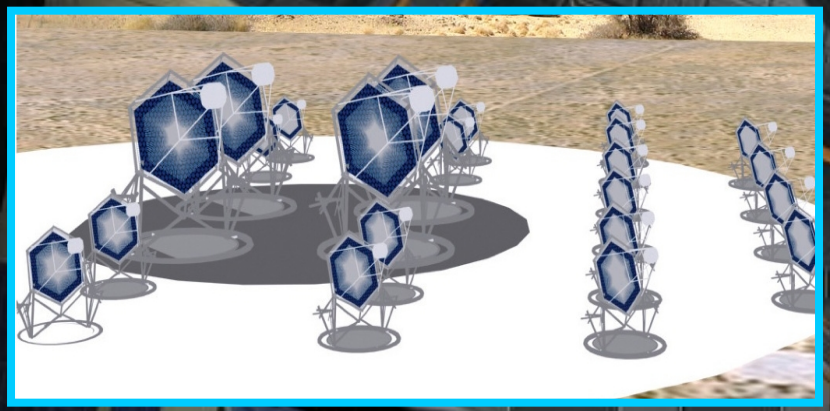
SiPM interdisciplinary application in the fields of Astroparticle Physics and Bio Molecular Science



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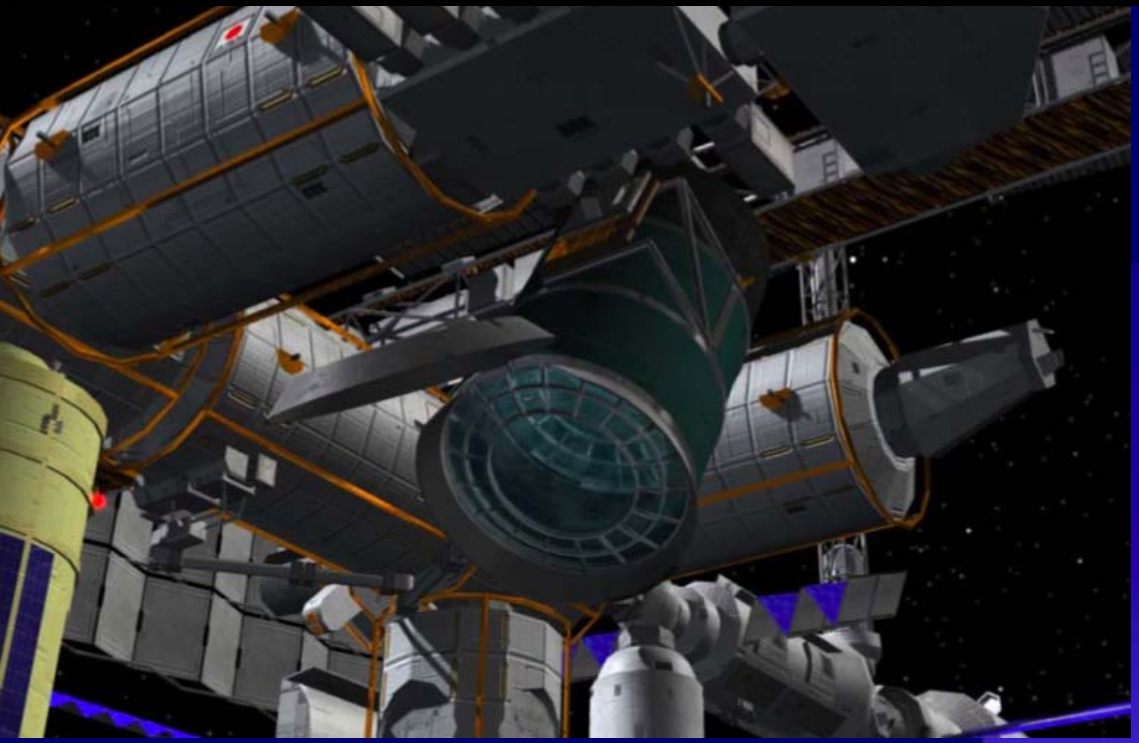
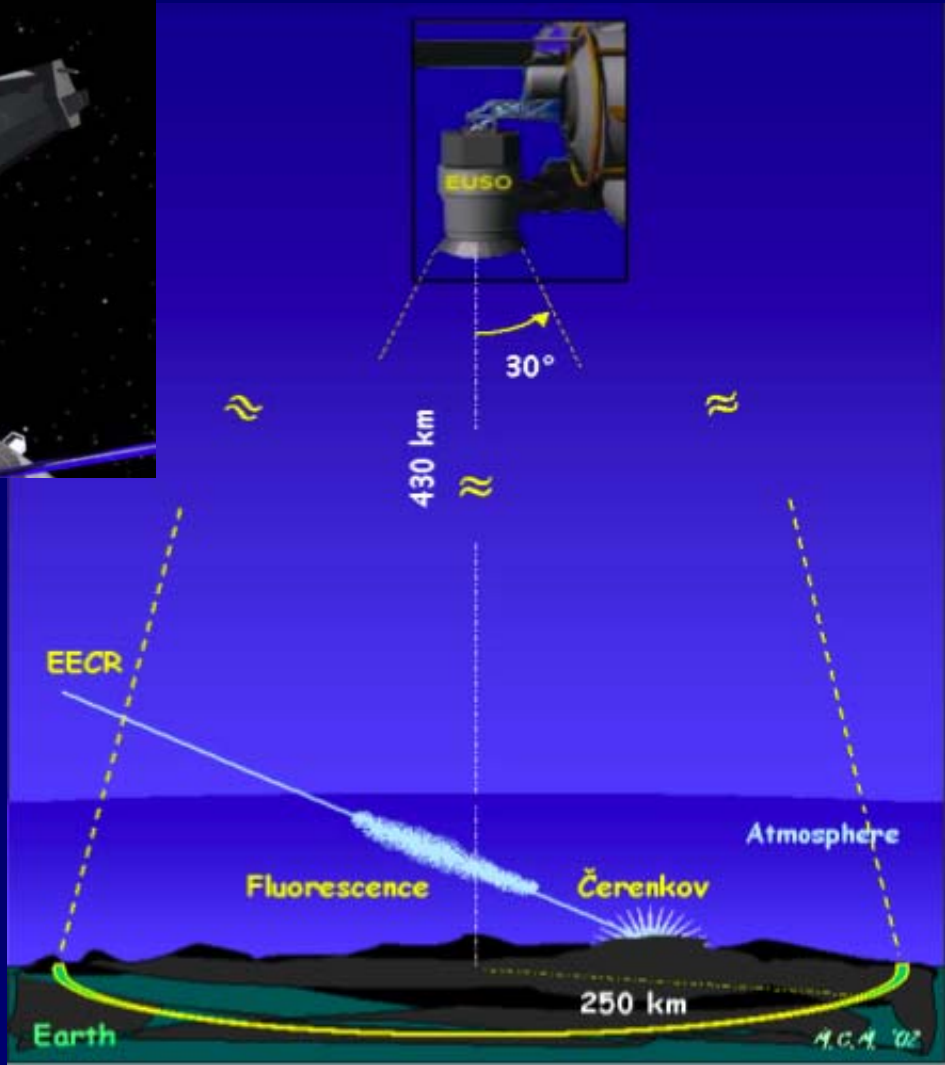
Extreme Universe Space Observatory



