount rate increased by 5-10 kcts/s)** → **now using staples instead**





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- Electronics and light sources/light system:
  - Stabilized LED already ordered, expect them end of September
  - All read out electronics already delivered to Tübingen
  - Picosecond-Laser delivered to Hamburg last week
  - Parts for laser system (filters, fibers, ...) not ordered yet
  - Cables for electronics and light system ordered, will be delivered soon
- Stronger computer for DAQ under discussion

Summary and Outlook

Summary and Outlook

- Commissioning of first container system: ***June 1st – July 14th***
- Mechanics and electronics:
  - ✓ ***Everything finished and installed, ready for shifting phase***
  - ✓ Only some cabling has to be adjusted
- DAQ:
  - ***Bigger delay*** due to multiple problems. DAQ software in final testing phase now, add some little things (additional LED measurements), some maintenance stuff left
  - DAQ runs in expert mode for more calibration and test measurements, but not completely finished yet
- Calibration and Data Taking:
  - ✓ ***Some measurements and many calibration runs already finished***
  - ✓ Analysis guys already started to work with data

    → on-going work and discussions to improve the system

Summary and Outlook II

- Remaining issues:
  - ***DAQ!***
    - → has to be convenient for "normal" shifters at the end
    - → on-going work, but very time-consuming
    - → very difficult to give a reliable schedule (2 weeks?)
  - Finish calibration of whole system!
  - ***Finalize shifter manual*** ASAP

- Other container systems:
  - ✓ ***most parts already delivered***
  - ✓ ***installation and preparation of 2nd container is advanced***

    → everything well in schedule (shipment of 2nd container hopefully on end of October 2017)

For more information....

...see also DocDB (talks from on-site workshops, documentation of container loading procedure, notes with suggestions on data naming convention and calibration...)

→ keyword **PMT test**

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DFG Deutsche Forschungsgemeinschaft

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Thank you.

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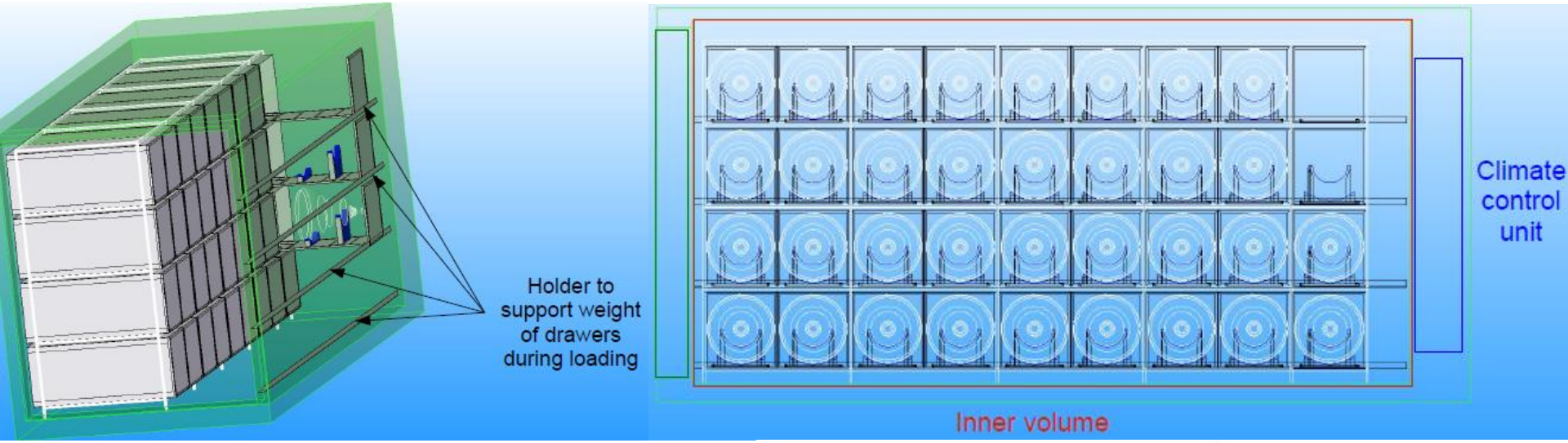
JUNO

