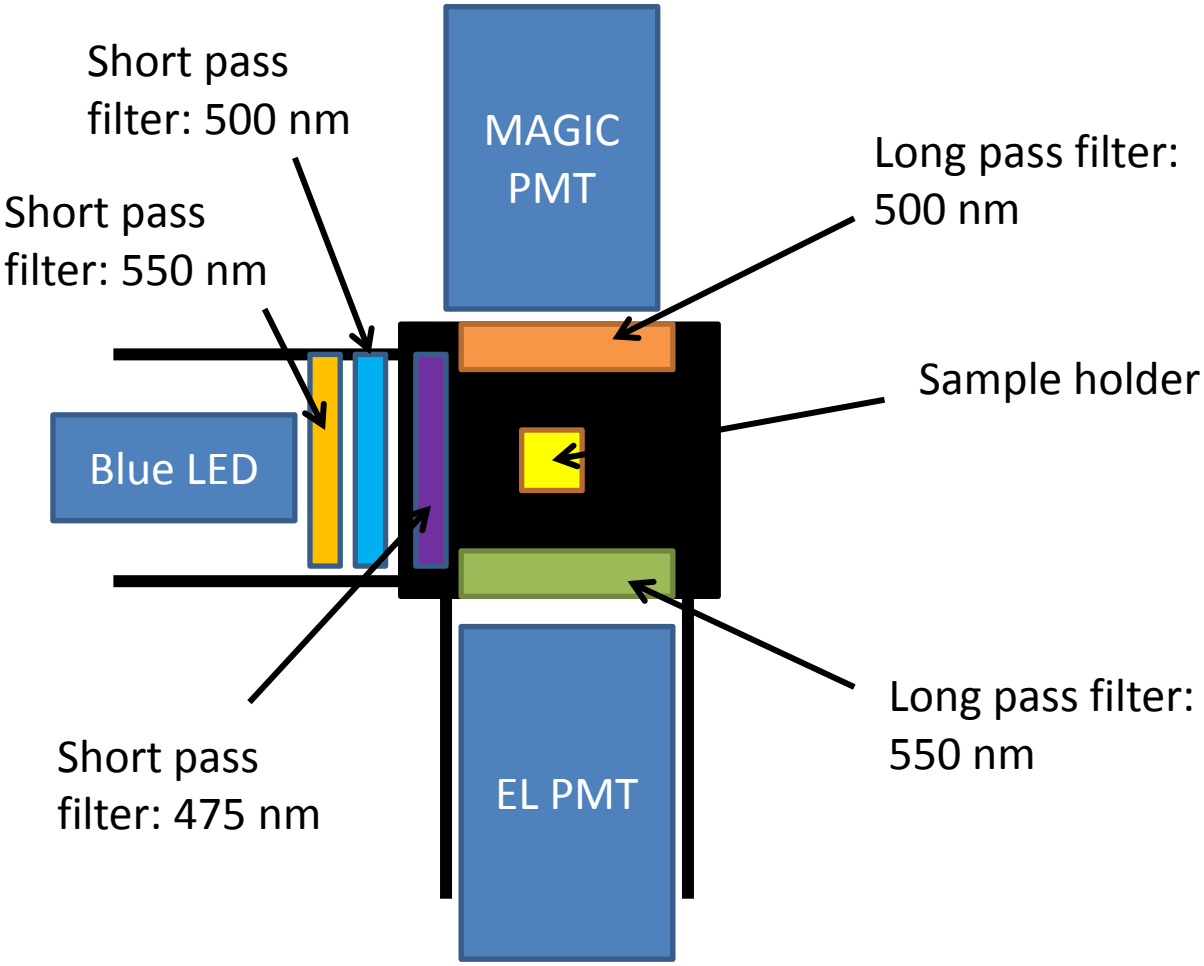
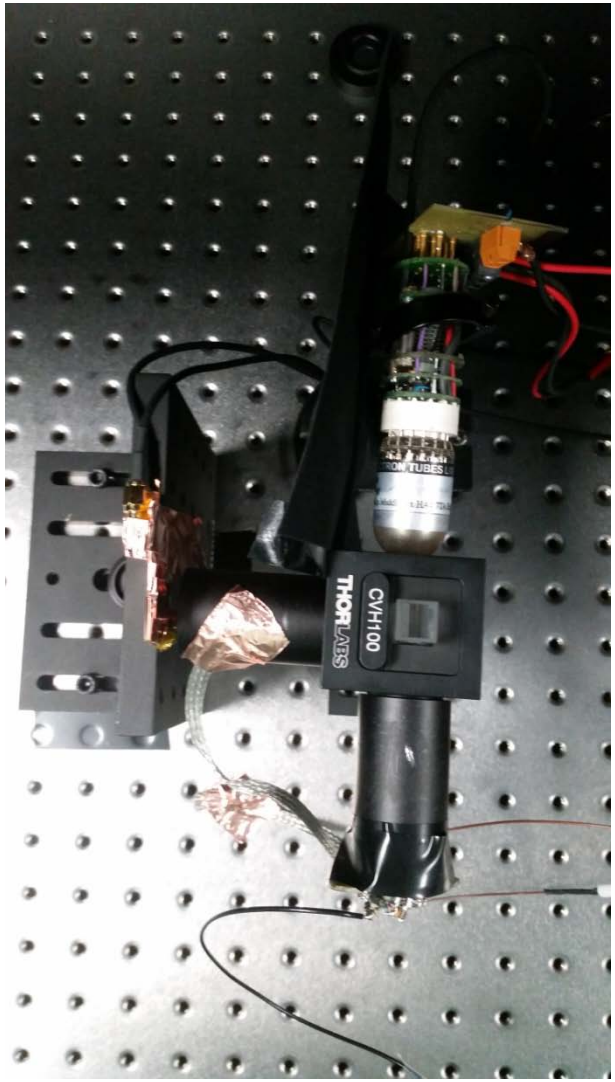
DNA Setup

Visit 11.07.2017

- Marc and Ruta passed by for other series of test
- Improved setup compared to previous test (much lower noise, everything more compact)
- Various samples (1 mL): pure DNA, pure water, pure scintillator, several DNA + small fraction of scintillator
- Goals:
  - Some electronics test (no signal filter vs 100 MHz filter)
  - Minimum fraction of scintillator detectable (commercial device DNA + 1/2000 addition of scintillator)

Setup

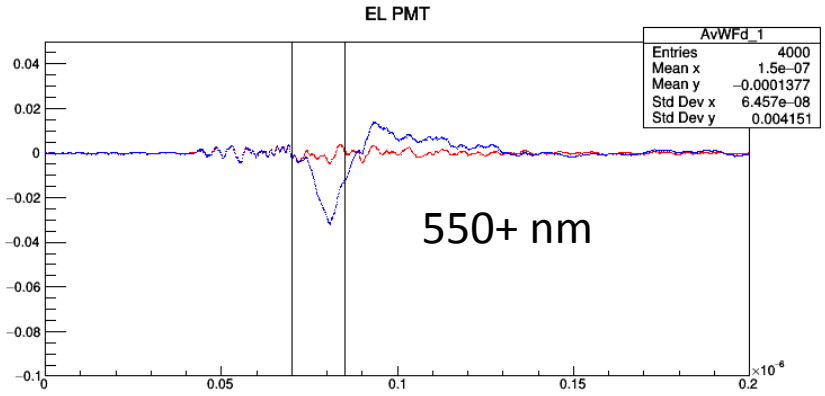

Short pass filter: 500 nm
MAGIC PMT
Long pass filter: 500 nm
Short pass filter: 550 nm
Blue LED
Sample holder
Short pass filter: 475 nm
EL PMT
Long pass filter: 550 nm

