Summary of Mechanics/Production/PMTs parallel session

Content:

Characterization of Hamamatsu R12199 PMTs	*O. Kalekin*
PMTs hardware	*G. Kieft*
PMTs measurements in Nikhef	*D. Samtleben*
Stretch of Dyneema ropes	*B. Van Der Kroon*
DOM mechanics	*E. Berbee*
DU assembly procedure-LOM loading-	*P. Kooijman*
Production	*E. Berbee*

Hamamatsu R12199-02 PMTs

Specifications

- QE @ 470nm > 20%
- HV for $5x10^6$ gain 1000-1400V
- TTS <2ns sigma
- Dark rate <1kHz
- Peak-to-valley ratio >3

Test:

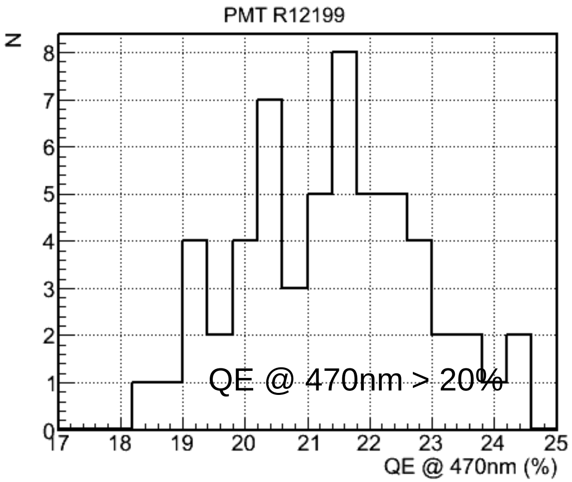
200 PMTs delivered and under tests in Nikhef, ECAP and LNS Catania

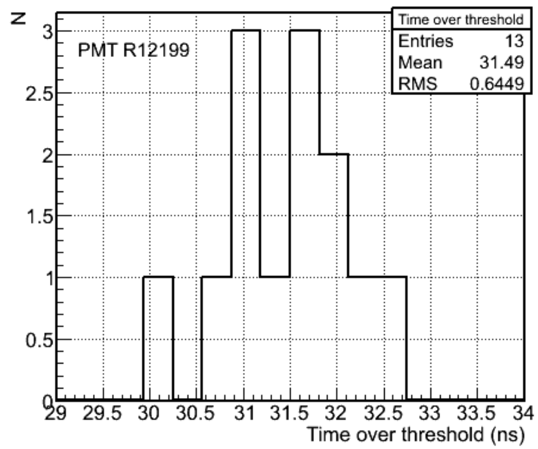
Test results for 56 PMTs are presented

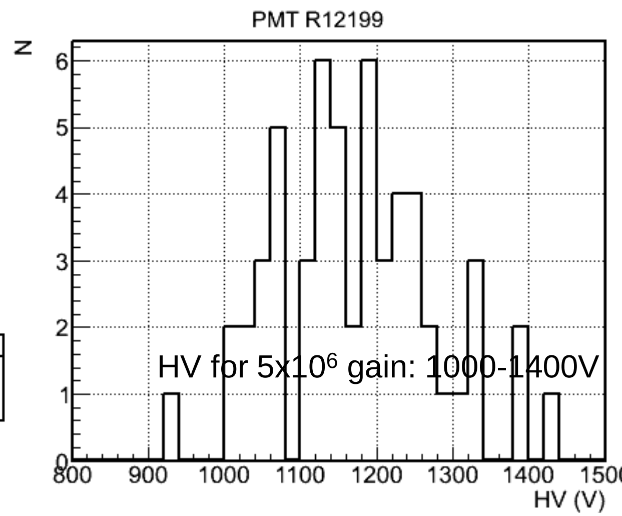
Resistor base according to recommended voltage ratio

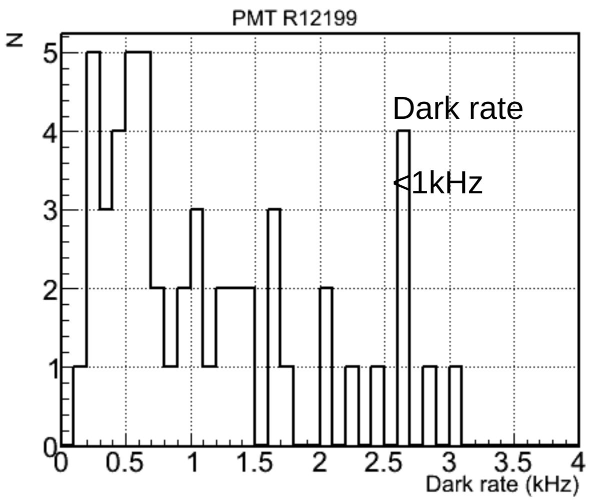
ERLANGEN CENTRE FOR ASTROPARTICLE PHYSICS

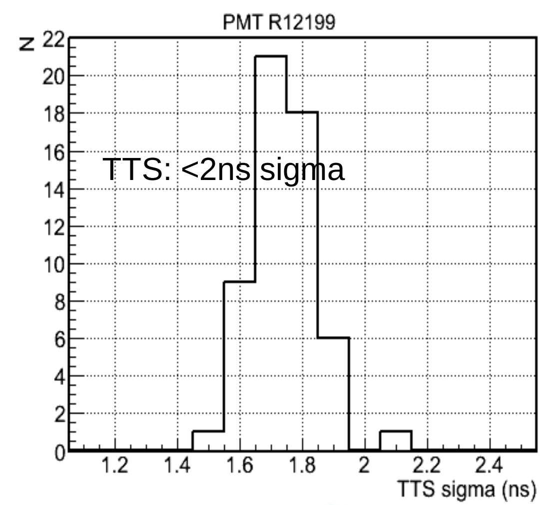
Some test results in Erlangen











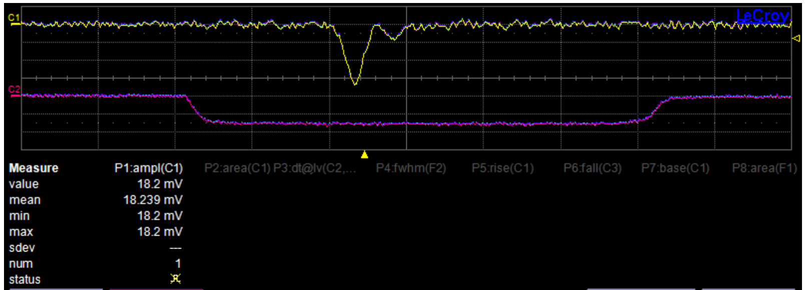
Dark counts and Charge measurememts

Dark Count:

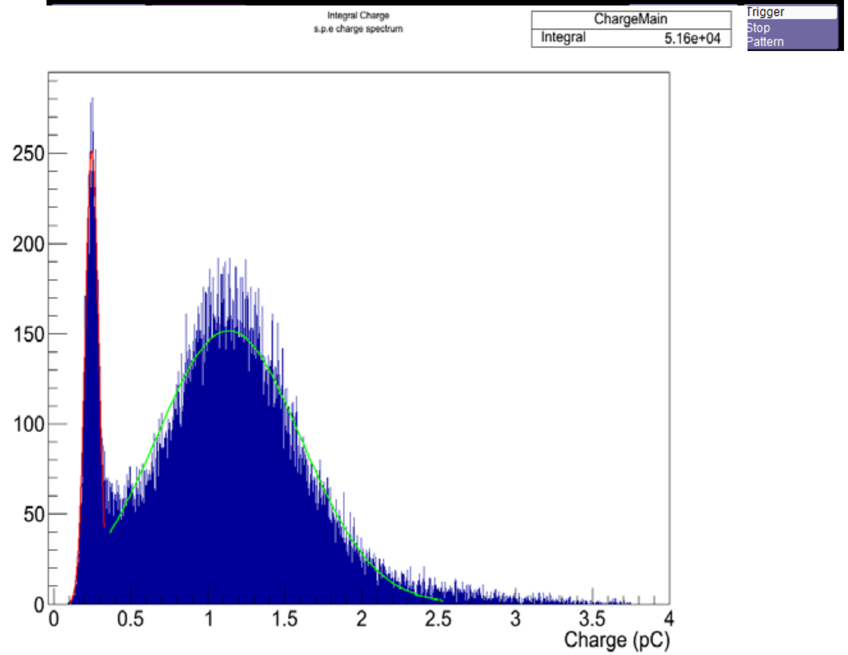
Measured by counter NIM CAEN at a threshold of 1/3 of s.p.e

Charge measurements

PMT signals acquired by Le Croy waverunner 1 GHz oscilloscope and elaborate in ROOT



	Volt @ gain 5 E6 [V]	DC rate [Hz]	P/V
ZB6310	**1100**	**843**	**3.3**
ZB6306	**1070**	**345**	**2.9**
ZB6309	**1030**	**555**	**2.8**
ZB6336	**1017**	**182**	**2.7**



Typical charge spectrum in spe condition

<u>Preliminary</u> results show P/V values lower than those declared by Hamamatsu

…we are investigating about that!