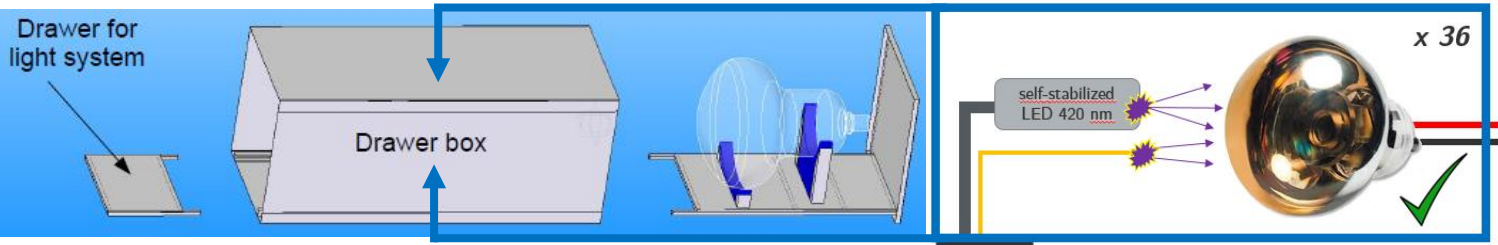
Backup

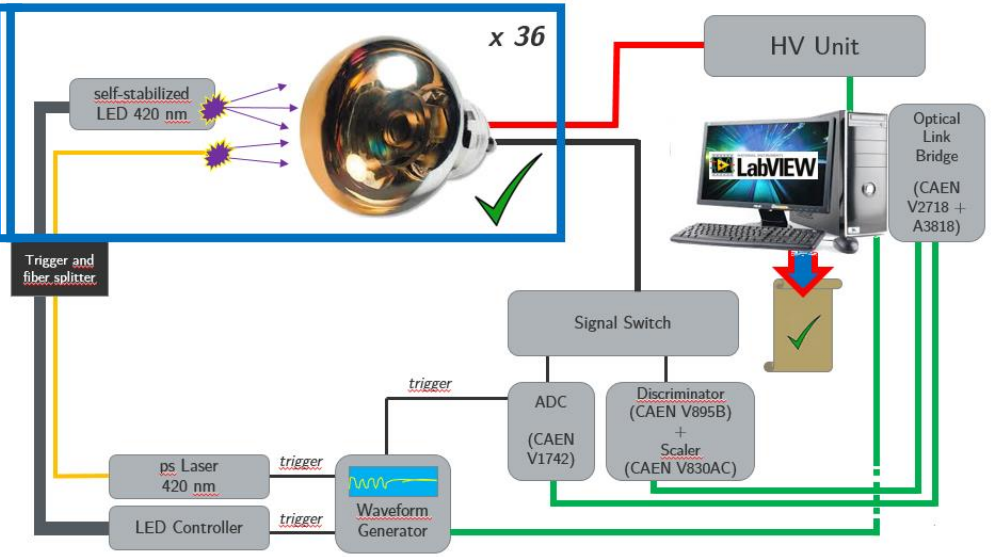
Reminder: PMT Mass Testing Container System

- Set up a mass testing facility to ***test and characterize all ~ 20'000 20-inch PMTs*** before mounting them into the JUNO detector
- Create ***stable and comparable testing conditions*** and environment, using commercial shipping containers with special shielding and climate control unit
- Check ***crucial parameters*** like PDE, dark rate, HV/gain, TTS, rise/fall time, pre-/afterpulse rate for every single PMT
- (sampled photo cathode uniformity tests with Dubna's scanning station)
- (one test of bare PMTs and one test with potted PMTs and standard JUNO electronics)
- Set up 4 identical container systems to test ***up to 140 PMTs in parallel***