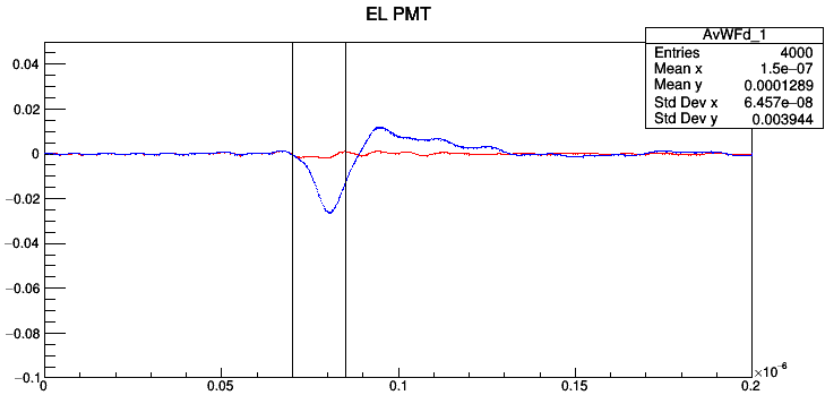

THORLABS
CVH100

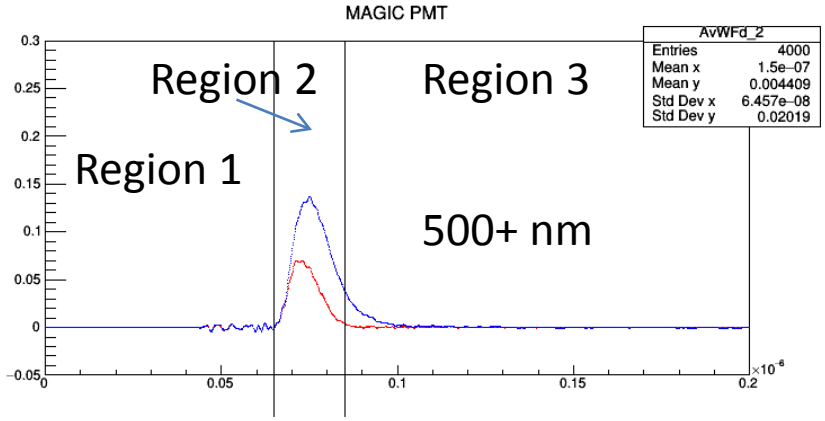
DNA+1/10000 vs DNA

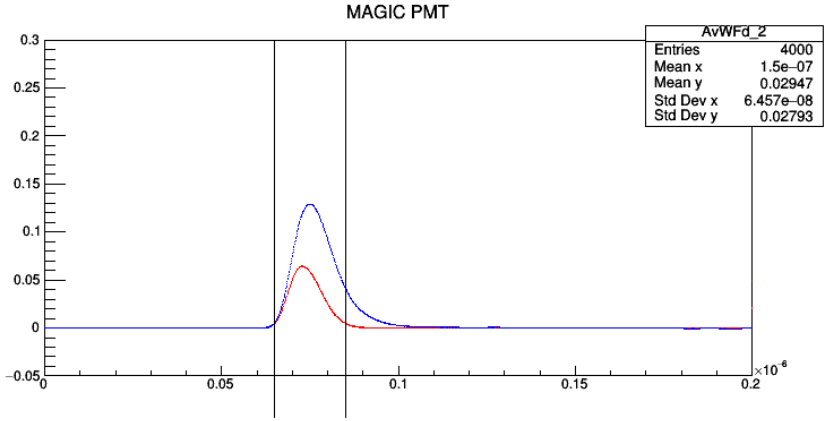
Red: pure DNA
Blue: DNA + 1/10000 scintillator
Left: No filter
Right: 100 MHz digital filter
Average waveforms over 5000 events each

Still simple integral analysis
Clear difference visible in both PMTs:
- signal above 550 nm with scinitllator
- signal longer with MAGIC PMT









DNA+1/10000 vs DNA

No Filter

550+ nm (EL PMT):
- Ratio region 1 (Signal to background): 1.00341
- Region 2: 13.5768
- Region 3: -21.9035 (problematic due to overshoot)

500+ nm (MAGIC PMT):
- Region 1: 1.78613 (both integrals close to 0)
- Region 2: 2.28086
- Region 3: 27.5077

Ratio of both PMT signals defined as:
R= (Int2_MAGIC+Int3_MAGIC)/(Int2_EL)

Pure DNA: 44.4
DNA + 1/10000 scintillator: 8.2

100 MHz Filter

550+ nm (EL PMT):
- Region 1: 1.05805
- Region 2: 14.2617
- Region 3: -27.3453

500+ nm (MAGIC PMT):
- Region 1: 0.89875
- Region 2: 2.31177
- Region 3: 19.5243

Ratio of both PMT signals:

Pure DNA: 47.3
DNA + 1/10000 scintillator: 8.8

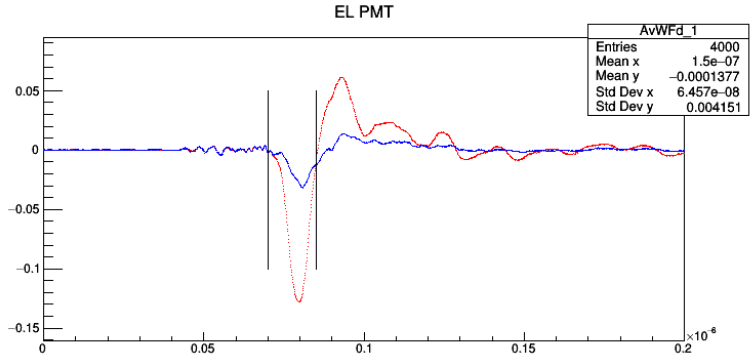
Scintillator vs DNA+1/10000

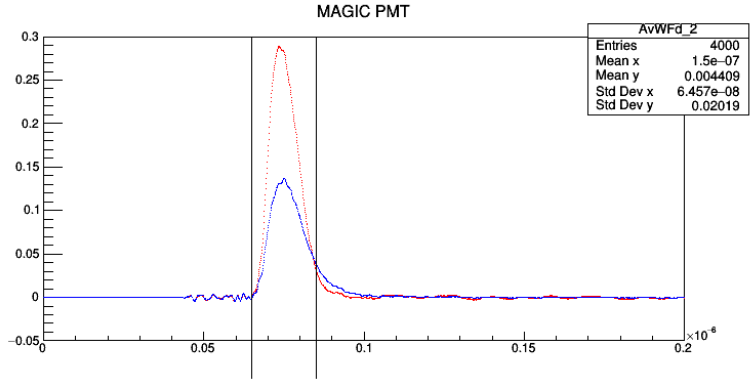
Red: pure scintillator
Blue: DNA+1/10000 Scintillator

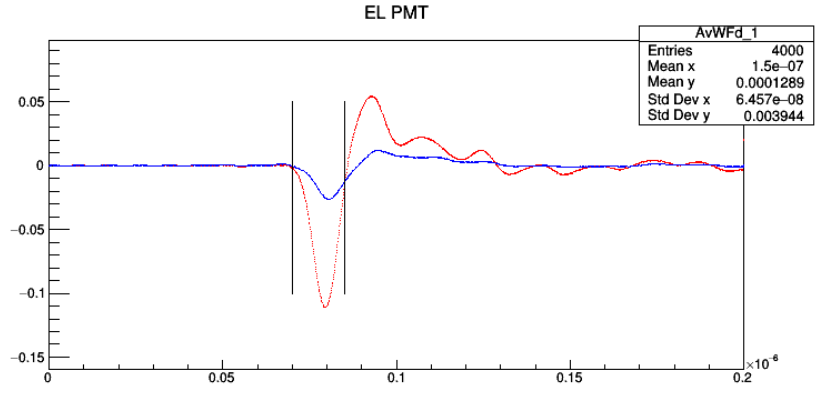
Overall more light with pure scintillator

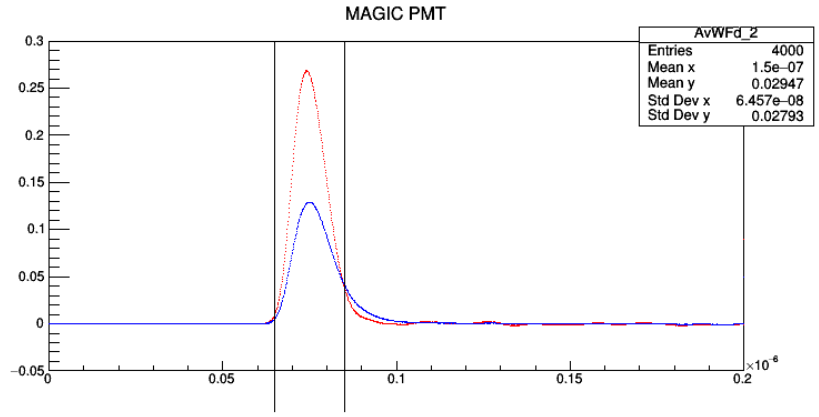
But more light in region 3 for dilution

Can be observed with both PMTs with and without filter









Scintillator vs DNA+1/10000

No Filter

550+ nm (EL PMT):
- Ratio region 1 (Signal to background): 1.23835
- Region 2: 0.242027
- Region 3: 0.235367 (problematic due to overshoot)

500+ nm (MAGIC PMT):
- Region 1: 1.28463 (both integrals close to 0)
- Region 2: 0.527026
- Region 3: 2.749470

Ratio of both PMT signals:

