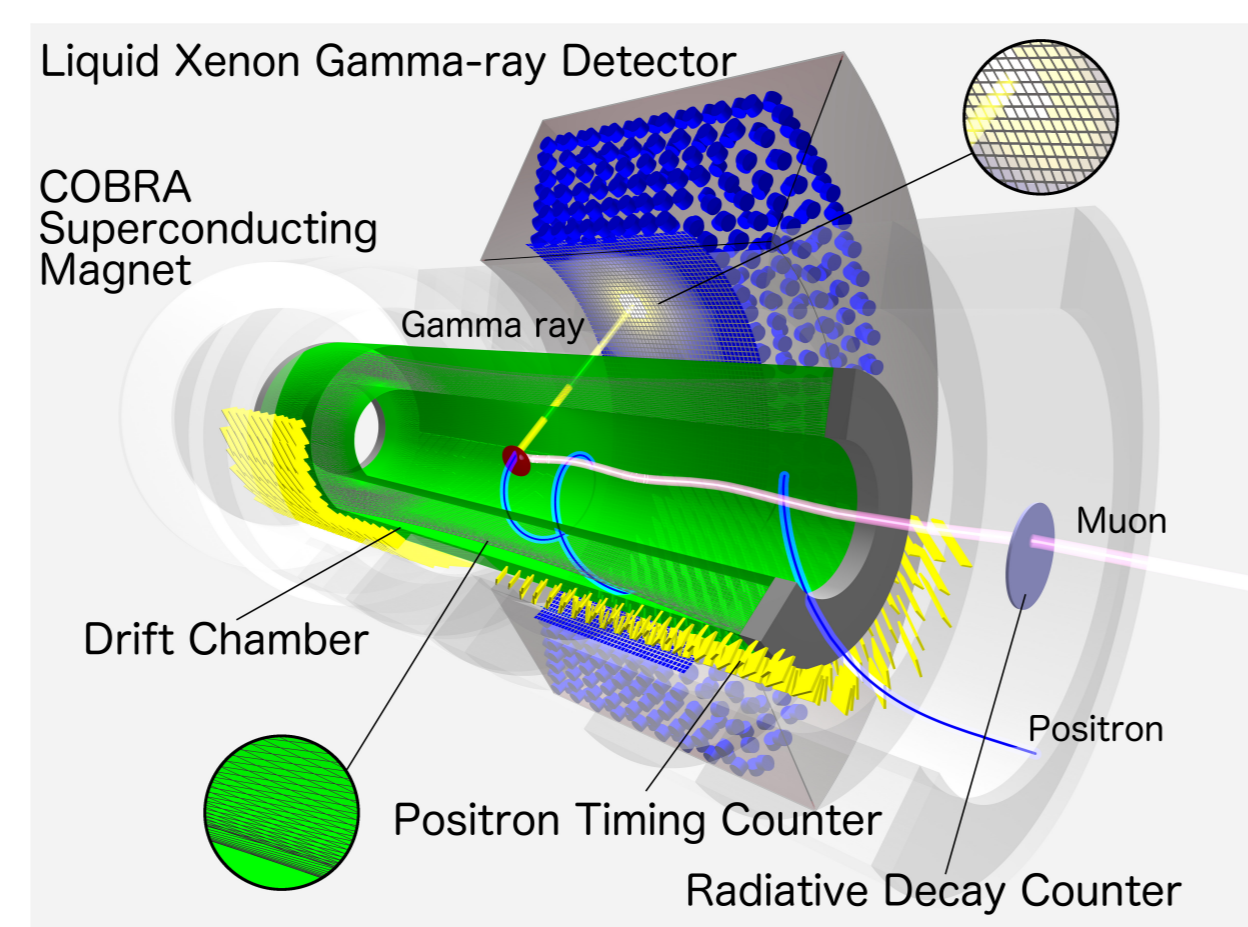


Upgrade of liquid xenon calorimeter for MEG II experiment with VUV sensitive MPPCs

1. MEG II Experiment

MEG experiment searches for lepton flavor violating decay of muon, $\mu^+ \rightarrow e^+ \gamma$.

◆ BR upper limit (90% C.L.): 5.7×10^{-13}



MEG II experiment is the upgrade of MEG experiment.