Reminder II: PMT Mass Testing Container System





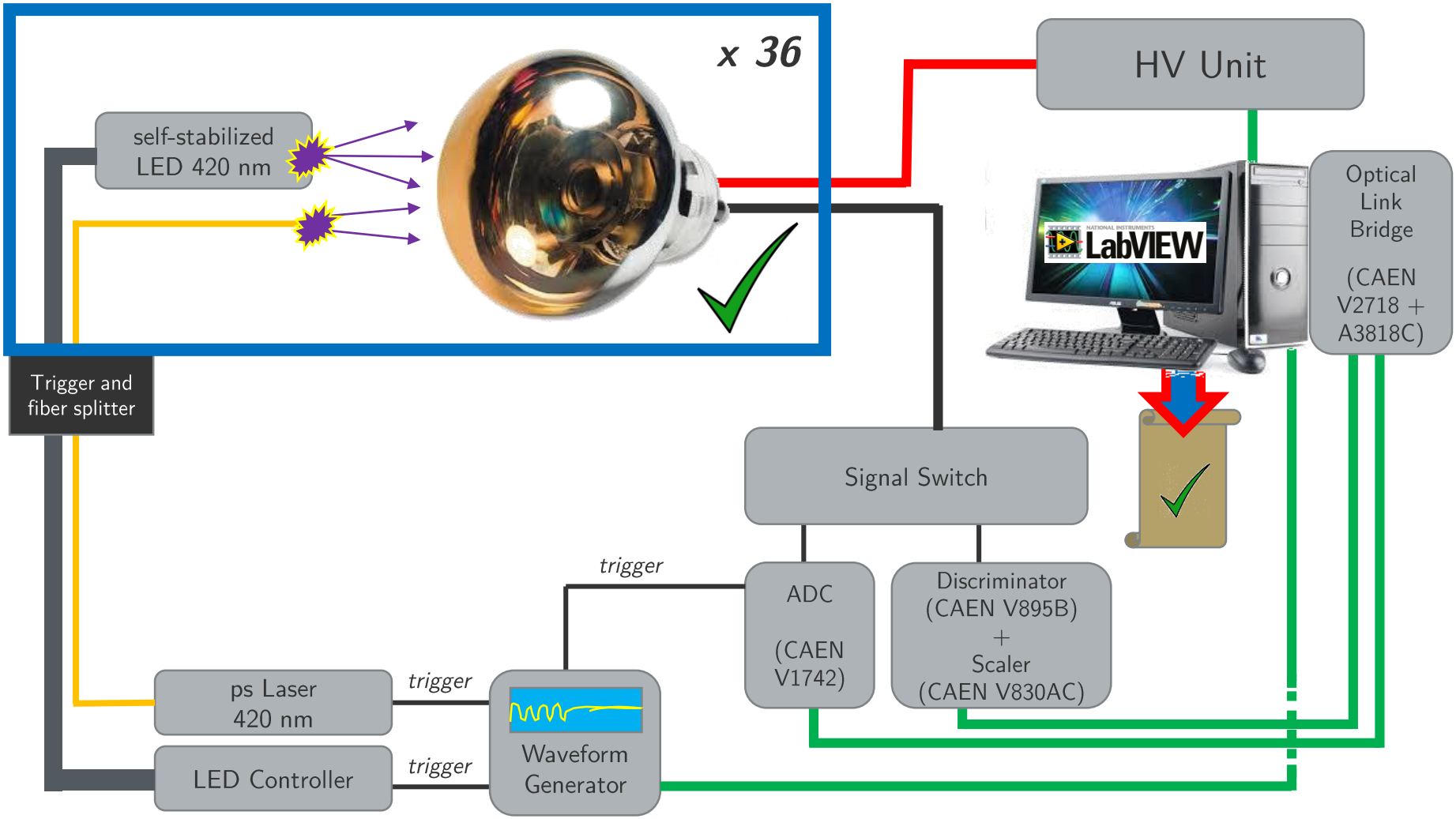


PMT mass testing system for up to 36 PMTs/container load, with automated electronics read out DAQ

Some purposes of the system

- Full characterization of 36 PMTs in parallel (32 "new" + 4 reference PMTs) per container run
- Measurement of PMT at magnetic field reduced to 10% of EMF
- Climate controllable, and so stable environment
- Determine HV for 10^7 gain, dark count rate, PE spectrum, TTS, pre- and afterpulse rate
- Automated data taking, saving all the data on a server system
- PMT testing shifts done by collaboration

Schematic overview: Electronics, DAQ and Analysis



Mass Testing Site

- 1st container ***finished and arrived*** to JUNO site (commissioning and testing area in a Pan-Asia storage hall in Zhongshan, ~ 1.5h by car from JUNO surface area)

Pan-Asia Warehouse: testing site (ready now) – pictures by Wei Wang from DocDB-2167

Dark Count Test Measurements

Cooled PMT faced to different materials, placed on container alley and covered with curtain (EA1581, $DCR_{exp} = 8.4$ kHz (value by Hamamatsu)); remaining difference most likely caused by increased air temperature and lower threshold).

- **without anything:** **14.4 kHz**
- **with piece of pure Tyvek:** **15.7 kHz**
- **Tyvek with glue on backside:** **19.7 kHz**
- **without anything again:** **13.8 kHz**
- **with piece of pure Tyvek again (now illuminated before):** **16.6 kHz**
- **Tyvek with glue on backside again (also illuminated before):** **21.5 kHz**
- **without anything again:** **14.0 kHz**
- **covered with aluminum (reflecting):** **14.7 kHz**
- **Tyvek with glue on front side:** **43.4 kHz**
- **last test without anything again:** **14.5 kHz**

→ **No significant increase by pure Tyvek**
→ **"Small" increase by Tyvek with glue on backside**
→ **Huge increase when glue is pointed directly to PMT**
→ **No glowing from PMT inside observed**

Dark Count Excess Measurements

Dark count excess measurements with 36 Hamamatsu-PMTs (uncharacterized before). Values in table show the excess w.r.t. the expected dark count rate (values given by vendor)

[kHz]	1	2	3	4	5	6	7	8	9
A	+1.8	+19.6	+12.7	+3.9	+11.5	+6.9	+9.2	+14.2	+15.6
B	+11.6	+13.4	+8.8	+7.7	+11.6	+10.5	+10.7	+14.9	+2.9
C	+2.0	+8.8	+8.9	+15.3	+9.9	+8.1	+9.4	+16.7	+6.1
D	+8.3	+5.5	+8.9	+6.7	+7.7	+5.2	+7.1	+5.2	+7.4