DNA+1/10000: 8.2
Pure scintillator: 3.45

100 MHz Filter

550+ nm (EL PMT):
- Region 1: 10.6996
- Region 2: 0.246137
- Region 3: 0.255705

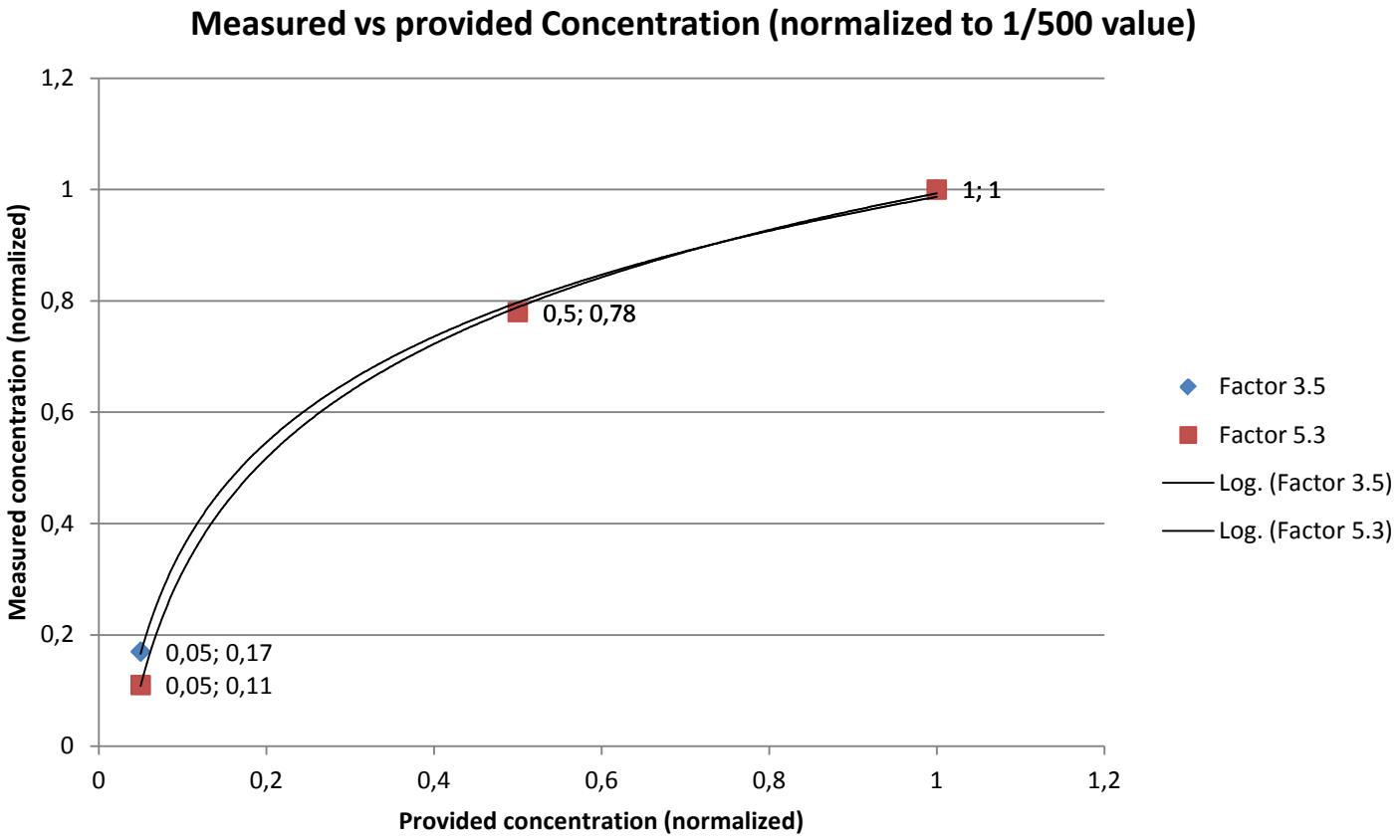
500+ nm (MAGIC PMT):
- Region 1: 0.530792
- Region 2: 0.53307
- Region 3: 2.29346

Ratio of both PMT signals:

DNA+1/10000: 8.8
Pure scintillator: 3.6

Concentration Extrapolation

- DNA+1/10000 extrapolated with factor from previous slide to DNA+1/1000 and DNA+1/500 data
- Result is obviously not linear at all
- more points would be necessary to find equation describing curve
- trendline for the moment is logarithmic (without physics motivation)



Status

- Analysis still primitive but results strong indication that 1/10000 can be easily detected => plans for August
- Light yield not linear with concentration
- Digital filter helps the eye but does not bring improvement, more likely is worsening the ratio result in the 3rd region
- Open question afterwards was: What is the background? Pure DNA or pure scintillator? => None of these as I learned since then but

	Sample 1	Sample 2
	DNA+1/10000	1/10000
DNA, mL	0,2	0
Scintillator, mL	0,0001	0,0001
Buffer, mL	0,7999	0,9999
Total volume, mL	1	1

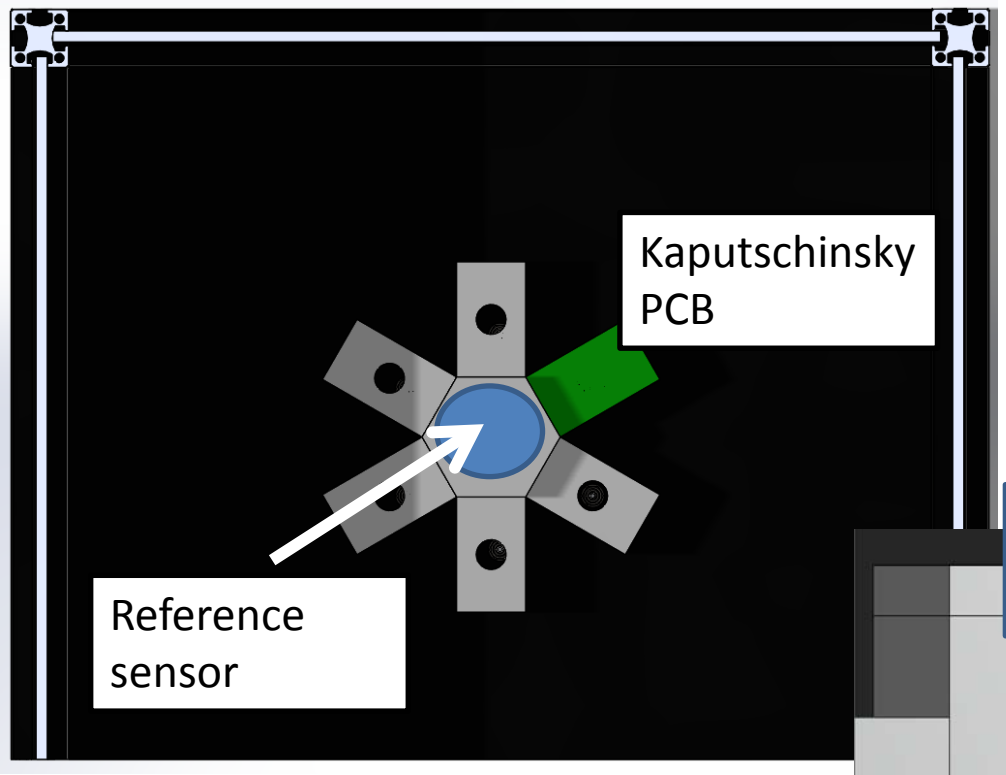
- We need to understand better the sample preparation procedure, especially for the real case => crash course in September (already learned not broken DNA but free DNA and increase compared to normal levels is relevant)
- More tests in autumn with full set of samples => will need to buy cube from Thorlabs