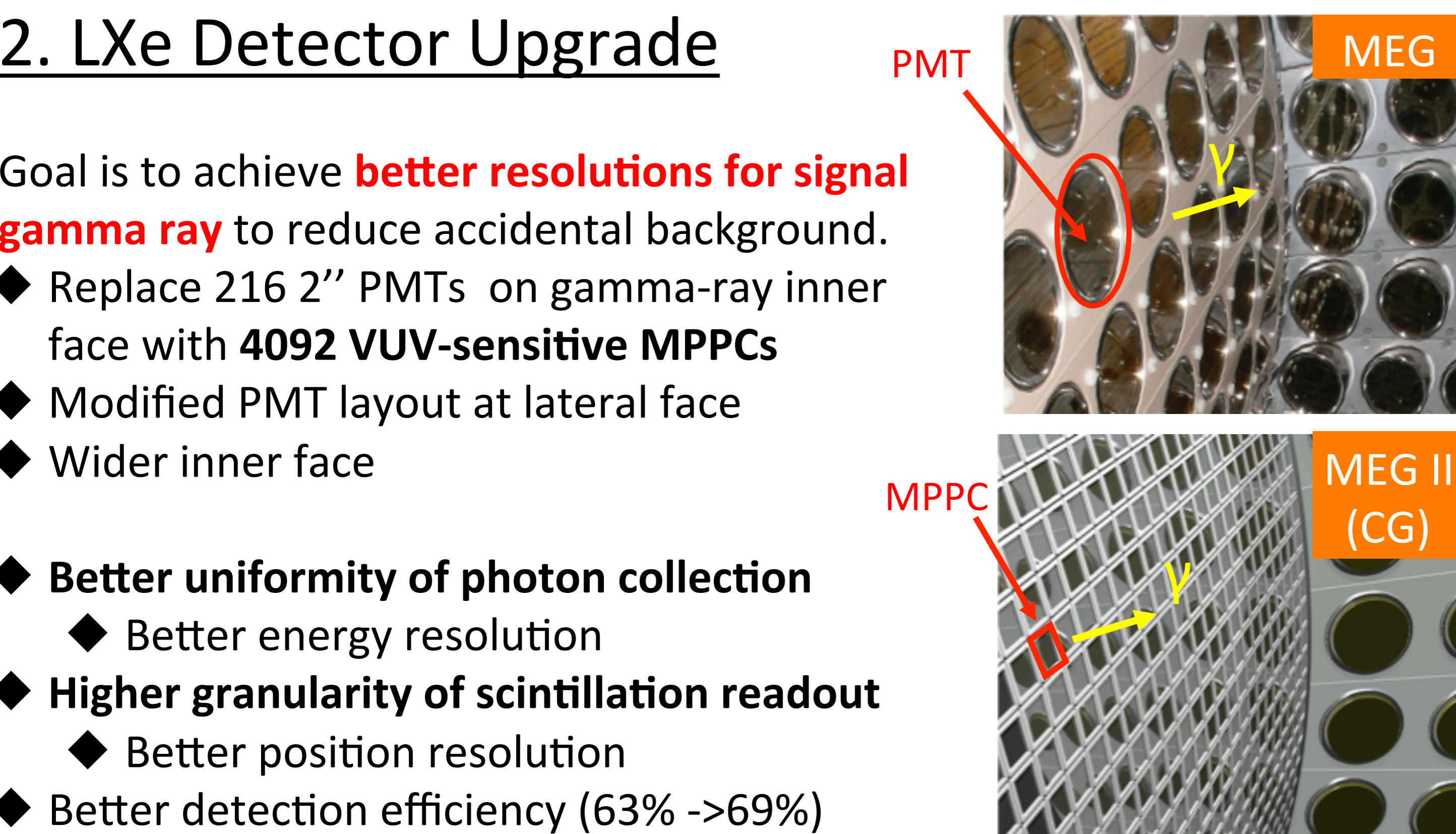
◆ **Expected BR sensitivity (90% C.L.): 4×10^{-14}**

- ◆ Higher beam rate
- ◆ LXe gamma-ray detector with MPPC readout
- ◆ Pixelated positron timing counter
- ◆ Cylindrical drift chamber for positron tracking
- ◆ Radiative decay counter for background identification

2. LXe Detector Upgrade

Goal is to achieve **better resolutions for signal gamma ray** to reduce accidental background.