excess in dark rate: +(9.3±4.2) kHz

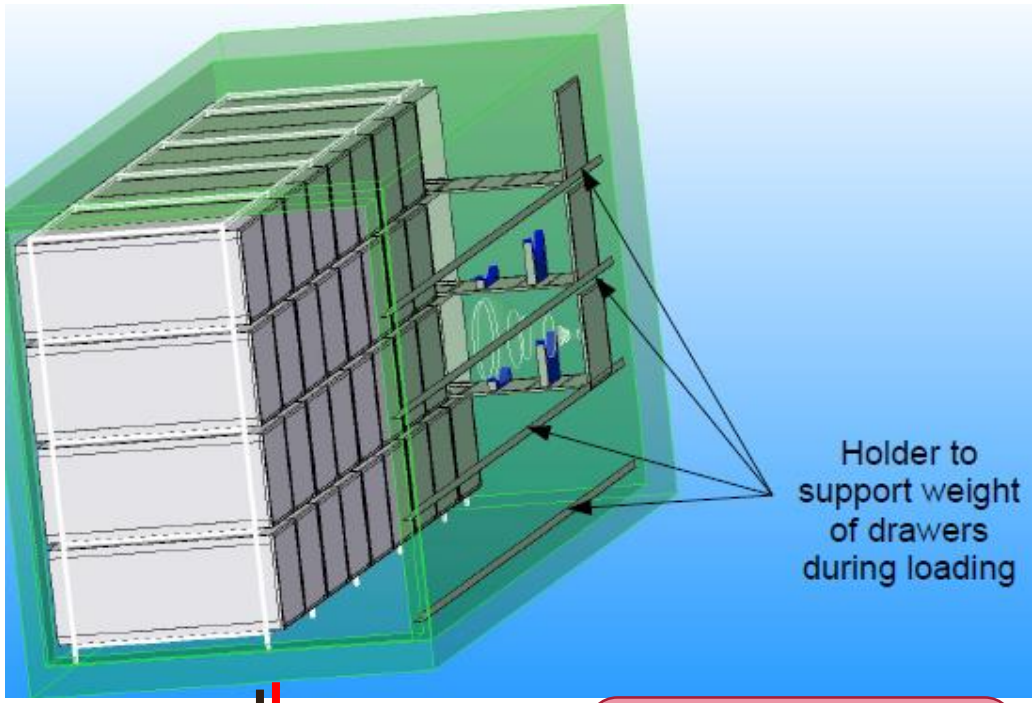
After changing the PMT positions:

[kHz]	1	2	3	4	5	6	7	8	9
A	+4.0	+25.0	+13.2	+7.1	+14.0	+13.7	+11.6	+18.0	+17.6
B	+12.2	+4.9	+9.3	+10.9	+14.1	+10.3	+10.5	+17.0	+4.9
C	+1.6	+10.3	+9.3	+16.4	+9.2	+9.5	+11.0	+17.5	+7.9
D	+9.5	+5.5	+9.3	+5.7	+8.7	+6.7	+8.1	+7.8	+8.1

difference to above: +(1.3±2.3) kHz

About the container DAQ: Main idea

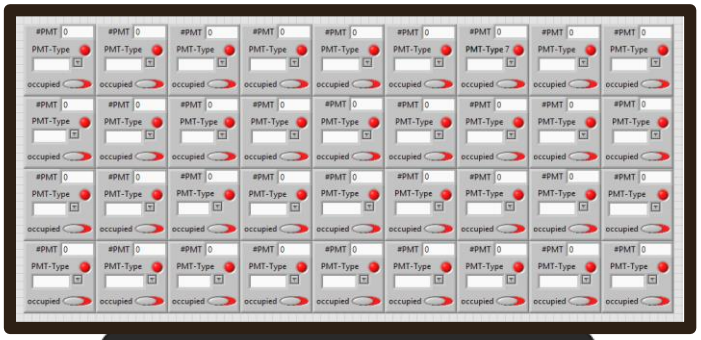
- ✓ Automated data taking by DAQ (shifter should just press the „**START**“ button)
- ✓ Every electronics unit should be controllable by PC
- ✓ Set up a LabView program with easy user interface for shifters



commercial electronics

remote control on electronics via PC

Setup of DAQ



DAQ („black box“)

Raw data

PMT input information (type, ID, drawer, supply voltage, ...)

Parameter config file

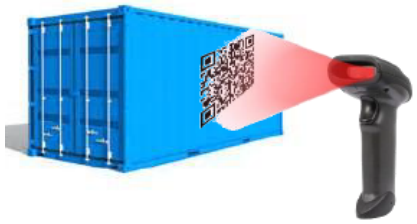
check

Log summary file about container run (short test: OK?)