X30 Auger South

UHECRs $2x10^6$ km^2 sr yr

UHE ν 20 T-ton yr

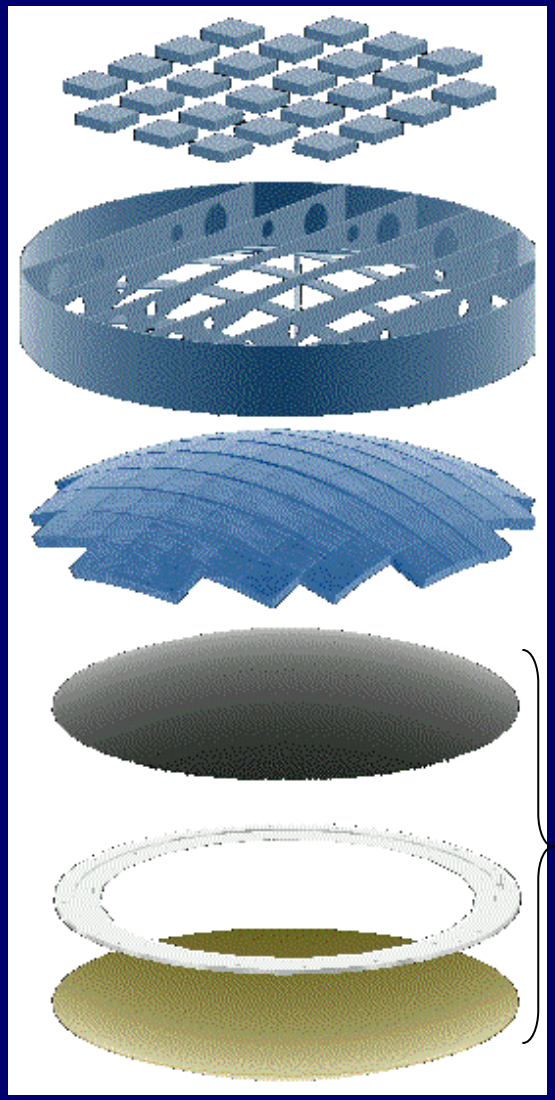


JEM-EUSO

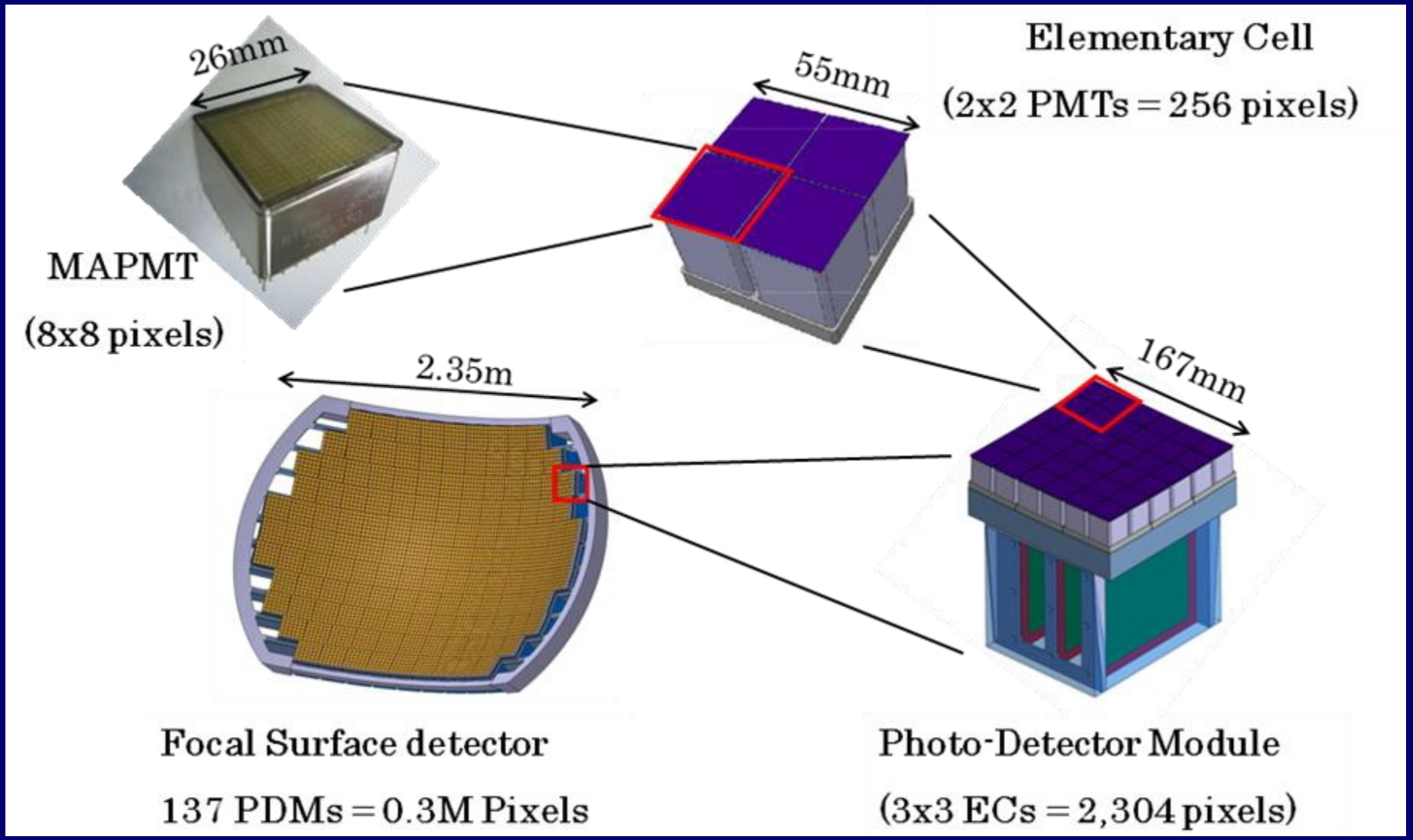
A novel sapce-borne fluorescence telescope

Astronomy with UHECRs

JEM-EUSO Telescope Structure



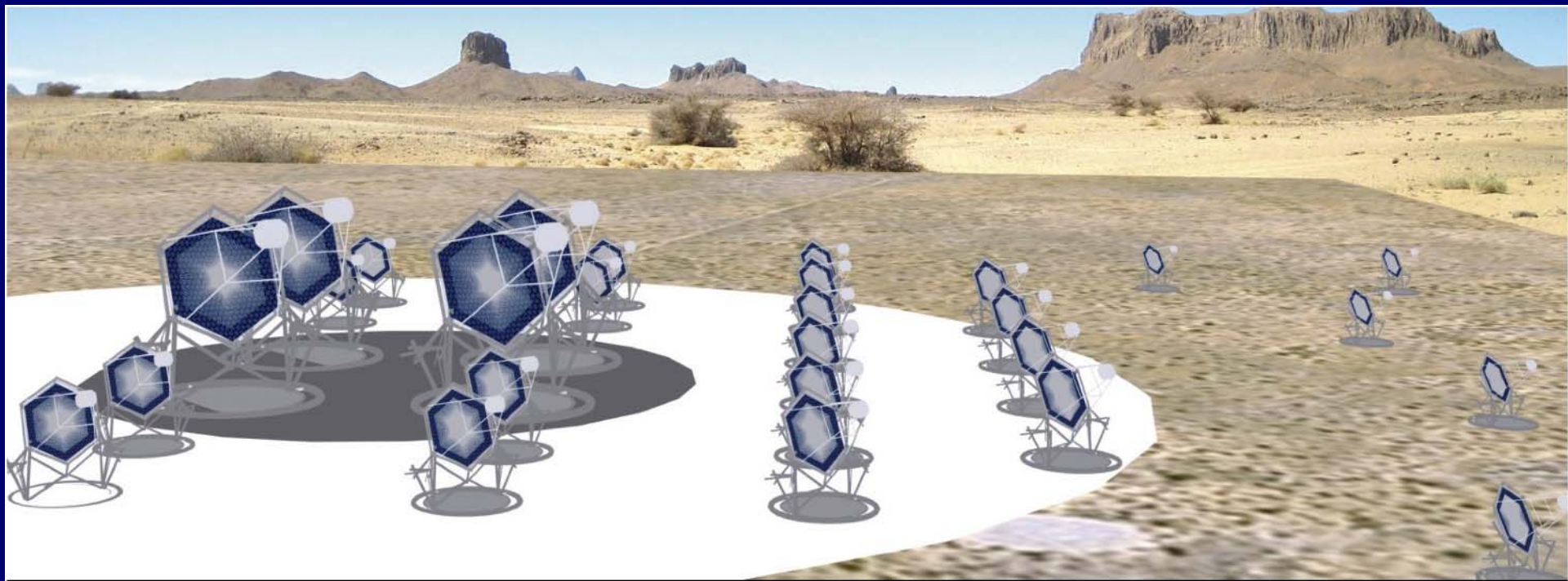
JEM-EUSO Focal surface



Readout technology for 0.3 M pixels!

