14th September 2016

Strip Calorimeter beam test at ELPH in Tohoku U with electron beam

K. Kotera *et al.*, Shinshu University

CALICE meeting @Arlington

Activity in Shinshu

HCAL

Strip scintillator HCAL

Segmented Lead glass Čerenkov calorimeter

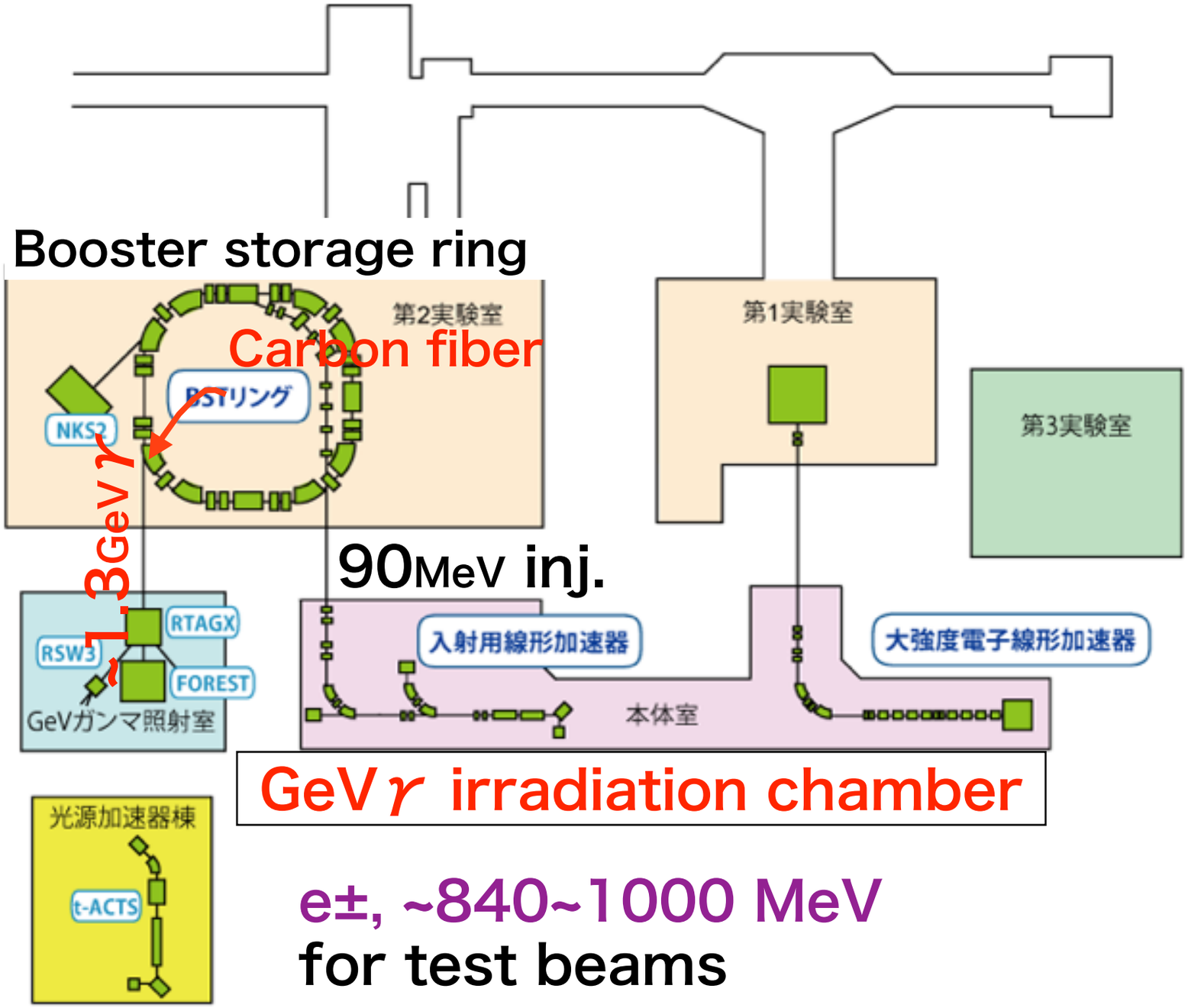
ECAL

Segmented Lead glass Čerenkov calorimeter

Strip scintillator ECAL on EBU

Test Combination of those three detectors.

Research Center for ELectron PHoton Science in Tohoku Uni.