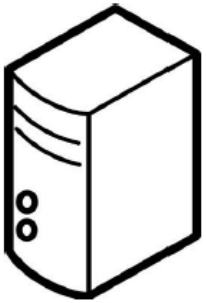
?

save

QR code



save

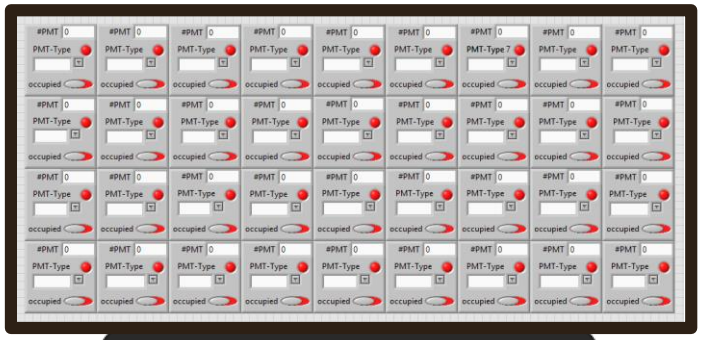


Server station

later

Data analysis

Setup of DAQ



input-file_for_DAQ - Editor

Datei Bearbeiten Format Ansicht ?

```
Example for a DAQ input file for 1 container load:

## ------------------------------------------------------
## PMTid        HAM(0)/MCP(1)   V_prod          Box
013577          1               1620            B1 / 09
013578          1               1630            B2 / 10
013579          1               1650            B3 / 11
013580          1               1620            B4 / 12
013581          1               1710            B5 / 13
316262          0               1920            C8 / 25
316263          0               1870            C9 / 26
```

Has to be generated automatically or by hand from shifter

DAQ („black box“)

Raw data

?

PMT input information (type, ID, drawer, supply voltage, ...)

Parameter config file

Fixed!

check

Log summary file about container run (short test: OK?)

save

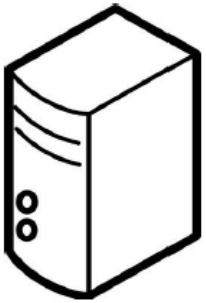
QR code

save

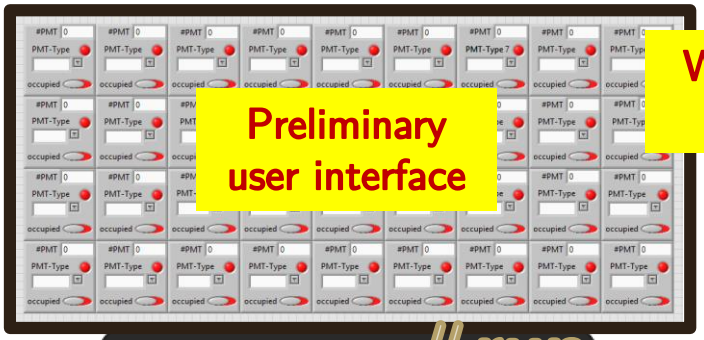
Data analysis

later

Server station



Setup of DAQ



Preliminary user interface

Will give advises to shifter if needed

#run

DAQ („black box“)

Raw data

?

save

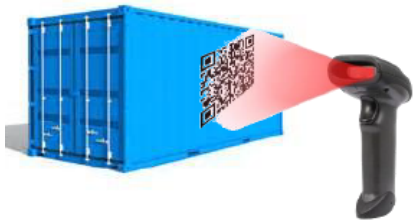
PMT input information (type, ID, drawer, supply voltage, ...)

Parameter config file

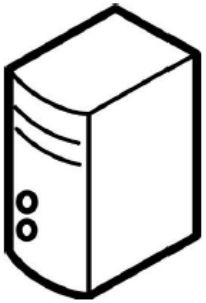
check

Log summary file about container run (short test: OK?)

QR code



save

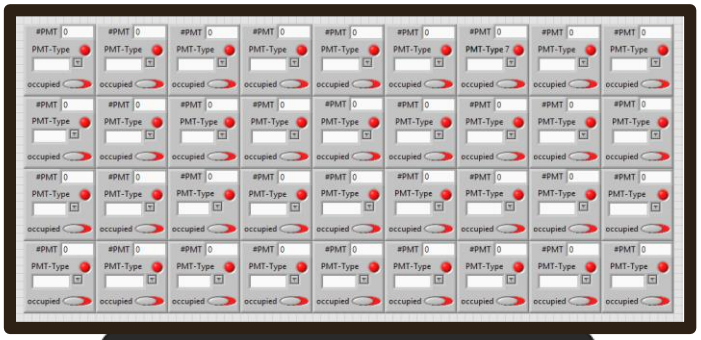


Server station

Data analysis

later

Setup of DAQ



DAQ („black box“)

Saved locally as binary files (a few ASCII coded)

Raw data

PMT input information (type, ID, drawer, supply voltage, ...)

Parameter config file

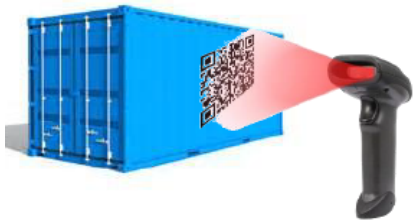
check

Log summary file about container run (short test: OK?)