WA105 Light Calibration

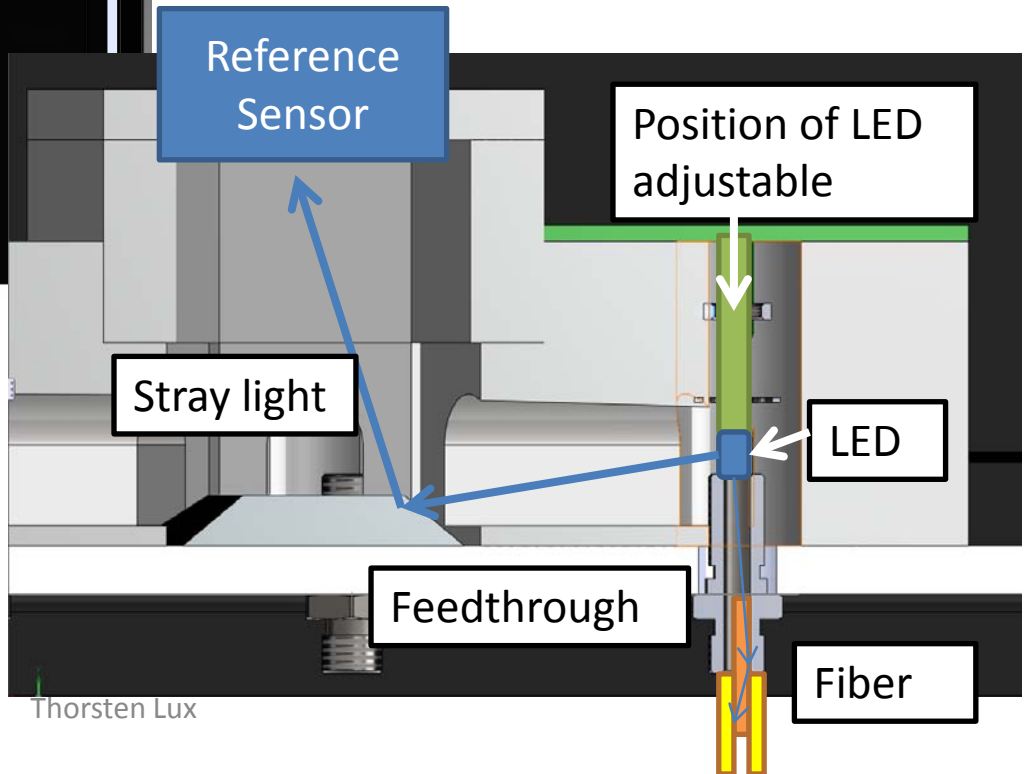
What happened until now?

- Black box has arrived
- Light cavity printed and cleaned from rests at workshop
- New Kaputschinsky PCB designed, tested and production of 20 PCBs ordered
- “Full” setup tested with powermeter and SiPM/PMT

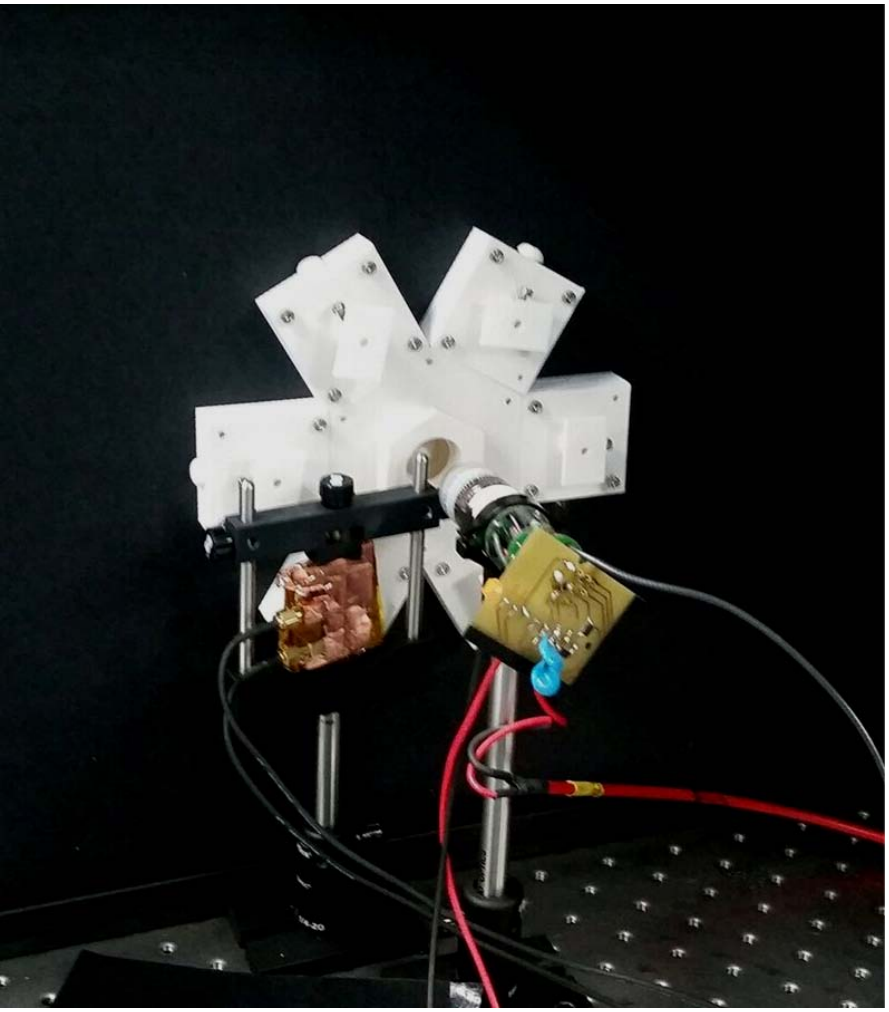
Implementation (Conceptual)



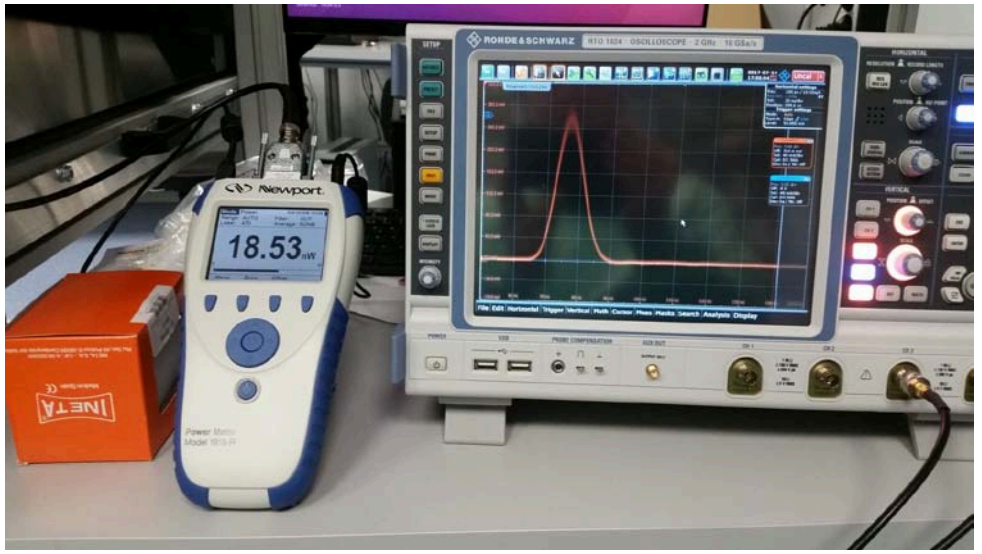
- central reference sensor
- 6 Kaputschinsky PCBs around
- each Kaputschinsky with light cavity to guide light to reference sensor
- material: either 3D printed plastic or aluminium



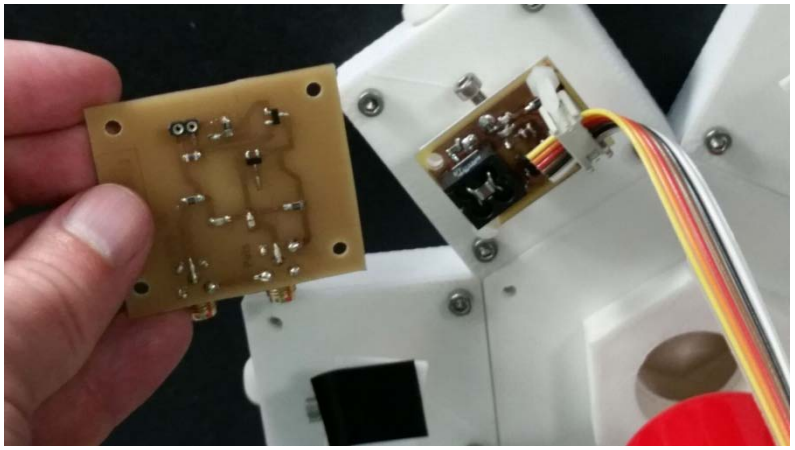
Now Reality



- first tests with old Kaputschinsky + MAGIC PMT
- worked perfectly with large PMT signal and large output power

