Poster #26

Test model of energetic electron detector with 2-pi steradian field-of-view

by S. Kasahara

ABSTRACT

Generation of energetic electrons (up to > MeV) in planetary magnetospheres is a long-standing mystery, since their seed energy is of the order of 100 eV (solar wind) or much less (ionosphere). Furthermore, such high-energy electrons have significant influences for ionospheric dynamics as well as the long-term development of planets'/moons' surface and atmosphere. Since velocity distributions of electrons are not omni-directional in many cases, observed velocity distribution function is the important information which provides specific restriction on the generation mechanisms and effects on planets and moons. In most cases, however, spacecraft for planetary explorations are 3-axis stabilised, and therefore it is difficult for traditional telescope-type electron detectors to obtain broad field-of-view (FOV). Toward future planetary explorations, here we design and fabricate a novel electron detector (20 - 100 keV) which can cover almost 2-pi steradian without the spacecraft spin. We develop this instrument in a step manner. First we will test the performance of this detector in a sounding rocket experiment on pulsating aurora, and then plan to downsize by using ASIC, and also extend the measurement energy up to ~ MeV by stacking detectors.

Test model of energetic electron detector with 2-pi steradian field-of-view

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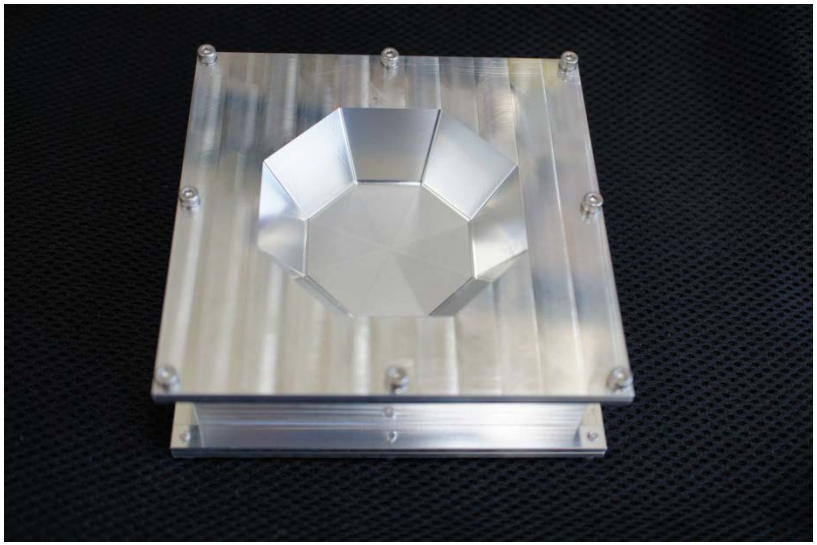
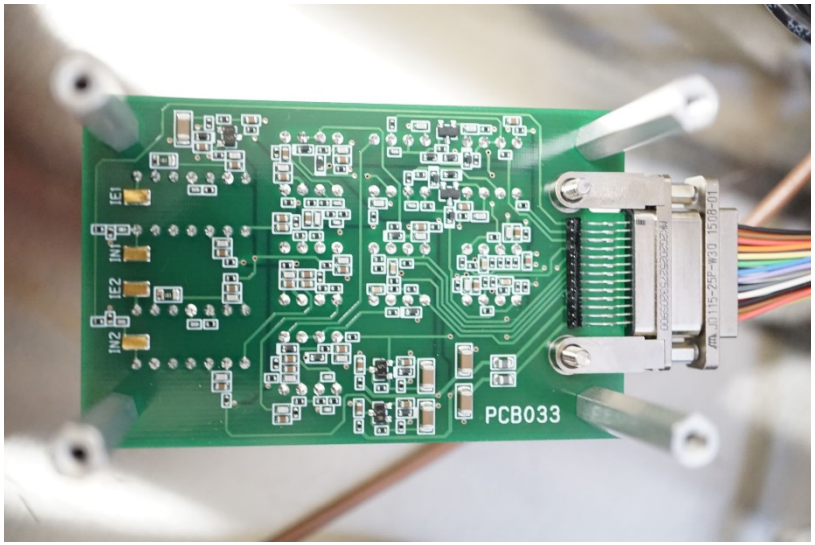
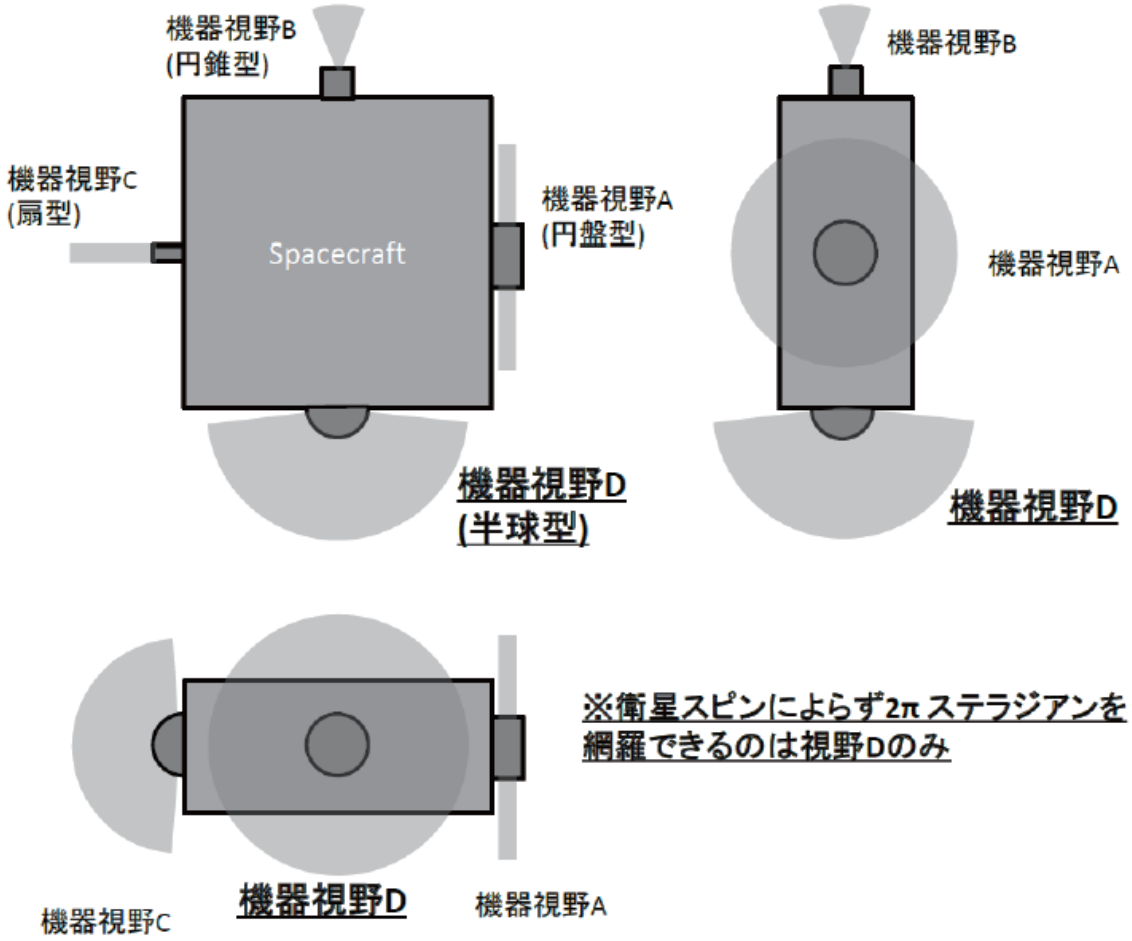