GeV γ irradiation chamber

e±, ~840~1000 MeV
for test beams
20 mmϕspot, ～kHz

5 sec. e^- (90MeV) inject.
2 sec. accelerate ,
10 sec. 10~30 mA
→ ~1.3GeV γ

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Detectors

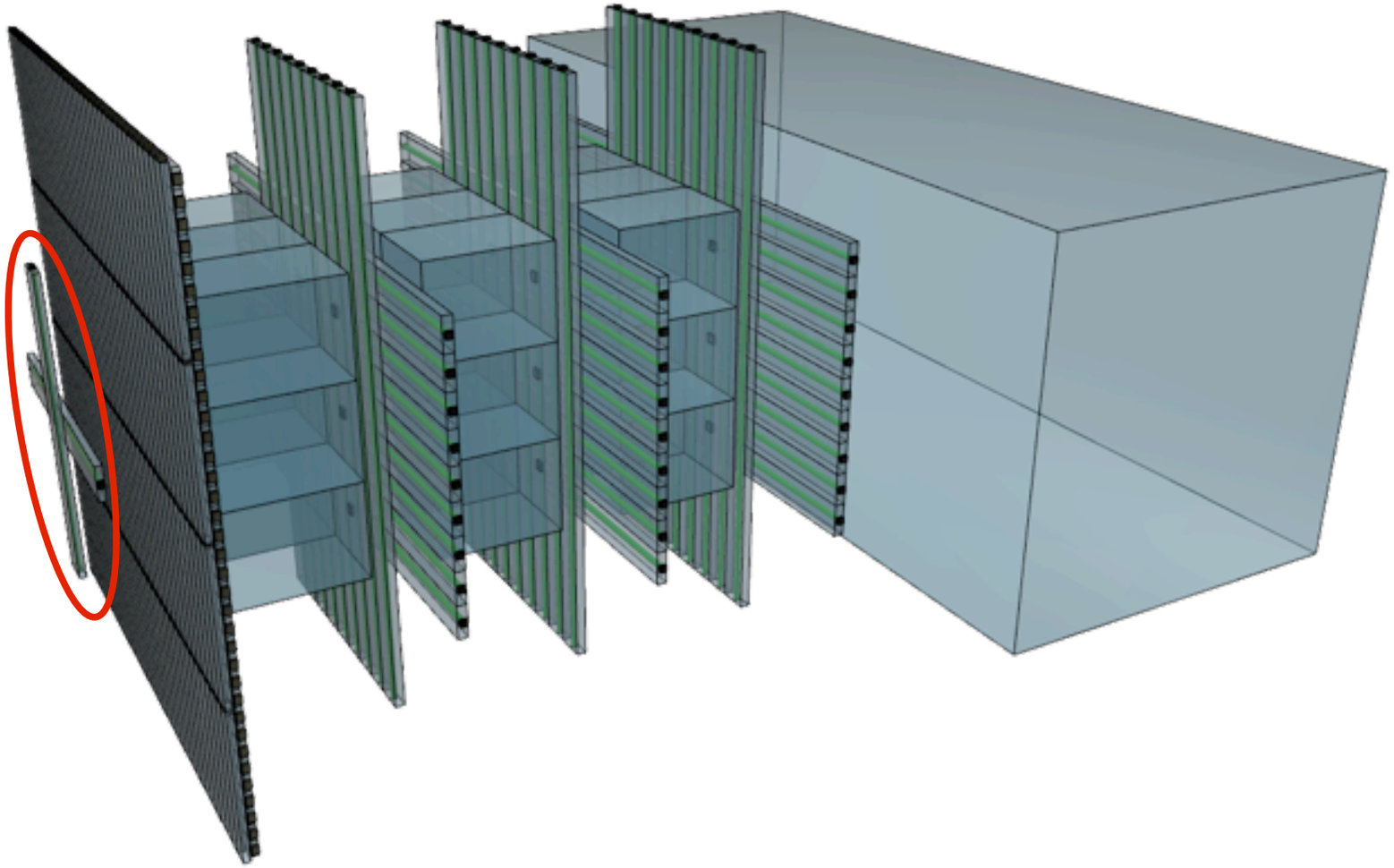
9×1×0.3cm^3 strip × 2 (cross): trigger

EBU 45×5×2mm^3 strip×144 (18×18cm^2) × 2: ECAL part

3×3×4cm^3 lead-glass × 9 (area9×9cm^2) × 3: HCAL absorber

18×1×0.3cm^3 strip × 9 (area18×9cm^2) × 6: HCAL part

25×12×12cm^3 lead-glass : tail catcher



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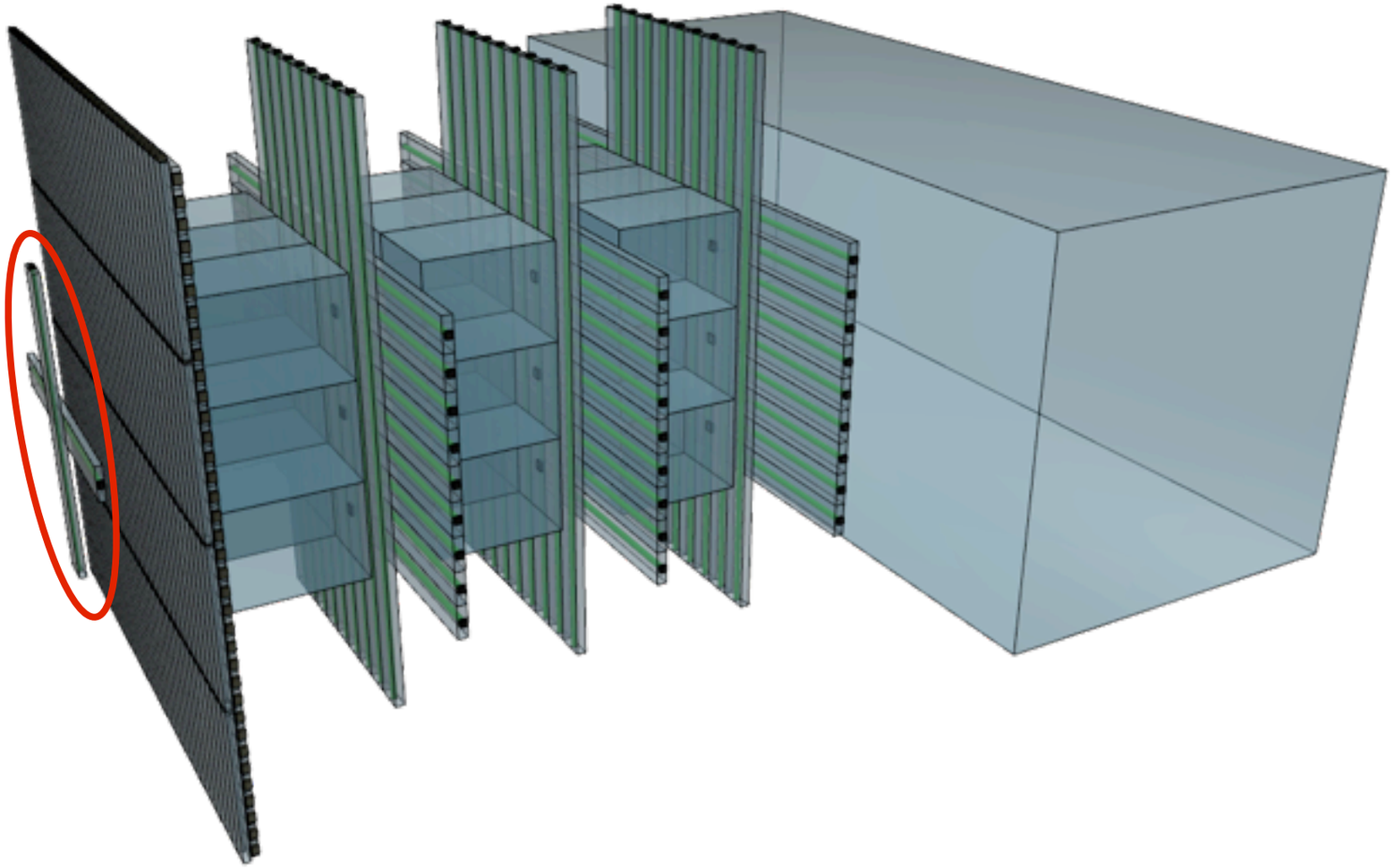

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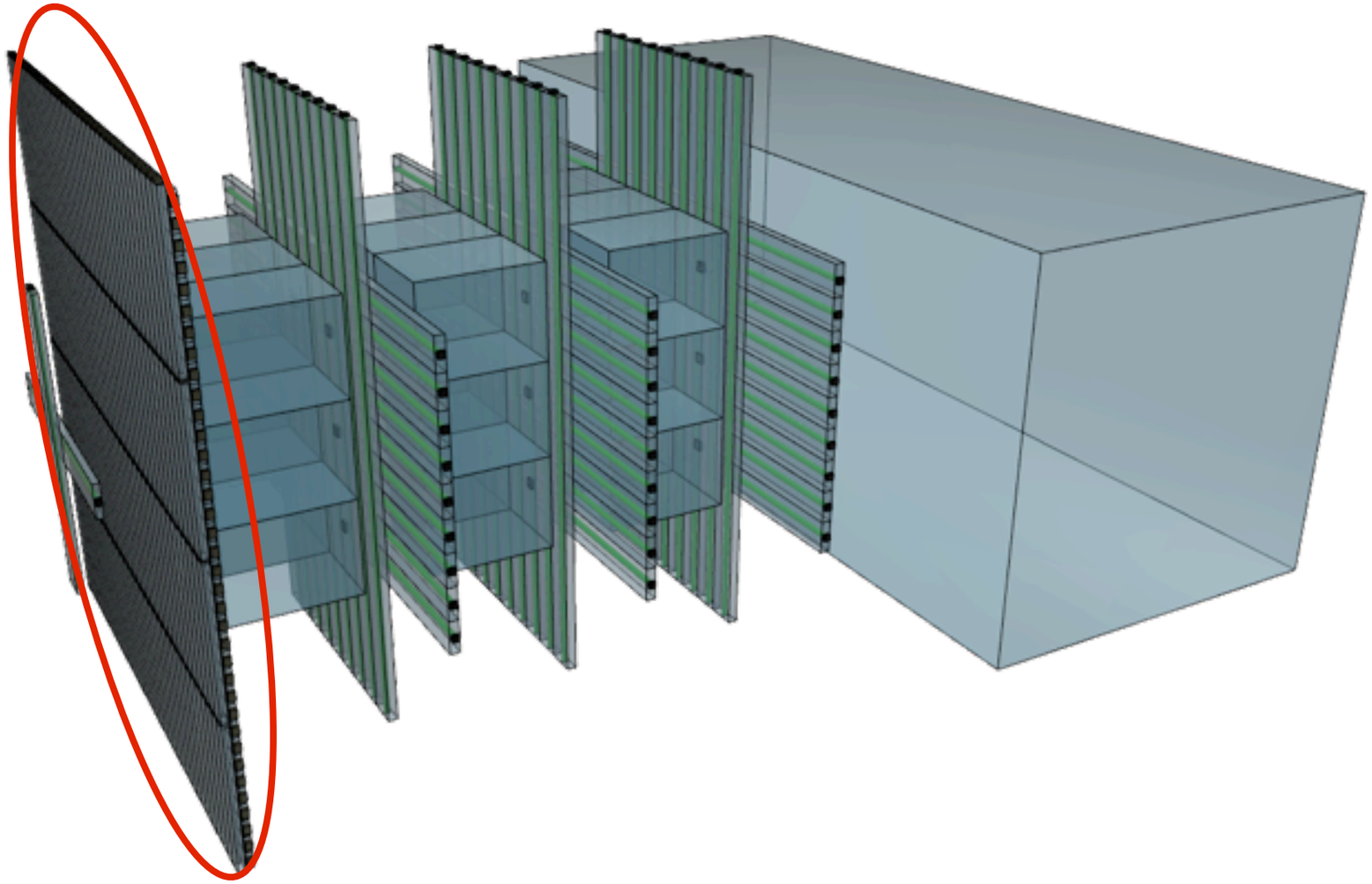

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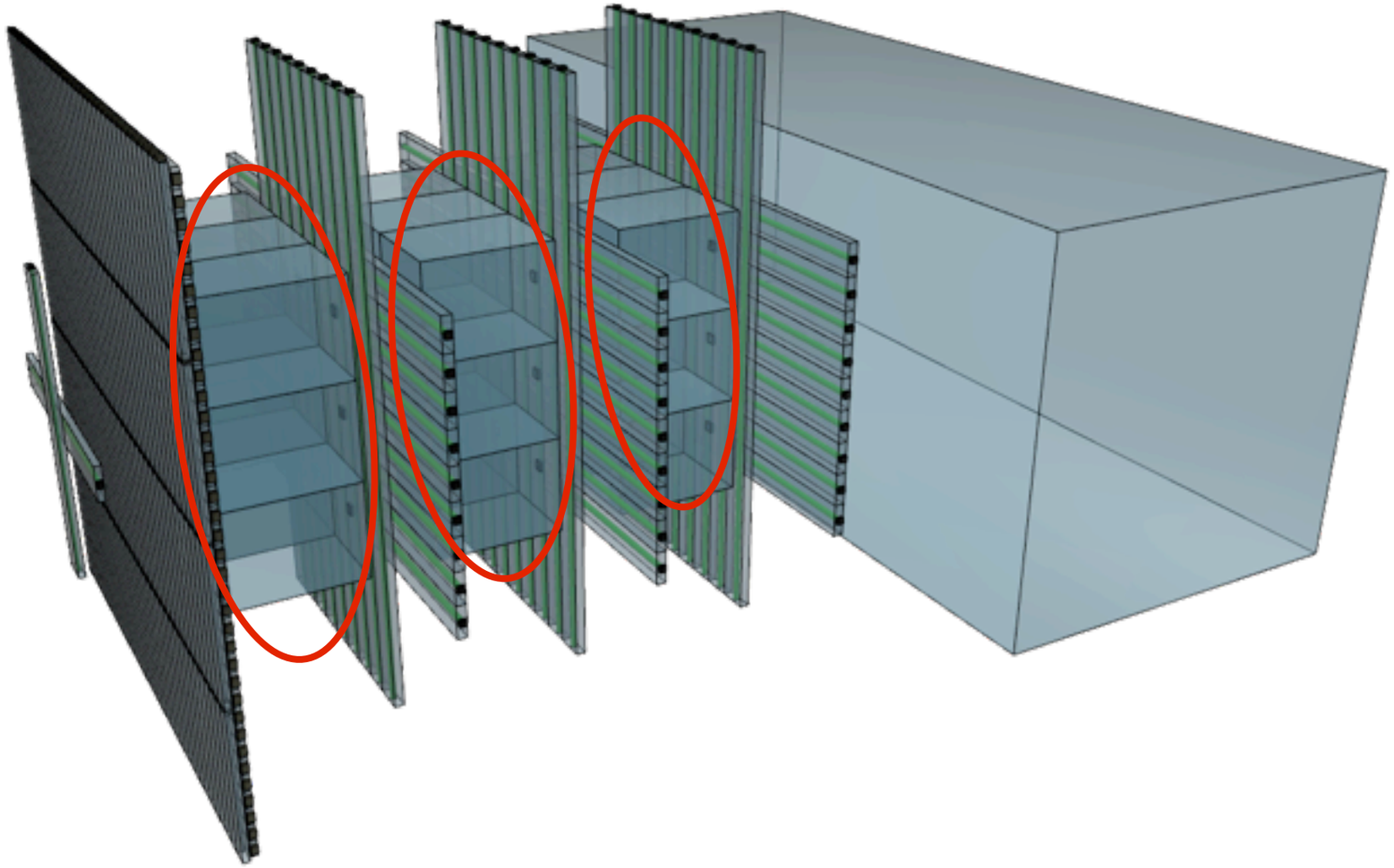