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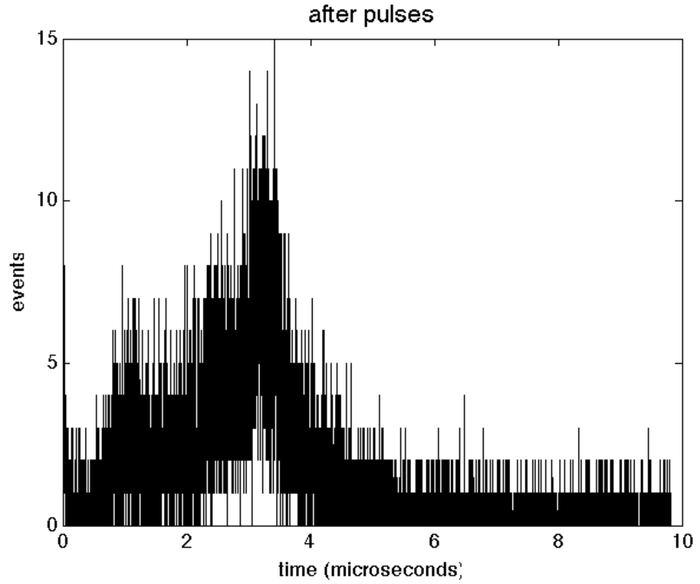
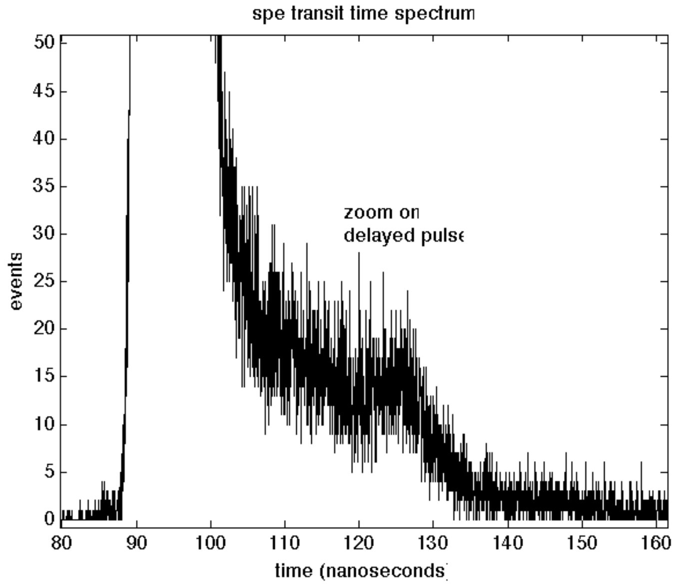
Typical distribution and timing results



Typical time distribution of after pulse



Typical time distribution of delayed pulse

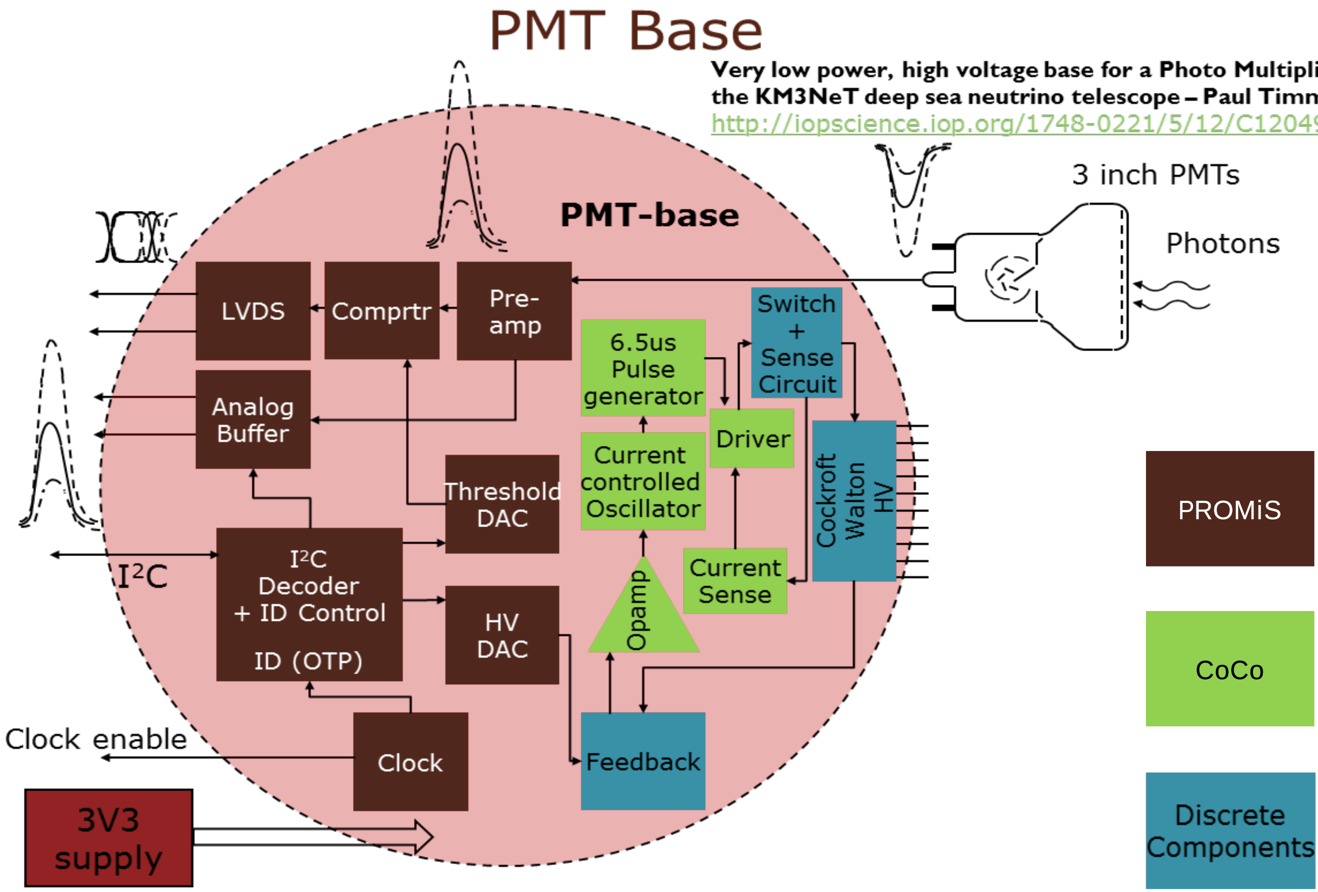
Ratio between number of spurious events on number of PMT main pulses was calculated

	TTS (FWHM) (ns)	Pre-pulse (%)	Delayed-pulse (%)	After-pulse (%)
ZB6310	4.20	0.20	5.12	7.40
ZB6306	3.82	0.06	5.30	3.00
ZB6309	4.23	0.09	5.90	3.90
ZB6336	3.63	0.03	5.70	5.30

PMT tubes

- Currently PMT tubes from 3 manufacturers: ETEL, Hamamatsu and HZC-Photonics
- Different PMT types per manufacturer
- Different pinning diameter and layout of the pins
- Different High Voltage division between pins
- In principle one PMT base design sufficient for all PMT types
- Only minor schematics adjustments to adjust for HV division
- But different PCB layout due to different pin layout
- Base PCB layout is very critical due to minimal space and HV