Points

- Spacecraft for planetary explorations are mostly 3-axis stabilised
- Wide field-of-view under the non-spin platform is thus required for particle instruments
  - Note that such instruments are also important for high-time resolution observations even in the case of spin-stabilised spacecraft
- We develop the energetic particle instrument with 2-pi str field-of-view

Motivation



- Previous particle instruments cover only a small part of full solid angle if the platform does not spin
- Since spacecraft do not spin in most planetary missions, wide field-of-view is essential for particle sensors

Strategy

2016 → 2018 → 2020

Heritage

ERG

MEP-e

10-80keV
Φ300 x 400 mm^3

Widening FOV
Removing ESA

MED

20-100 keV
100x100x200mm^3

Sounding rocket
for
Pulsating aurora

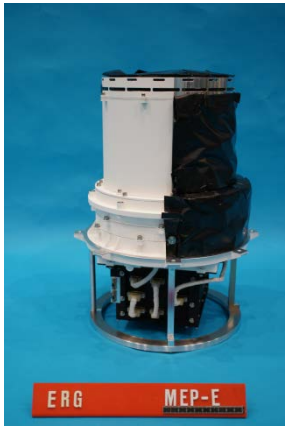
Downsizing by using ASIC

Stacking Detectors for
the broader energy coverage

MED+

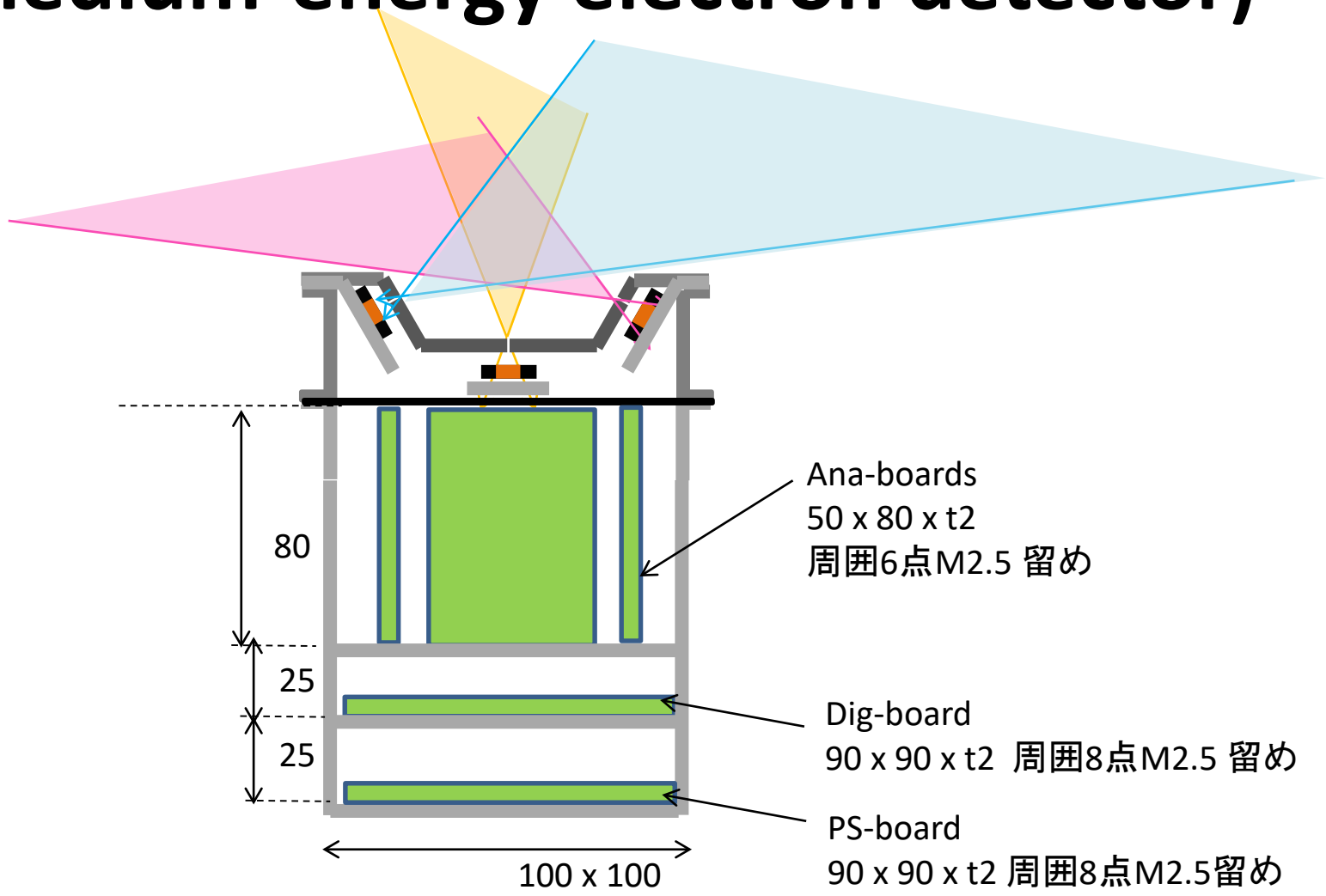
20-1000 keV
100x100x100mm^3

Planetary exploration
/High-time resolution obs.

