

$\mu^+ \rightarrow e^+ \gamma$ 探索実験 MEG II の建設状況

(Construction status of the MEG II
experiment searching for $\mu^+ \rightarrow e^+ \gamma$)

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日本物理学会大2015秋季大会@大阪市立大学



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他 MEG II collaboration

Abstract

1. **MEG II** is upgrade of MEG experiment, searching for $\mu \rightarrow e\gamma$
2. All the detectors are now under construction
3. To carry out a **'pre'-engineering run in 2015**
4. Toward starting data taking in 2016

Next $\mu \rightarrow e\gamma$ Experiment

- **Aim at sensitivity of $O(10^{-14})$**
 - x10 improvement from MEG
- **By exploiting the full beam power available today,**
 - $\sim 10^8 \mu^+/\text{s}$ at PSI $\pi E5$
- **By upgrading the MEG detector**
 - Keep experimental concept
 - in short (~ 5 years), at low cost

MEG II Experiment

MEG II

Keep 3 keys of MEG

1. World's most intense DC μ beam @ PSI
2. Innovative liquid xenon γ -ray detector
3. Gradient B-field e^+ -spectrometer

Double beam intensity,
Double efficiency,
Suppress BG factor ~ 30

- Halve every resolution,
- Add new detector to identify BG

Where We Will Be

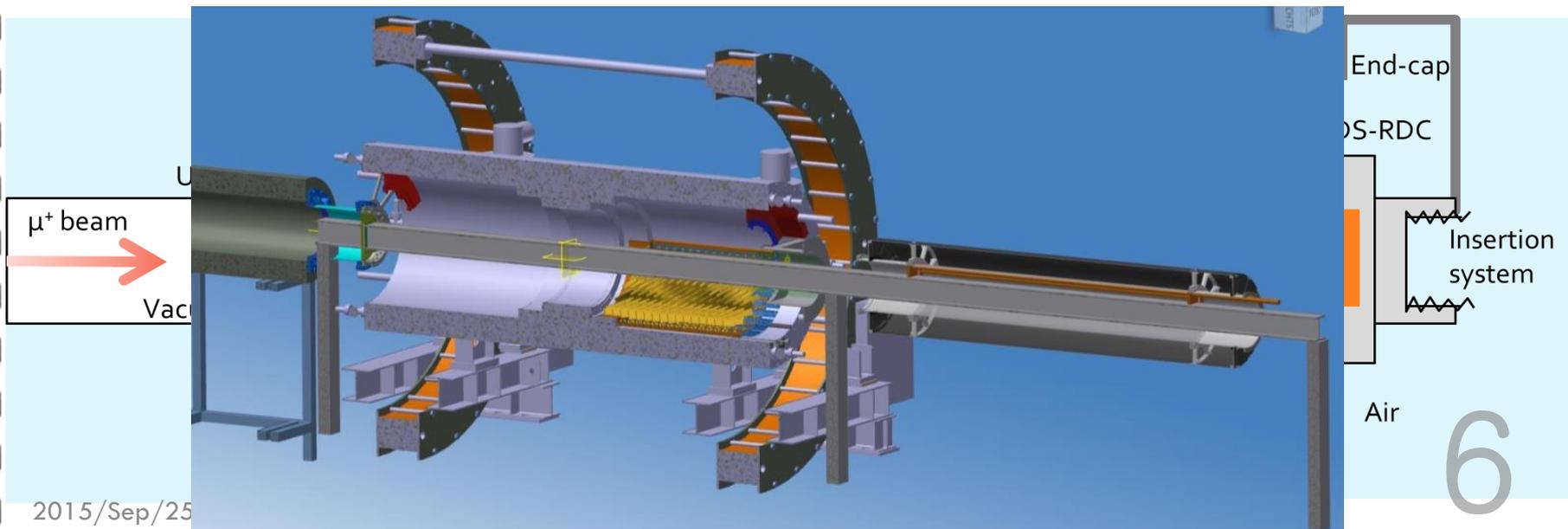
4×10^{-14} 500

2012	Start the project. Conceptual designing. Submit the proposal to PSI
2013	Proposal approval.
2014	R&D Construction partially start.
2015	Detector construction. Detector commissioning. Pre-engineering run.
2016	Full engineering run. Data taking.
2017,2018	



Goal of 2015

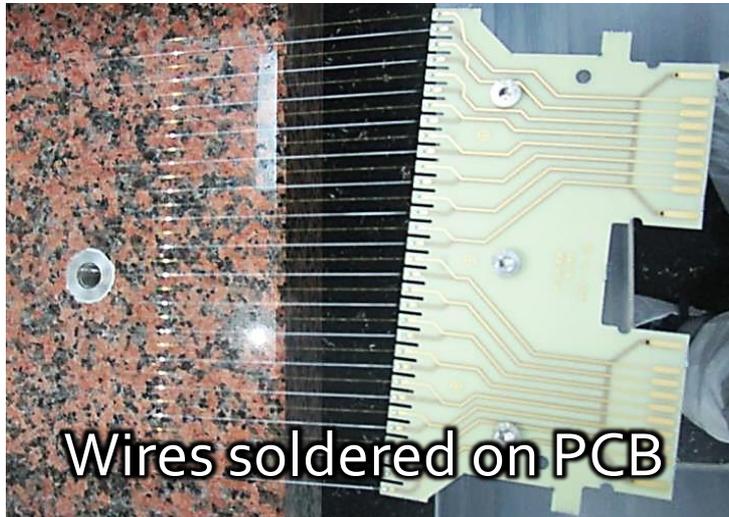
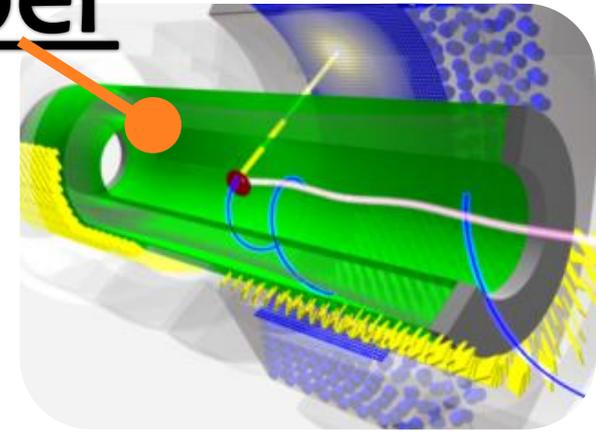
- Check the **mechanical integrity & functionality** of the MEG-II upgrade design
 - Enable design corrections & modifications well before Engineering run in 2016
- Enable beam optimization & setup of new target
- Aim at **Michel beam test** of DS **Timing Counter** system with limited readout