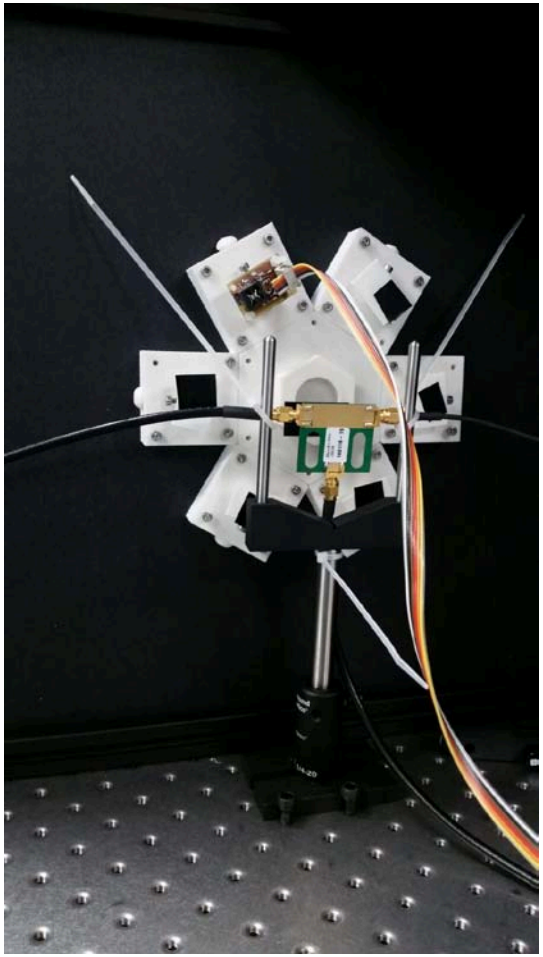


More Detailed Characterization



- new Kaputschinsky PCB prototype used => smaller, less power (1/3), bit narrower pulse, larger noise ripple with PMT, some saturation at high LED bias voltage
- Sensle SiPM instead of PMT => no noise ripple, 2 outputs: fast and slow, powered by standard LV power supply

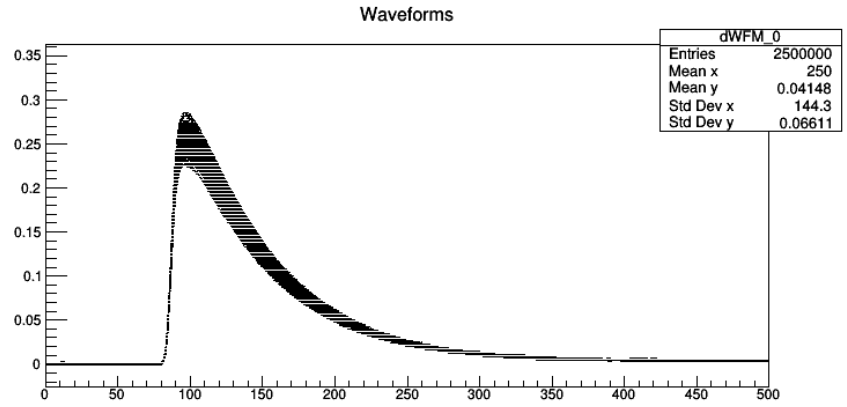
Measuring All Positions

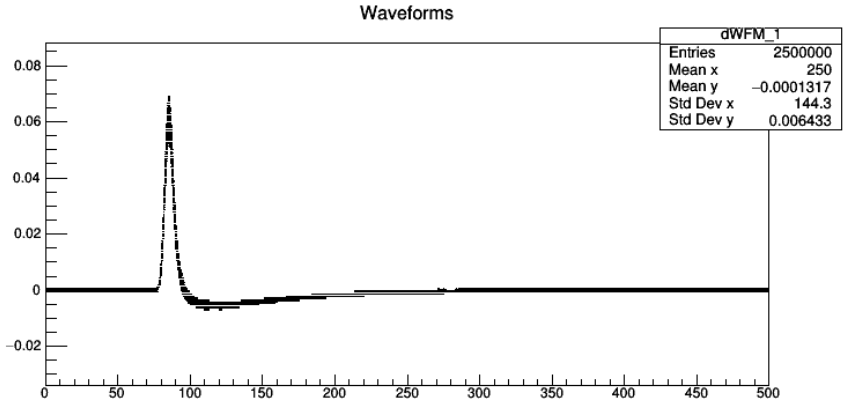


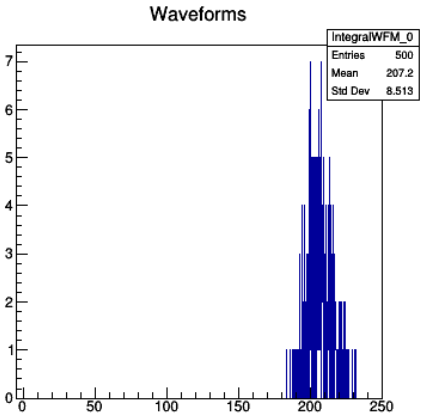
- tested Kaputschinsky in all 6 positions and measured power entering fiber with powermeter
- large variations from position to position: ~2 factor
- Tested same position several times: roughly the same

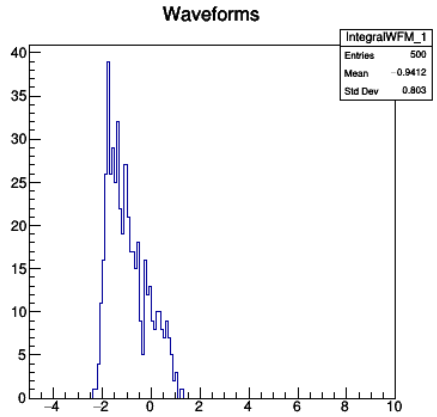
=> Sensitive to placing of Kaputschinsky PCB but might be better with final PCBs and long LEDs (by mistake legs of these was cut)

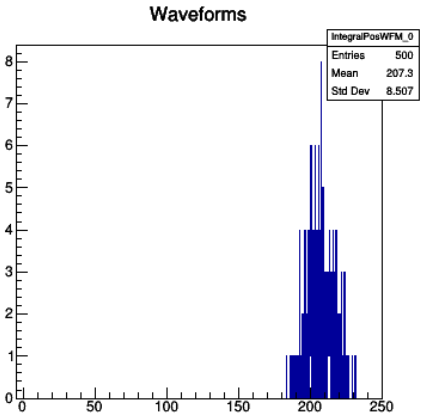
Results

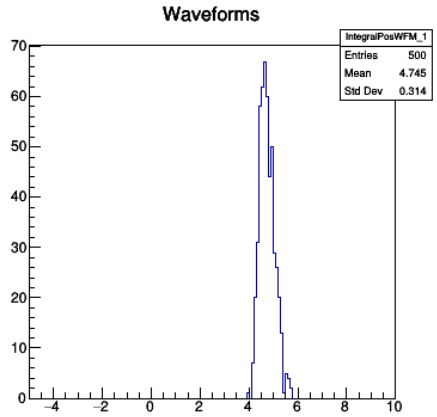

Waveforms
dWFM_0
Entries 2500000
Mean x 250
Mean y 0.04148
Std Dev x 144.3
Std Dev y 0.06611


Waveforms
dWFM_1
Entries 2500000
Mean x 250
Mean y −0.0001317
Std Dev x 144.3
Std Dev y 0.006433