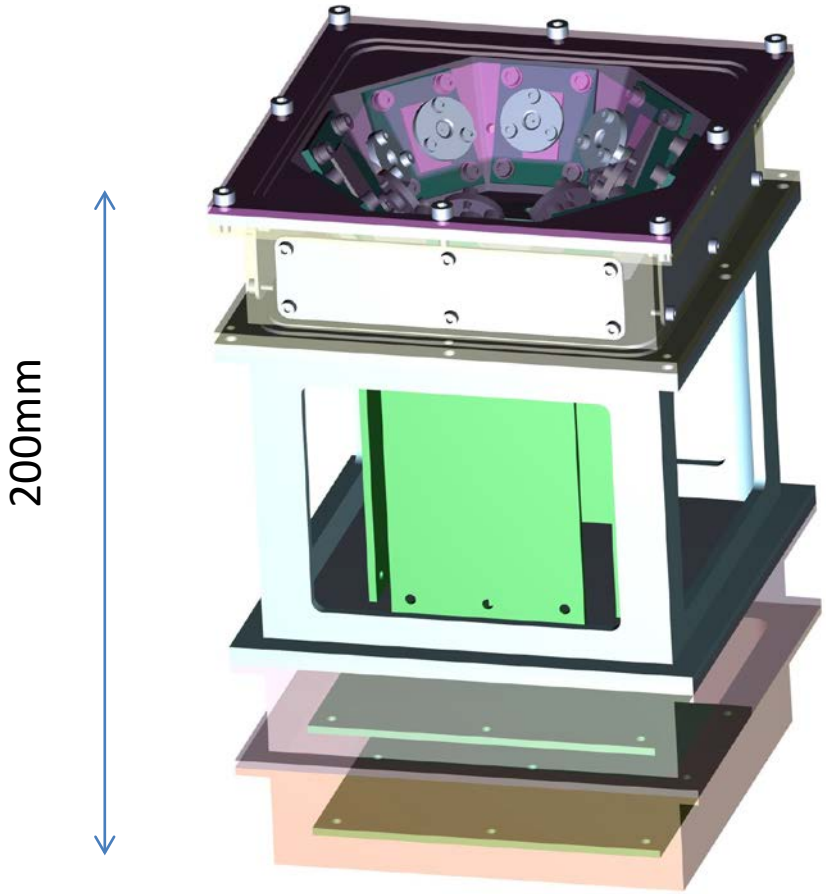


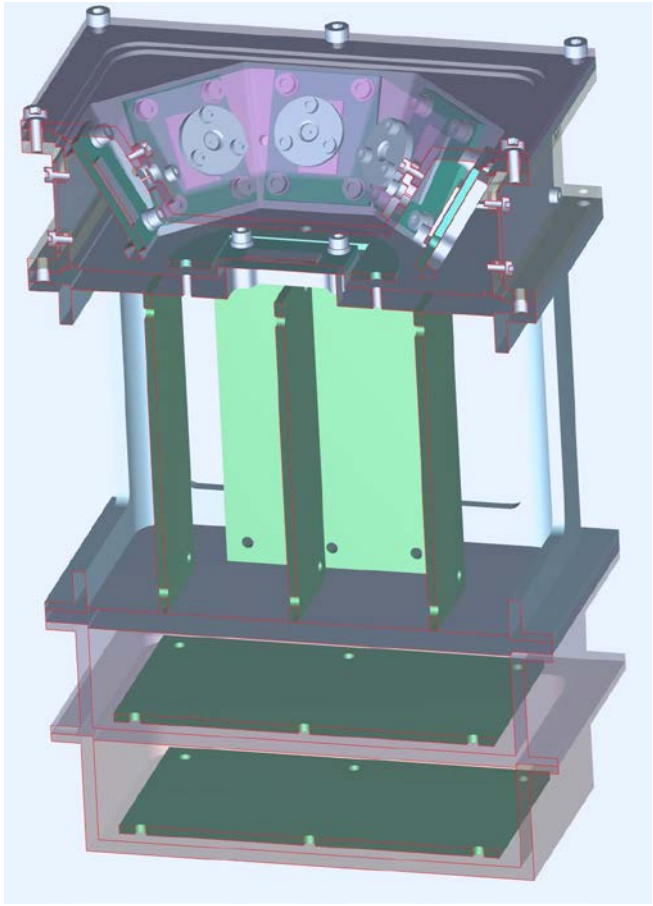
We are hear

Schematic view of MED (medium-energy electron detector)