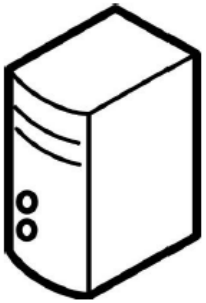
?

save

QR code



save

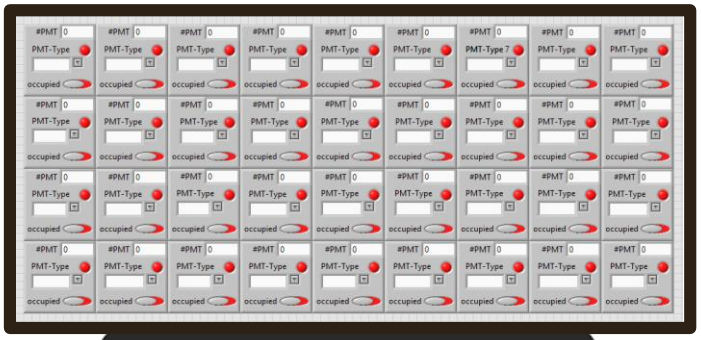


Server station

later

Data analysis

Setup of DAQ



DAQ („black box“)

Raw data

?

PMT input information (type, ID, drawer, supply voltage, ...)

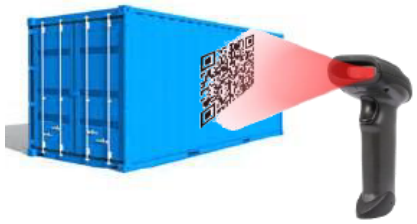
Parameter config file

check

Log summary file about container run (short test: OK?)

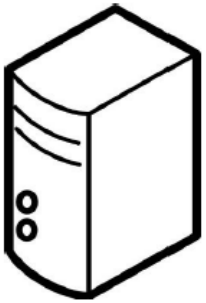
save

QR code



First short data check and transfer to server by shifter

save

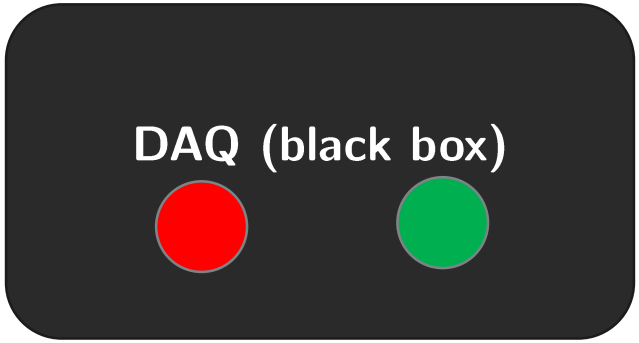


Data analysis

later

Server station

Design goal of the „black box“



- ***DATA TAKING***
  - Easy to handle input and output files
  - Only a few infos needed as input
- ***SOFTWARE***
  - DAQ should be as easy as possible to control (start/stop)
  - Should be capable to handle with some errors (by its own, as far as possible)
- ***SHIFTERS***
  - Shifters need clear instructions how to handle DAQ (especially when errors occur – some kind of „emergency procedure“ at least for shift-experts)
  - Shifters should be capable to check whether measurement cycle has run completely (simple completion checks, check log summary file, check data for consistency...)

DAQ Measurement Sequence

Step 1. Connection tests.
- ✓ Base plugged on? (apply 100 V, look for current)
- ✓ HV working? (try to apply input voltage)
- ✓ Data cable plugged? (look for some counts)

→ If one test fails: **BREAK!** (last time!!)

Step 2. Cool down phase.
- ✓ Wait for several hours
- ✓ Dark noise tests: PMT cool now? ("dark count threshold")

→ Continue, when all PMTs cool or **after 12 h** (max. cooling time)

Step 3. HV/gain determination
- ✓ Take data @ $[V_0, V_0 \pm \Delta V, V_0 \pm 2\Delta V, V_0 \pm 3\Delta V]$
- ✓ Do some simple fits of spectrum to determine gain @ HV
- ✓ Fit gains to find correct HV

→ Apply correct voltage

Step 4. Final **dark count** measurement @ correct HV (gain $= 10^7$)

DAQ Measurement Sequence II

Step 5. LED measurement
- ✓ Switch LEDs on
- ✓ Record waveform (520 ns) – **most parameters**
- ✓ Different light intensities? ($\sim$ 0.1 p.e. / $\sim$ 1 p.e.)

Step 6. Laser measurements
- ✓ Switch ps-Laser on
- ✓ Record waveform:
  - ➢ (520 ns) – **TTS measurement**
  - ~~➢ *(20 µs = 20 x 1024 ns) – **afterpulse measurement***~~

Step 7. Afterpulse counting
- ✓ Another Laser measurement
- ✓ Just counting pulses in 20 µs window (VETO for initial pulse)

Step 8. Turn off HV, **save all the data** (waveforms as binary, counters as txt-file), stop DAQ, create **LOG-SUMMARY** for shifter.