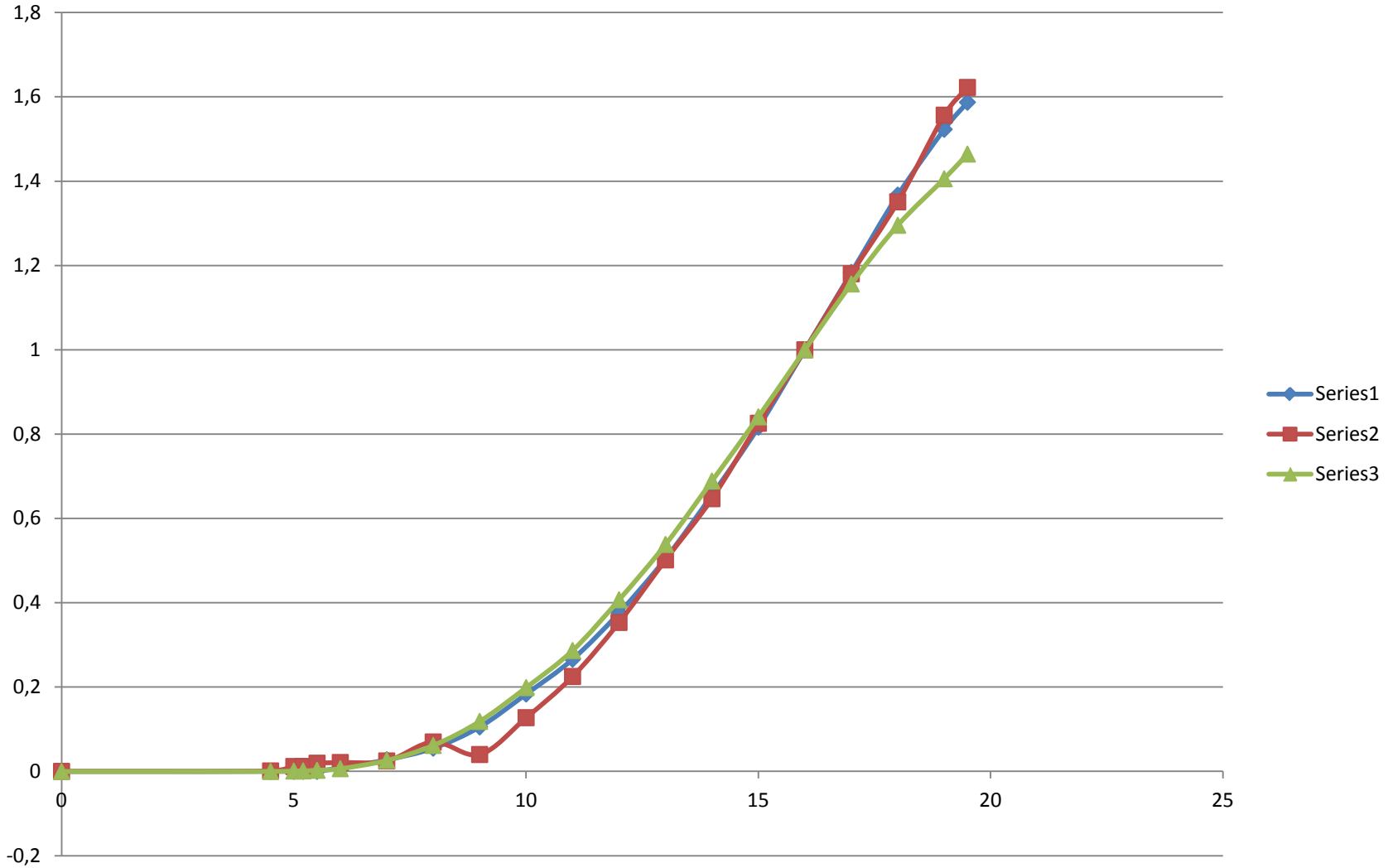

Waveforms
IntegralWFM_0
Entries 500
Mean 207.2
Std Dev 8.513


Waveforms
IntegralWFM_1
Entries 500
Mean −0.9412
Std Dev 0.803

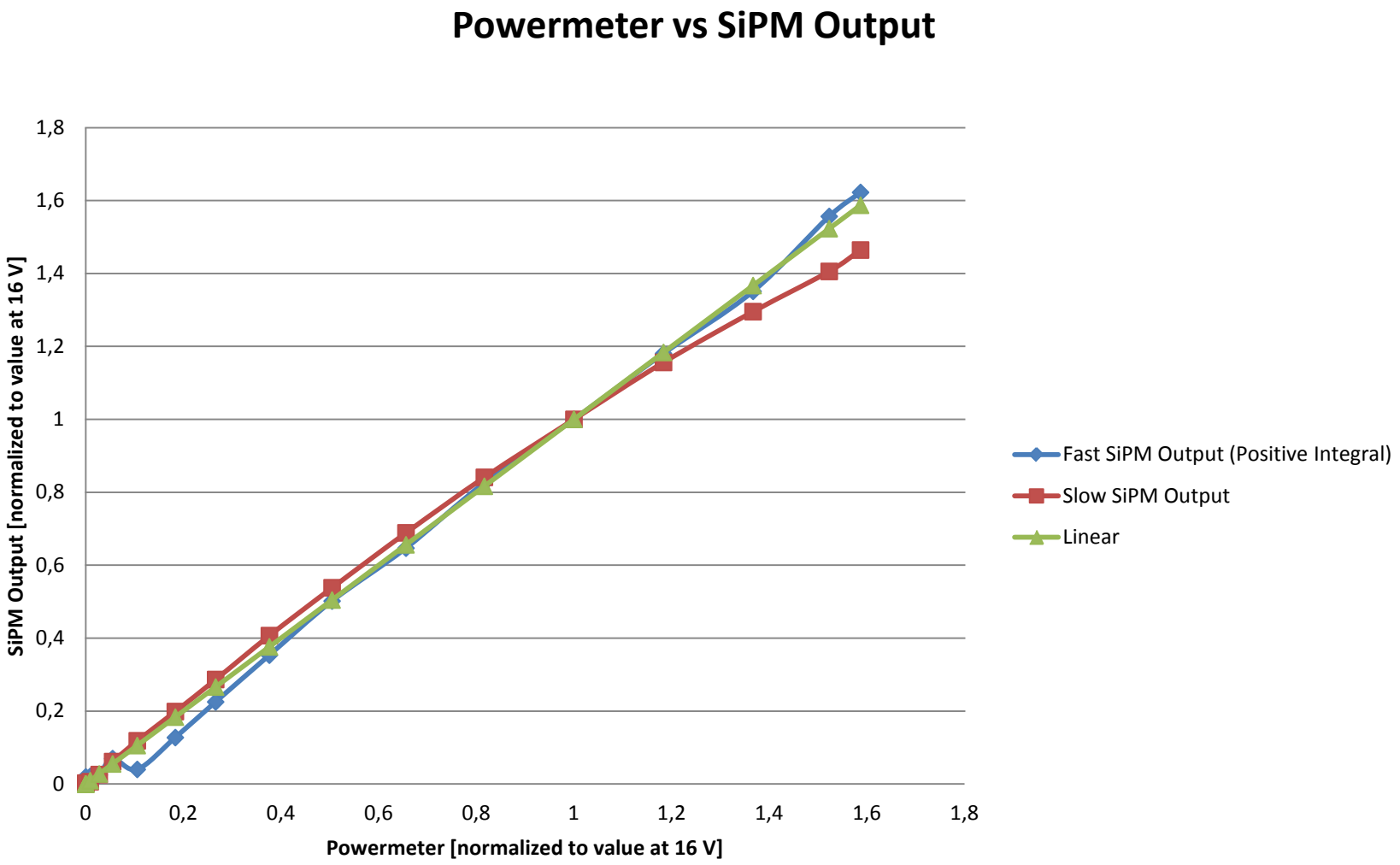

Waveforms
IntegralPosWFM_0
Entries 500
Mean 207.3
Std Dev 8.507


Waveforms
IntegralPosWFM_1
Entries 500
Mean 4.745
Std Dev 0.314

Results


1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
-0,2
0
5
10
15
20
25
Series1
Series2
Series3

Results


Powermeter vs SiPM Output
SiPM Output [normalized to value at 16 V]
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
1,8
Powermeter [normalized to value at 16 V]
Fast SiPM Output (Positive Integral)
Slow SiPM Output
Linear

Status

- Light cavity works in all positions
- New Kaputschinsky PCBs ordered (although not so good as mine XD)
- Lot of light for reference sensor (in fact too much almost for SiPM/PMT but not enough for powermeter)
- Some non-linearities in the system
- Each Kaputschinsky will have to be characterized in-sitiu during the installation process
- Next steps: BeagleBoard to control Kaputs + readout ADC, central PCB design to distribute voltages + SiPM, simple DAQ