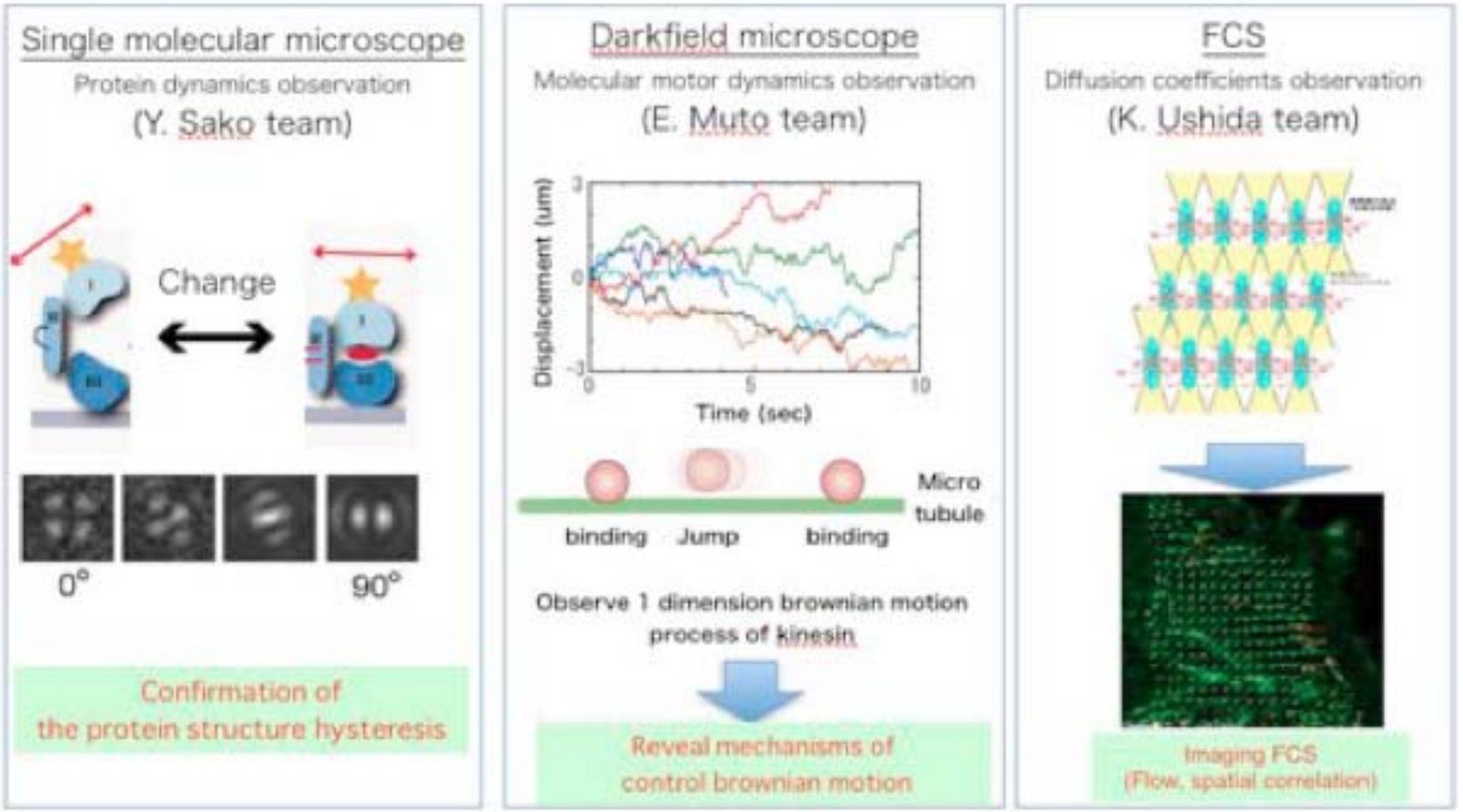
SiPM camera for Cherenkov telescopes

- Application to ground based Cherenkov telescopes such as MAGIC/MAGIC-II, CTA
- LLL sensitivity, fast/good time response/resolution



Bio molecular science

Our targets



- *Fast (sub-us), LLL (Low Light Level) camera will open a new window in bio molecular observations!!*

From astroparticle experiment to bio molecular science

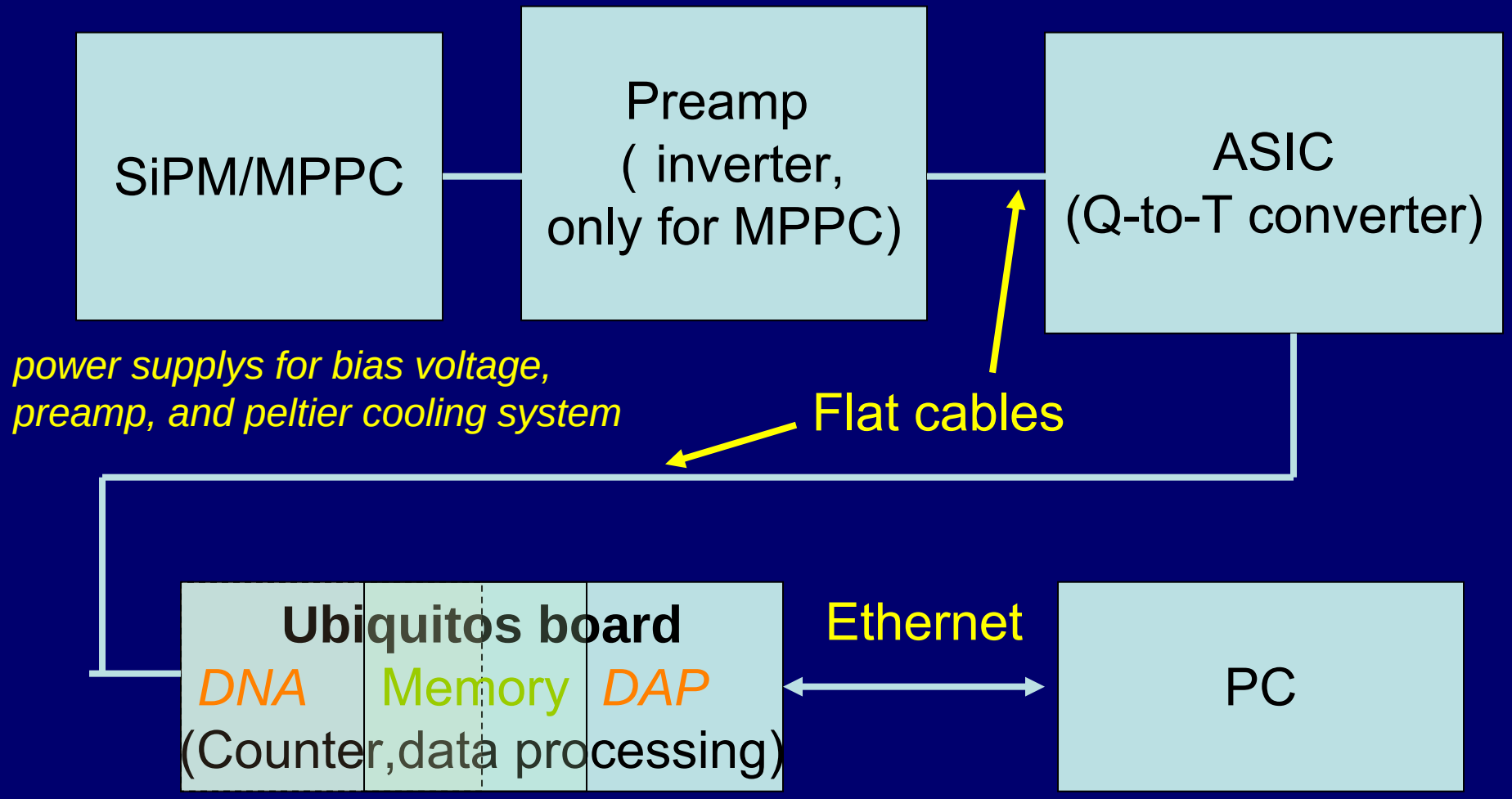
- Readout a large number of channel
- From fast response/sub-us camera
- With a LLL sensitivity

and a SiPM sub-us camera is expected..

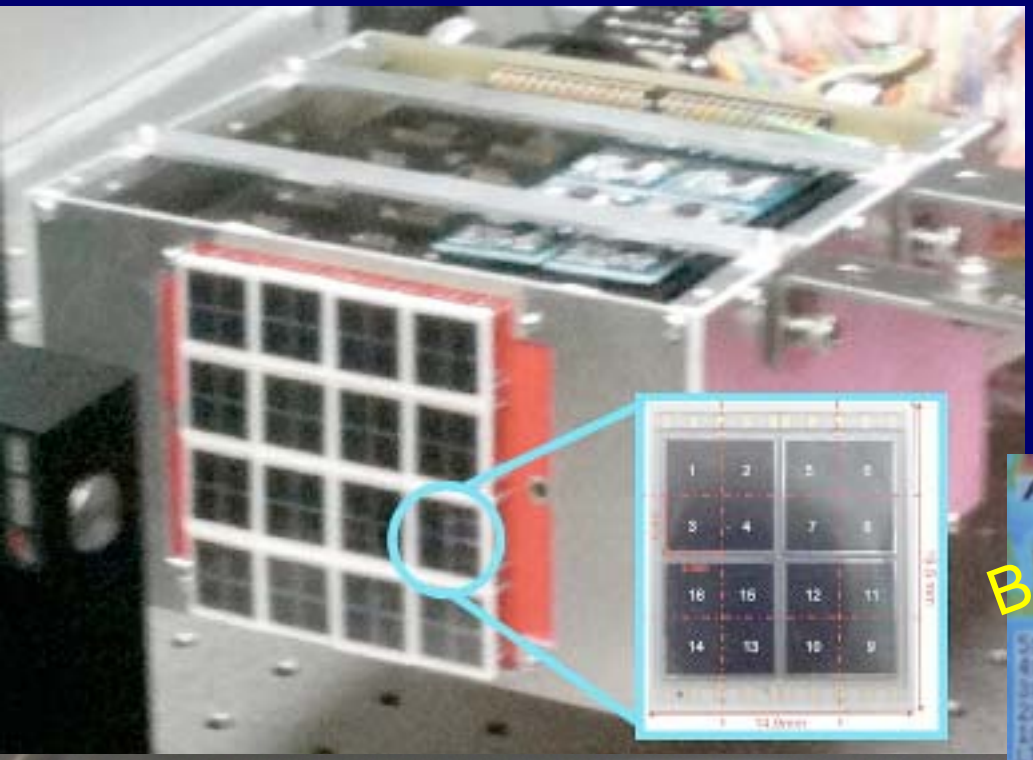
- High PDE
- Good time resolution (<ns)
- Could be better time and cost performance for a large number of channels in the future.
- And other general advantages comparing to a large number of PMTs..

and enable us to open a new window in not only in *astroparticle physics experiments*, but also in *bio molecular science!*