New Drift Chamber

◆ Stereo-wire low-mass drift chamber

- 1200 sense wires, $1.7 \times 10^{-3} X_0$ per track
- Partially wired **‘mock-up chamber’** was built and being installed today.
 - with HV & gas system
 - for mechanical integration & operation test
- **Final chamber under construction.**
 - Wiring has been started (several months delay), takes ~half year.
 - Full system will be ready by Aug. 2016. (~5 months delay)

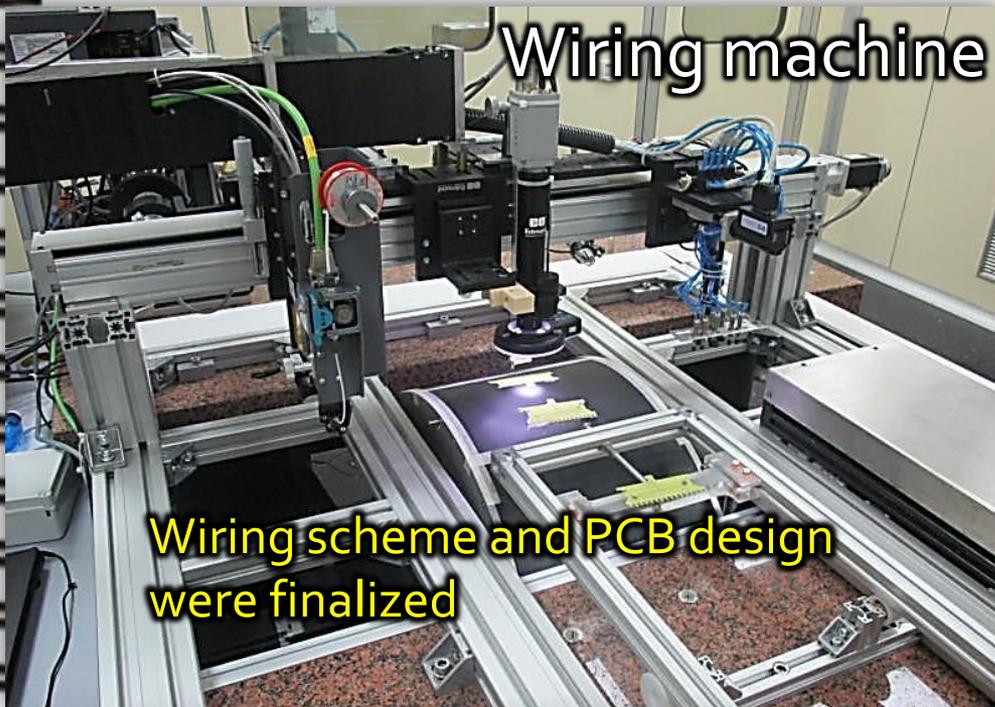


Wires soldered on PCB

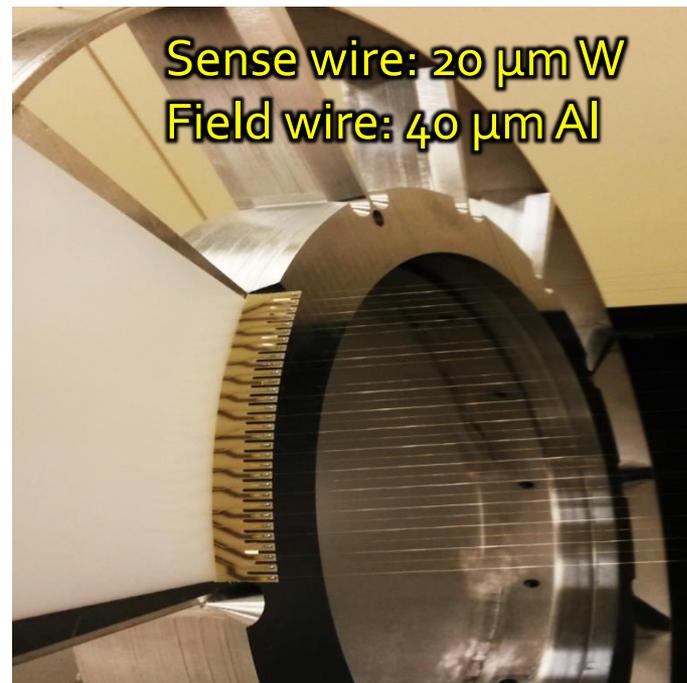


The 'mock-up' chamber

Wiring machine



Wiring scheme and PCB design were finalized

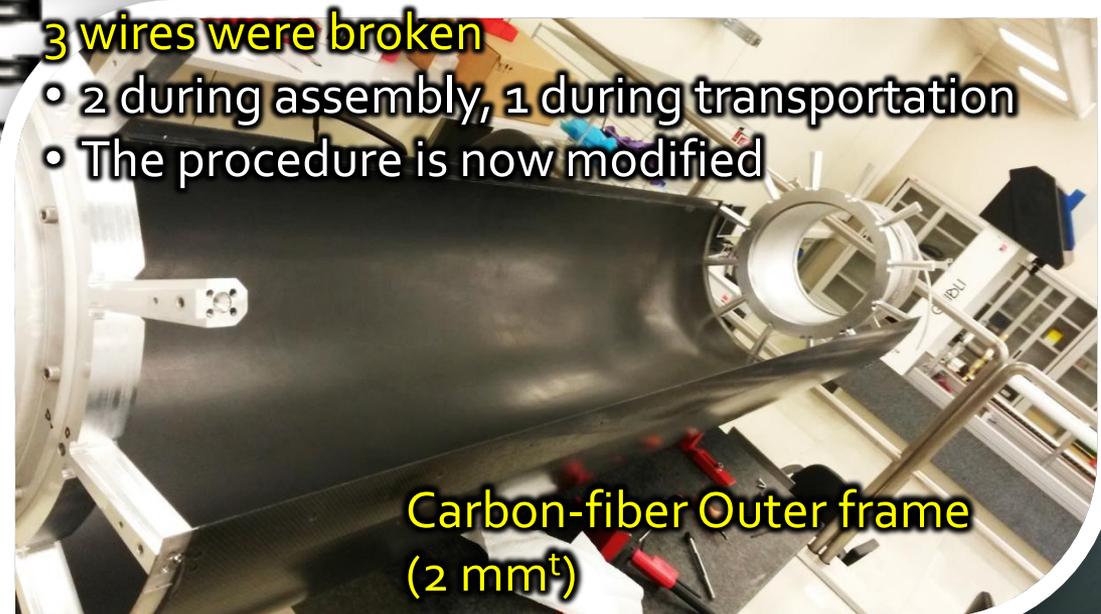


Sense wire: $20\ \mu\text{m W}$
Field wire: $40\ \mu\text{m Al}$

3 wires were broken

- 2 during assembly, 1 during transportation
- The procedure is now modified

Carbon-fiber Outer frame
($2\ \text{mm}^t$)