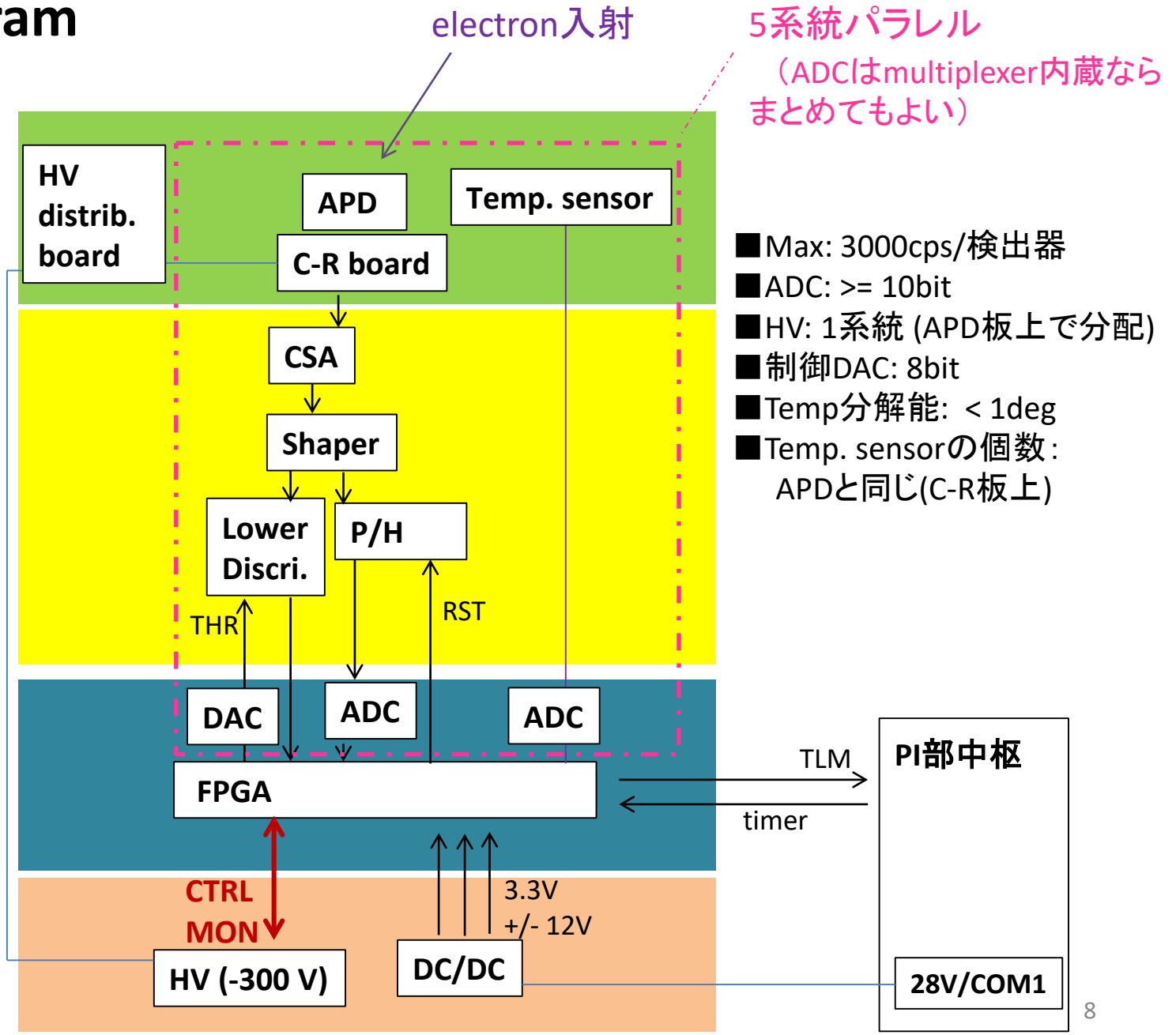


Sensor structure

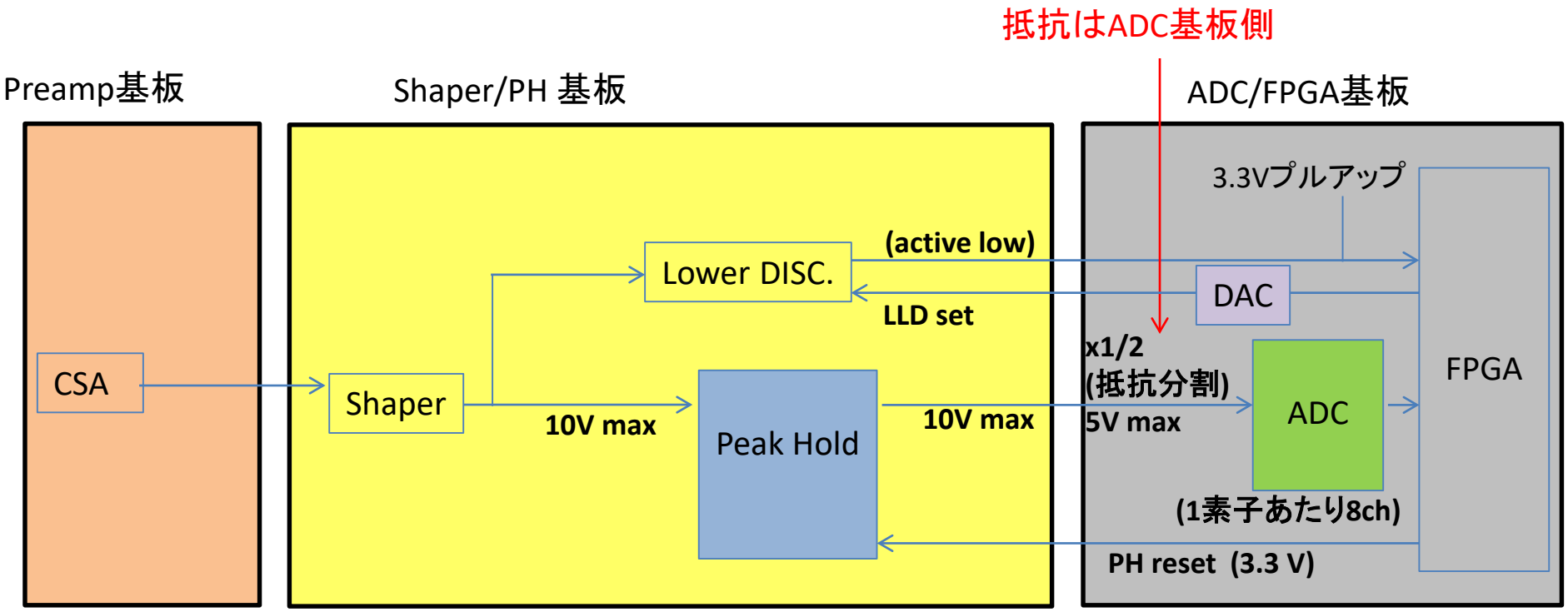




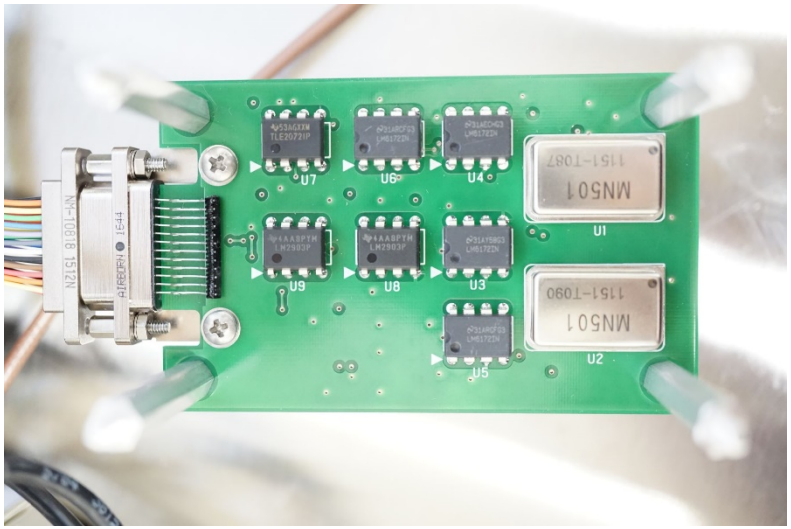
Block diagram

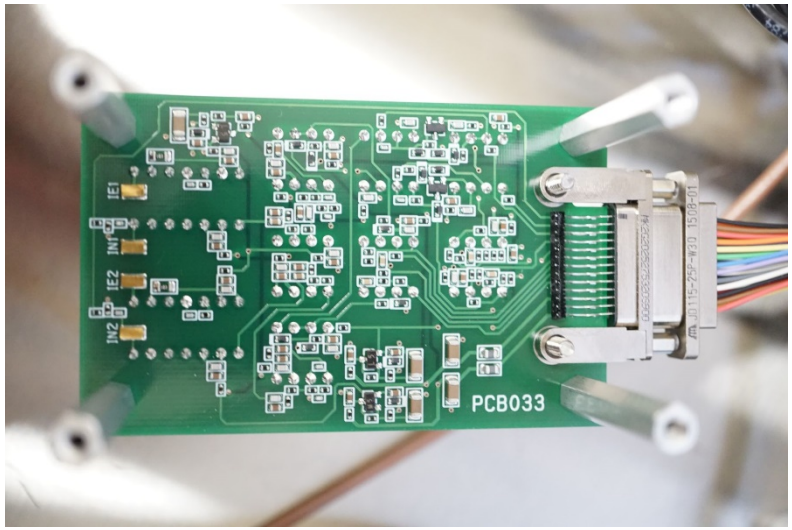