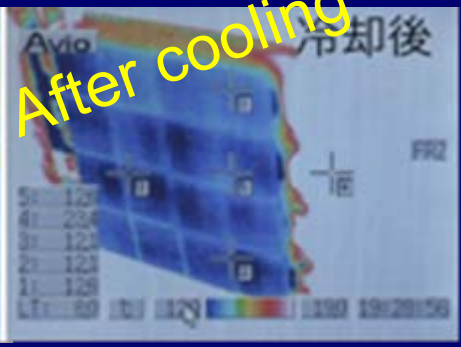
Simple DAQ diagram



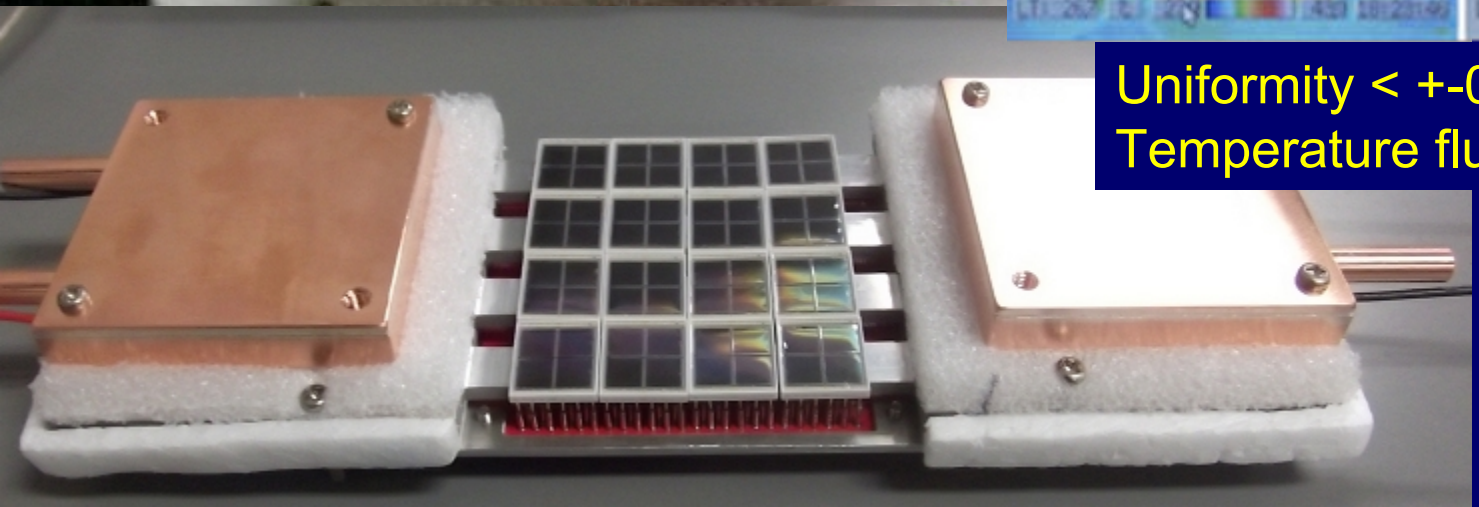
SiPM(G-APD)/MPPC



- Hamamtsu 16 ch MPPC produced by Hamamatsu in collaborating MPI
- 256 ch in total (16 x 16ch MPPCs)
- Peltier cooling system

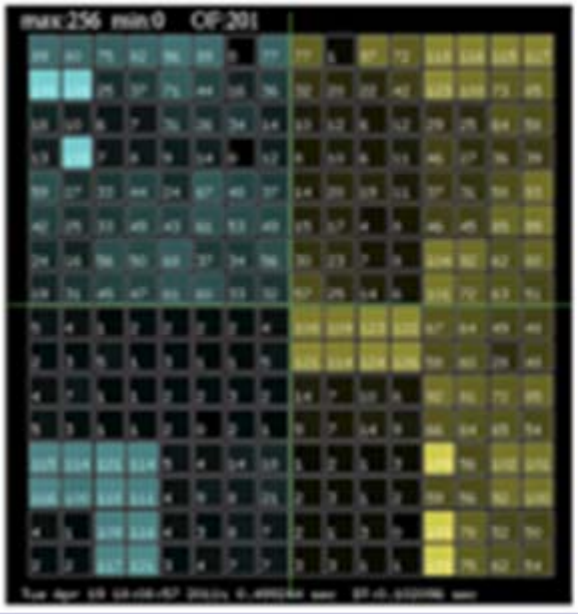


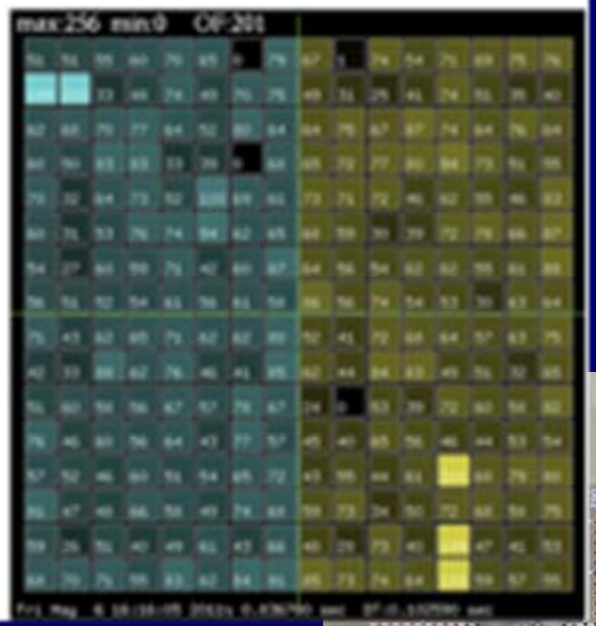
Uniformity < +-0.3C
Temperature fluctuation < +-0.5C

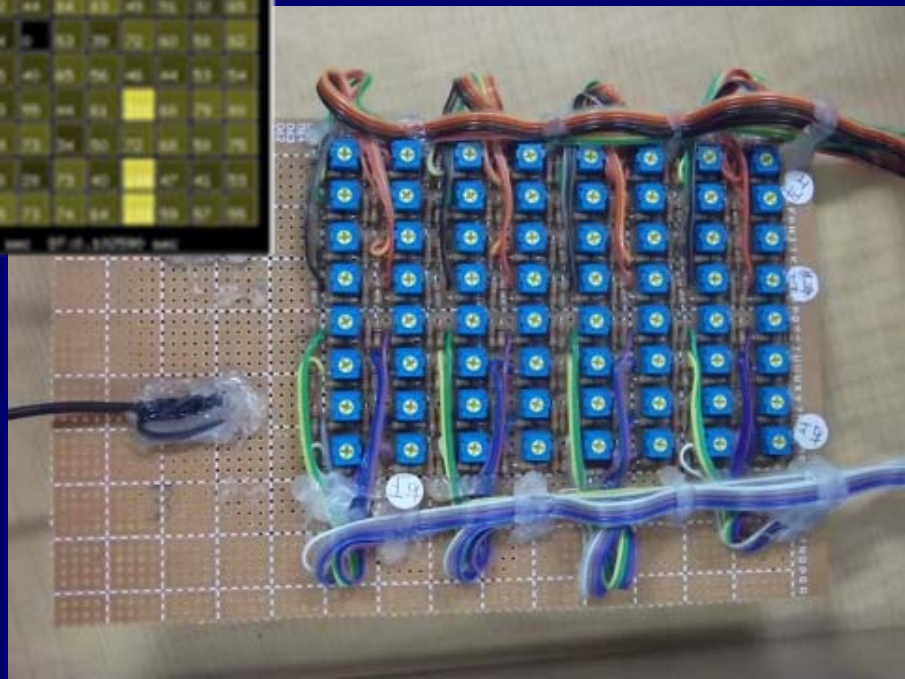


Compensation of MPPC operation voltage variation by a divider circuit

No Bias V adjustment Bias V adjusted by divide circuit

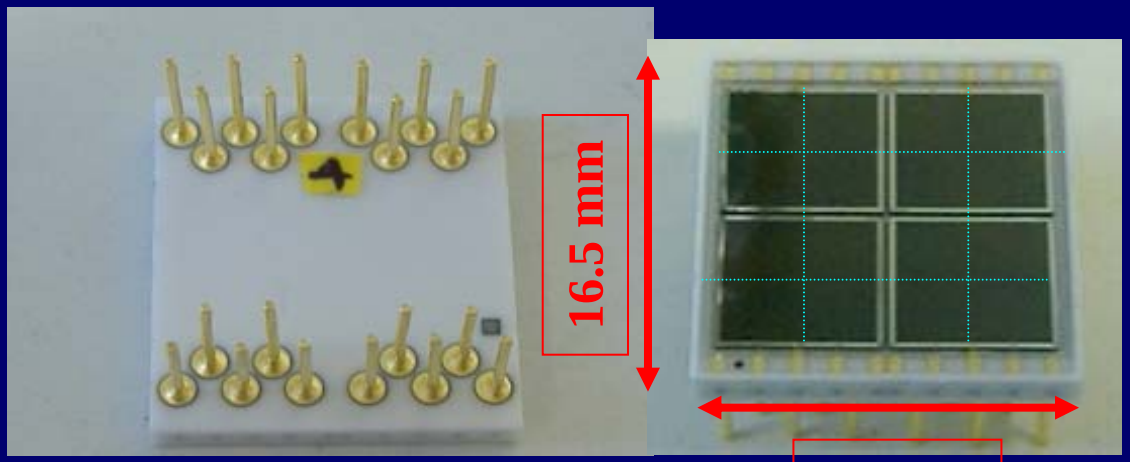






Combining a thermistor temperature compensation circuit will be also useful in the future