- ◆ Replace 216 2" PMTs on gamma-ray inner face with **4092 VUV-sensitive MPPCs**
- ◆ Modified PMT layout at lateral face
- ◆ Wider inner face
- ◆ **Better uniformity of photon collection**
 - ◆ Better energy resolution
- ◆ **Higher granularity of scintillation readout**
 - ◆ Better position resolution
- ◆ Better detection efficiency (63% → 69%)



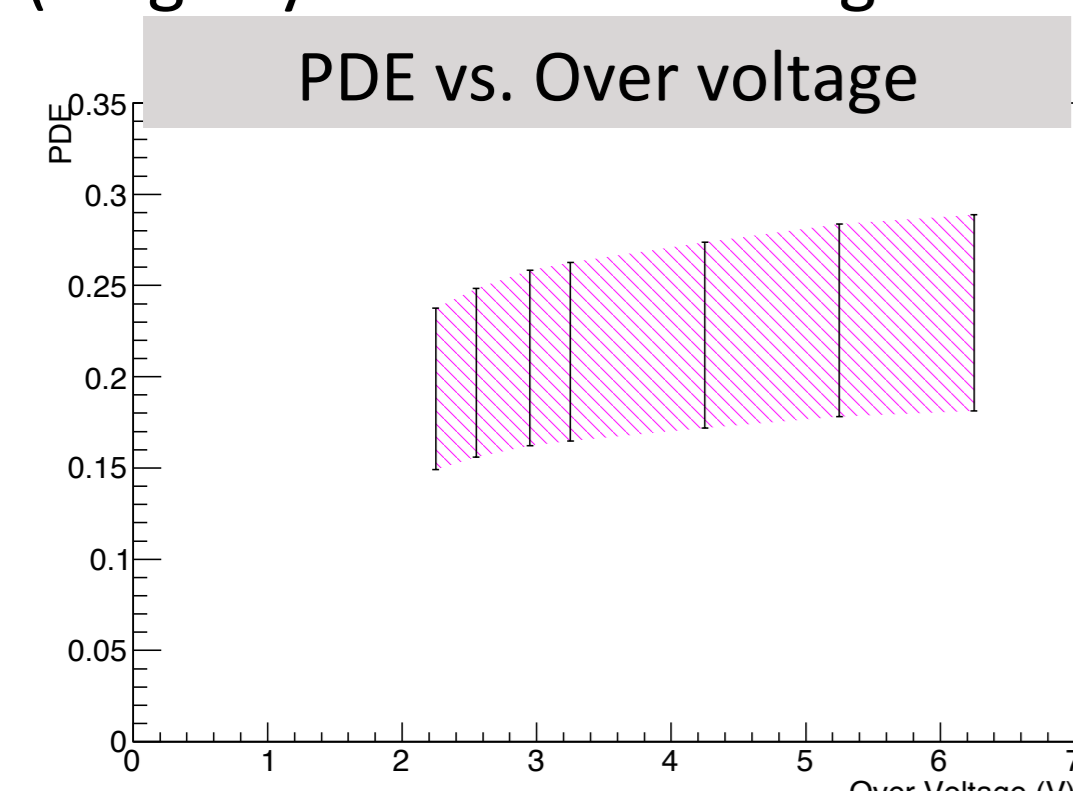
3. Development of VUV-Sensitive MPPC

Large area VUV-sensitive MPPCs have been developed in collaboration with Hamamatsu Photonics K.K.

Performance was measured in LXe.