Data format

- Two types of files with different data format:
  - → *WAVEFORM DATA* (recorded by ADC, 520 ns windows, baseline and waveform, saved as **4 separate**, **big-endian coded binary dat-files**)
  - → *COUNTING DATA* (recorded by Scaler, just int numbers, saved as **ASCII coded txt-files**)
  - → Additional: *LOG-SUMMARIES* for each PMT, saved as **txt-files**

- All measurements connected to waveforms and pulse analysis (HV/gain, p.e. spectrum, rise-/fall-time, TTS) recorded as waveform data; also some raw baseline test data and trigger pulse data files will be recorded in that way

- All measurements connected to rate determinations (afterpulses, dark noise) recorded as counting data

Expected number and size of all data files

- HV/Gain-determination: **36** ch. **x 7** HV settings **x 4** files *(binary)*
- Dark noise measurement: **36** ch. **x 1** file *(ASCII txt-file)*
- LED-measurement: **36** ch. **x 2** light intensities **x 4** files *(binary)*
- Laser-measurement (TTS): **36** ch. **x 2** light intensities **x 4** files *(binary)*
- Afterpulse measurement: **36** ch. **x 2** file *(w/ and w/o light; ASCII txt-file)*
- Additional: **4 x 2** ADCs **x 2** light intensities **x 4** trigger files to substract ADC jitter for TTS determination *(binary)*
- **36** ch. **x 4** file with just noise, to monitor ADC against overvoltage (OV) protection *(binary)*
- **37** additional files: 1 log-summary per PMT for container run, and 1 input-parameter-file ASCII txt-files

---

Saving of all waveform data into **4 separate files** („*part1.dat*“, …, „*part4.dat*“) is for performance reasons. Each file contains a quarter of the total number of acquired waveforms.

OV protection saves ADC from voltage spikes, but cannot be recognized by running DAQ → noise files will be used by shifters as „data quality check files“ (work in progress…).

Expected number and size of all data files II

In total: **1937** files per full container run

1792 raw data binary files (.dat)
145 ASCII-coded txt-files

- Total amount of data per container run: between **100** and **250 GB** (depends on number of data points, number of recorded waveforms and number of measurements – not yet finally decided)
- All files can compressed into a zip-file before transferred to server (*"Run_0050.zip"*)
- Waveform files can also converted into a ROOT tree before transferred to server

Data compression/conversion and transfer to server is duty of the shifter! Scripts for this should be provided (work in progress...)

Suggested naming convention for data files

- Every single file (except the input file, the log-summary and the trigger monitor files) should at least include the PMT ID, the drawer box number (from inside the container: 101...136) and the container run number
- Suggested naming convention:

Example File Name	Explanation
EA0001_101_0050_HV_1800_part1.dat	PMT-ID_BOX_RUN-No_HV-Measurement_appliedVoltage_part
EA0001_101_0050_DNR_1830.txt	PMT-ID_BOX_RUN-No_DarkNoiseRate-Measurement_appliedVoltage
EA0001_101_0050_LED_LOW_part1.dat	PMT-ID_BOX_RUN-No_LED-Measurement_LOW/HIGH-Intensity_part
EA0001_101_0050_LASER-TTS_950_part1.dat	PMT-ID_BOX_RUN-No_Laser/TTS-Measurement_Laser-Tuning_part
EA0001_101_0050_AFP.txt	PMT-ID_BOX_RUN-No_Afterpuls-Measurement
EA0001_101_0050_AFPdark.txt	PMT-ID_BOX_RUN-No_Afterpuls-Measurement-without-light
0050_TTS_Triggerfile_11-18_part1.dat	RUN-No_Recorded-Trigger-for-TTS-ADC1-CH1-8_part
EA0001_101_0050_OVcheckData_part1.dat	PMT-ID_BOX_RUN-No_OvervoltageCheck-Data_part
log-summary_EA0001_101_0050.txt / DAQ-input_0050.txt	LogSummary_PMT-ID_BOX_RUN-No / DAQ-Input_RUN-No

Suggested structure on the server farm

Location of the container testing data on the server farm (currently only calibration and test data saved there):

farm1.pmt.ihep.ac.cn:*/pmtfs/disk01/container_data/*

One folder for each container run (for example run #50).

(1) Uncompressed/unconverted:

container_data/mass_test_data/run0050/EA0001_101_0050_HV_1800_part1.dat
container_data/mass_test_data/run0050/EA0001_101_0050_HV_1800_part2.dat
container_data/mass_test_data/run0050/EA0001_101_0050_HV_1800_part3.dat
container_data/mass_test_data/run0050/EA0001_101_0050_HV_1800_part4.dat
container_data/mass_test_data/run0050/EA0002_102_0050_HV_1740_part1.dat
...

or (2) Compressed into 1 zip-file:

container_data/mass_test_data/run0050/run_0050.zip

or (3) Waveforms converted into ROOT-trees:

container_data/mass_test_data/run0050/EA0001_101_0050_HV_1800.root
container_data/mass_test_data/run0050/EA0002_102_0050_HV_1740.root
container_data/mass_test_data/run0050/EA0004_103_0050_HV_1920.root
...