Hamamatsu 16 ch MPPC



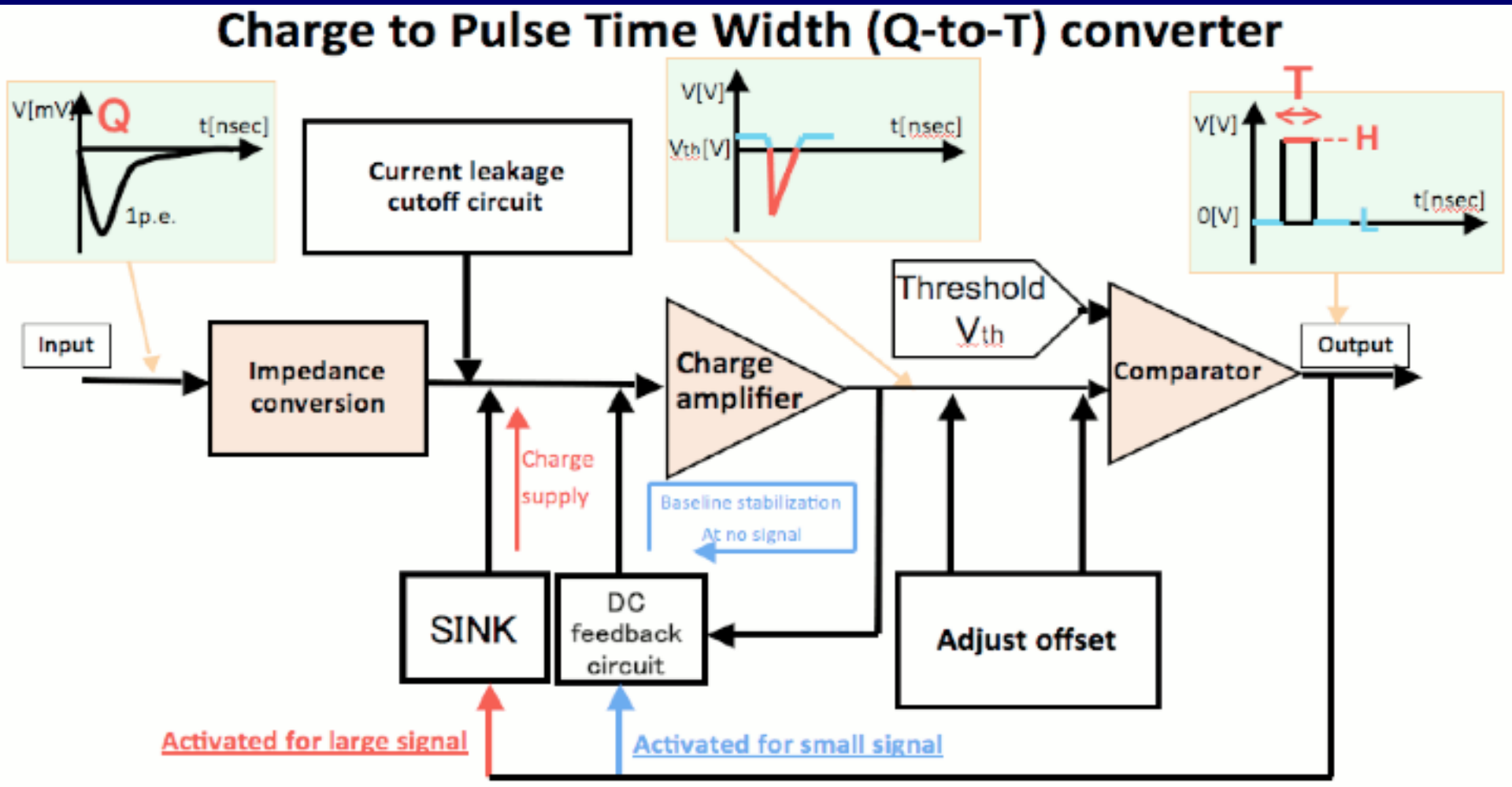
4x4 array of 9 mm^2 pixel device

- Developed by Hamamatsu-MPI
- Commercial device
- Large detection area!
- Device is ready!
- Used for 256ch prototype camera
- Low dark rate at operation voltage and temperature

Dolgoshein's SiPM and MPI-HLL's SiMPl are also candidate

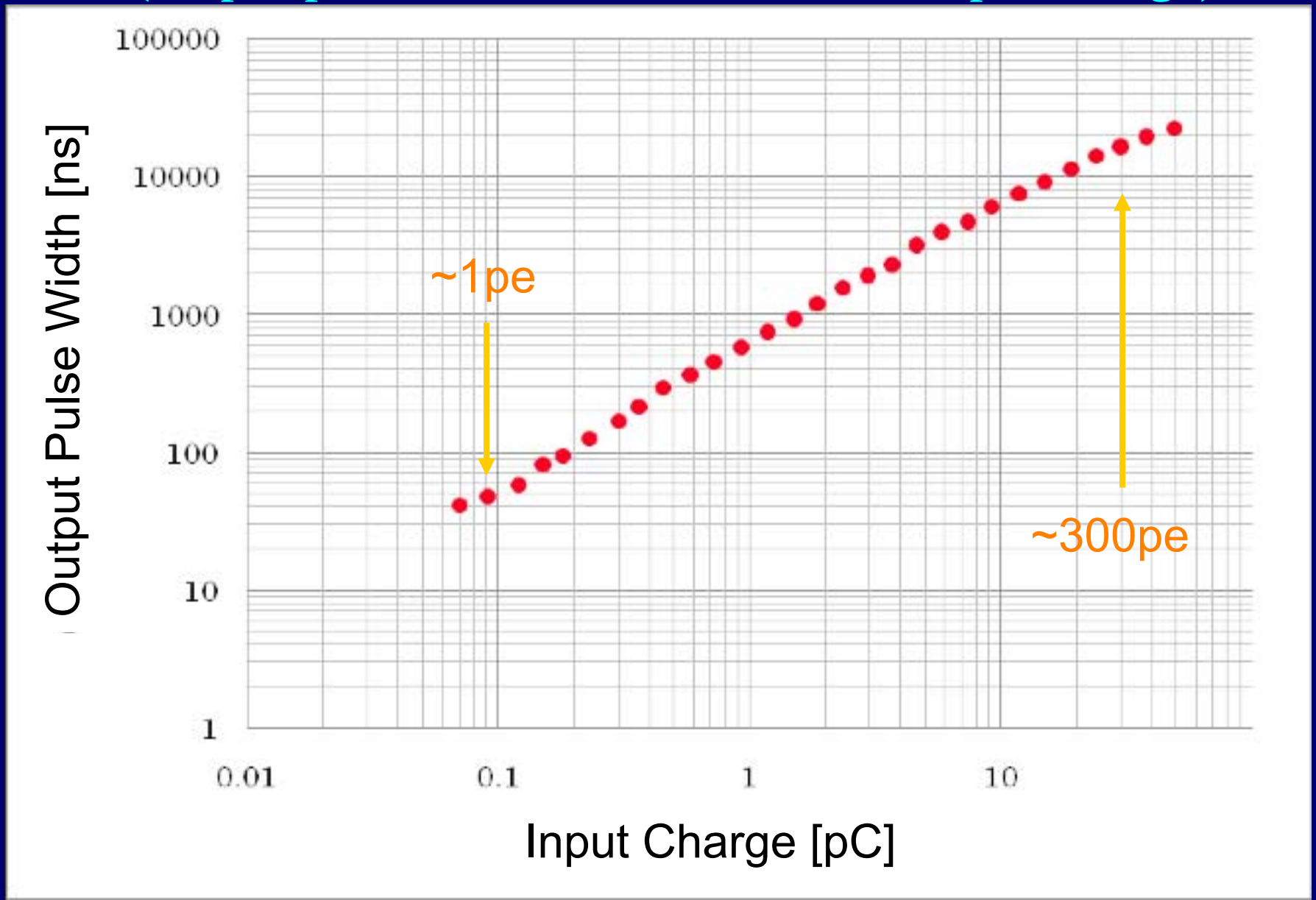
ASIC (KI03 Charge to Time converter)

- Developed for a JEM-EUSO front-end circuit
- Dynamic range of 1/3 pe ~ 300 pe in a unit time window
- Low power consumption (~0.8 mW/ch)