◆ **Measured PDE: 16% - 27%**

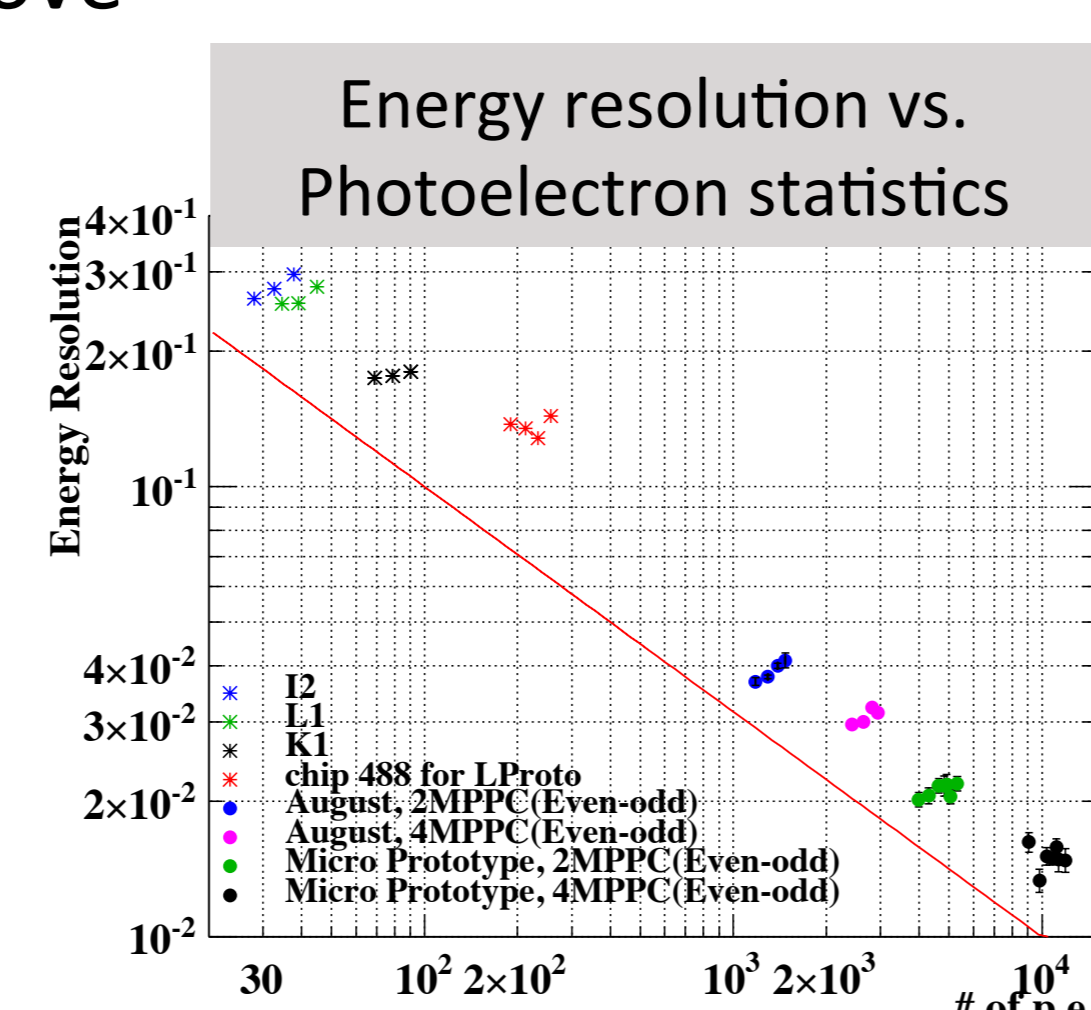
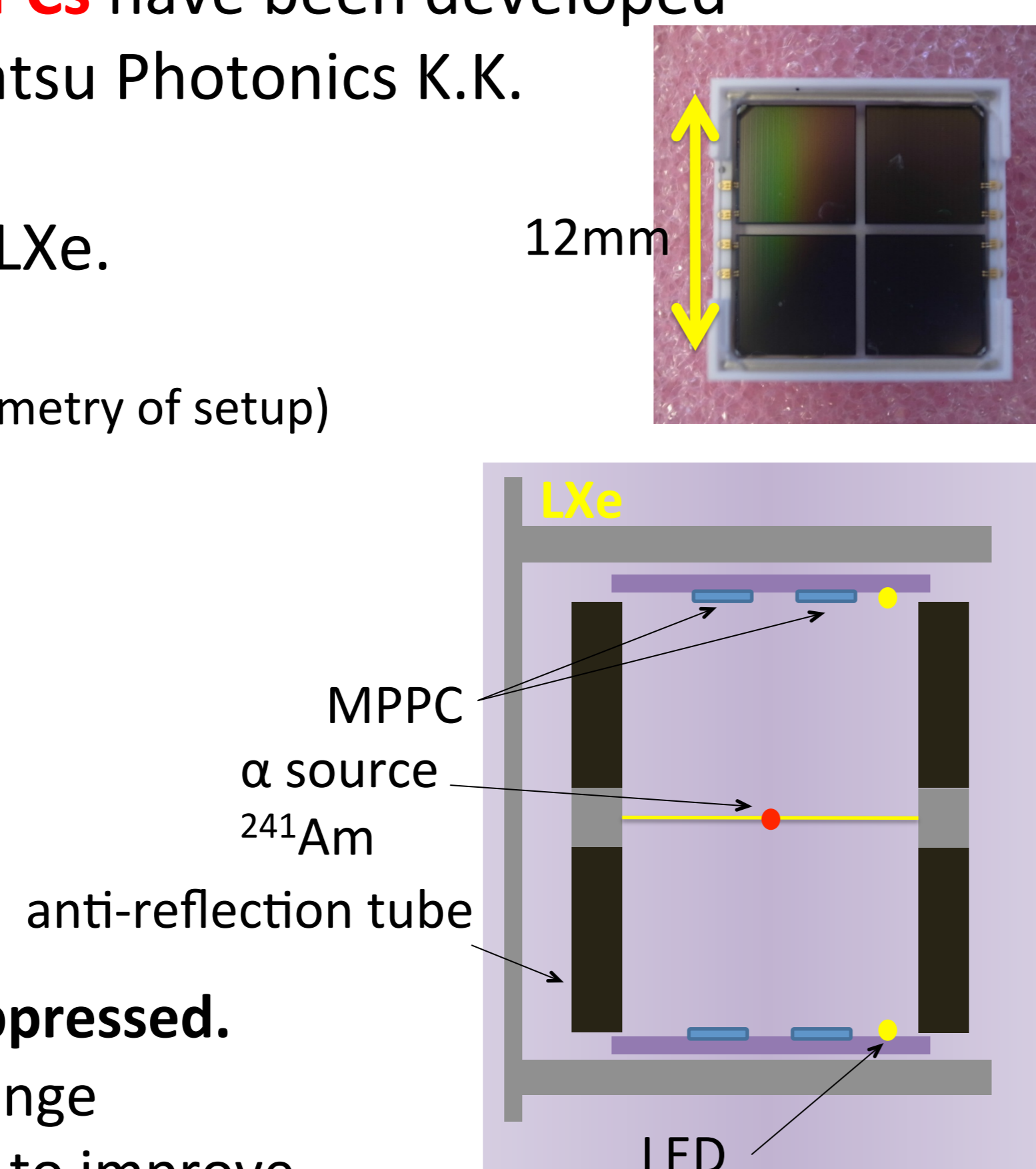