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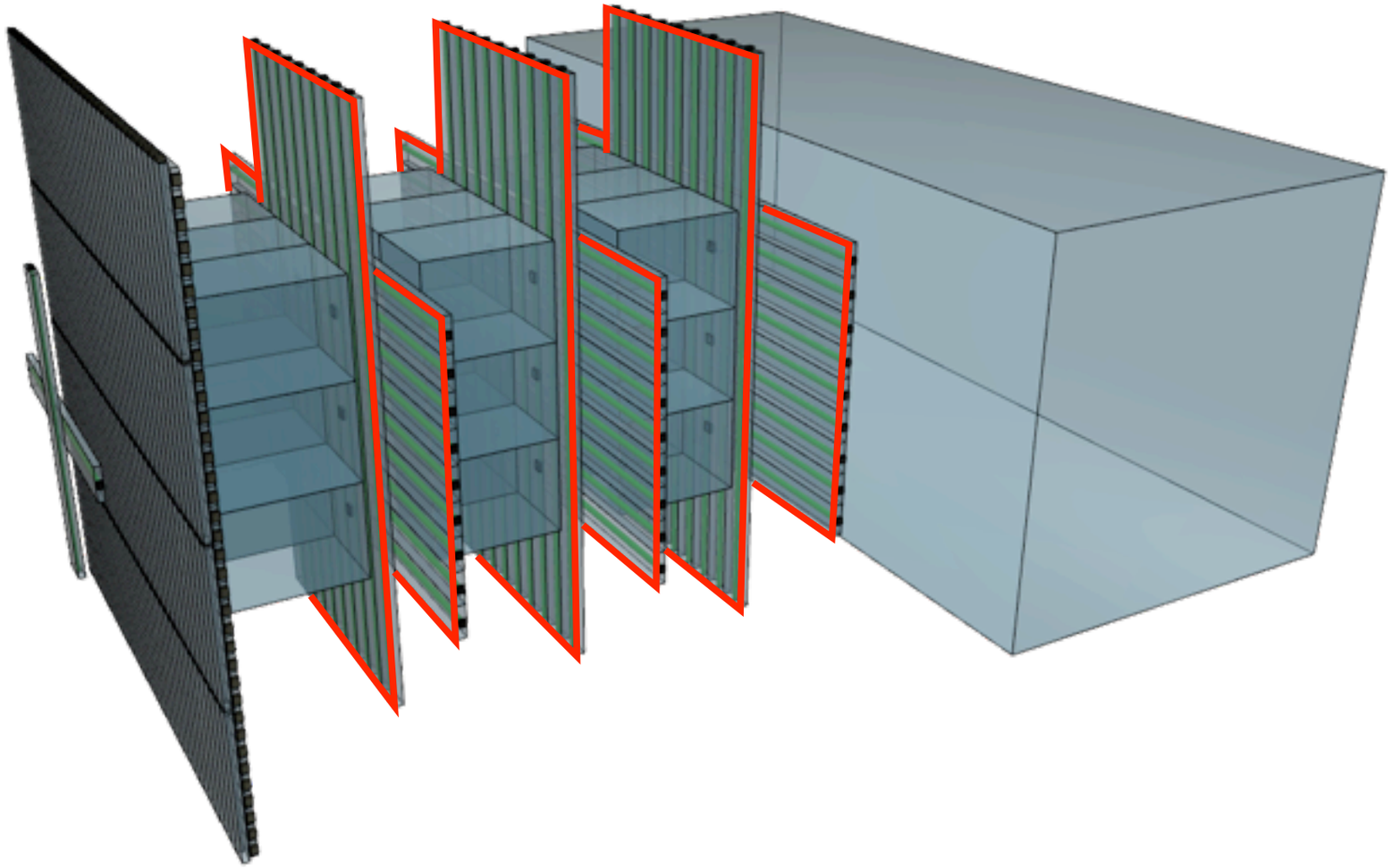

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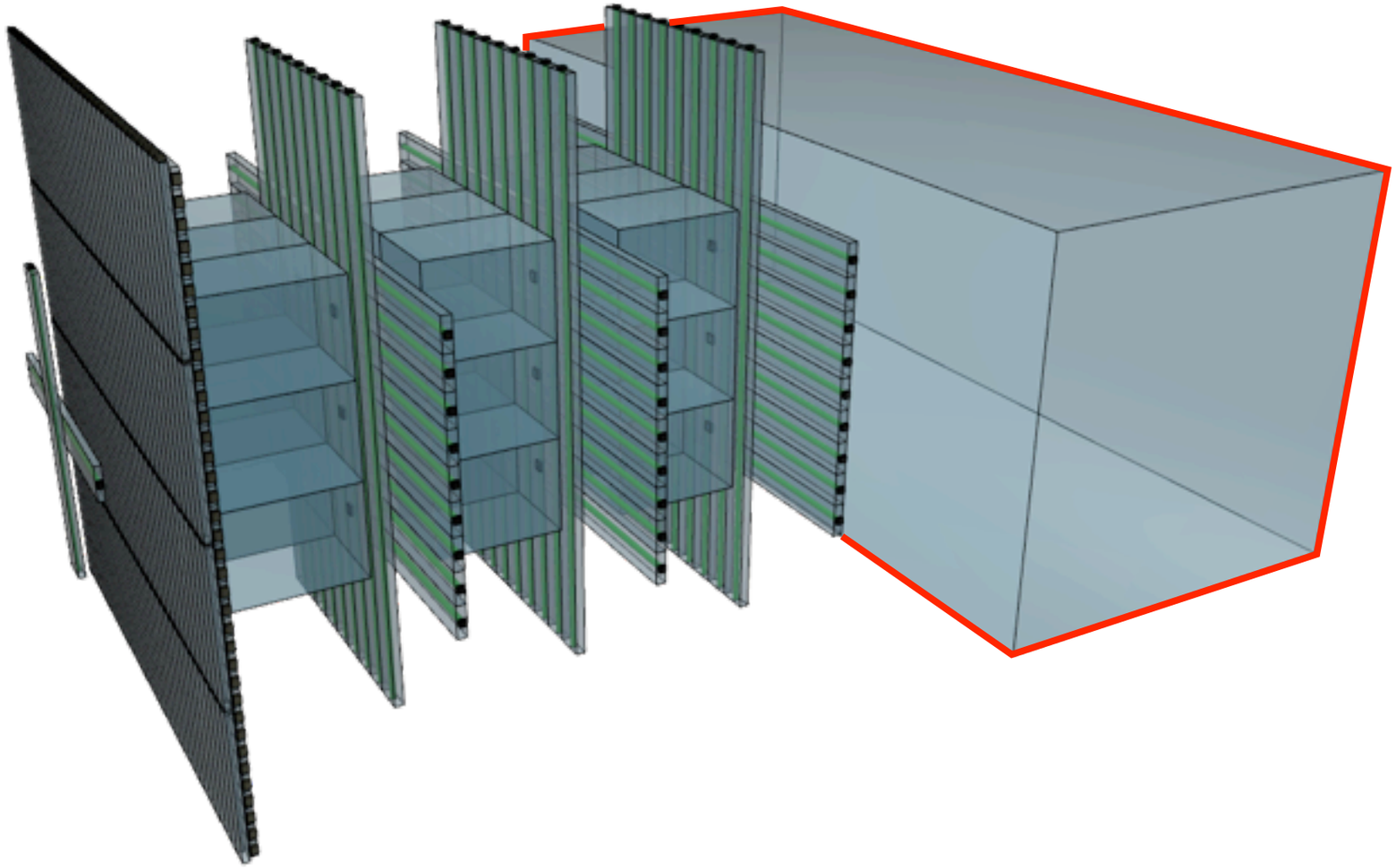


Purpose

Evaluation of segmented-lead-glass/scintillator strip system to EM showers.