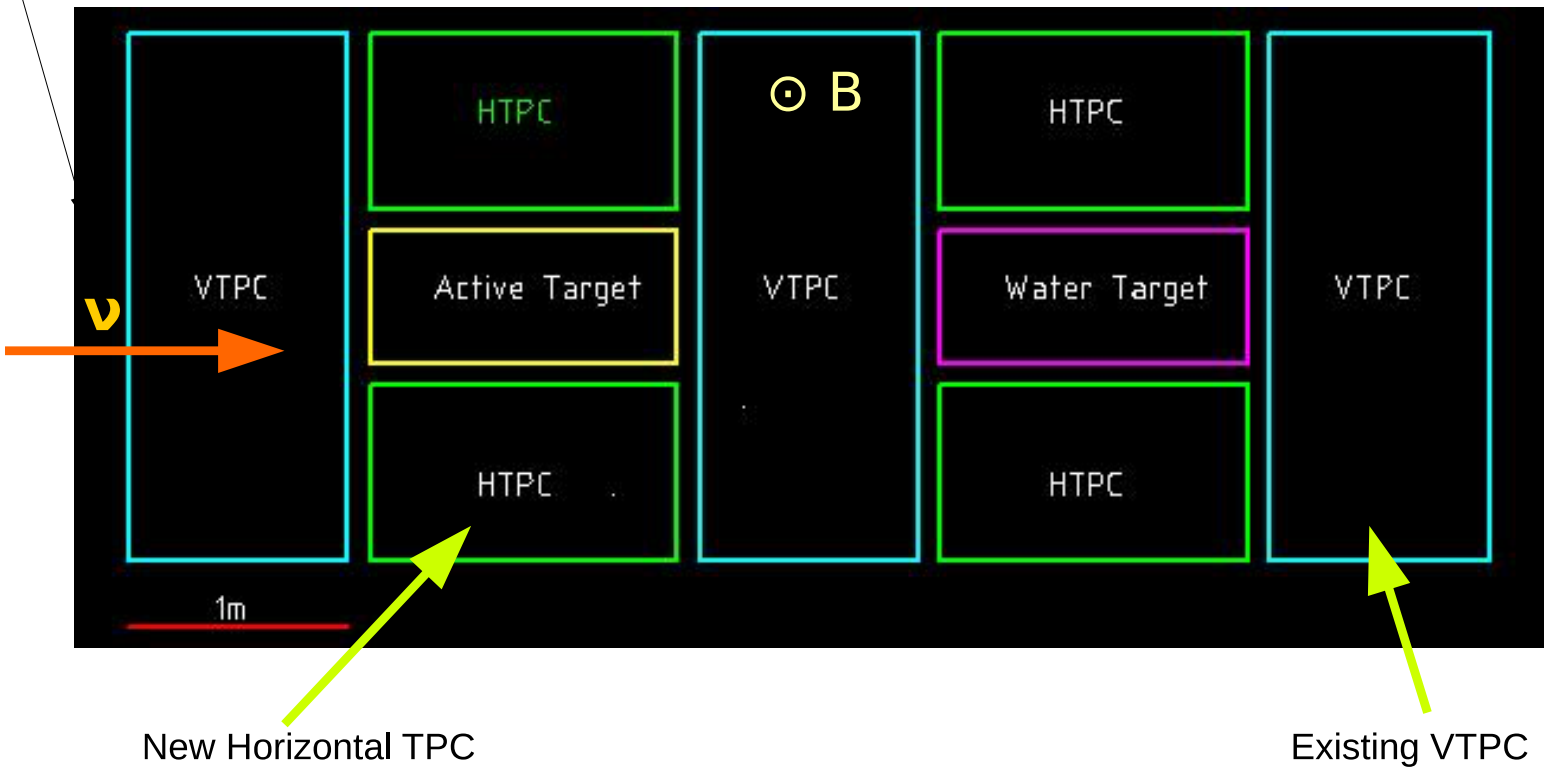
T2K TPC Upgrade: Mechanics

What happened?

- Got in contact with Emilio Radicioni (Bari) to evaluate collaboration in field cage design of new TPC prototype
- Bari, Padua and IFAE
- Kick-off meeting in Padua 13.07.2017

The baseline design for the upgraded ND280

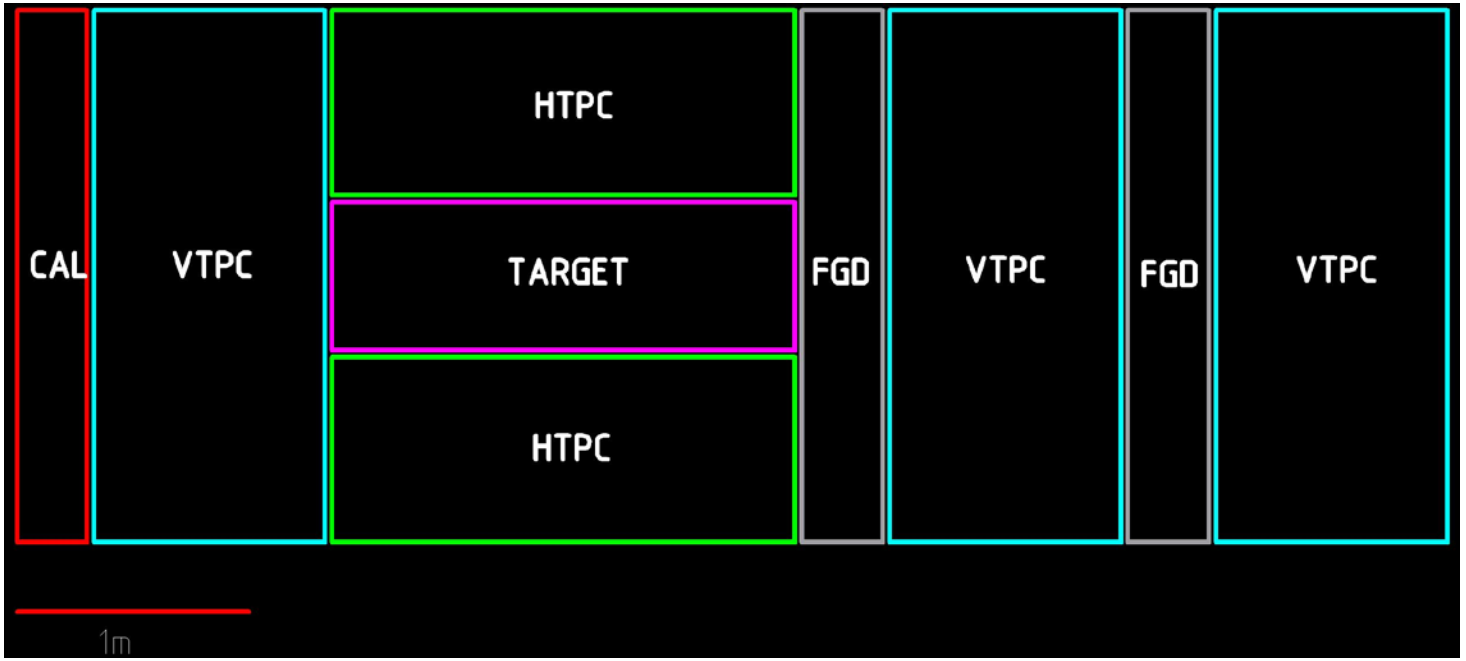
All this inside the EM calorimeter and the UA1 magnet



4 new Horizontal TPCs

* Design still under optimization

A possible alternate configuration



Provide ~4t of instrumented target with excellent acceptance both for forward/backward and high angle tracks.
Minimize reshuffling of detectors. Concentrate on upstream part. Keep most of the current ND280 tracker untouched.

HTPC

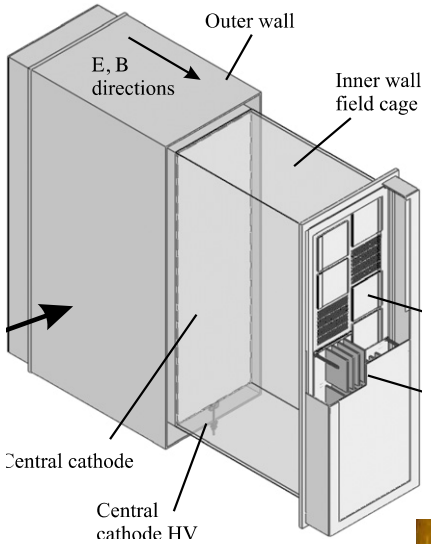
Parameter	Value	Comment
Overall dimensions	2 (x) x 0.8 (y) x 1.3 (z) m**3	4 identical TPC
Volume	2.1 m**3	Each
Drift Length	90 cm	Cathode in the middle
Pad area	~1 cm**2	
Sensitive area tot	7.3 m**2	Tot 4 TPC
N MM	~ 66	Tot 4 TPC with MM ~35x35 cm**2 each
N channels	7.3 10**4	Tot 4 TPC

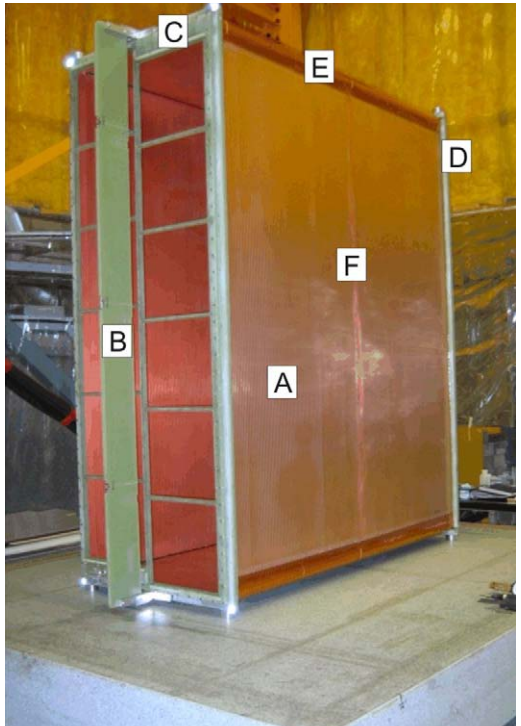
* From Marco Zito

“old” T2K field-cages

- create panels from rohacell + Cu-clad G10 foils and G10 bars
- cut field-shaping strips by milling the Cu surface
  - only 1 strip layer → larger volume wasted because of distorted field
  - ... but easy construction

- dual gas volumes
  - outer: CO_2 for insulation
  - inner: active
  - inner field-cage panels must not
    - degrade the E field
    - provide gas tighness
    - stand overpressure