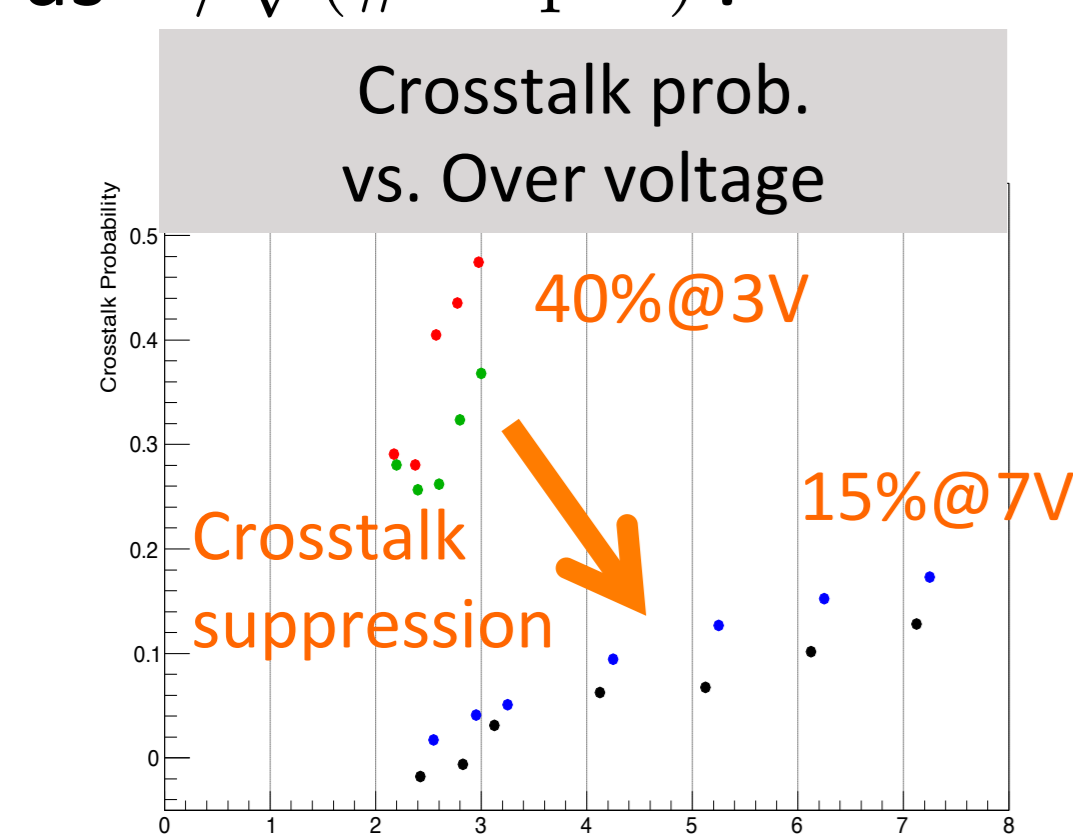
(Large systematics coming from geometry of setup)