Inner foil
($20\ \mu\text{m Al-Mylar}$)

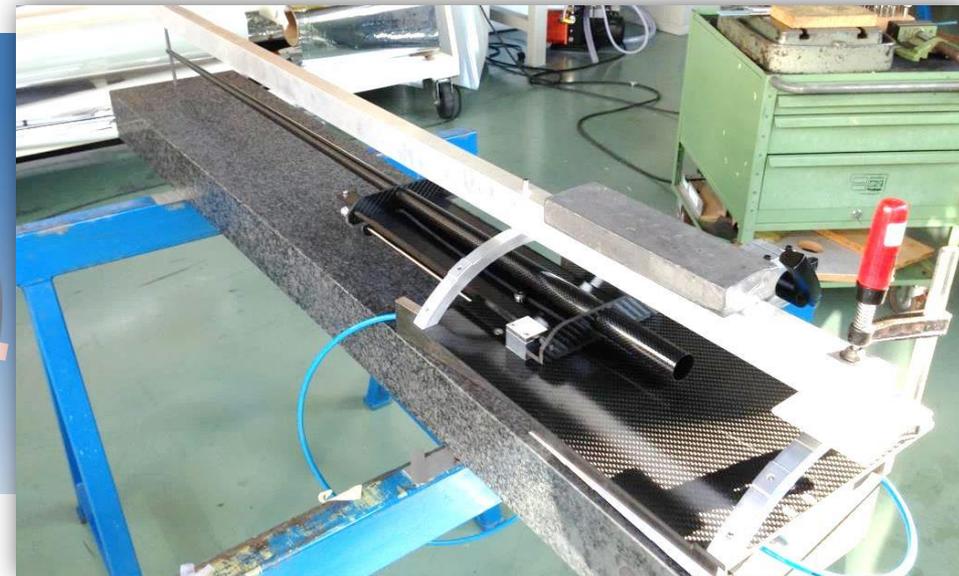
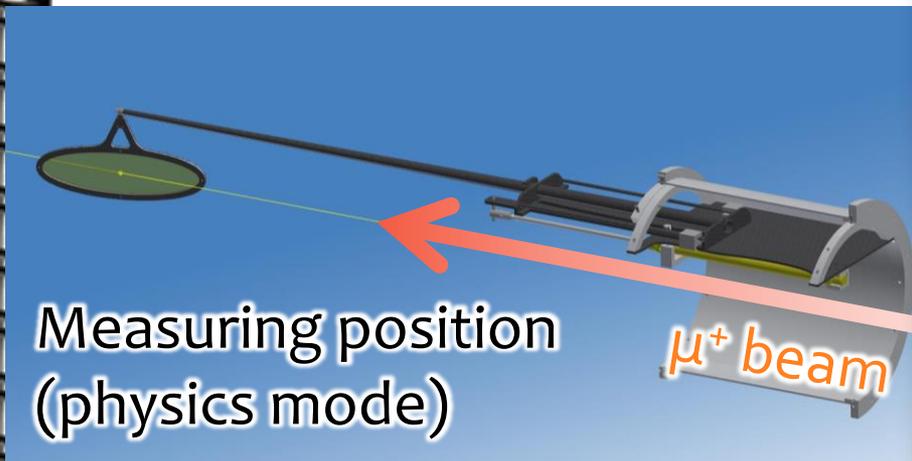


Target System

◆ New μ -stopping target system new spectrometer

● Target material under study

- Deformation issue in MEG I
 1. Polyethylene (140 μm)
 2. Beryllium (90 μm)
 3. Scintillator film (130 μm)



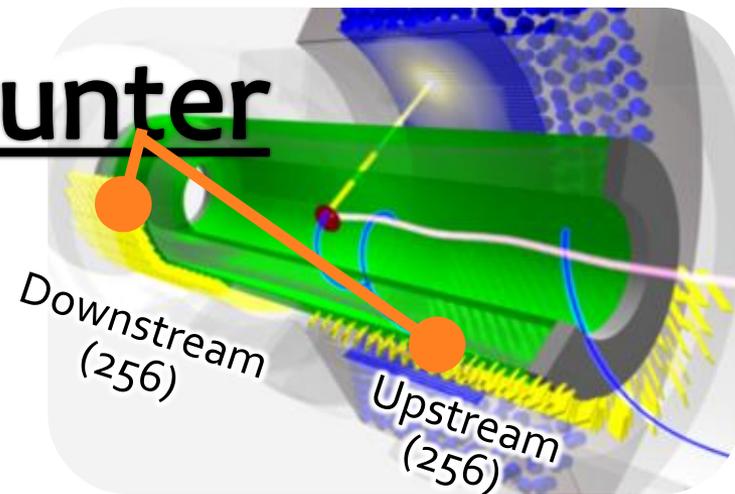
Pixelated Timing Counter

- ◆ 30-ps resolution counter system with segmented scint. counters
- Engineering run with half of downstream (128) counters
 - ~140 counters have been constructed

- Single counter resolution $\sigma \sim 75$ ps
 ~ 10 ps worse than expected due to lower PDE of mass-produced SiPMs (AdvanSiD)
 \Rightarrow 15% worse overall resolution: 28 \rightarrow 32 ps
- Scintillator production failure (Saint-Gobain)
 Good production eff. $\sim 35\%$. Reproduction on-going

– Mechanical & installation system ready

- Test calibration system
- Installation starts at mid-Oct.