KI03 response

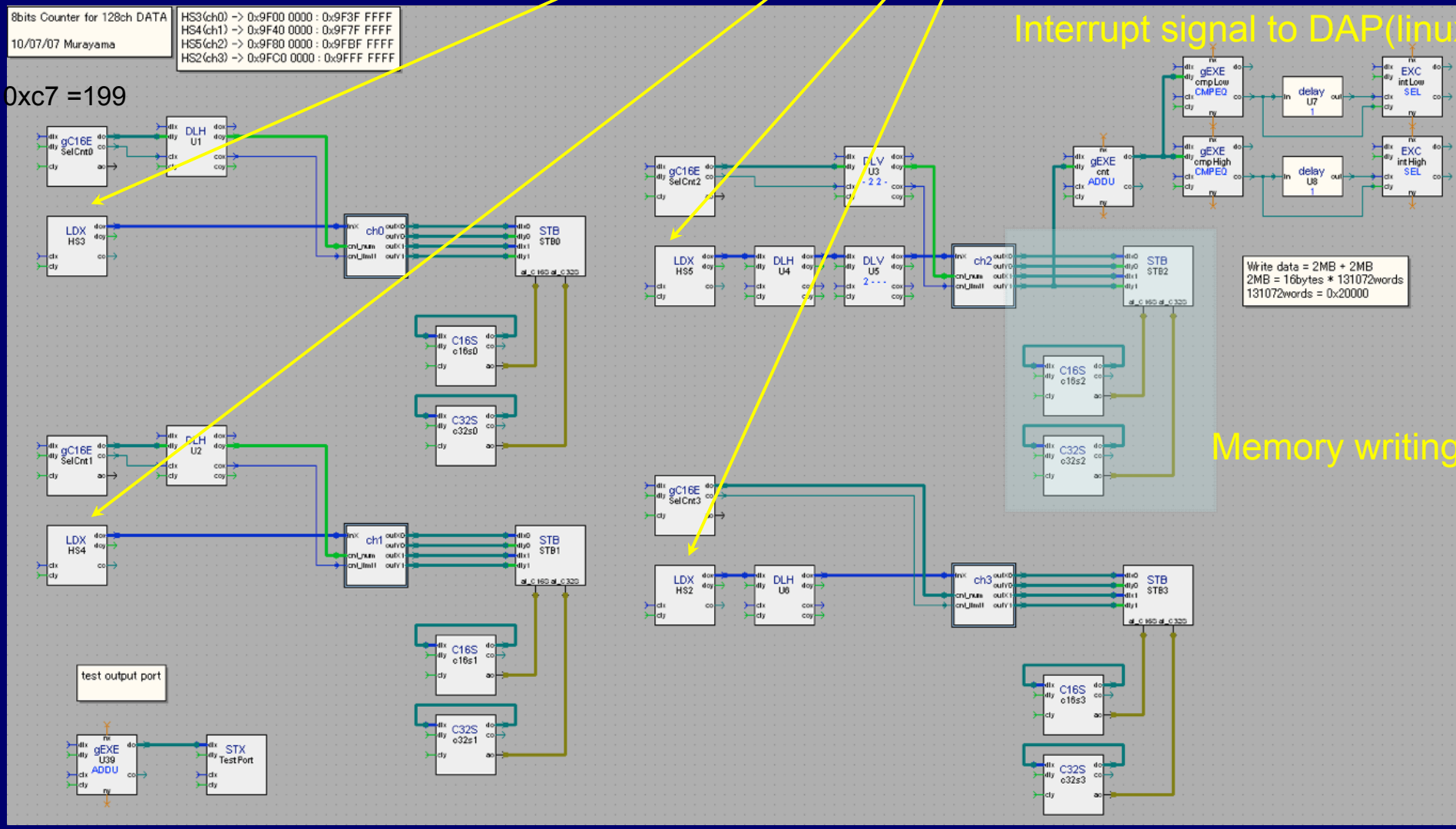
(output pulse width as a function of input charge)



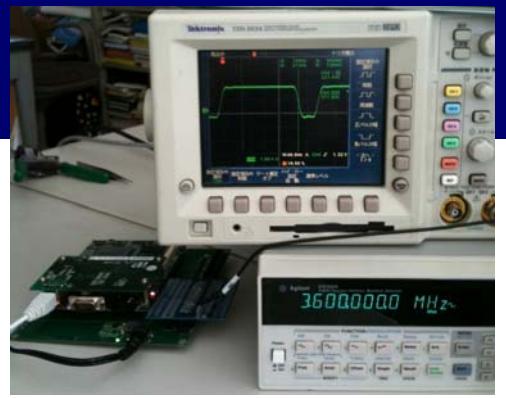
DAP/DNA ~ counter, data processing

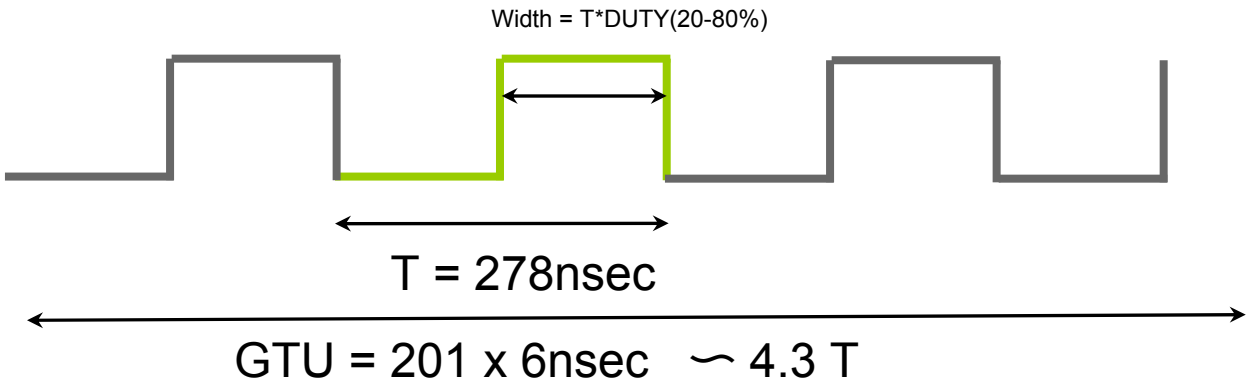
- Developed in former project for many kinds of application
- Capable with handling 128ch per chip (board)
- Programmable as suitable for the purpose of data handling

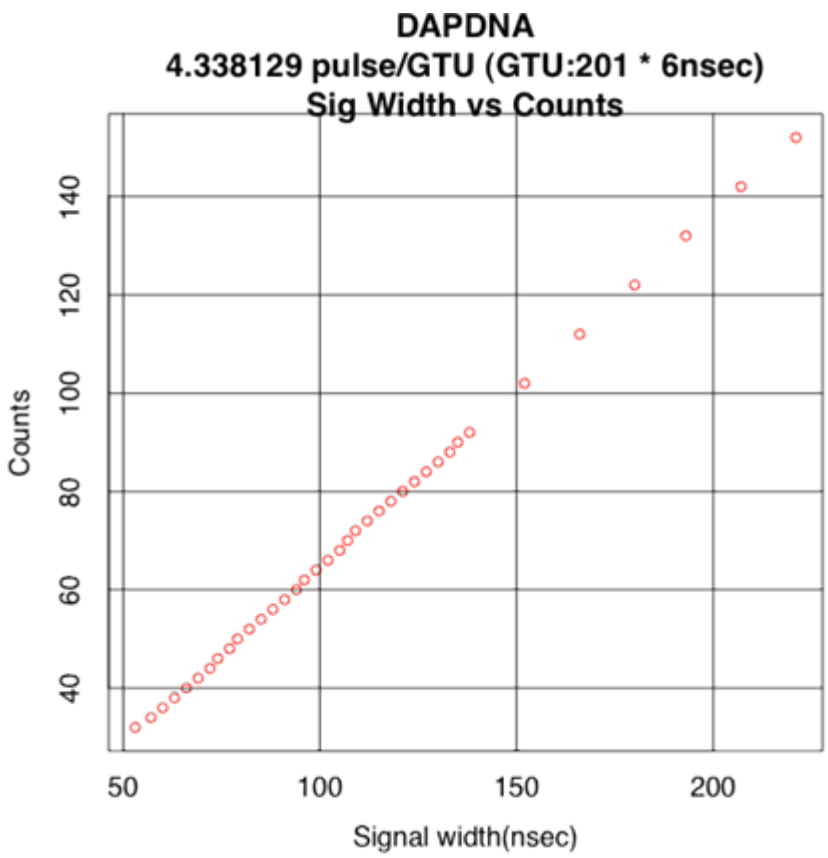
DAP/DNA(Ubiquitos circuit)
Readout every 6ns

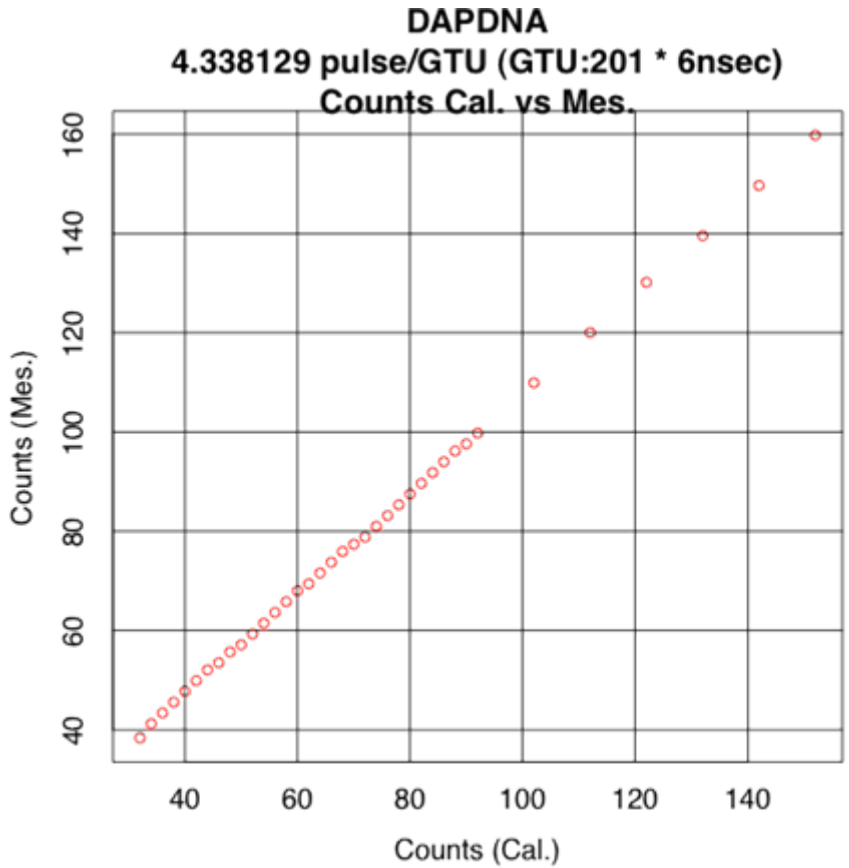


DAP/DNA
(Response of Ubiuquitos circuit)









SPEC ~ what can we see?