Energy resolution, esp. lead-glass part

angular position resolution.

EBU - modification of status (MIP, p.e. separation)
using high light yield scintillator strips.

- provide fine position information.

Others

Practice of CALICE E/HBU DAQ with CCC and LDA.

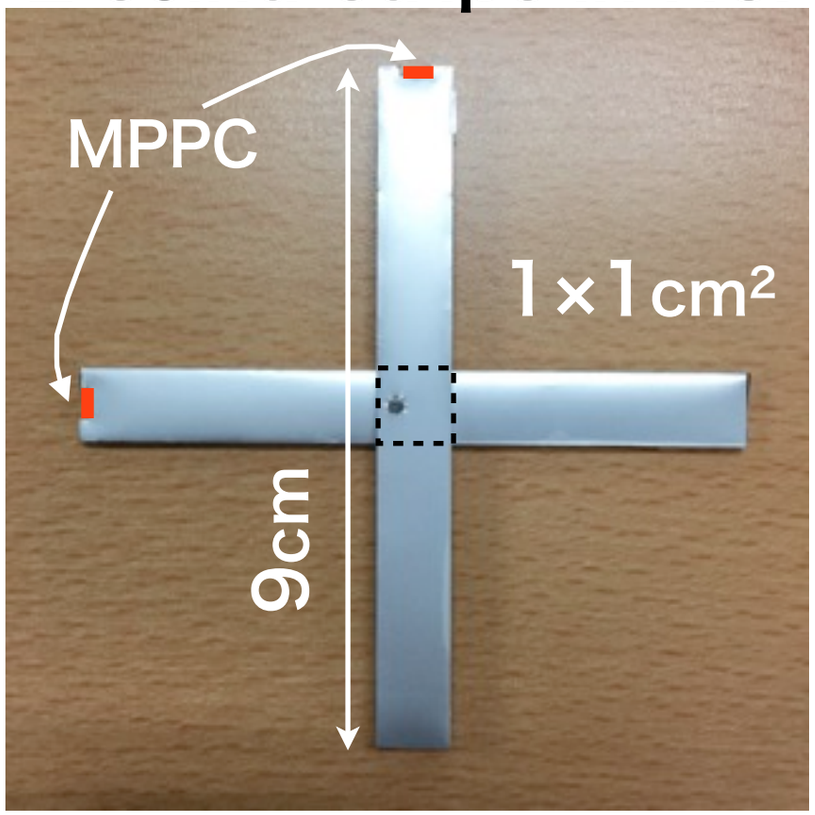
Practice of Firmware coding of FPGA in Easiroc Module: internal coincidence for trigger so on.

Each detector part

Trigger counter and tail catcher

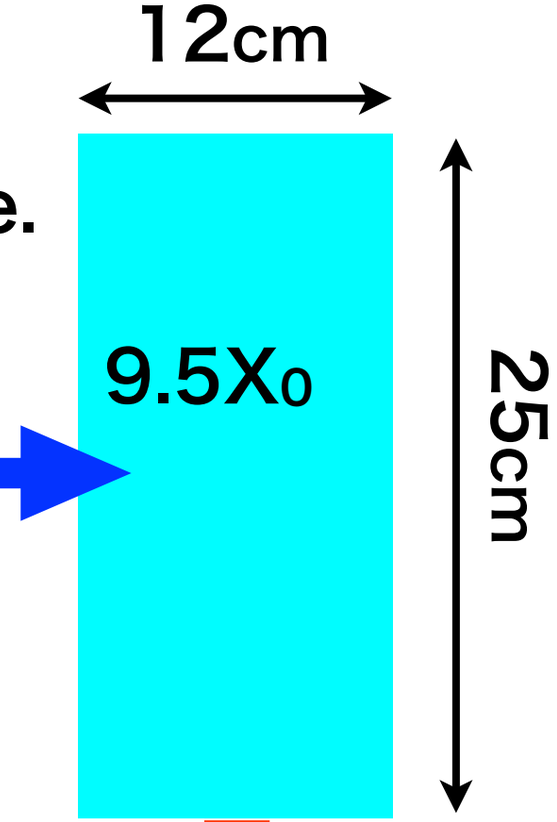
Trigger counter

2 scinti-strips in HCAL



MPPC S10362-11-25P,
25μm, 1600pix on 1mm²
2008 products

Tail catcher

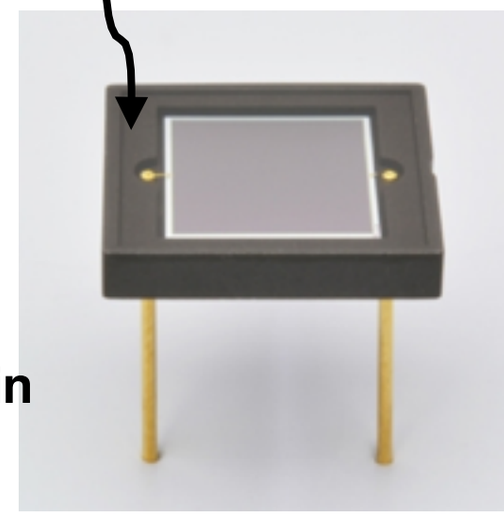


Expected # p.e.
6 p.e./MIP

beam

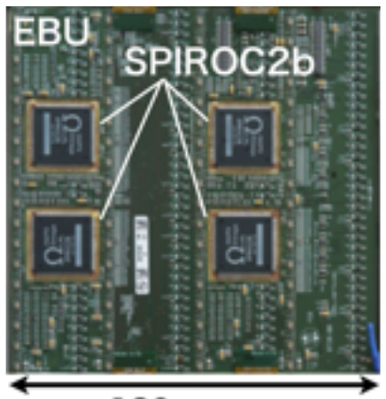
<u>MPPC (S133083-050CS)</u>

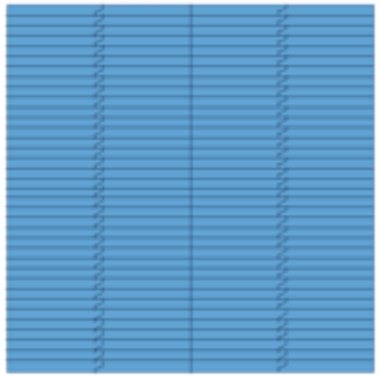
- Pixel pitch: 50μm
- Effective photosensitive area: 6.0mm×6.0mm
- Number of pixels: 14400
- Package: Ceramic
- Window material: Silicone resin
- Refractive index of window material: 1.41



EBUs

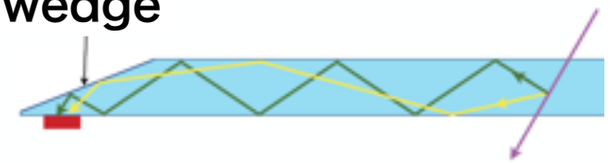
EBU_0 Transverse type

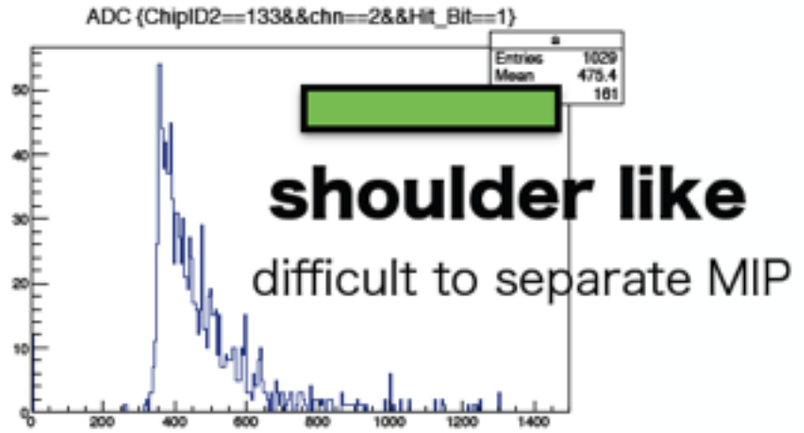




- Bottom readout
- 10k pix MPPCs
- 144 channels

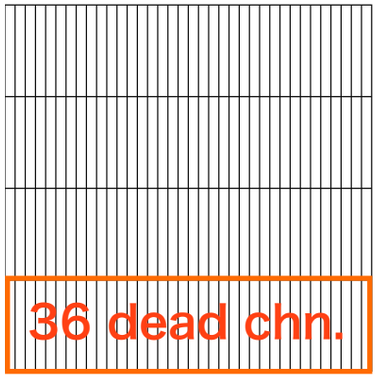
wedge



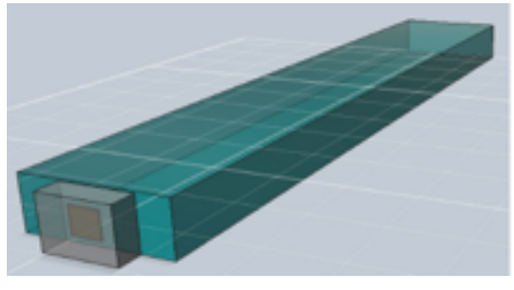


MIP insufficient separation

EBU_1 Longitudinal type



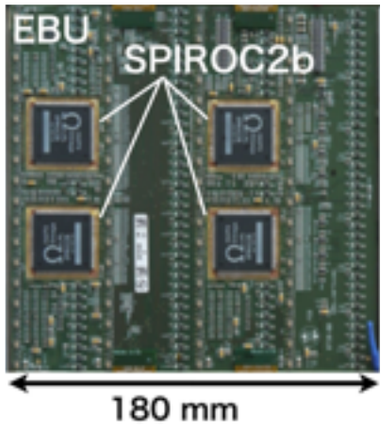
- Baseline readout
- 10k pix MPPCs
- 108 channels