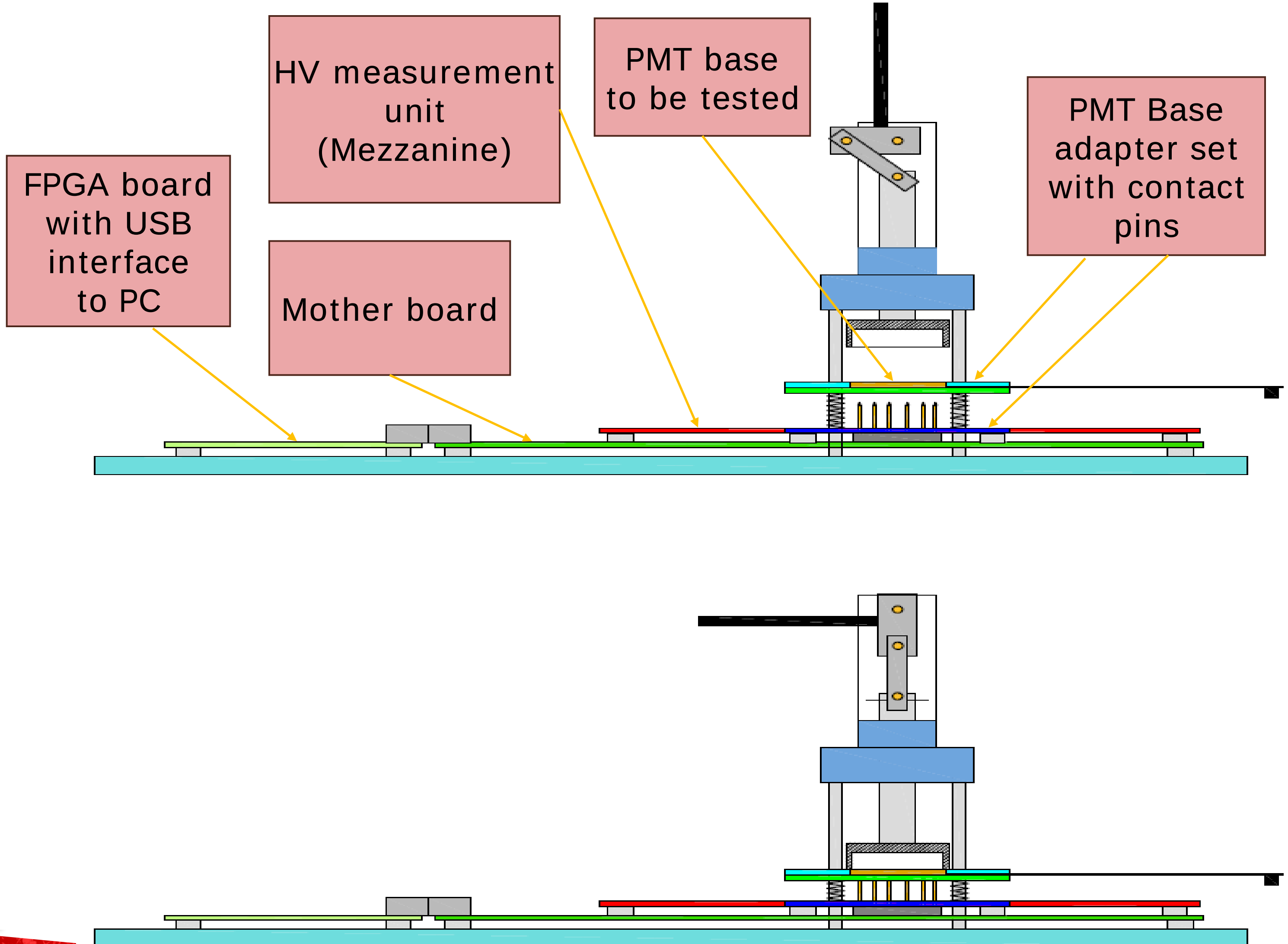
Block diagram of PMT



- PMT Base optimized for 76 mm PMTs.
- Base measures ~ 38 mm.
- PROMiS chip designed for single photon detection.
- CoCo chip designed and optimized for this base design.

G. Kieft
Nikhef
Amsterdam
Electronics

Mechanical overview of tester



G. Kieft
Nikhef Amsterdam
Electronics

Camac set-up to test PMT tubes

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Nikhef
Amsterda
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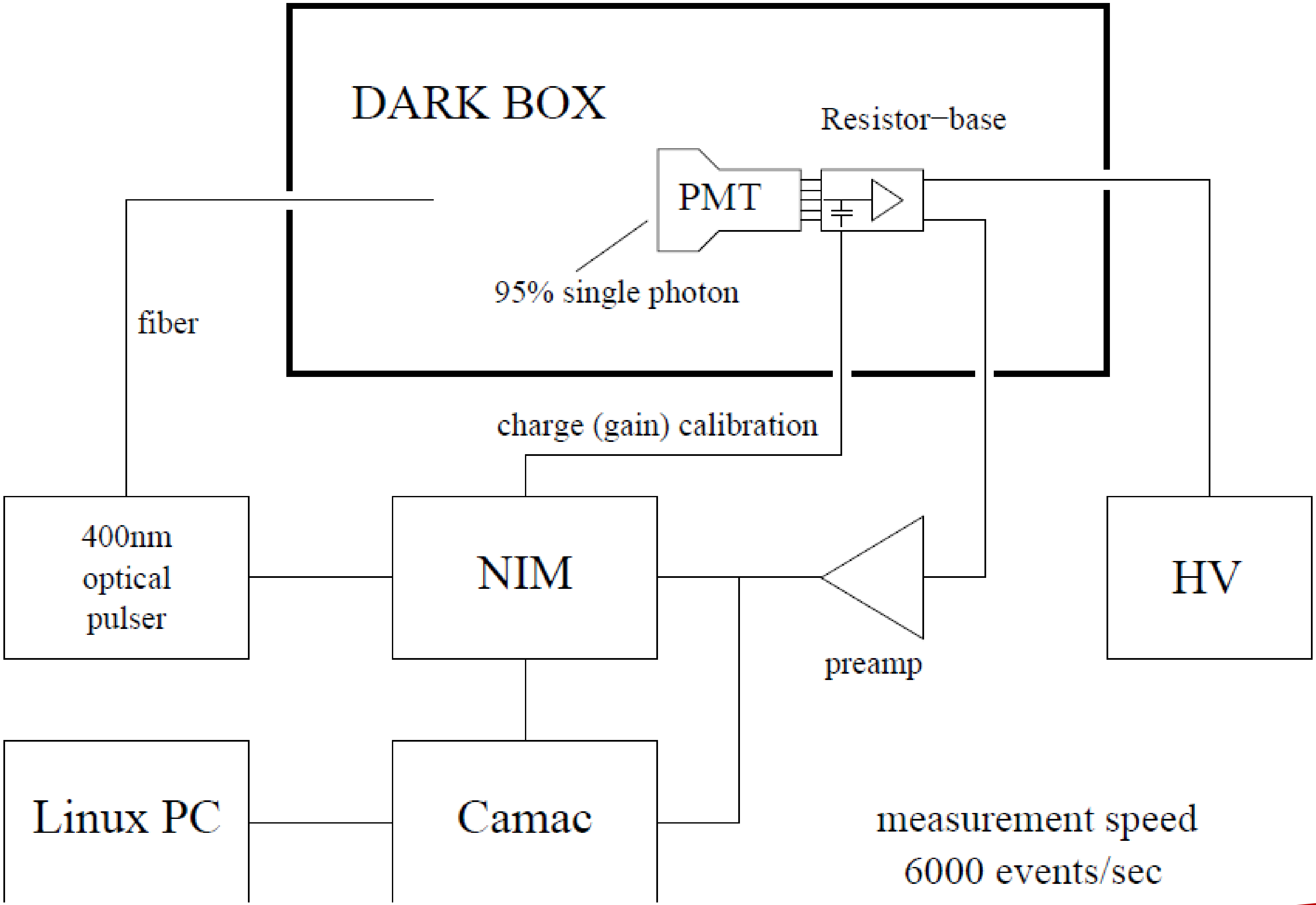
Electronics