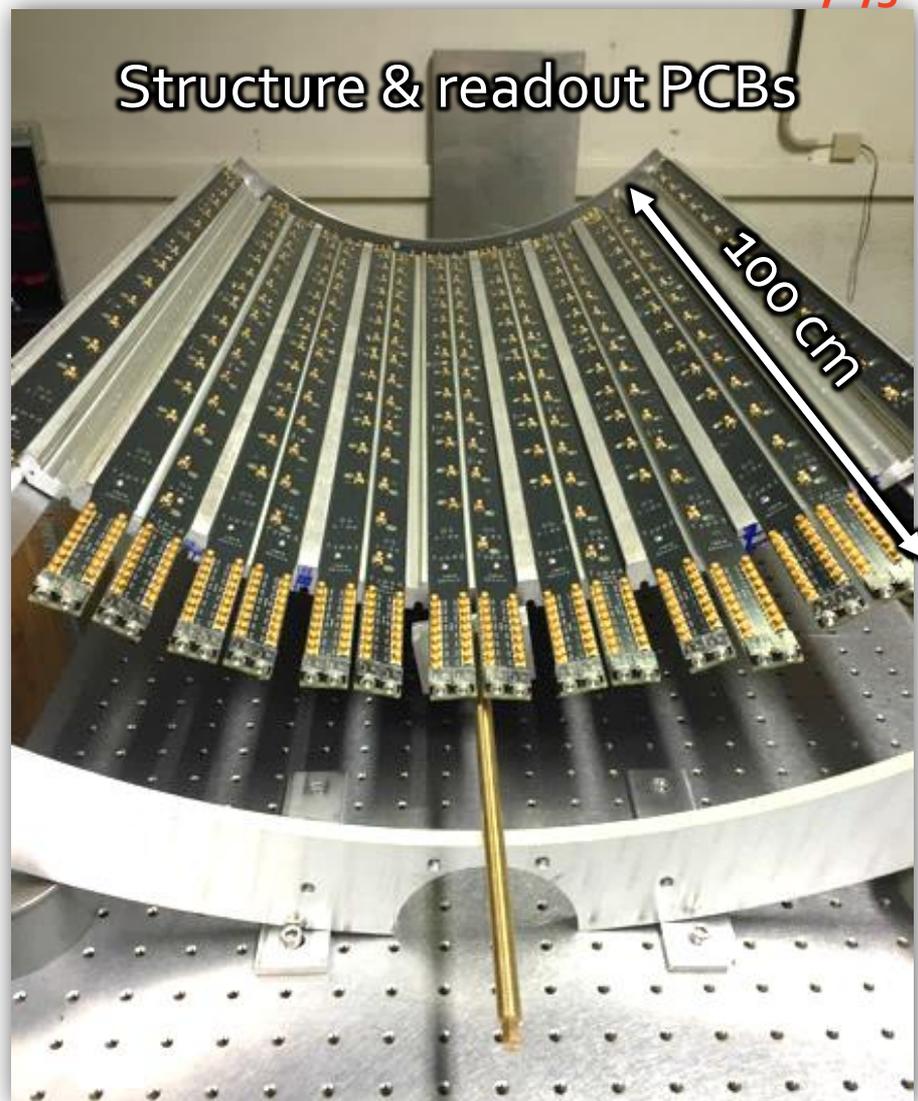


Wrapped in ESR film

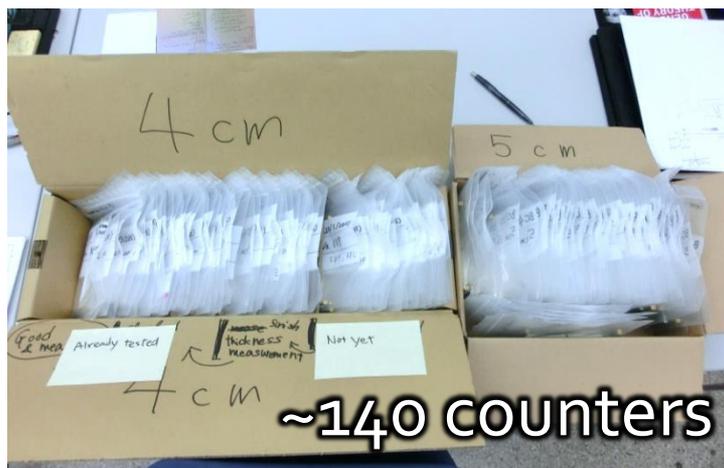
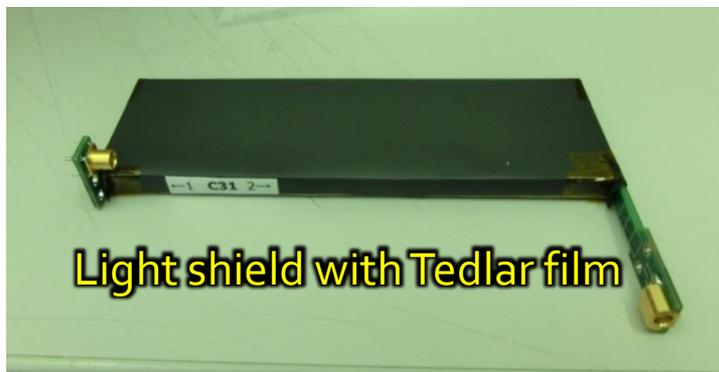


26aSN1,2,3

Structure & readout PCBs



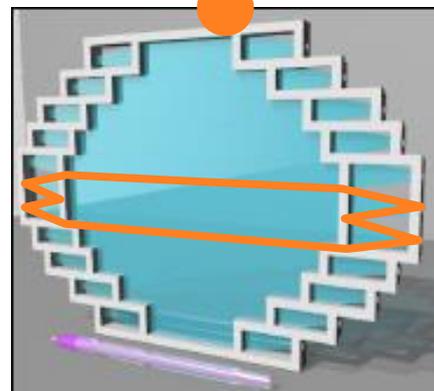
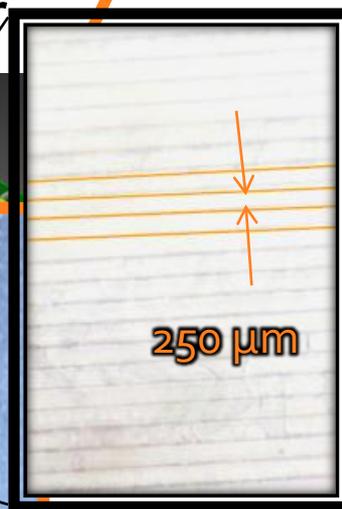
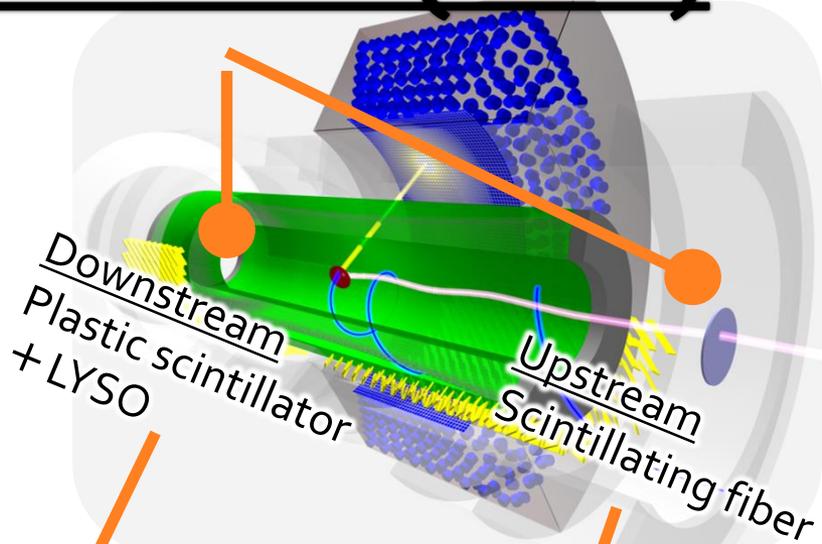
Light shield with Tedlar film