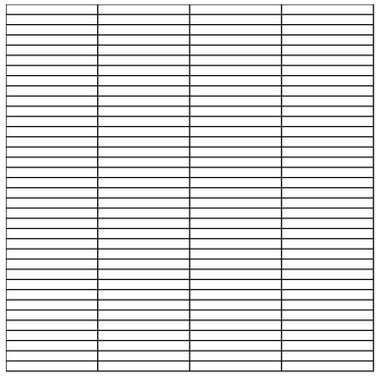


Kraray ➡ EJ

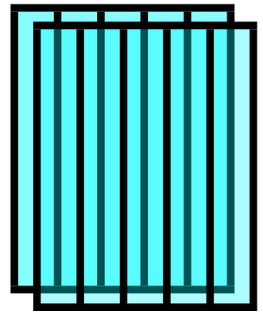
Thickness: 2mm ➡3mm

EBU_2 Transverse type





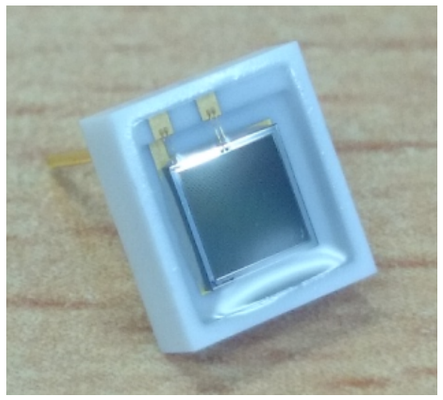
- Baseline readout
- 1600 pix MPPCs
- tested 2013 at DESY
- 144 channels



two longitudinal layer with 2.5mm shift ➡ fine position

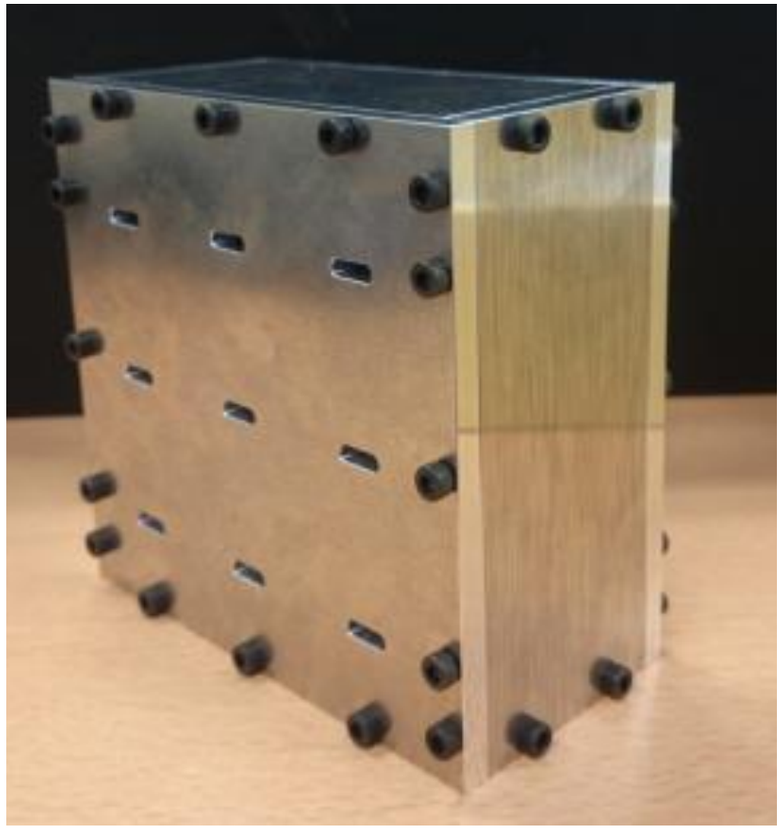
Lead-glass counters

MPPC (S13360-3050CS)



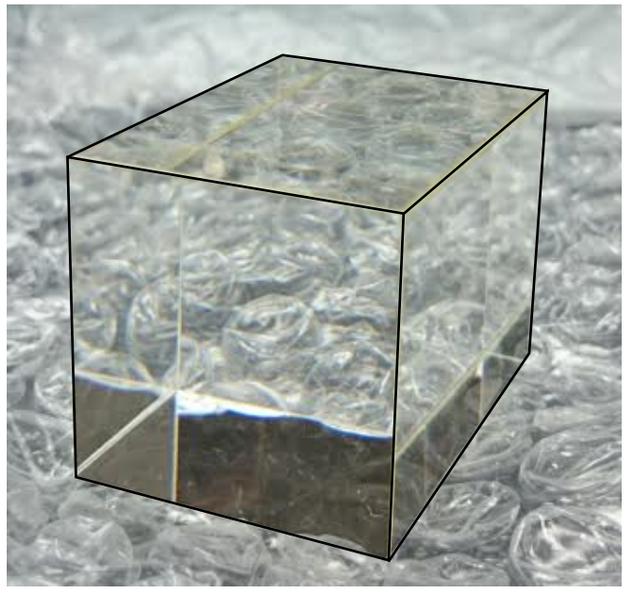
- **Pixel pitch: 50μm**
- **Effective photosensitive area: 3.0mm×3.0mm**
- **Number of pixels: 3600**
- **Package: Ceramic**
- **Window material: Silicone resin**
- **Refractive index of window material: 1.41**

3 × 3 lead-glass case



DF6

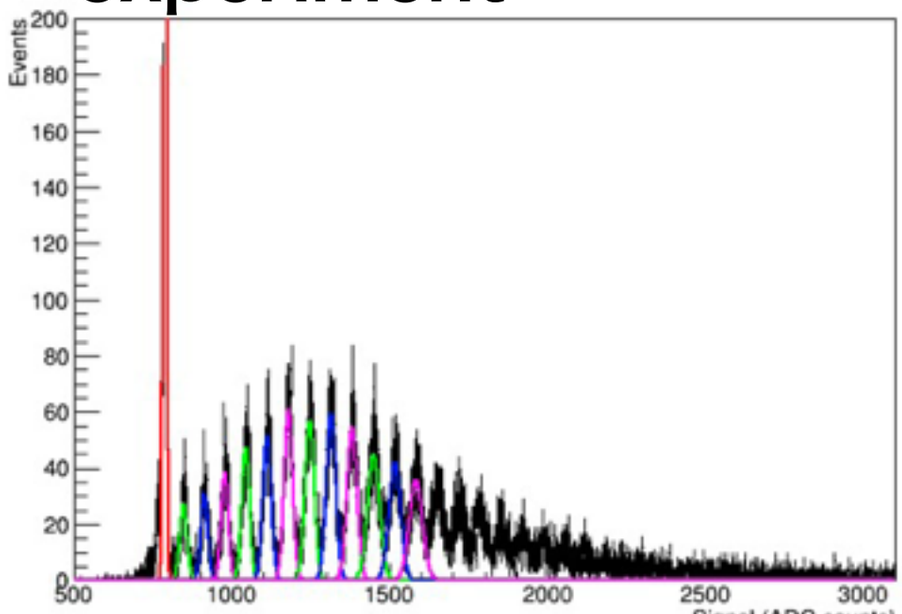
black edge lines were artificially added



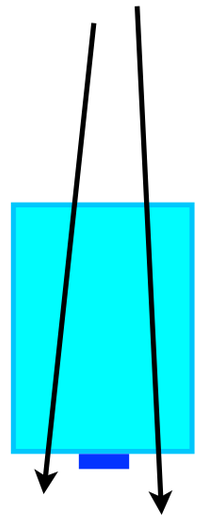
- **Size : 30×30×40 mm^3**
- **Refractive index: 1.8**
- **Density: 5.20 g/cm^3**
- **X_0 ~ 1.7 cm**
- **R_M ~ 3.9 cm**
- **λ_0 ~ 17 cm**
- **each block is wrapped with reflector film: 3M radiant ESR2 32μm**