Block diagram of Camac test set-up



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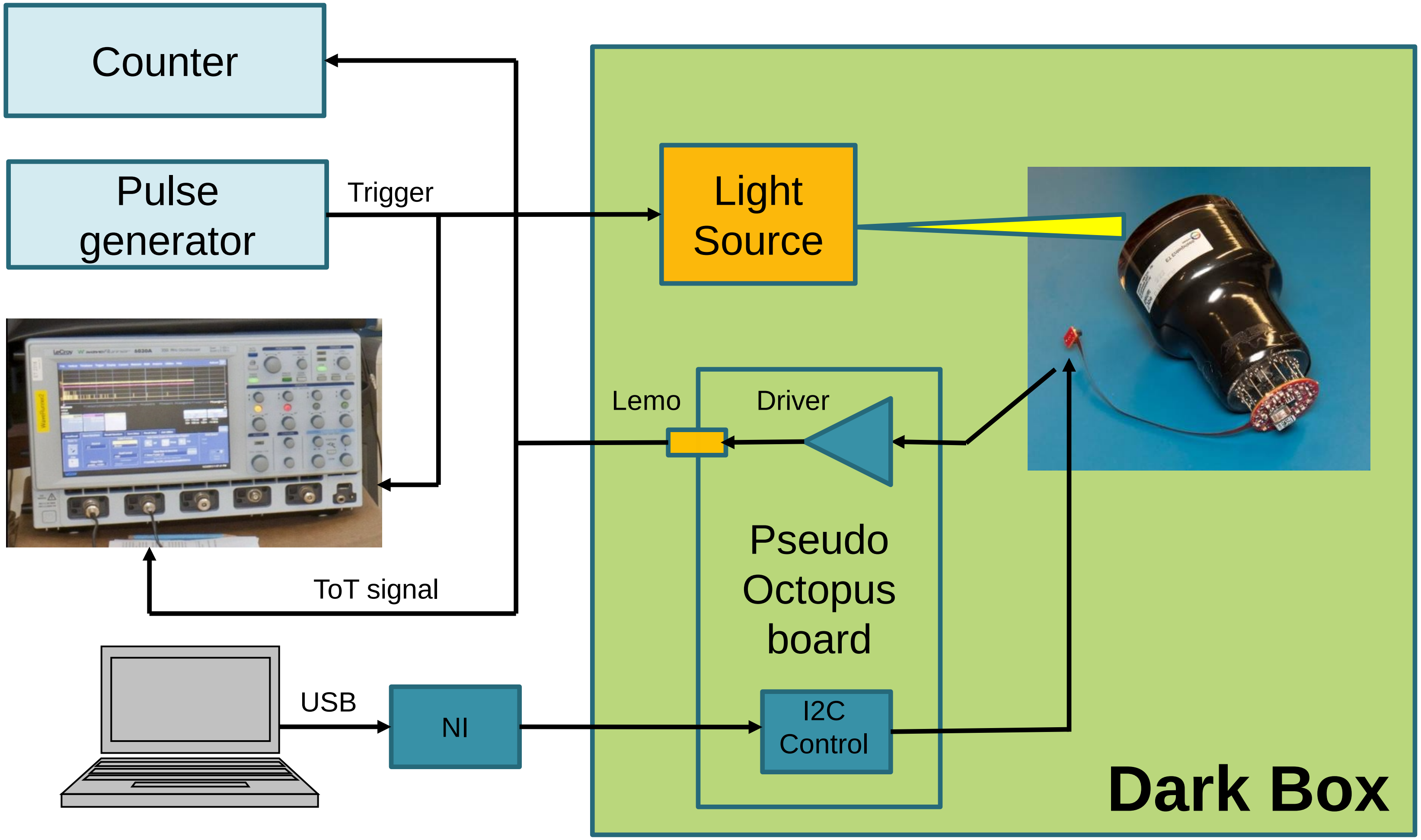
LeCroy test set-up for PMT's with base



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Tested PMTs:

30 Hamamatsu PMTs

94 ETL PMTs

7 HZC PMTs

Measurements of:

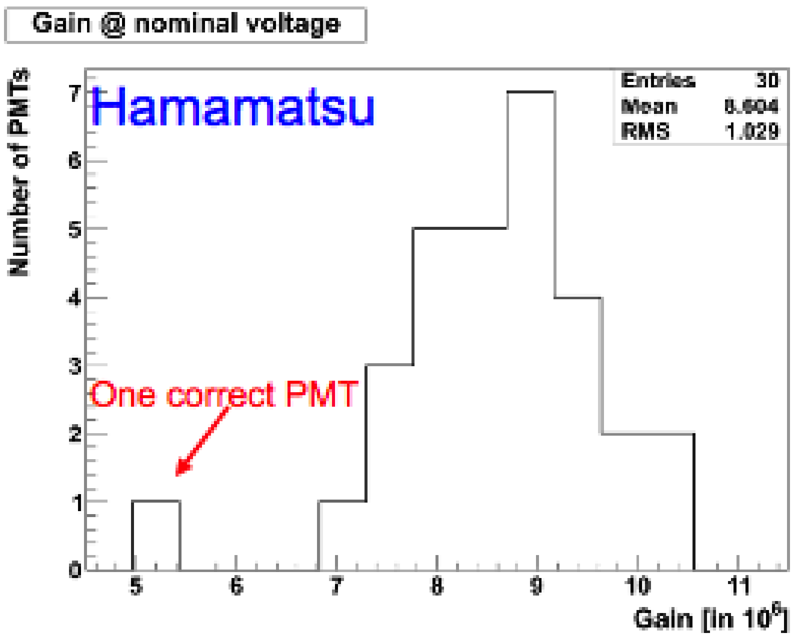
Gain, Dark rate, TTS, Afterpulse fraction

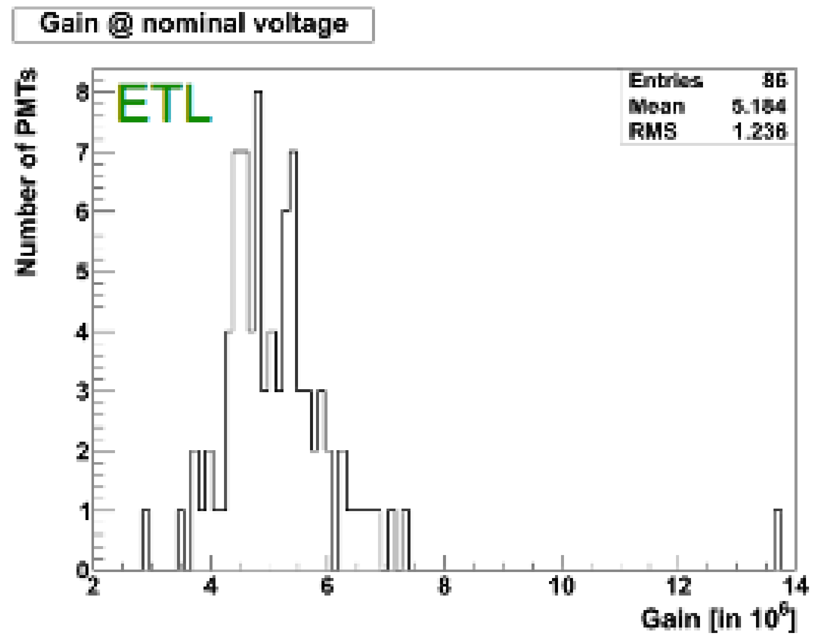
Engineers: Henk Peek, Jos Steiger

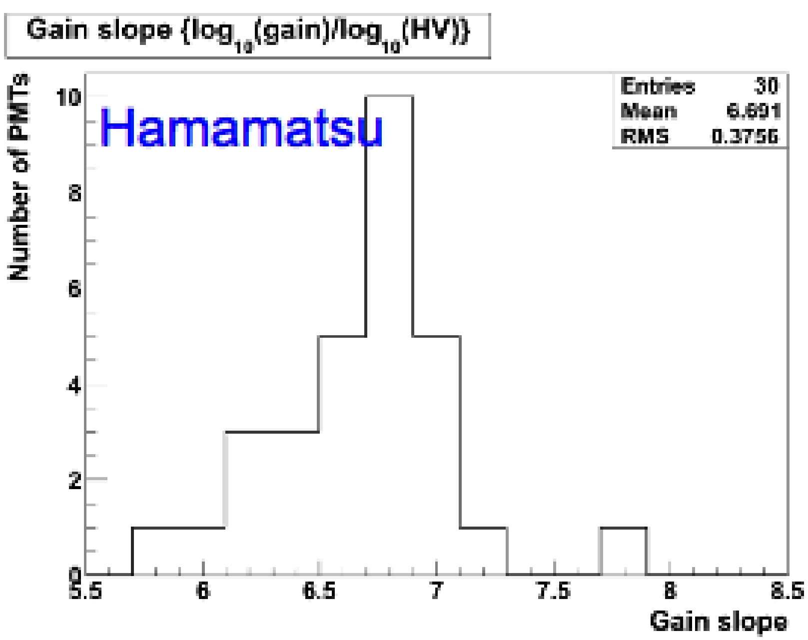
Students: Erwin Visser, Maria Tselengidou, Dimitris Paleosilitis, Robert Bormuth