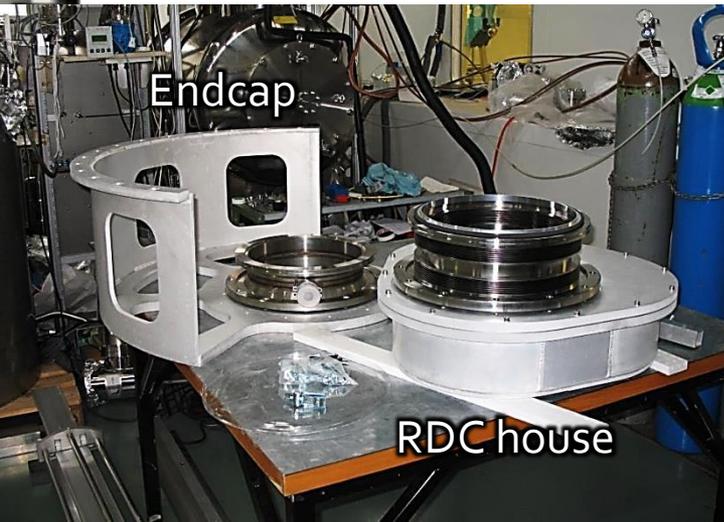
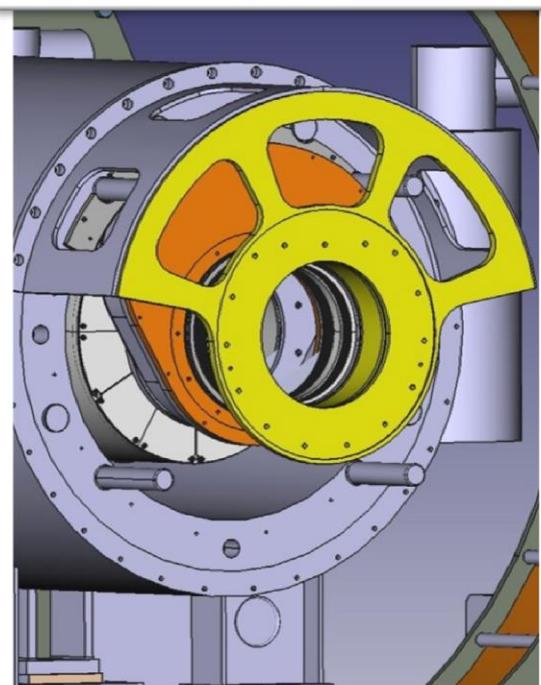
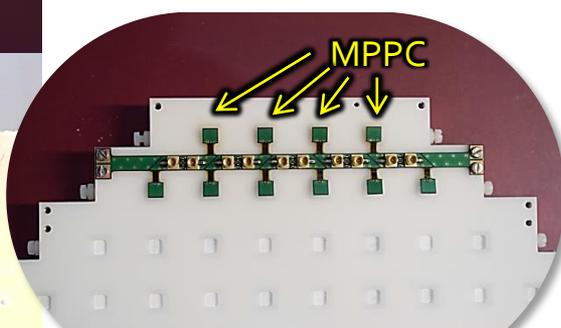
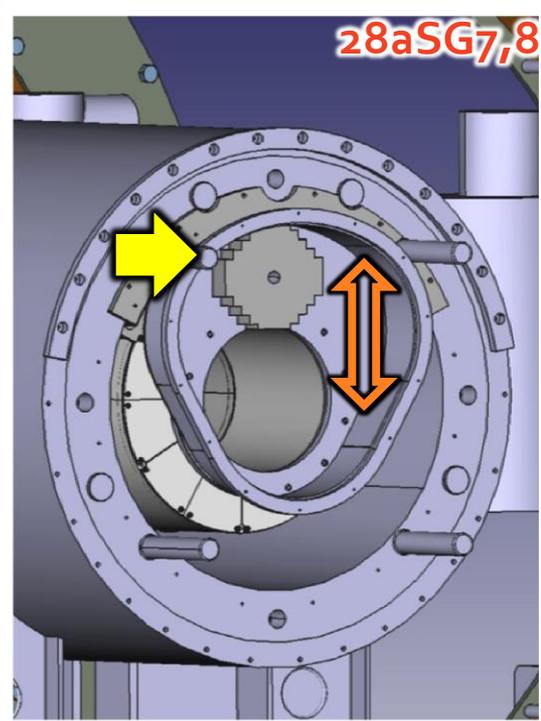
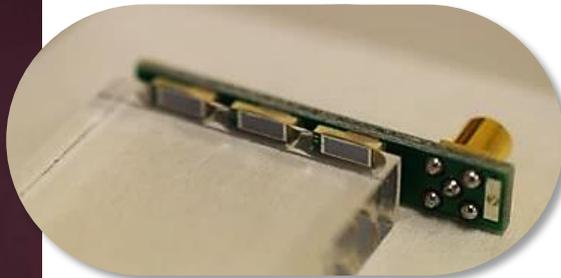
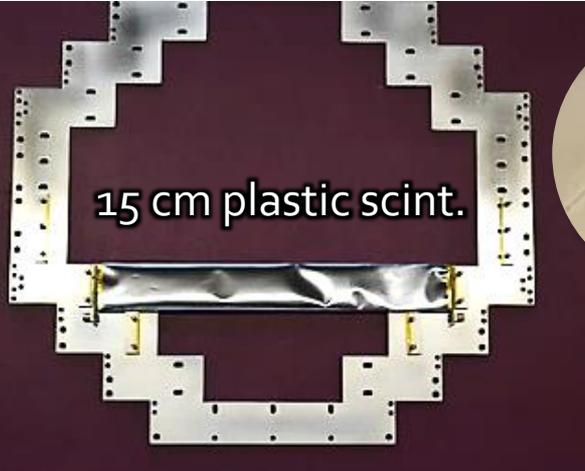