◆ **Crosstalk and afterpulse is suppressed.**

◆ Wider operating voltage range

◆ Energy resolution is confirmed to improve as $1/\sqrt{\text{# of p.e.}}$.

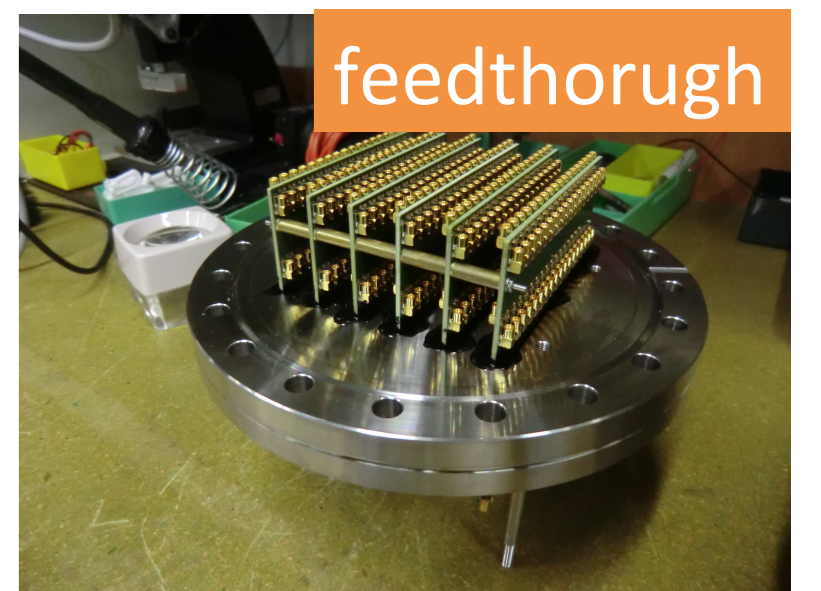


Mass production of MPPCs is going on.

4. Mass Test of MPPCs in LXe

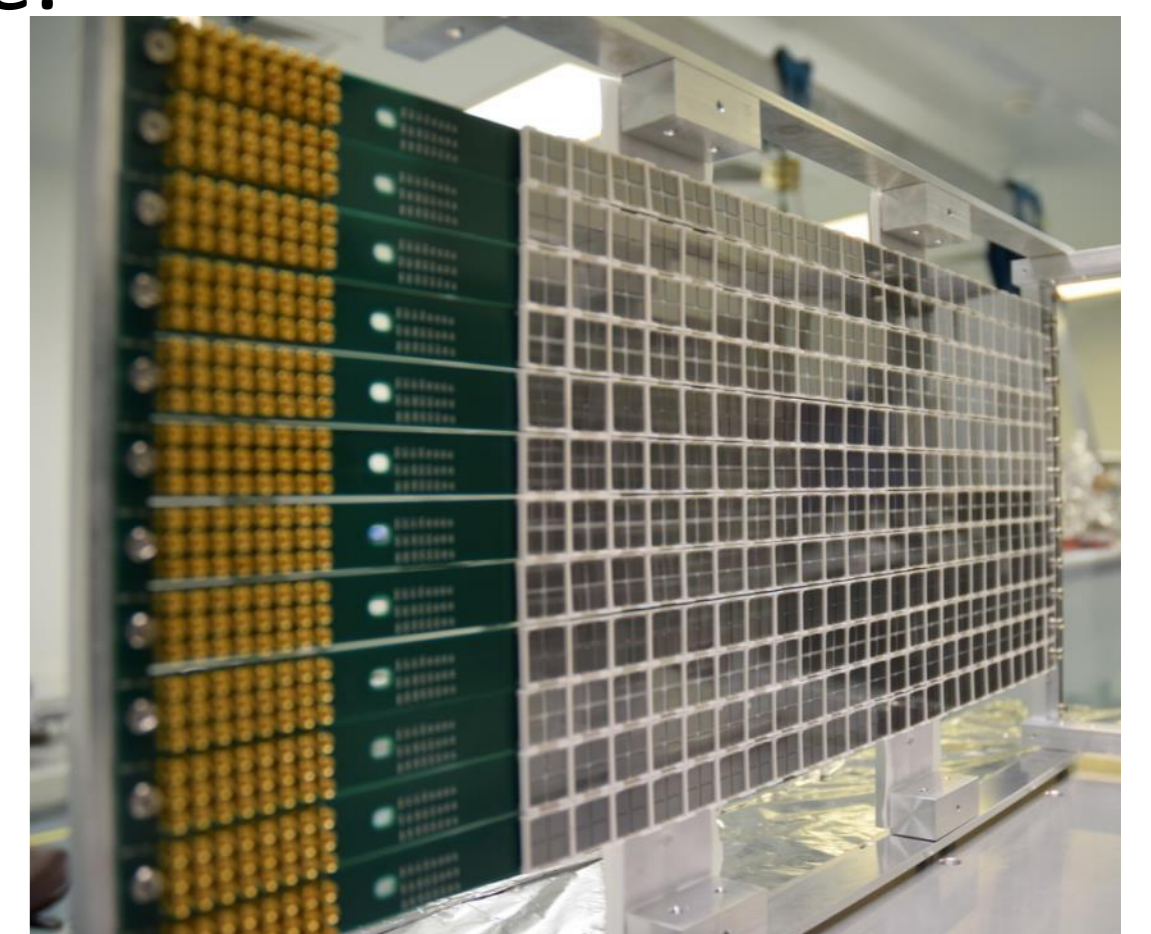
Various items for readout electronics have been developed.