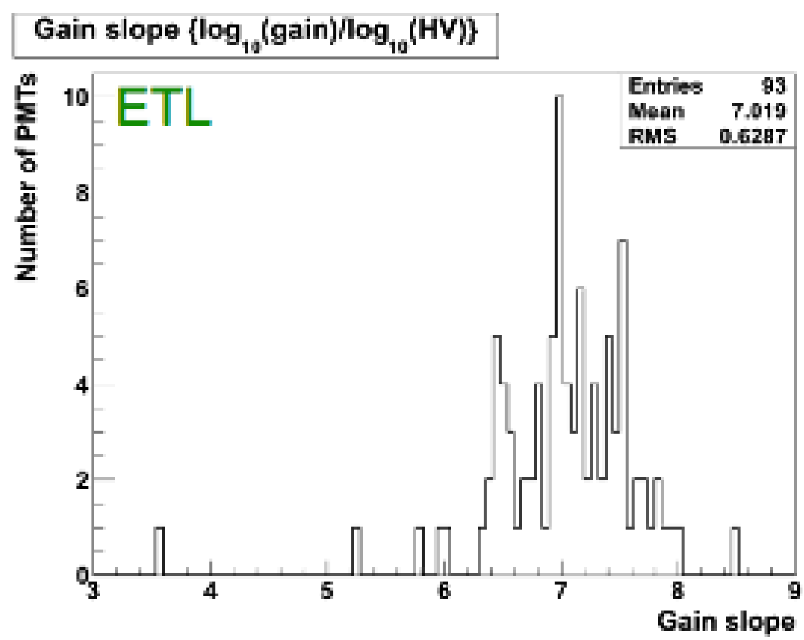
Specified: 5 million

Gain

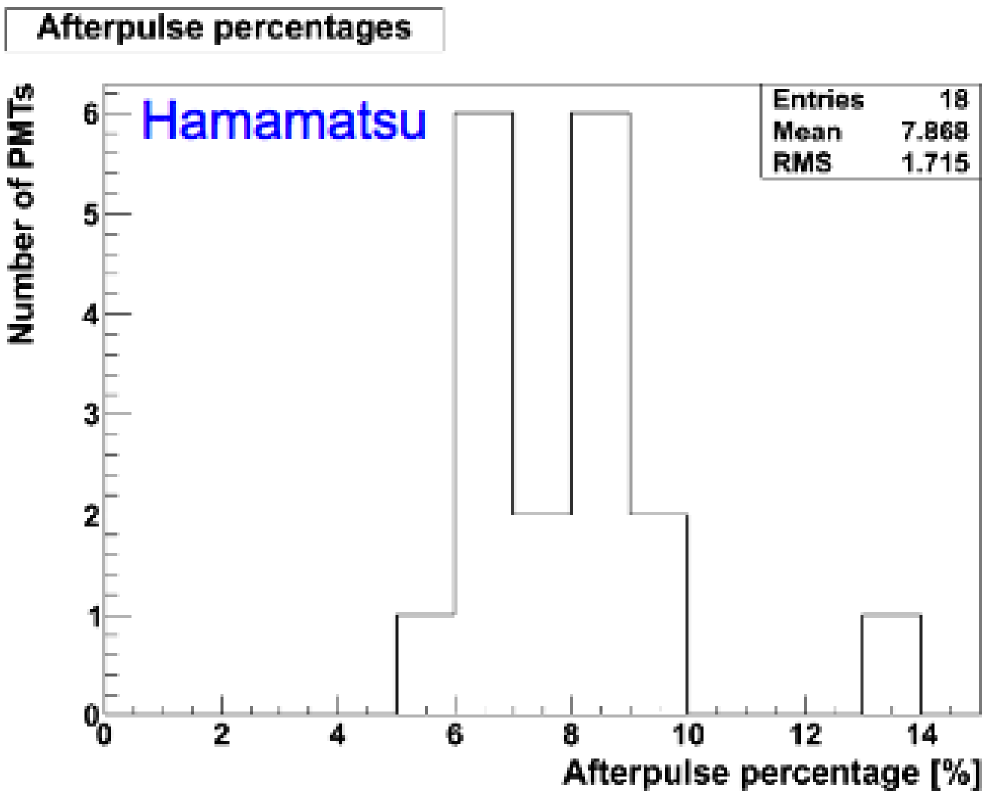


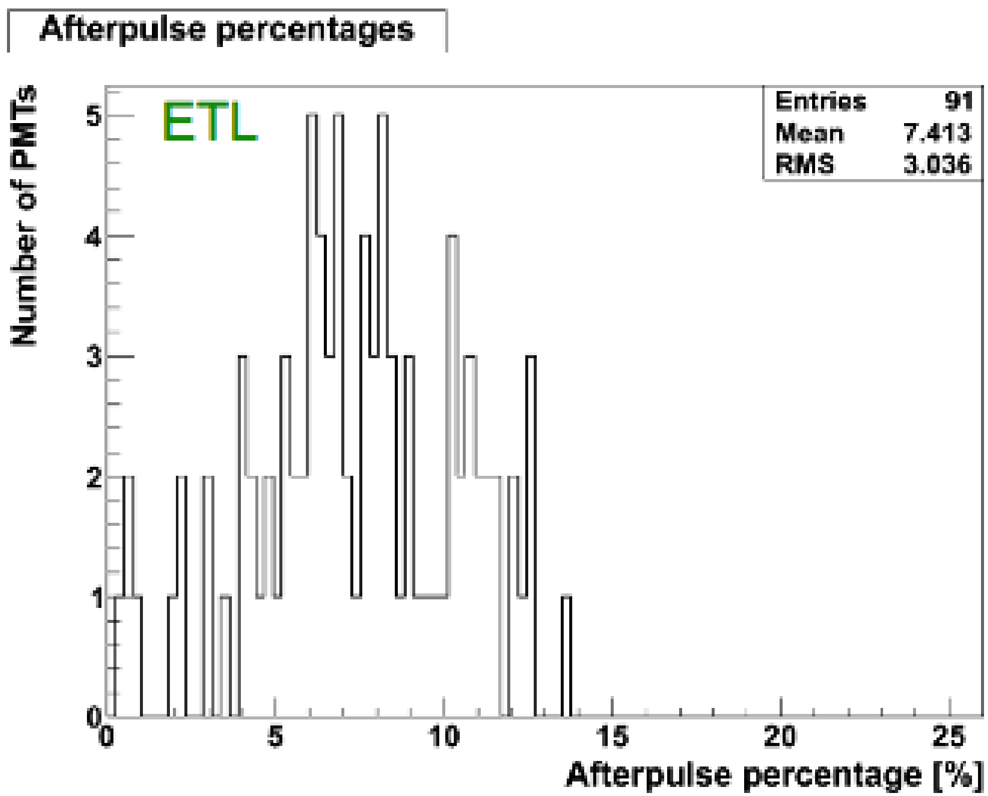






Afterpulses





Comparison to specifications

	ETL [accepted] / [total measured]	Hamamatsu [accepted] / [total measured]
Afterpulses	53 / 91	10 / 18
Dark count	83 / 94	19 / 23
Gain	83 / 86	1 / 30*
TTS	79 / 85	30 / 30
Total	37 / 85 (43.5%)	8 / 18 (44.4%)