Assembly & installation foreseen after JPS meeting

New BG Tagging Detector (RDC)

- **Optional detector, new for MEG II**
 - To actively tag BG from $\mu \rightarrow e\nu\bar{\nu}\gamma$
- **Test Upstream detector's impact on beam in this year's run**
 - for the final decision.
 - Prototyping.
- **Downstream detector was **approved** by the collaboration, giving **16%** higher sensitivity**
 - Construction underway (in this year)

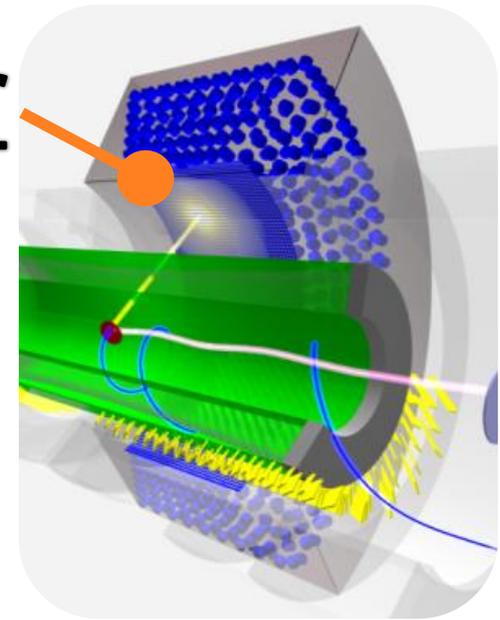




RDC is not installed this year

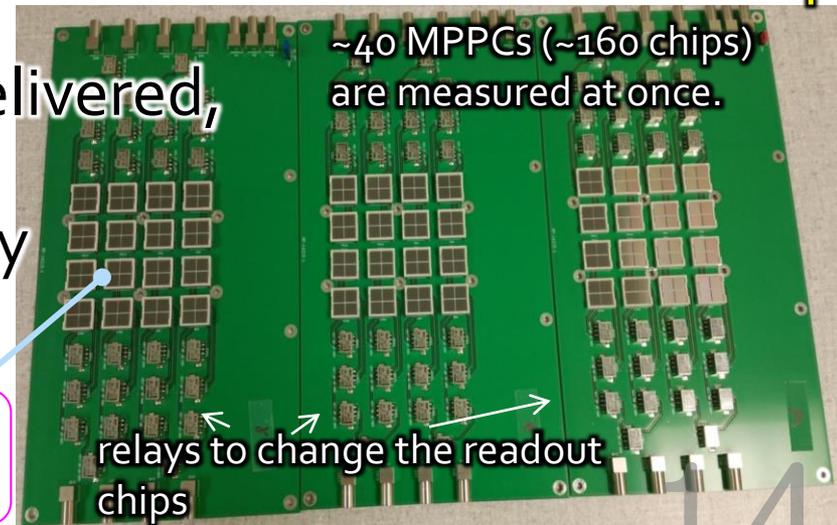
- Detailed mechanical design is not yet fixed (moving system, cabling, etc.)

LXe γ -ray Detector



- ◆ Replace inner-face PMTs with MPPCs
 - must be sensitive to LXe scint. light (175 nm)
- This year, concentrate on the construction (no engineering run), till April 2016.
- Final MPPCs are being delivered and tested.
 - 3370 (out of 4200) were delivered, and 2450 were tested.
 - ~2 months delay in delivery (Hamamatsu Photonics)

Mass test in room temp.

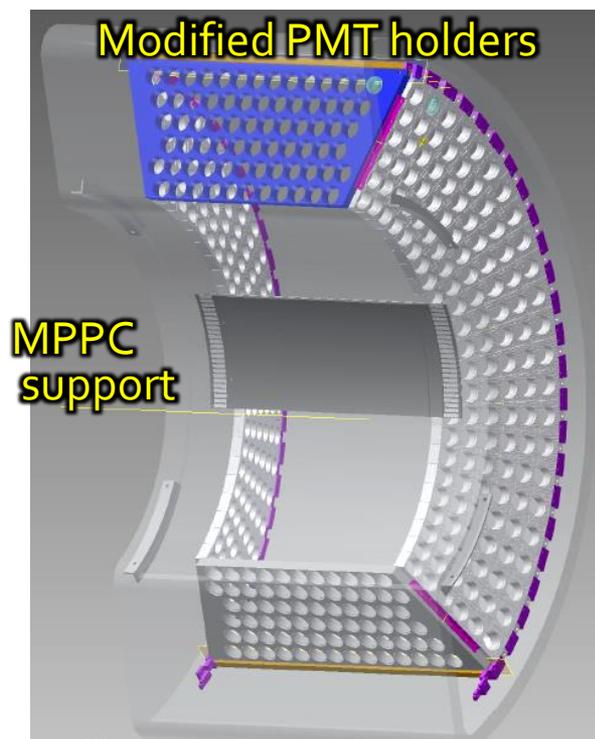


VUV MPPC (S10943-4186(X))
(12 × 12 mm²)

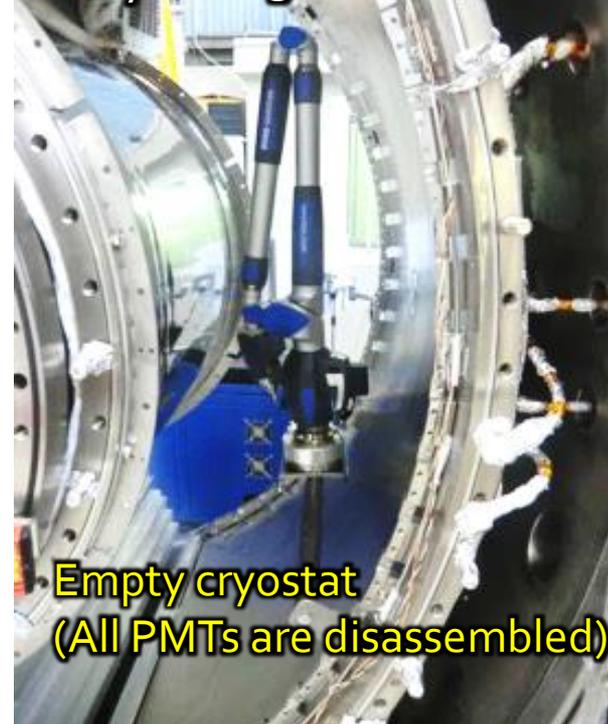
relays to change the readout chips

27aSN8,9,10

- Detailed measurement and mechanical test of cryostat done.
- Modification of PMT holders is finalized, construction to be started soon.