Sensitivity of Lead-glass

experiment



cosmic muon



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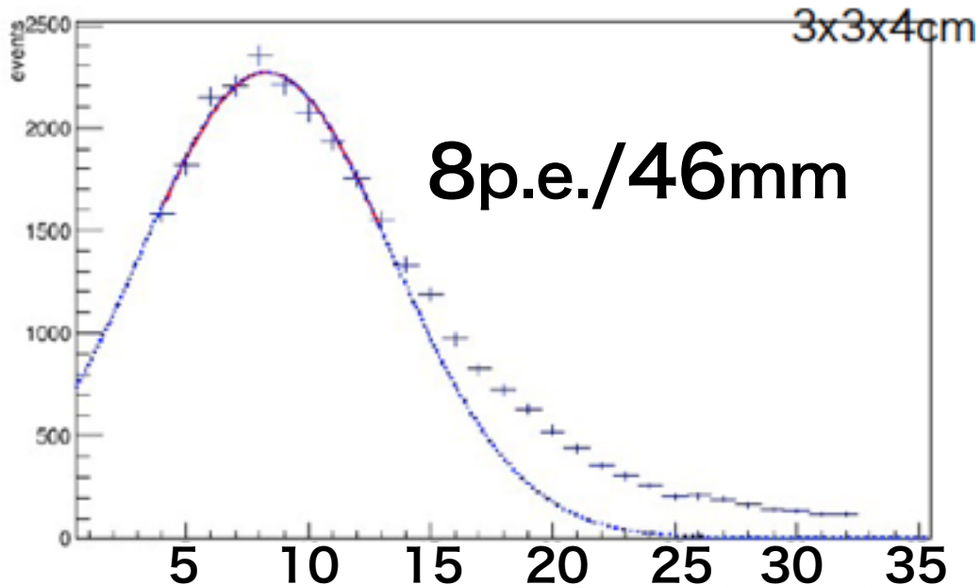

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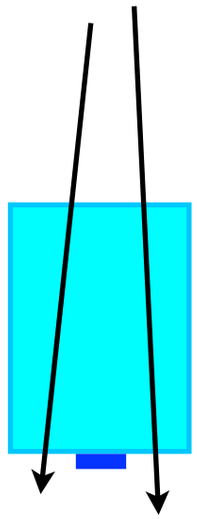

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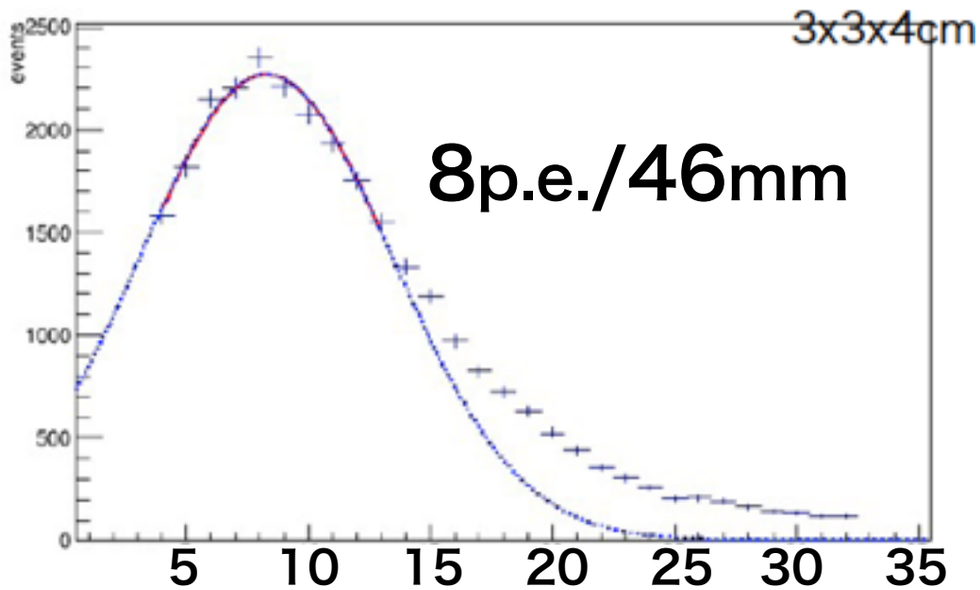
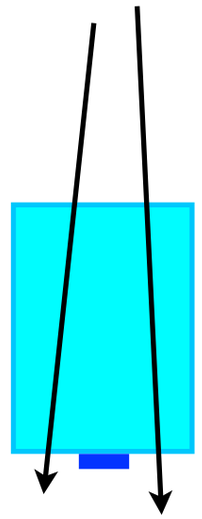


number of p.e.