* Gain can be tuned easily

HZC PMTs

Chinese manufacturer
Design based on Photonis expertise

Maarten de Jong/Els de Wolf visited in December
Prototype PMTs delivered in January

PMT No.	HV [V]	Gain [1×10^6]	HV at gain 3×10^6	TTS [ns]	dark current [per s]	Afterpulse to dark percent
18	1453	5.6	1342	3.81	1678	12.02
22	1485	5.0	1377	2.76	2363	43.78
48	1414	5.15	1312	3.24	3238	18.55
54	1668	4.96	1531	2.66	1750	13.35
58	1543	5.26	1411	3.13	2497	13.98
59	1546	4.56	1449	3.42	1921	11.91
66	1438	4.14	1354	2.94	1851	18.98

HV higher than requirements (max 1300V)

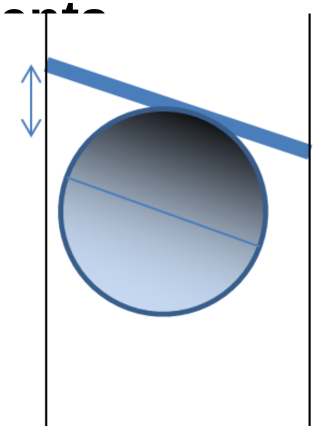
High dark current (max allowed 1500 Hz)

Very high afterpulse fractions (in total max 8% allowed)

HV can be tuned,
TTS marginally larger (~0.2ns on 100V)

At around 75 mm length-difference between the two stringcables
the DOM has an angle of 10° degrees.

A larger angle is not desirable because of the beacon, the orientation of the PMT’s and the other compon



This meant that the length of the cables should be equal within 7,5 x10^{-5} km

So a maximum difference of 4 mm on 40 meter

We did some tests to see if that’s plausible

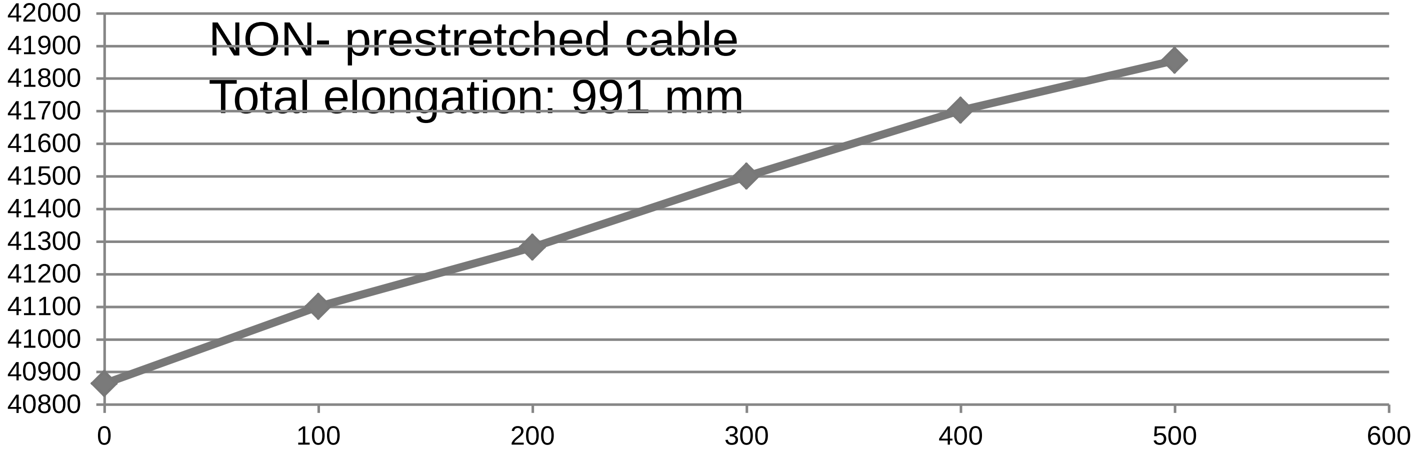
ELASTIC ELONGATION (E.E): Stretch or extension of a rope that is immediately recoverable after releasing the load.

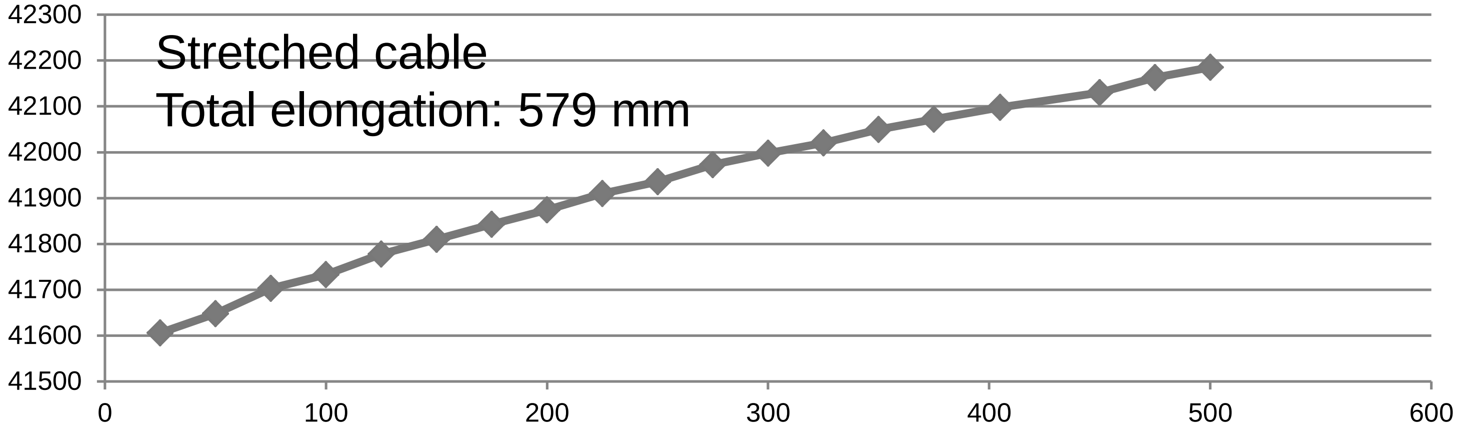
HYSTERESIS: Refers to a recoverable portion of stretch or extension over a period of time after a load is released

PERMANENT EXTENSION (P.E.): That portion of extension which, due to construction deformation and some plastic deformation of the yarn fibers

CREEP (COLD FLOW): Fiber deformation (elongation) due to molecular slippage under a constant, static loading situation.