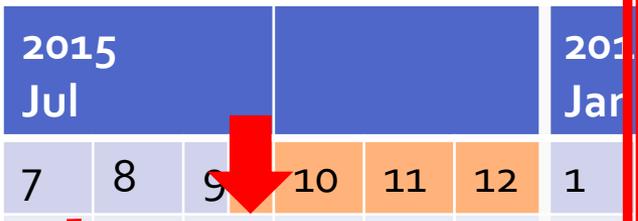
Survey with 3D laser scanner



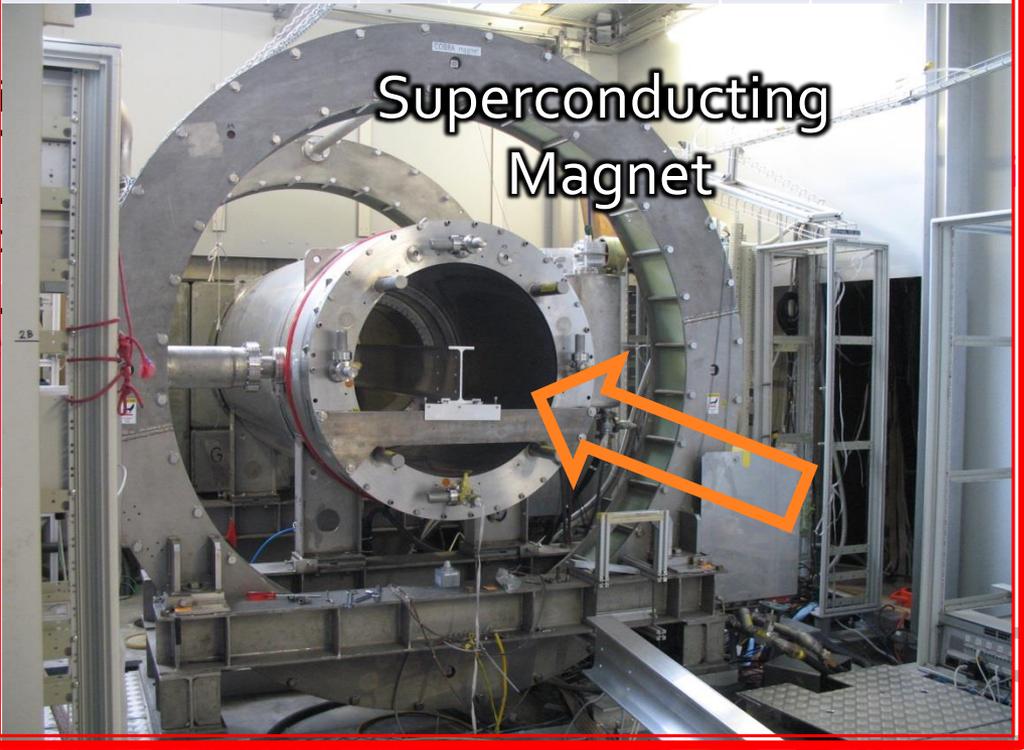
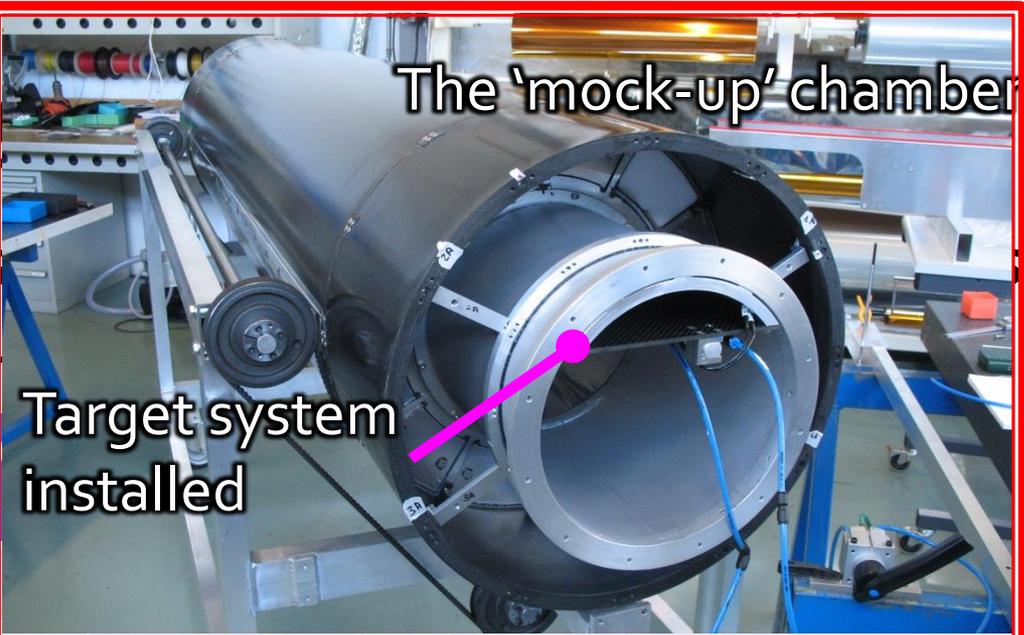
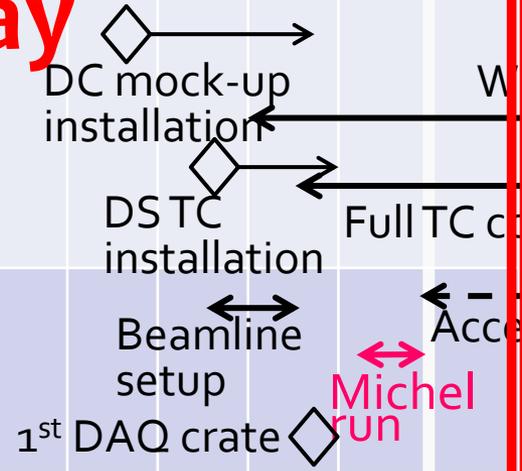
- Detector assembly starts in Nov. and will be completed by Apr. 2016
 - ✓ ~half year delay
- Installation & commissioning in spring–summer.
 - ✓ Liquefaction, operation & signal test