- ◆ MPPCs are mounted on PCB with coaxial-like signal line structure.
- ◆ Series connection of MPPCs are realized in PCB.
- ◆ PCB based feedthrough have been developed.



Mass test of 600 prototype MPPCs in LXe.

- ◆ **Most of the MPPCs works properly** except for 5% bad channels.
- ◆ Most of the bad channels are found to be caused by the problem of electronics, and these problem have **already fixed**.

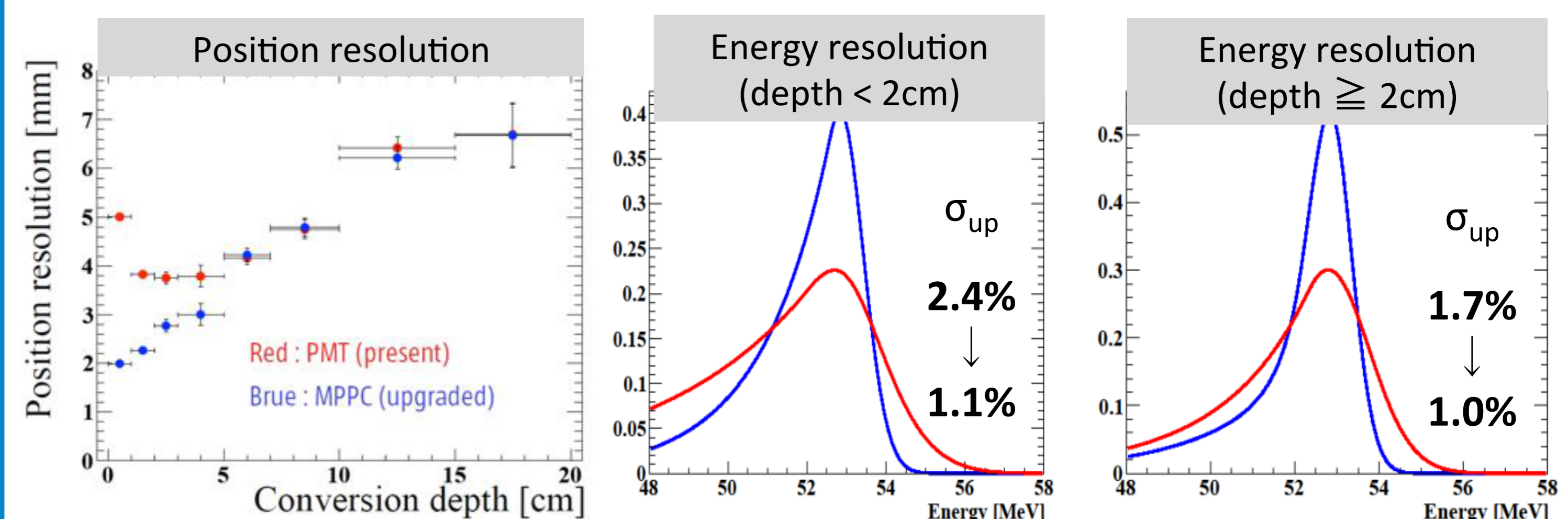


5. Expected Performance

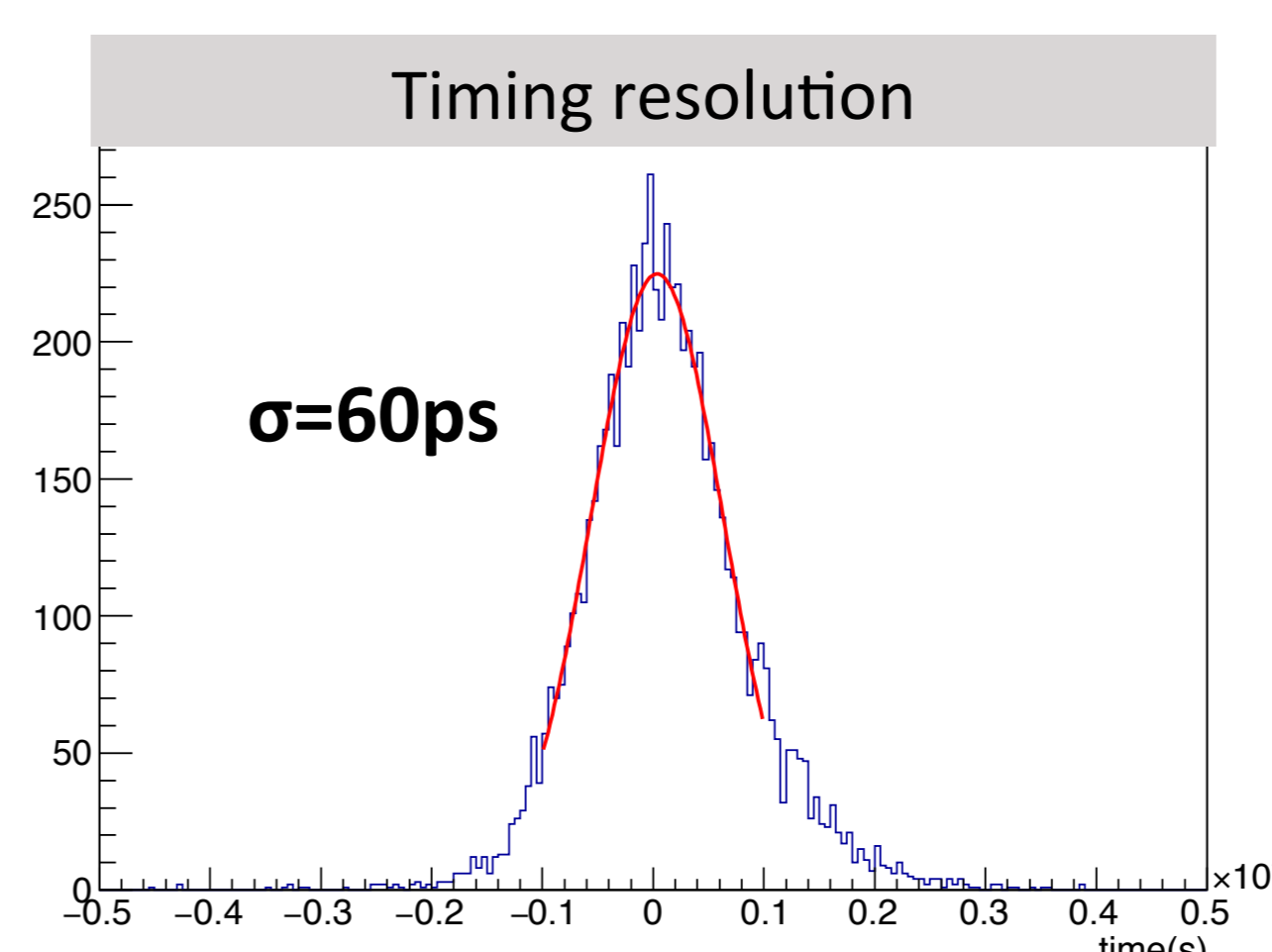
Resolutions are estimated by using Monte Carlo simulation.

- ◆ Simulation is based on the **measured properties of MPPC**.
 - ◆ Waveform of 1p.e. signal
 - ◆ PDE & gain
 - ◆ Crosstalk & afterpulse probability
- ◆ Reconstruction algorithm are being optimized to exploit the advantages of MPPC.

◆ **Position and energy resolution improves by a factor 2 from MEG.**



◆ Timing resolution is also expected to improve.



Resolution	MEG I	MEG II
u (mm)	5	2.4
v (mm)	5	2.2
w (mm)	6	3.1
E_γ (w<2cm)	2.4%	1.1%
E_γ (w>2cm)	1.7%	1.0%
t_γ (ps)	67	60

6. Summary & Prospect

- Liquid xenon gamma-ray detector with MPPC readout is under development for the MEG II experiment.
- VUV-sensitive MPPCs have been developed.
- We confirmed good resolutions with MC simulation based on measured properties of MPPCs.
- Mass production/test of MPPCs are on going.
- Detector construction will start in this summer.
- Commissioning will start late this year.
- Physics data taking will start next year.