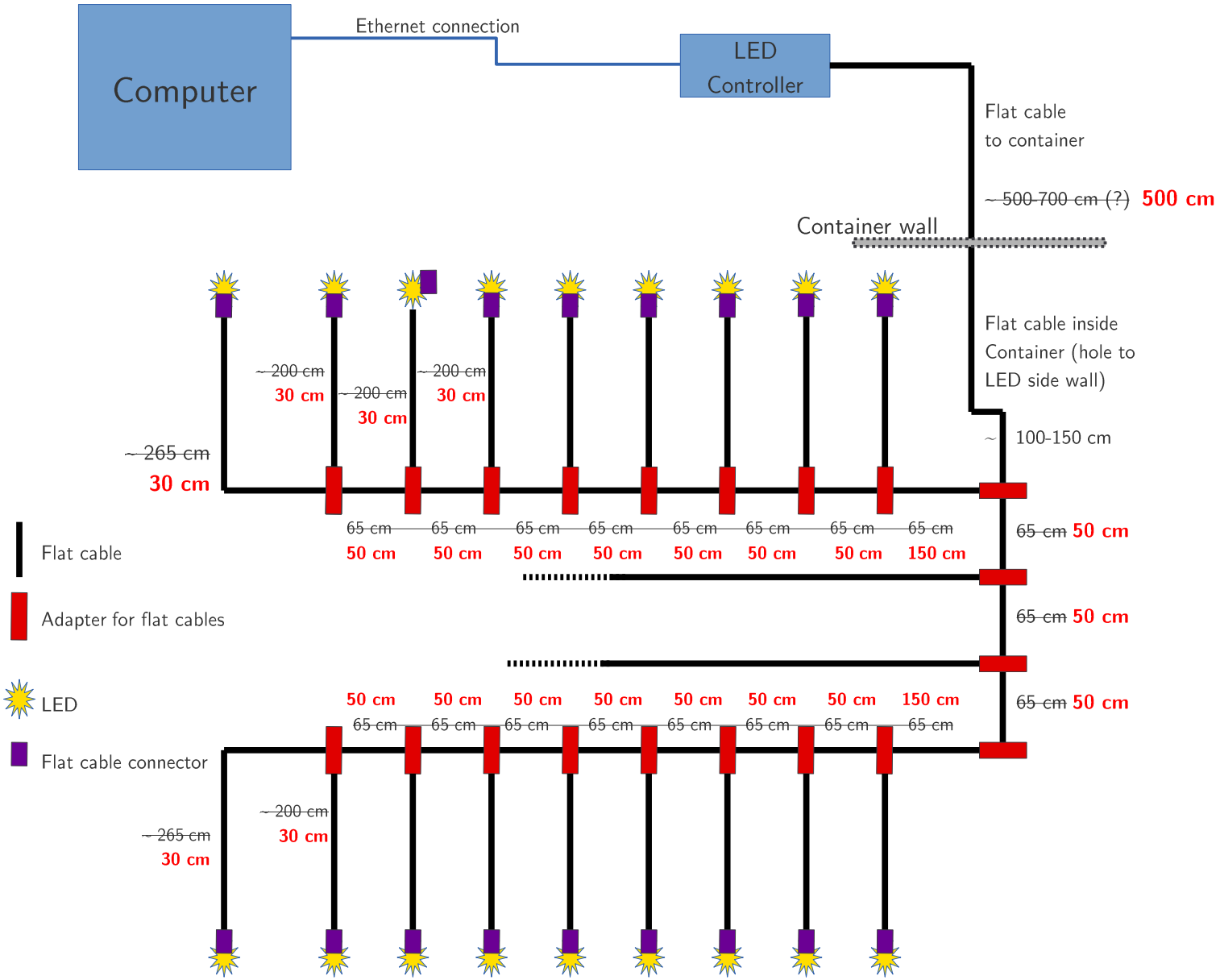
Cable of Potted PMTs (maybe obsolete?)

- 100 m cable from Xiaoshan
- Fits inside packaging
- Weight 7 kg

→ ***Total weight of tray with PMT: 15 kg***

- Two ways to keep it on tray:
  - (1) Curled around the neck, then close to head → quite ugly, but it fits (see picture)
  - (2) Near the base → Special holder necessary

- Maybe obsolete now with new electronics design?


Computer
Ethernet connection
LED Controller
Flat cable to container
~ 500-700 cm (?) 500 cm
Container wall
Flat cable inside Container (hole to LED side wall)
~ 100-150 cm
~ 200 cm 30 cm
~ 265 cm 30 cm
65 cm 50 cm
65 cm 50 cm
65 cm 50 cm
65 cm 50 cm
65 cm 50 cm
65 cm 50 cm
65 cm 50 cm
65 cm 150 cm
Flat cable
Adapter for flat cables
LED
Flat cable connector