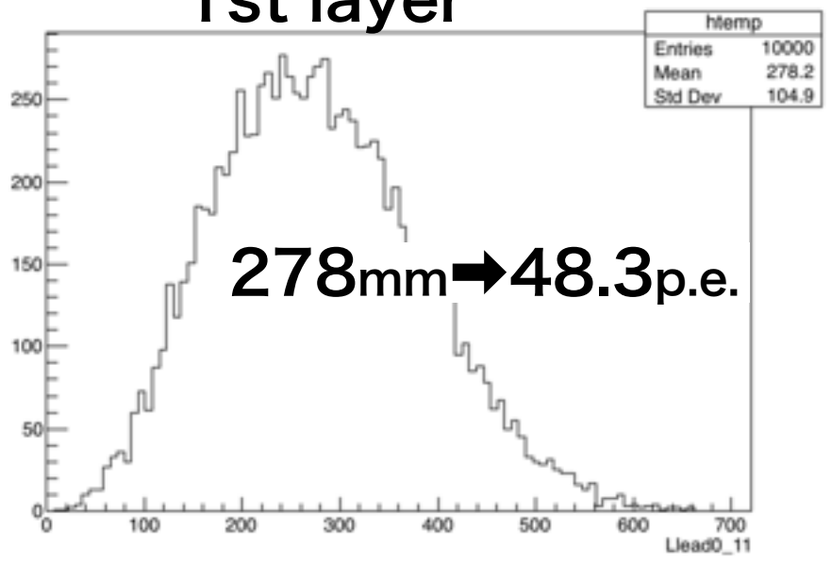
cosmic muon



each 2.35 X_0

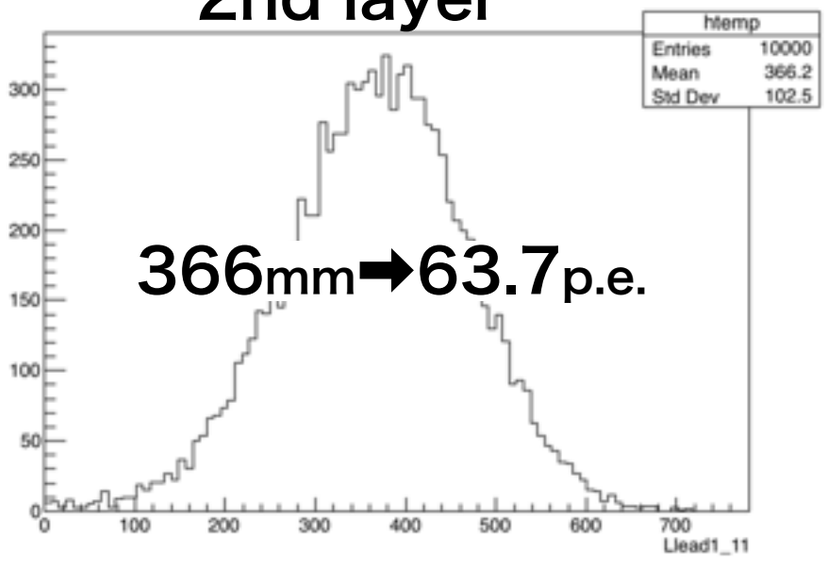
MC: Total track length of a 1 GeV event

1st layer



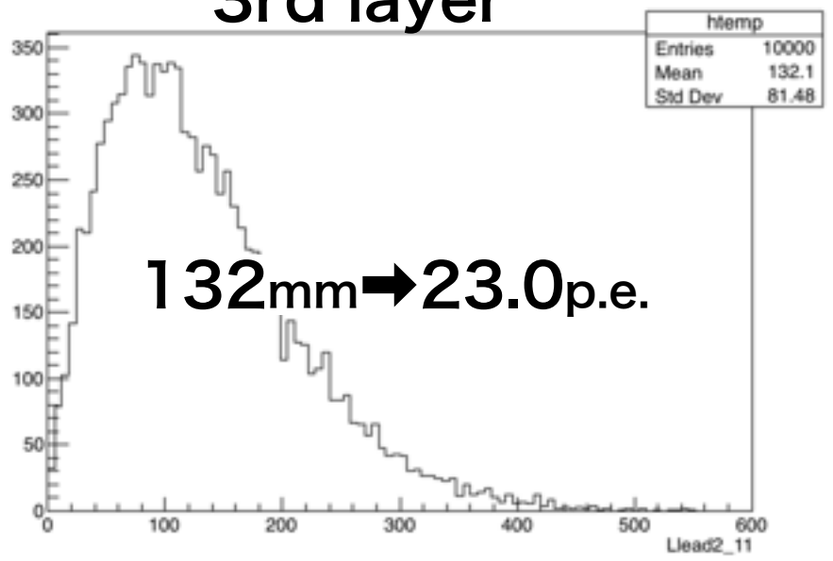
2.35 X_0

2nd layer



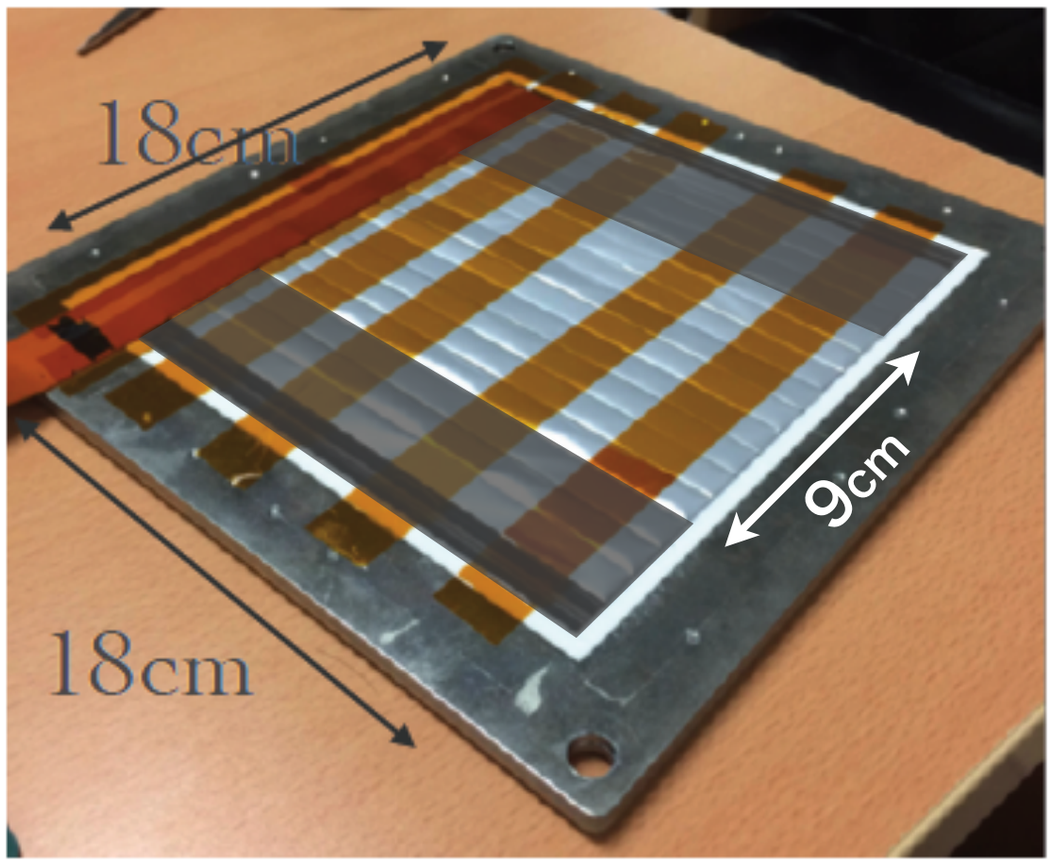
4.70 X_0

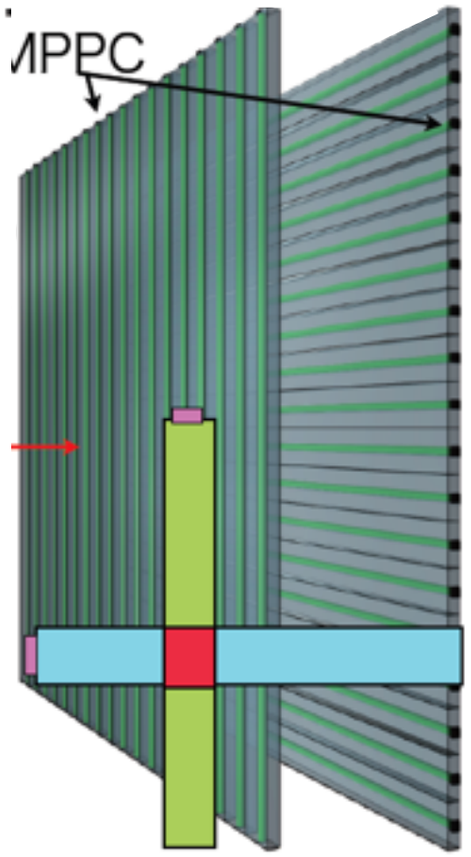
3rd layer

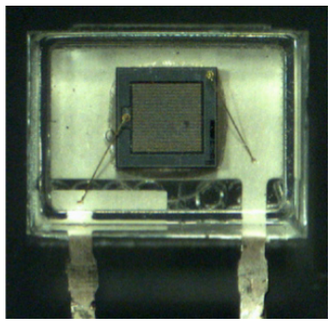


7.05 X_0

Scintillator strip layer



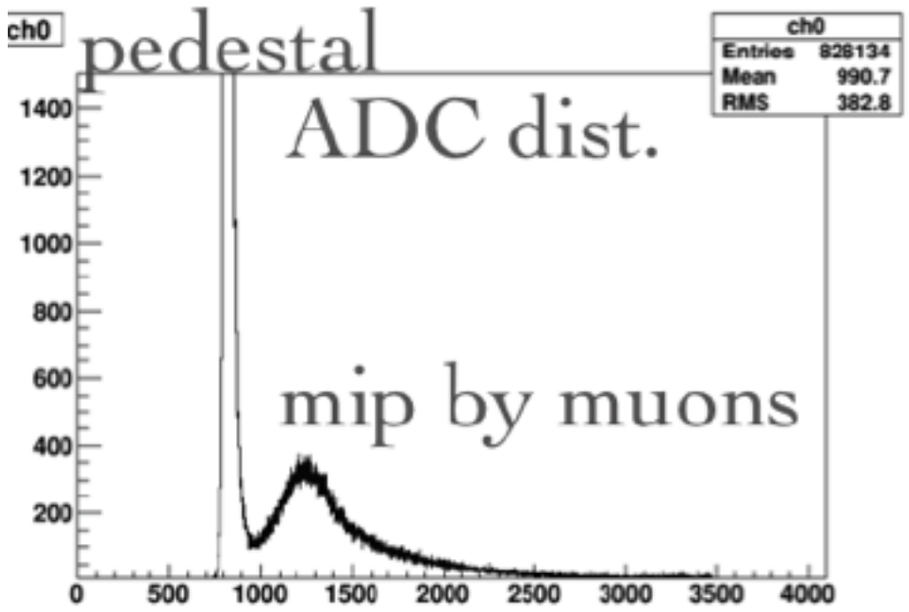


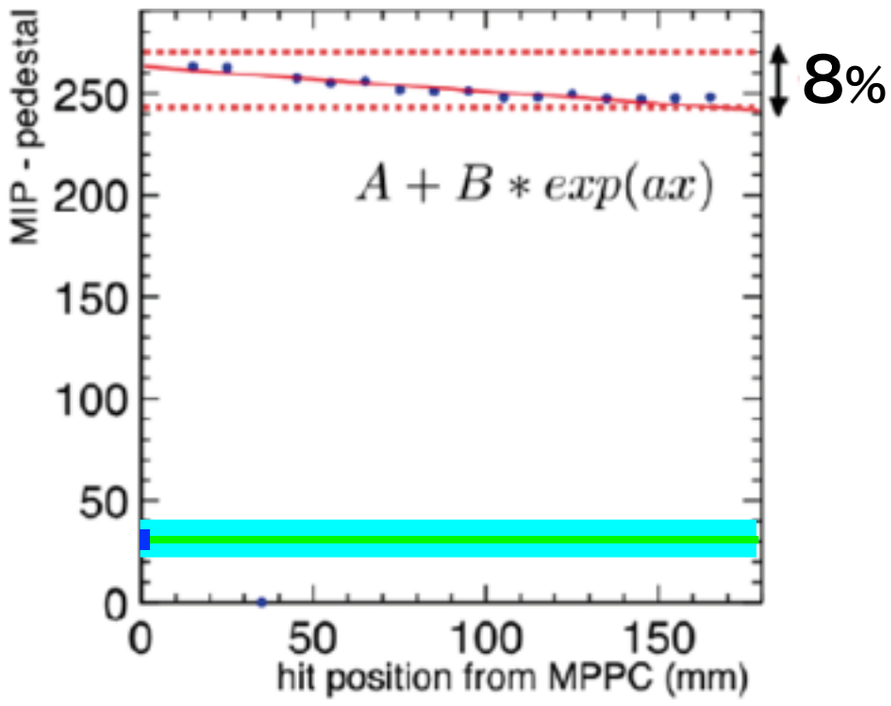


MPPC S10362-11-25P,
25μm, 1600pix on 1mm^2
2008 products

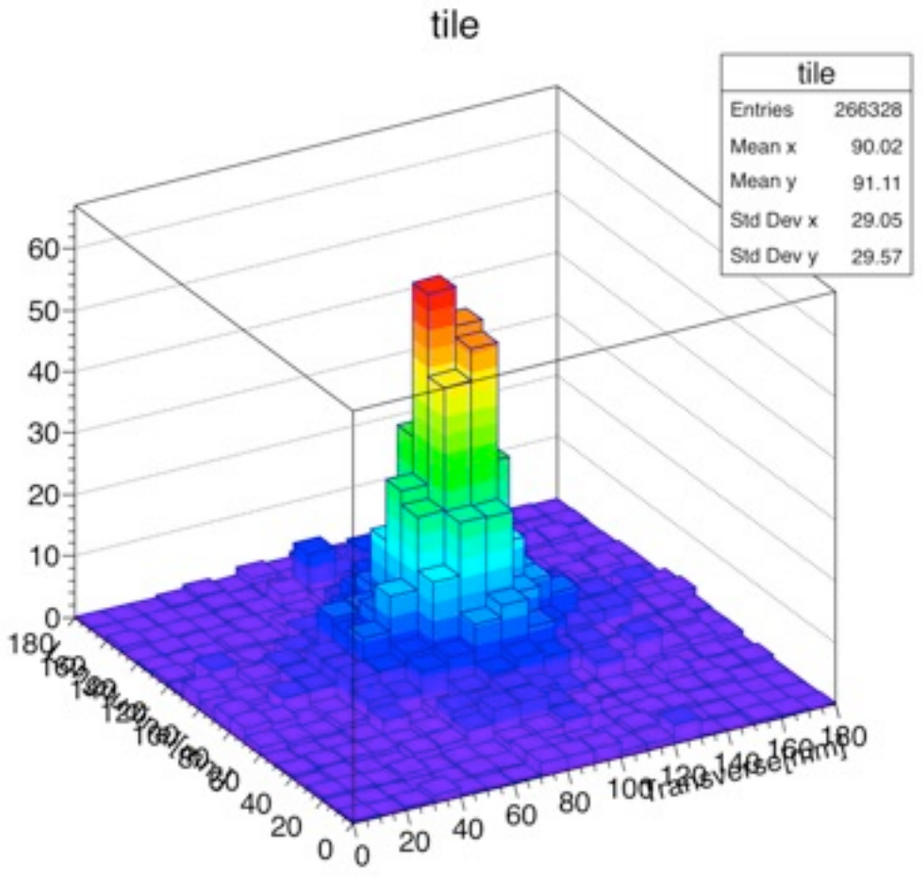
S10362-11-25P

CERN 2015





Position resolution(CoG)