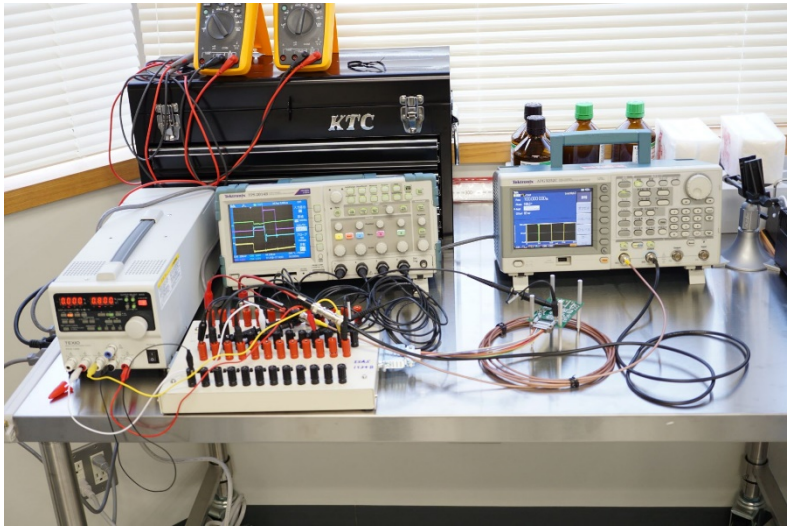
Analogue circuit



Test of the analogue electronics board

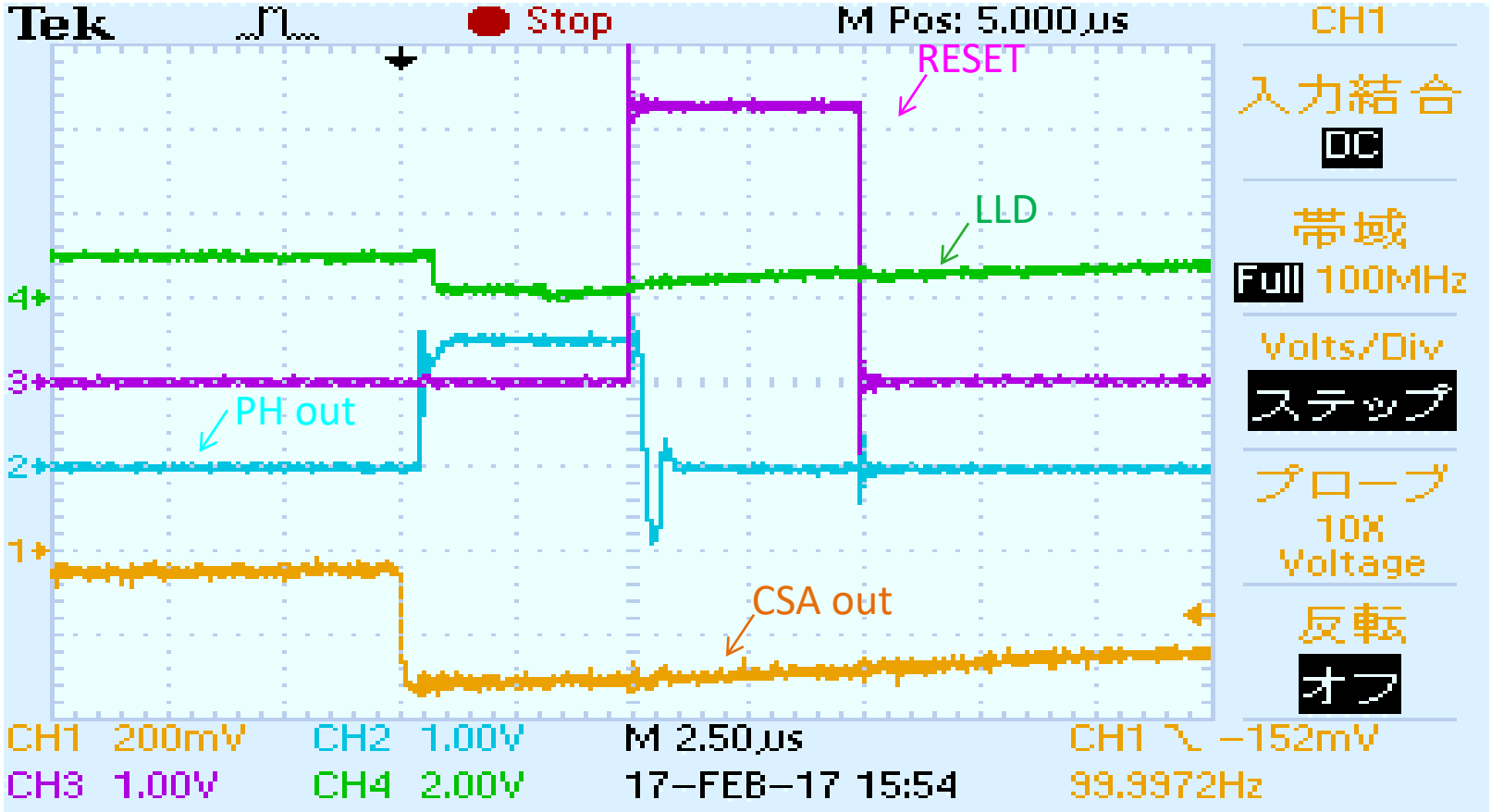






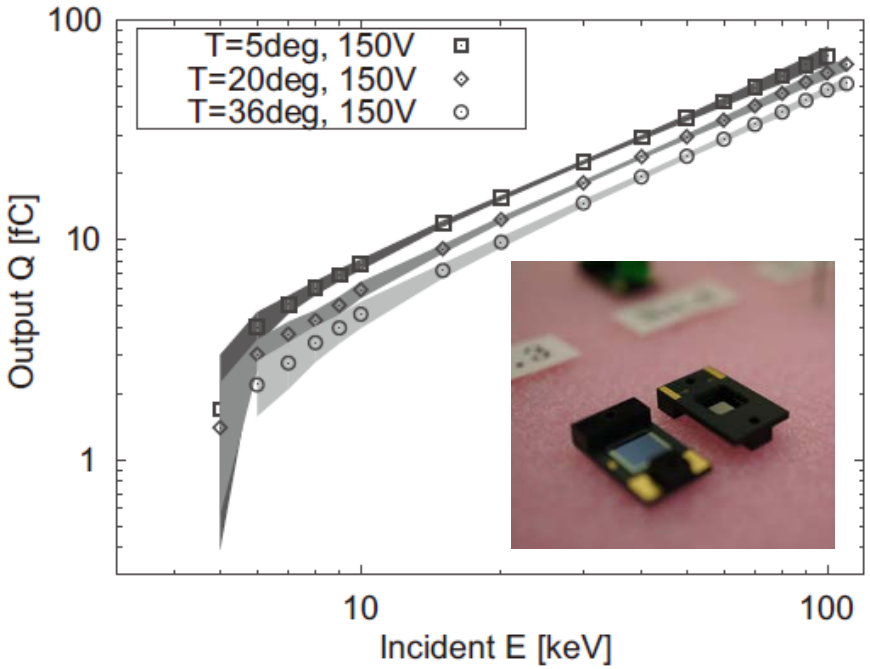
- The analog board was fabricated
- Performance test was conducted with artificial test pulses
- The board was found to work well for test pulses (see the next figure)