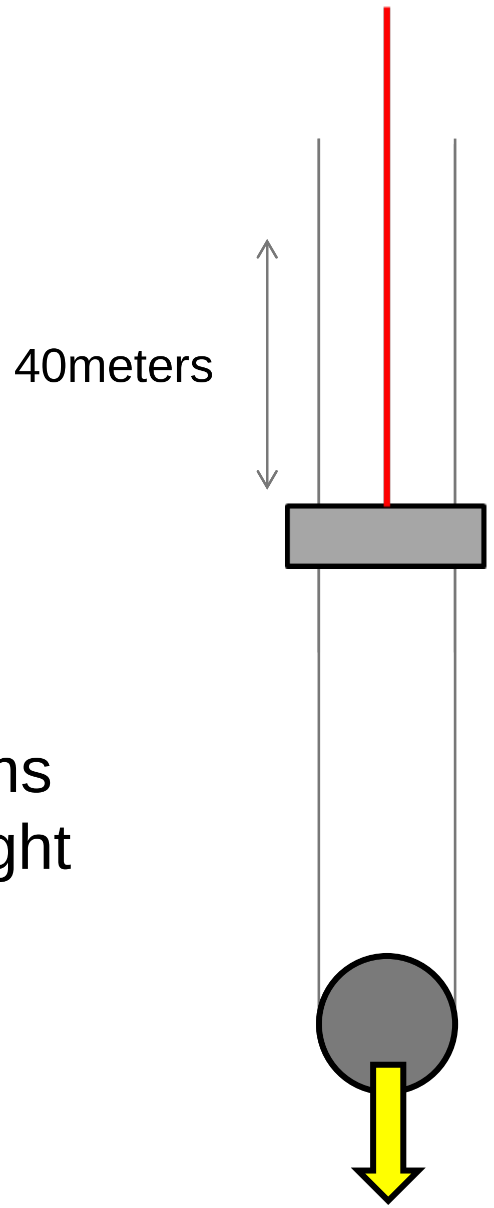
Stretch tests on ropes





NIKHEF

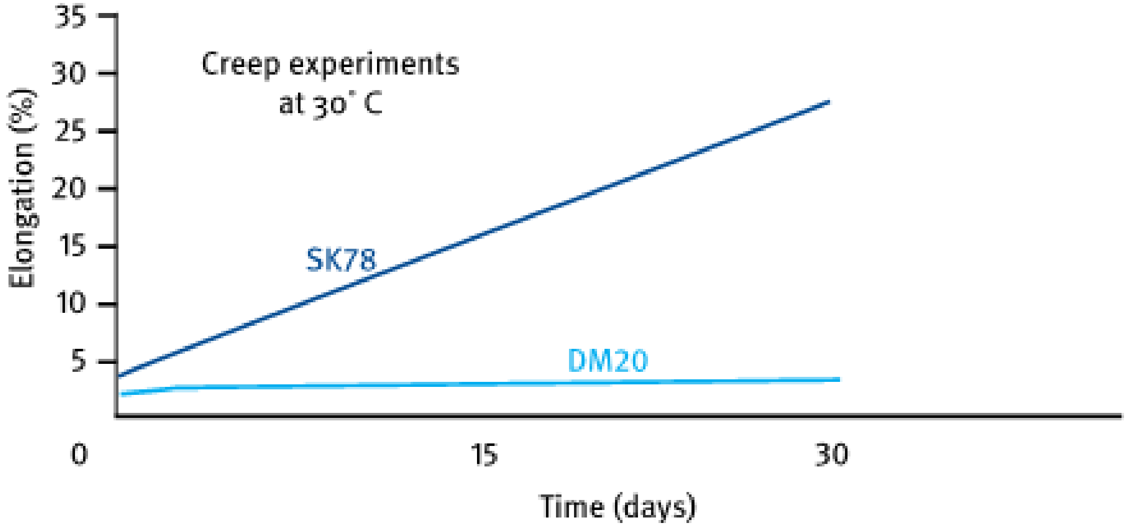
TEST



- NON prestretched ropes: few cms
- Prestretched ropes: < 2 mm lenght difference E.E for 40meters

In the future we would like to test the DM20 kind of Dyneema in stead of SK78.

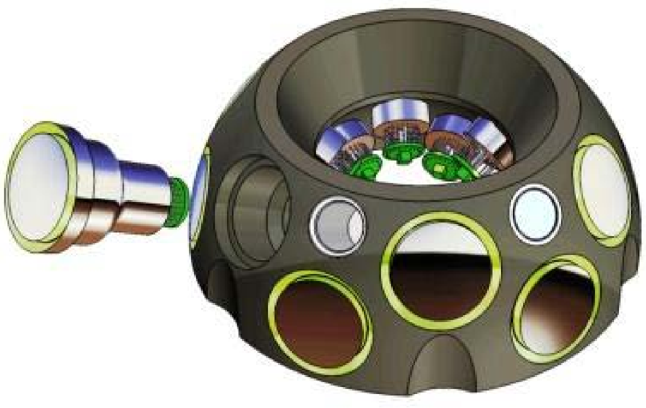
According to the cable supplier, the E.E. is around the same, but the creep would be far less.



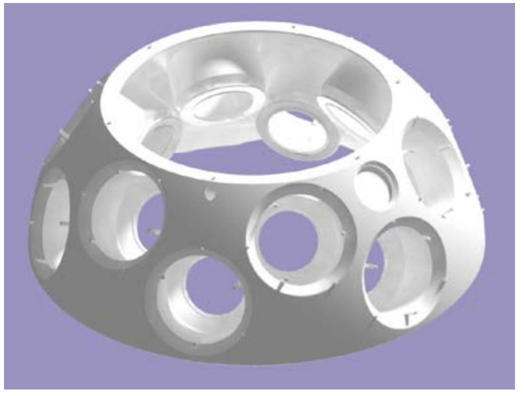
Measured elongation on a 29mm rope for a period of 30 days (Ifremer France), demonstrating the step change in creep performance between SK78 and DM20

Rapid prototyping versus foamcore

Foam core



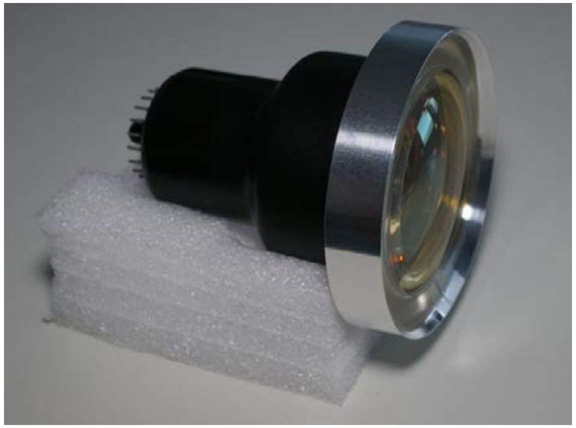
Rapid prototyping (SLS)



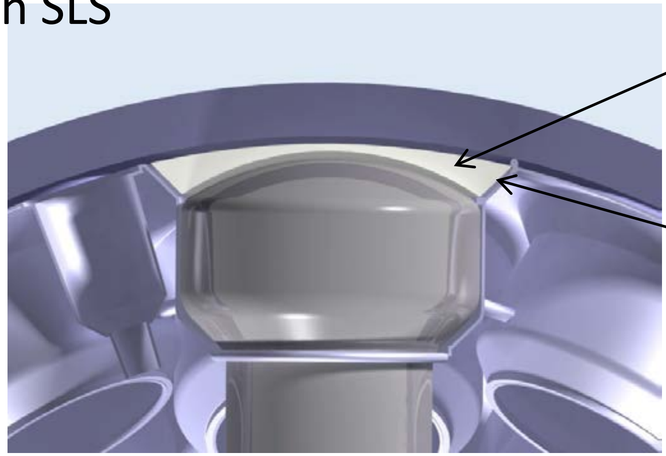
Many advantages for SLS despite higher cost

Reflecting ring

Old aluminium ring



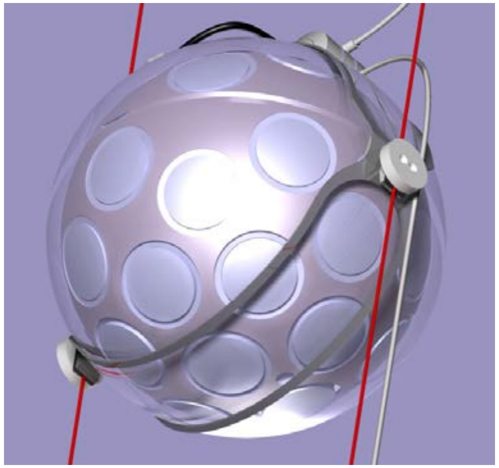
New version with SLS



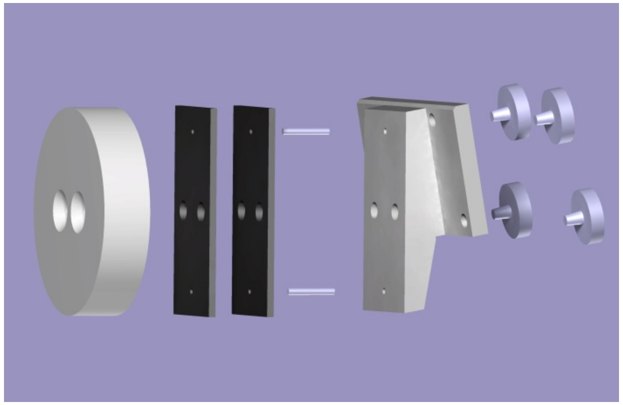
PMMA-lens

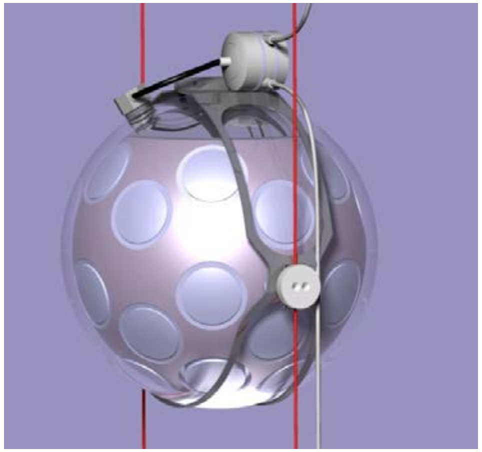
aluminum coating deposited by vacuum evaporation.