- Time window < us
- Minimum time resolution 6ns
- KI03 Charge-to-Time converter ASIC, dynmaic range of 1/3~300PEs in a time window
- Single photon sensitive with potentially high PDE (depends on SiPM for sensor)
- Large number of channel readout (currently 256 ch for a breadboard model)

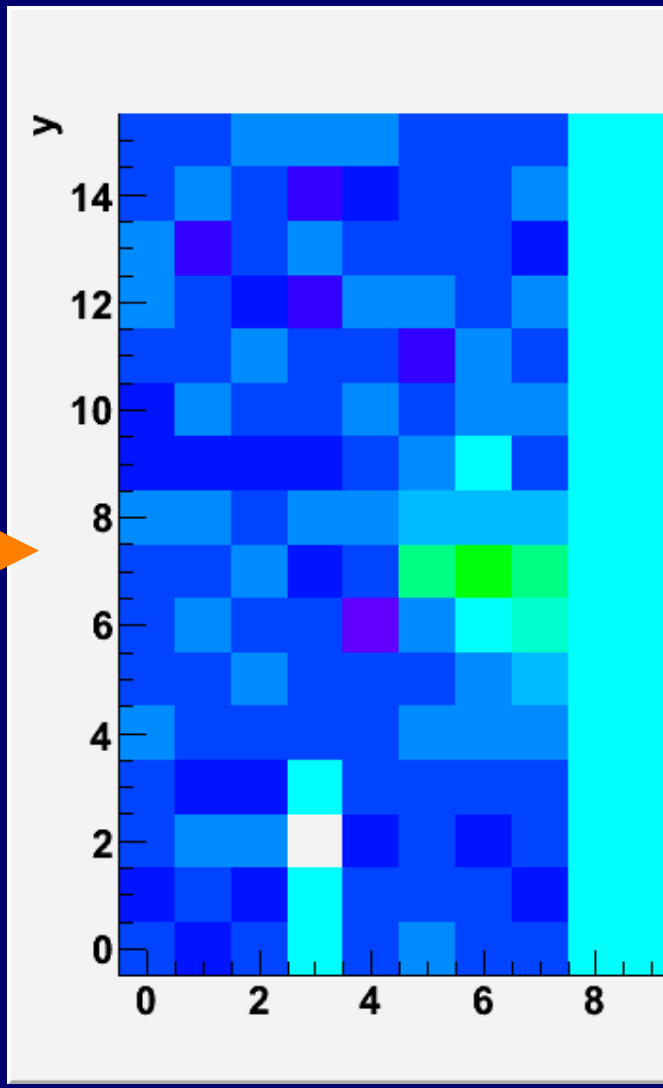
Imaging 40 nm Gold colloid for bio molecular observations

40um gold colloid on microscope

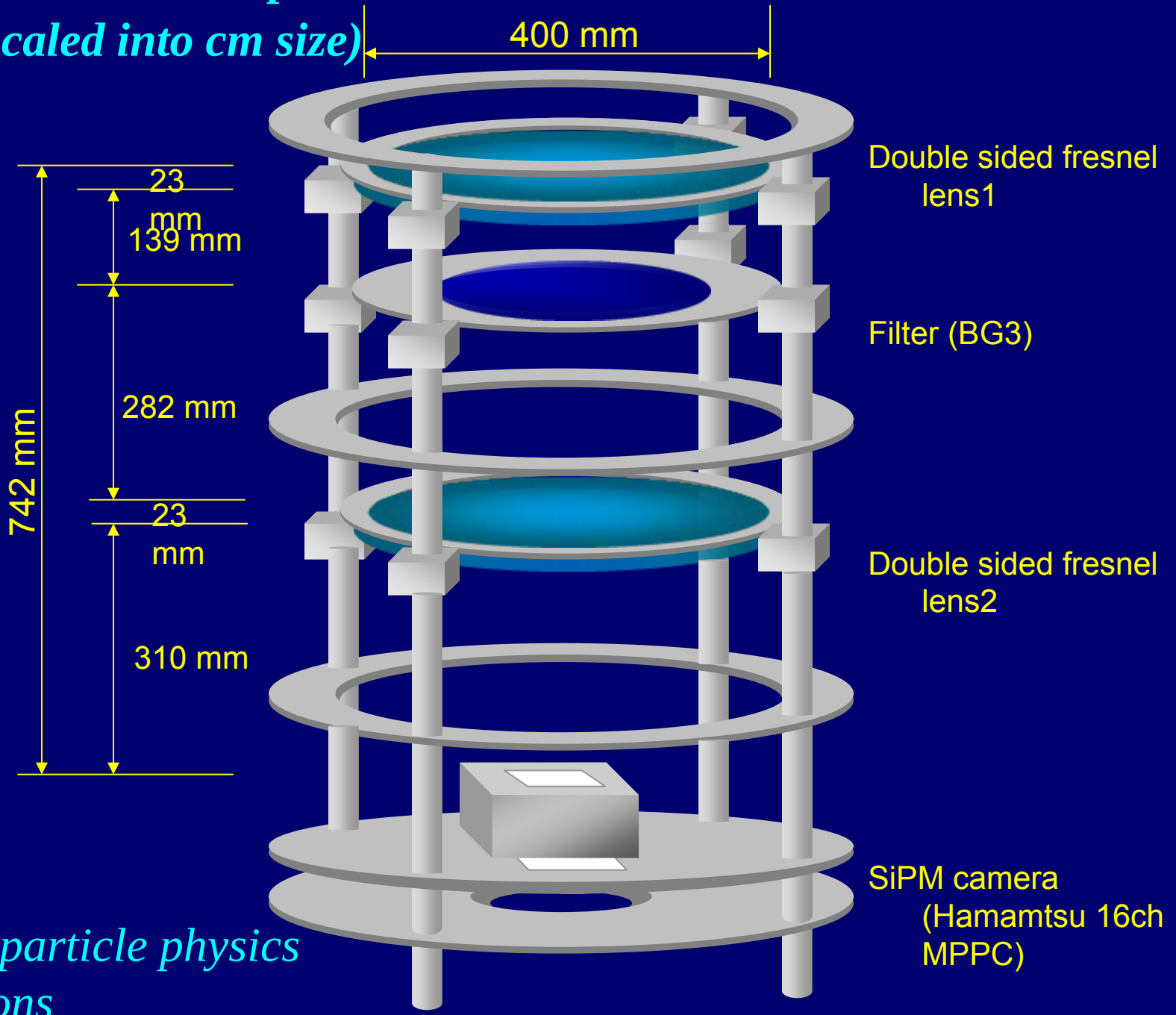
Focusing lens

MPPC camera

CW (DC) laser light source



Centi-EUSO telescope (EUSO scaled into cm size)