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- 2015 Beam time: start
- 2016 Beam time is



Today



Conclusion

● A very important step for MEG II realization

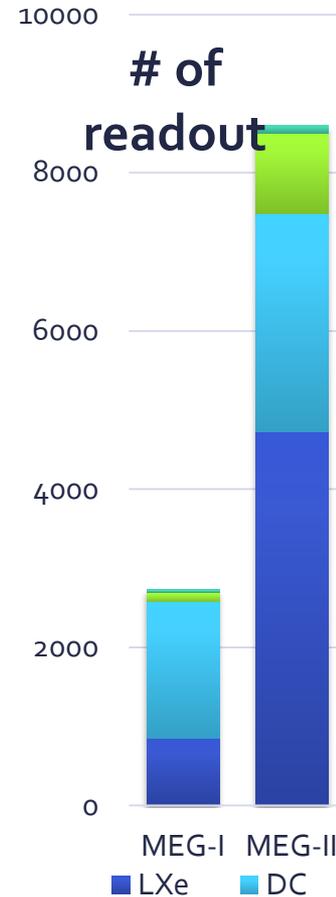
- All the detectors are now under construction
 - ✓ With facing and solving many technical problems
 - ✓ ~ half year delay
- We will carry out a ‘pre’-engineering run this autumn–winter (as scheduled)
 - ✓ Test mechanical integrity
 - ✓ Carry out Michel run with a Timing Counter

● Toward starting data-taking in 2016

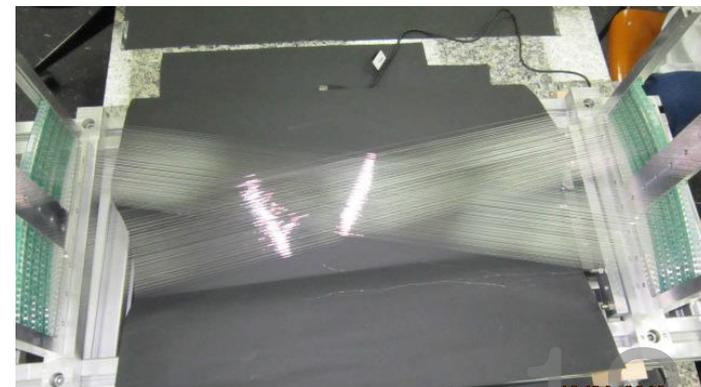
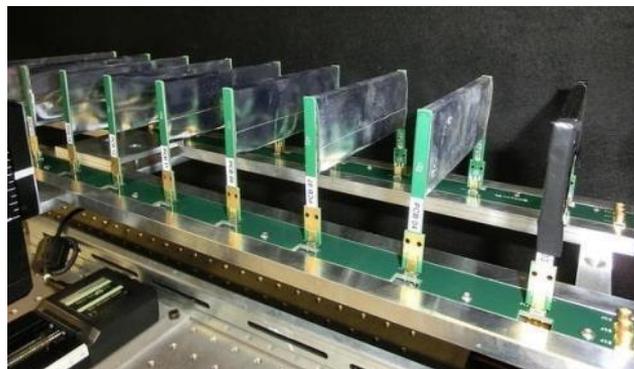
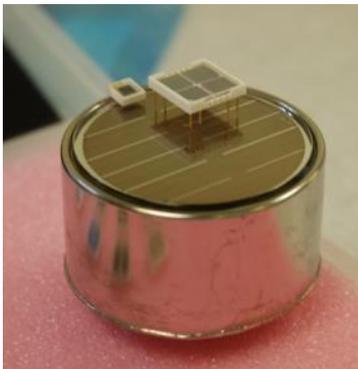
	26aSN01
TC	26aSN02
	26aSN03
	27aSN08
LXe	27aSN09
	27aSN10
	28aSG07
RDC	28aSG08

Detector technologies

- Large-area VUV sensitive SiPM
 - for the world's largest LXe detector. (wavelength 175 nm)
- 30 ps precision time measurement
 - with fast plastic scinti. & SiPMs
- Low mass long stereo-wire drift chamber
 - $0.0017 X_0$ for a particle
- Compact, dense DAQ system
 - To deal with increased channels
 - Waveform digitizer & first trigger step in a same board

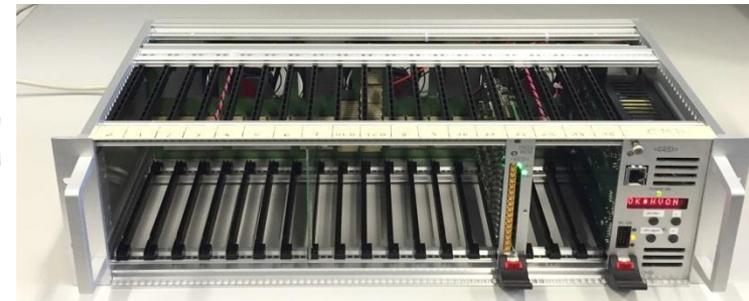
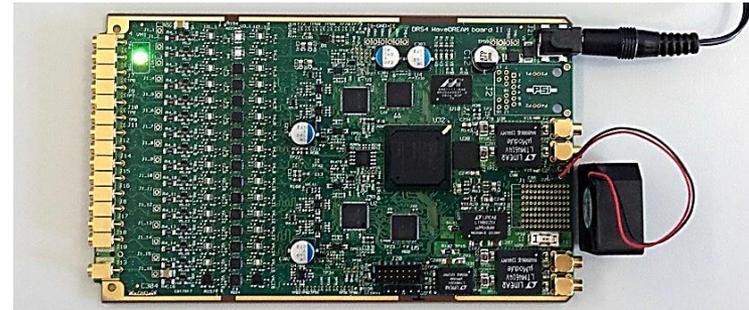


Prototypes



Electronics, DAQ

- **Innovative solution for Trigger & DAQ**
 - Waveform digitizer, frontend circuit, HV supply, 1st level trigger on a board
- **Prototype board under test**
 - Frontend circuit was tested with detector signal
- **First full crate (256 ch) available by Oct. this year**
 - tested in the pre-engineering run
- **Mass production will be started after the test**
- **Complete system ready by spring 2016**



Drift Chamber Wire PCB

- Final design fixed (4th version)

1st ver. in Feb
4th ver. in Sep