Shadowing effects is being looked at, future alternative might be like these pictures. In reality the two parallel strips will diverge.



An exploded view of the “boulders”, existing of PE and rubber anti-slip parts. The Dyneema ropes are blocked solid by two titanium pins in the rope.



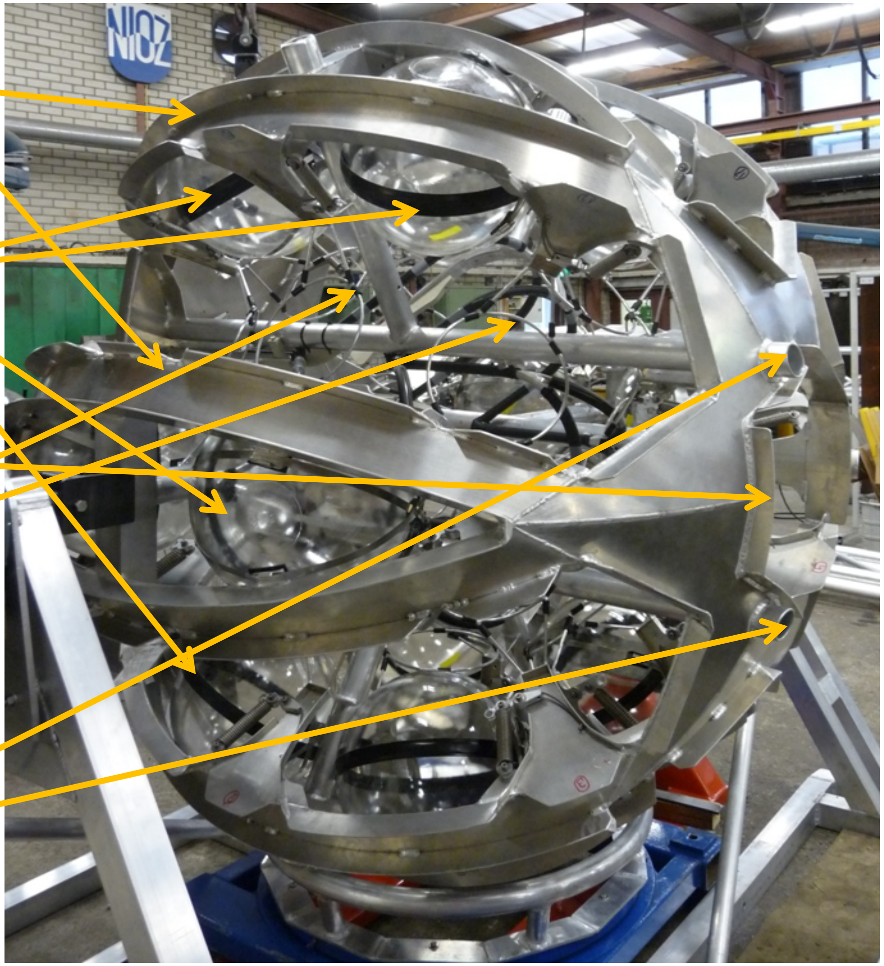


Parts

- Optical Modules
  - Pretested
  - BEOC attached – Empty of oil
- VEOC (see talk PK)
  - Filled with oil
  - Pretested for
    - Attenuation of fibres to each Break Out
    - Continuity of copper to each Break Out
  - Optical Fan-out Module attached
- Dyneema Ropes
  - Prestretched (method being defined)
  - Premarked at 1 m intervals (and at DOM position?)
- LOM on Rotator

Launching vehicle in the lab

- 3 pairs of parallel cable trays
- 12 glass spheres for buoyancy of the frame
- Hole for entrance of buoy-spheres
- 20 rings to suspend optical modules
- 3 tubes to guide tension cables to fix the frame to the anchor during descend

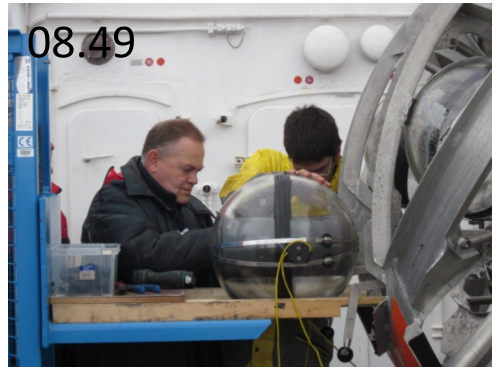


Launching vehicle in rotator

Procedure

	HR	Time (h:m)	Elapsed time	activity	comment
25	2	1:15	13:50	Repeat 12 to 23 until first track is full	7-times
26	2	0:30	14:20	Raise LOM on "Lazy Susan" rotate around the vertical axis by 60 degrees.	Heavy duty long fork trolley reqd.
27	2	1:15	21:50	Repeat 12 to 23 until track is full	6-times
28	2	0:30	22:20	Raise LOM on "Lazy Susan" rotate around the vertical axis by 60 degrees.	Heavy duty long fork trolley reqd.
29	2	1:15	29:50	Repeat 12 to 23 until track is full	6-times
30	2	0:15	30:05	Continue to feed 100 m to string bottom while crossing over every 10-12 m	
31	2	0:30	30:35	Feed Hoisting cables through LOM	
32	2	0:15	30:50	Place LOM on anchor / or shipping container	2 ton crane required.

For test deployments: 20 x 40 ≈ 13 hrs are saved because of no or limited splicing
Total 18 hrs x 2 = 5 fte days (mechanical), 13 hrs ≈ 1.5 fte days (fibre)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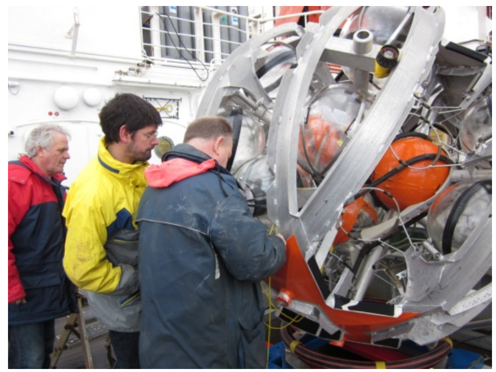
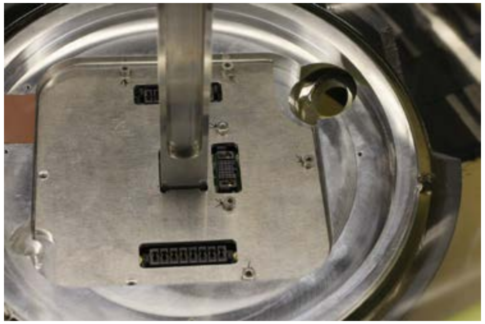
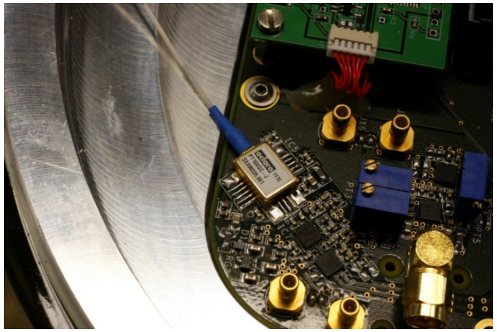


DOM assembly steps





Main issue: bubbles in the gel

Production of DOMs and DUs

- Hypothesis:

60 strings →1200 DOMs

DOM:

-2.5 days of building for one Dom, so a total amount of **15-20 Fte year** (due to starting up)

DUs:

-8 days of building for one string, so a total amount of **3-4 Fte year** (due to starting up)

Sites for assembly;

Following these estimations we could raise 4 sites with each 2 fte to assemble DOM´s, the moment for preparation of these sites is approaching rapidly.

In this way we could assemble 1200 DOM´s in 2 years (60 String/DU´s).

String assembly organization to be decided.

Candidates for assembly sites?