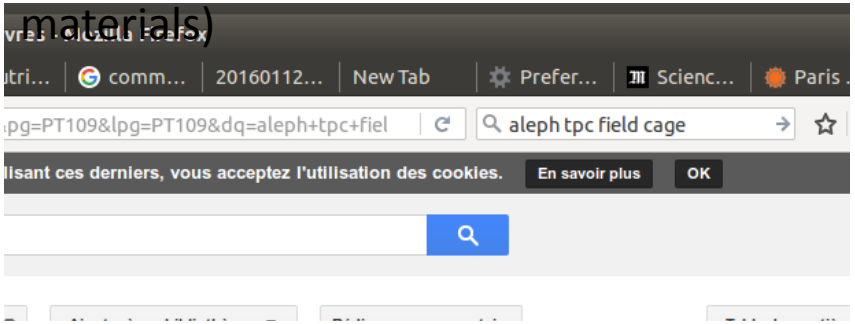




“new” field-cages

- no outer volume
  - Electrostatic insulation
  - gas tightness
  - overpressure
- minimal wasted volume
  - thin
  - light
  - multiple strip layers
- light + thin + overpressure + own weight → panel deformation → E-field dis-uniformity

Aleph / ILC scheme:
Strip layers glued / embedded in the mechanical structure (typically: composite materials)



sulator from a thin Mylar foil winded around many times using a higly resistive glue

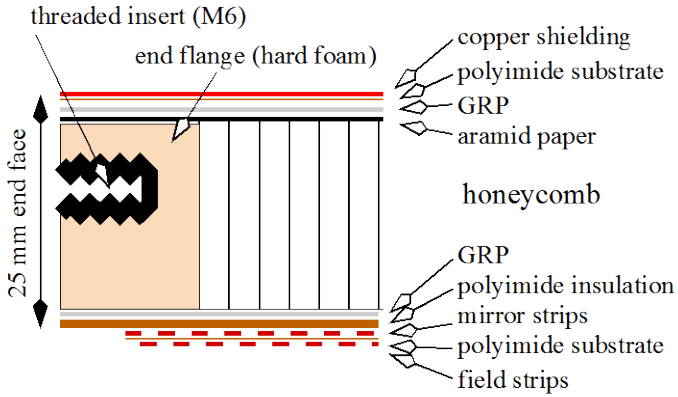
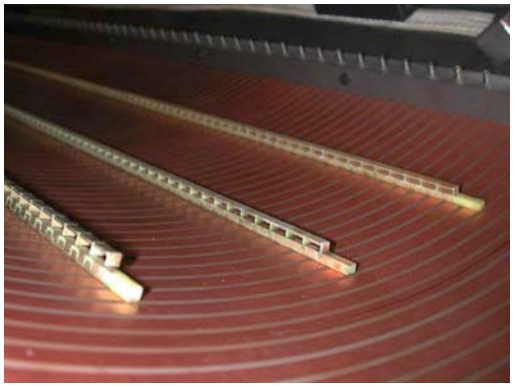
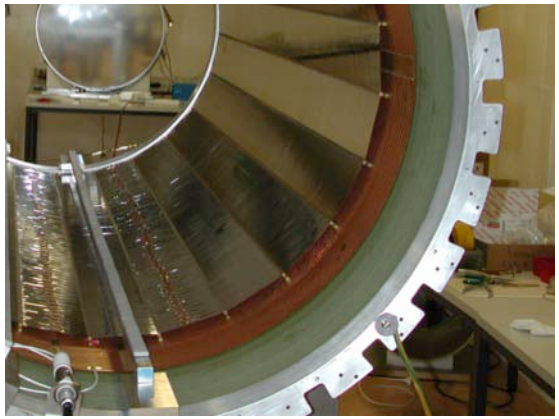


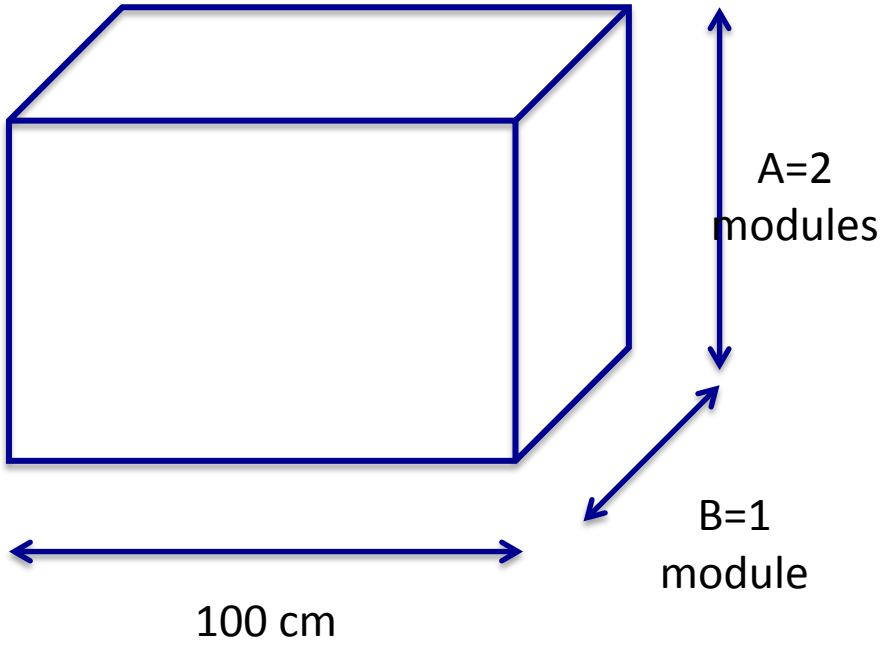
Figure 7: Cross section of the Large Prototype field cage wall.

HARP scheme:
One strip layer is glued to the mechanical structure, additional layers as mylar strips stretched on light supports





First stage?



- AxBx100cm
- Can host 2 MM chambers
- Realistic drift length
- Integration tests @ CERN (?)

TO BE DISCUSSED

- Prototype with final technical choices
- Smaller size but large enough to fit 2 readout modules
- To be used as verification of the construction technique
- And also useful for integration tests
- Timeline: 10/2018

IFAE Contribution (amont other)

- Panel deformation
  - perform calculations for gravity- and overpressure-induced deformations
    - top and bottom TPCs not symmetrical w.r.t. gravity deformations
    - do initial calculations for ILC-style structure
    - carbon fiber is attractive for the possibility of orienting fibers in a favorable way but difficult to evaluate by end of July
    - pre-compressed panels?
  - Regarding carbon fiber: ask to simulate in G4 what is the advantage of thinner (but more dense) panels VS thicker (honeycomb-like) ones.
  - 2 options: 5 and 10 mbar overpressure, for the moment. Not clear if more will be needed or if – on the contrary – is irrelevant.

Juli started to work on this: first results beginning of October!

3. COMPOSITES SIMULATION PLAN

- IFAE CAE SIMULATION EXPERTISE IN: SOLIDWORKS & PATRAN/NASTRAN
- PATRAN/NASTRAN is a more reliable software for structural analysis.
- Supports composite material modeling to perform a variety of analyses.

- An advanced training course in PATRAN/NASTRAN composites is scheduled for September'17 at IFAE.
- First simulations are planned by early October'17.

COURSE PAID BY SO MONEY!

Since Padua Meeting

- Juli provided cost estimation for Italian call (40 kEuro)

ROUGH COST ESTIMATION FOR TPC PROTOTYPE MANUFACTURING (2017/07/25; Version N)

System	Category	Rough cost	Comments
STRUCTURE	Raw material	9.900,00 €	Composites plates + Honeycomb (TBD)
	Tools	1.500,00 €	Manufacturing tools + consumables
	Material testing	3.600,00 €	Composite plate bending + characterization
FIELD CAGE	Raw material	5.400,00 €	Insulation plate + copper stripes
OUTSOURCING SERVICES		6.000,00 €	Assembly + Gluing of Structure & Field cage
LOGISTICS		720,00 €	
	TOTAL	**27.120,00 €**	

- Meeting in September (at CERN) with MM and end cap guys to ensure integration for prototype

Status

- Finally starting to move and with good momentum
- Agreed on basic concept for FC structure
- Strong preferences for HARP FC if possible
- IFAE contribution:
  - Juli: mechanical simulations
  - Possible tests at APPLUS of samples
  - Silvestro probably going to join the efforts from the simulation point of view
  - If double sided copper coated Kapton is needed for FC, Joan might help the design (asked already LabCircuit if they could produce these)
  - Participate in part production in first half of 2018
- Design should be ready end 2017/beginning 2018 latest
- Prototype: Mid 2018

Other Stuff

Rest

- WA105: stayed 4 days at CIEMAT for R&D projects (another time) + PMT handling
- WA105: 1st PMT for testing arrives today at CERN => Fits it in coating device with cable?
- DUNE: IFAE signed up for Photo Detection System of DP Far Detector => have to propose Consortium leader until Monday