Capture from OSC

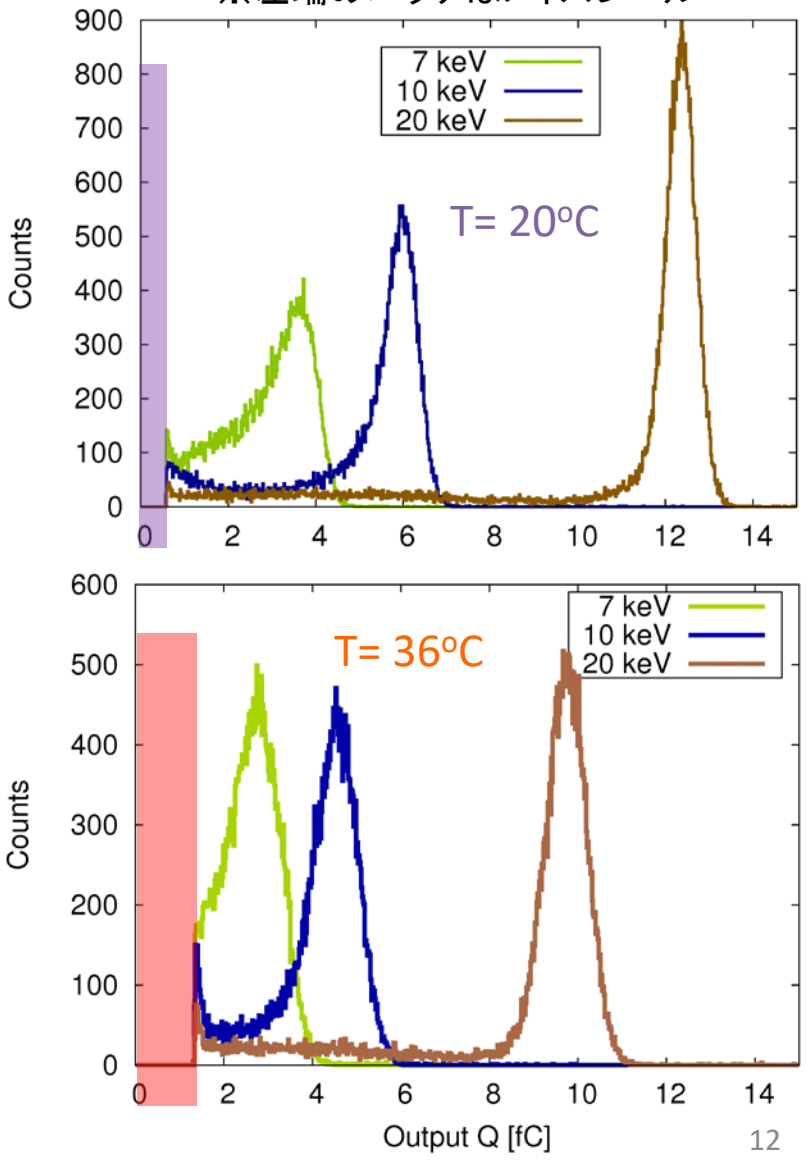


- Test pulse is injected to generate CSA output
- The CSA output is shaped and its peak value is held at Peak-holder(PH)
- The digital electronics reads the PHOUT value when LLD “LOW” is detected
  - Then send the RESET signal to flush the PHOUT

Detector: Avalanche photodiode



※左端のハッチはノイズレベル



- リーチスルータイプAPDを用いる
- 印加 HV 150-250V
- 面積 ~5 x 5 mm^2
- 空乏層の厚み70um
- 不感層の厚み~0.2um/2um
- Energy resolution
  - < 20% (>20 keV)
  - < 30% (10-20 keV)

Specification

Items		
Target	Electron	
Energy coverage	20 keV – 100 keV	
Energy resolution	10-20%	depending on the incident energy
Sensitivity	~ 10^{-3} cm^2-sr	Per detector
FOV	80 deg cone (envelope)	Centre of FOV points the direction perpendicular to the rocket spin axis.
Size	100mm x 100mm x 200mm	
Weight	2 kg	
Power	6 W	AMP: 3W, HV: 1W, CNTL: 2W
Data rate	300kbps	

Summary

- We have designed energetic electron detector with 2-pi str FOV, which should be installed on future planetary explorers
- We have tested an analogue circuit board
  - It works well as expected
- We're preparing for
  - Check of APD performance
    - Especially the EUV rejection property