For astroparticle physics applications

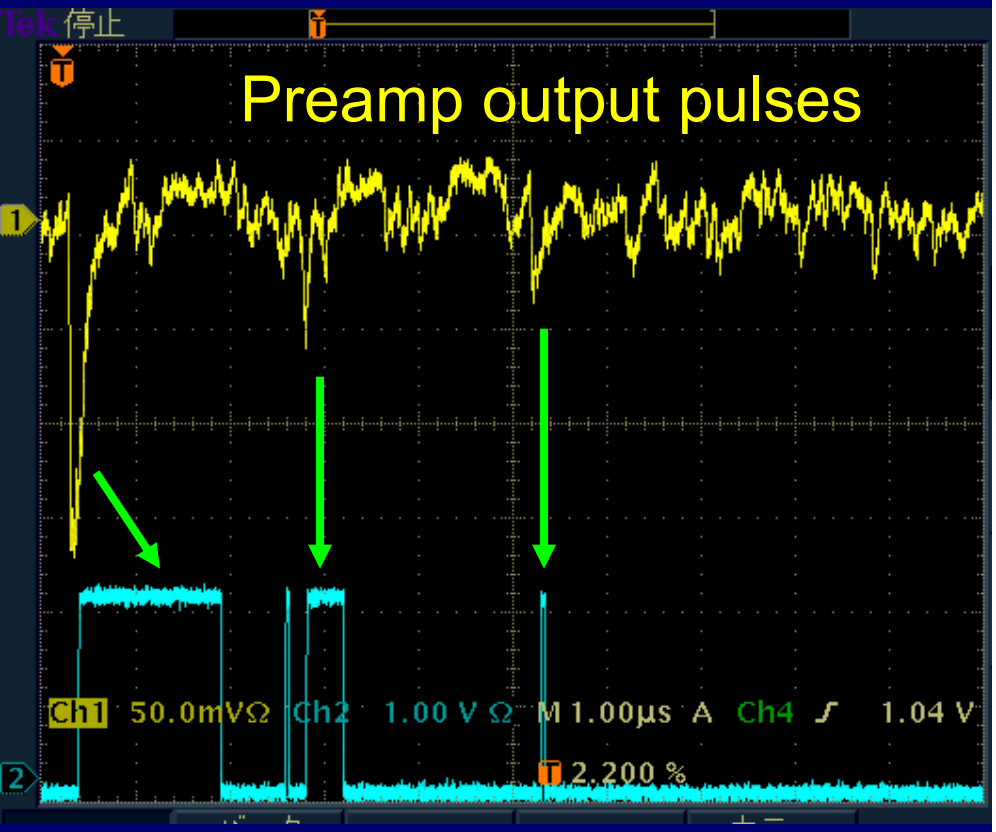
Centi-EUSO telescope with MPPC camera

- Check the operation of whole camera system

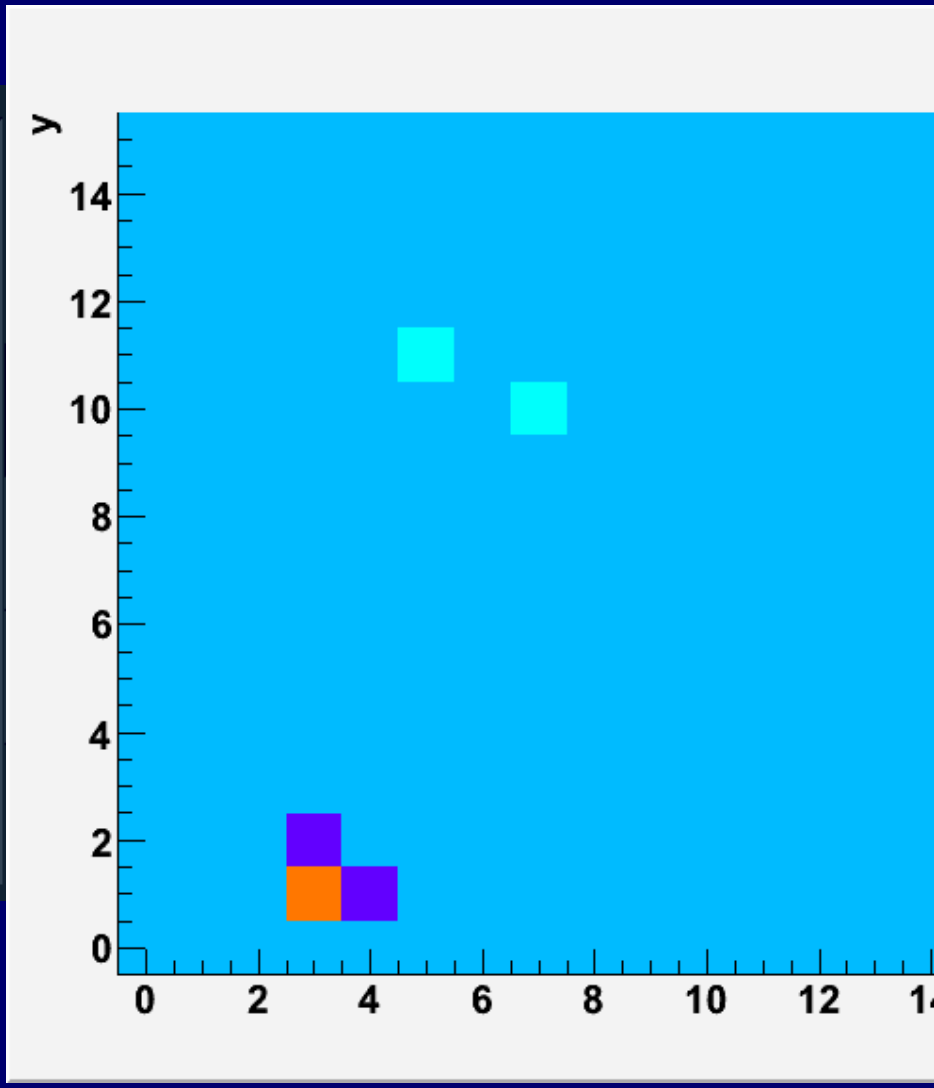
(temperature, humidity, dark rate, night sky bkg, etc…)

- Test imaging in night sky background
- Trigger system

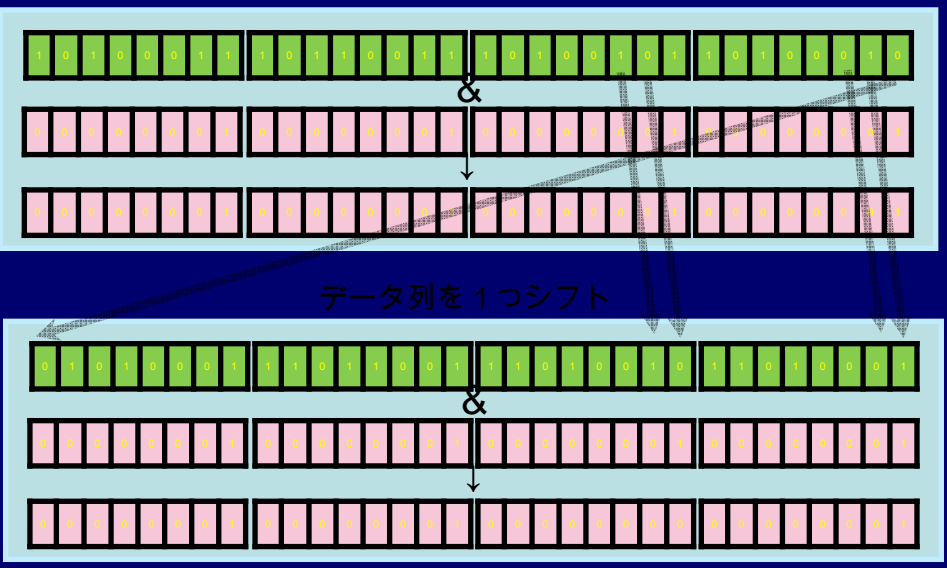
Camera response with LED light source



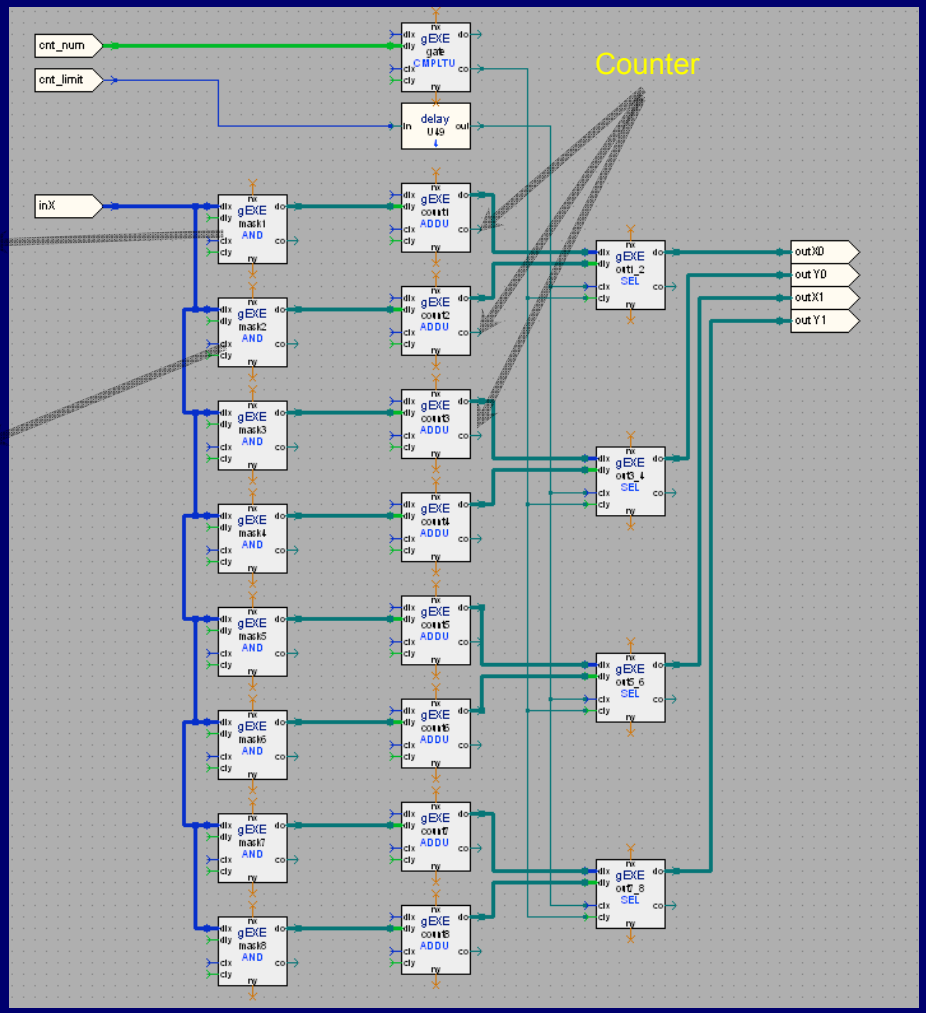
KI03 (ASIC Q-to-T converter) output pulses



An example of trigger algorithm (*preliminary!*)



Produce ON/OFF data every 8bit
with shifting data with 7 bits



External sum trigger is also considered

Summary & Outlook

Summary

- Assembli of sensors and all the breadboard is finished and tests are ongoing
- All the components operation are confirmed at first level
- Observed 40 um gold colloid with ~us time window (Confirmed capability of application in bio molecular science)

Outlook

- Demonstration with using Centi-EUSO to check fundamental capability for the application to Cherenkov telescopes (trigger, nature environment, etc.)
- Trigger algorithm (internal logical/external sum triggers are considered as an option)

Thank you for your attention!