MC:

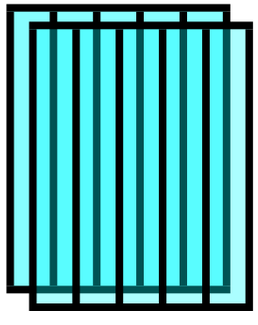
1mmϕ beam ➡ σ Center-of-GravitationE
= 8mm in 10×90mm^2 strips,

position resolution was already smeared by CoG fluctuation.

w/o absorber layers ➡ mip track.

Exp:

10mm trigger ➡ How much smeared?
5mm EBU ➡ How much smeared?
2.5mm EBU grid ➡ How much smeared?

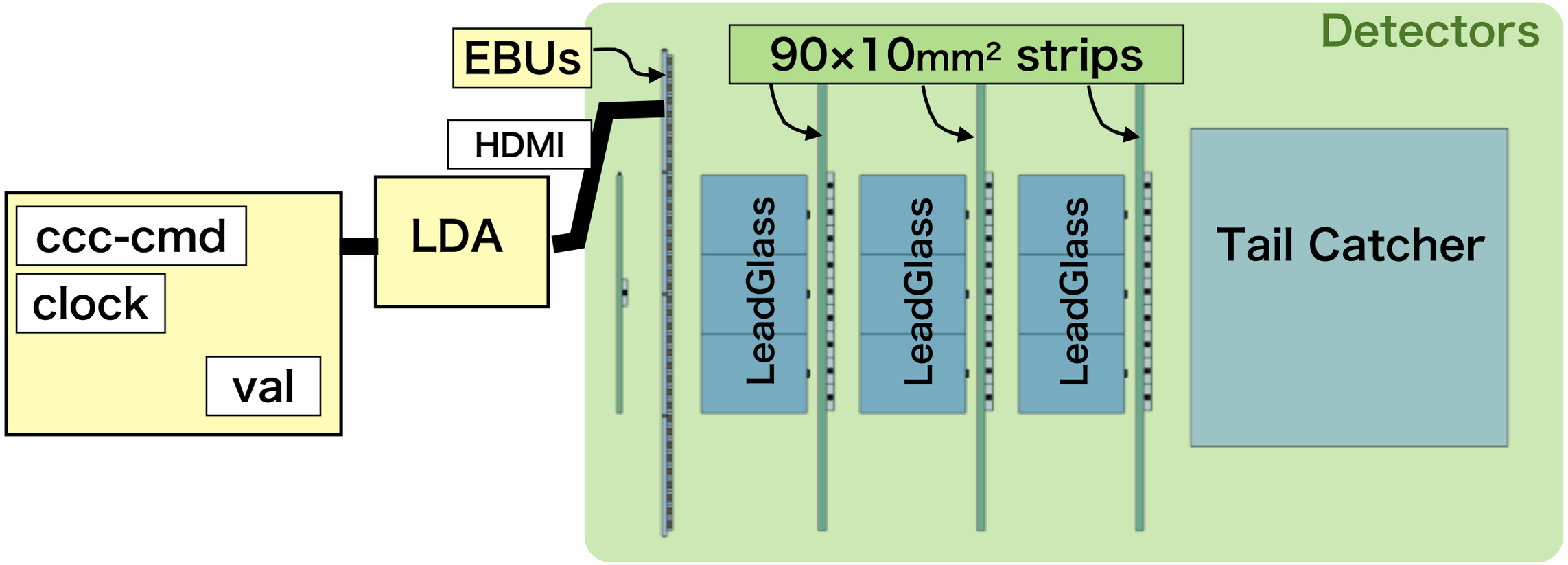


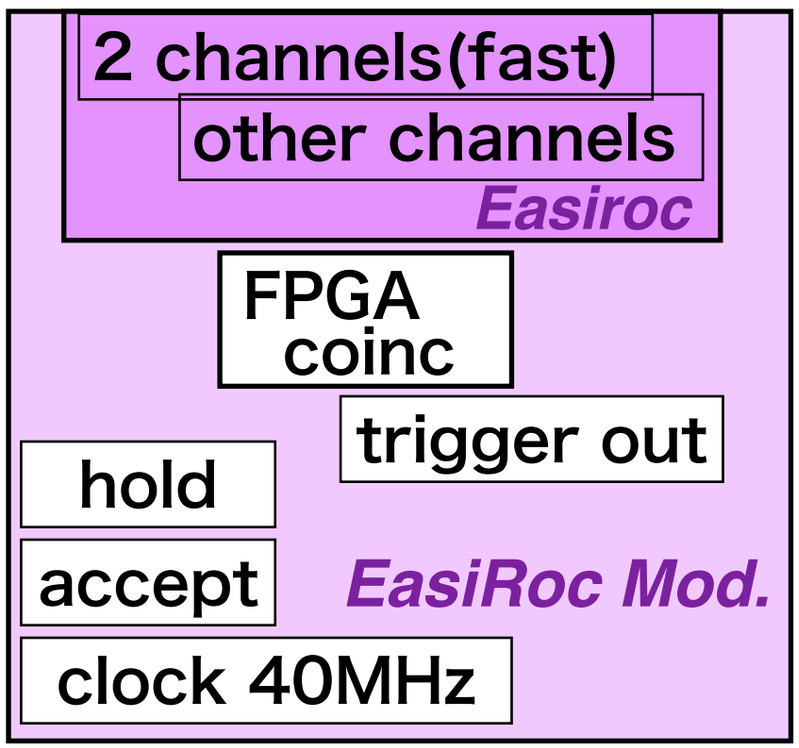
two shift EBUs make narrow grid.

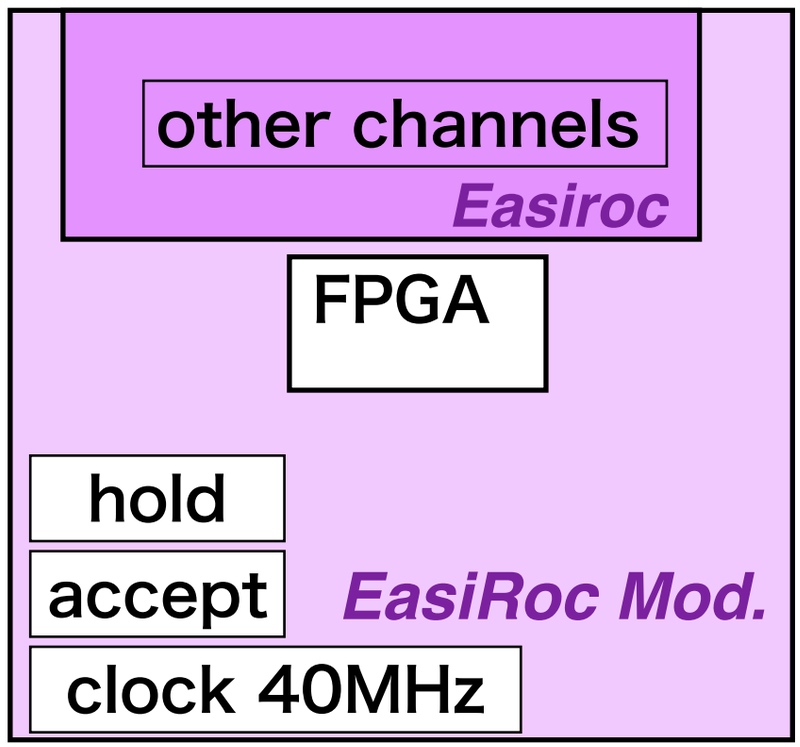
Extract the kernel width due to σ_{CoG}

DAQ /synchronizations

Thanks for Jiri







DAQ /synchronizations

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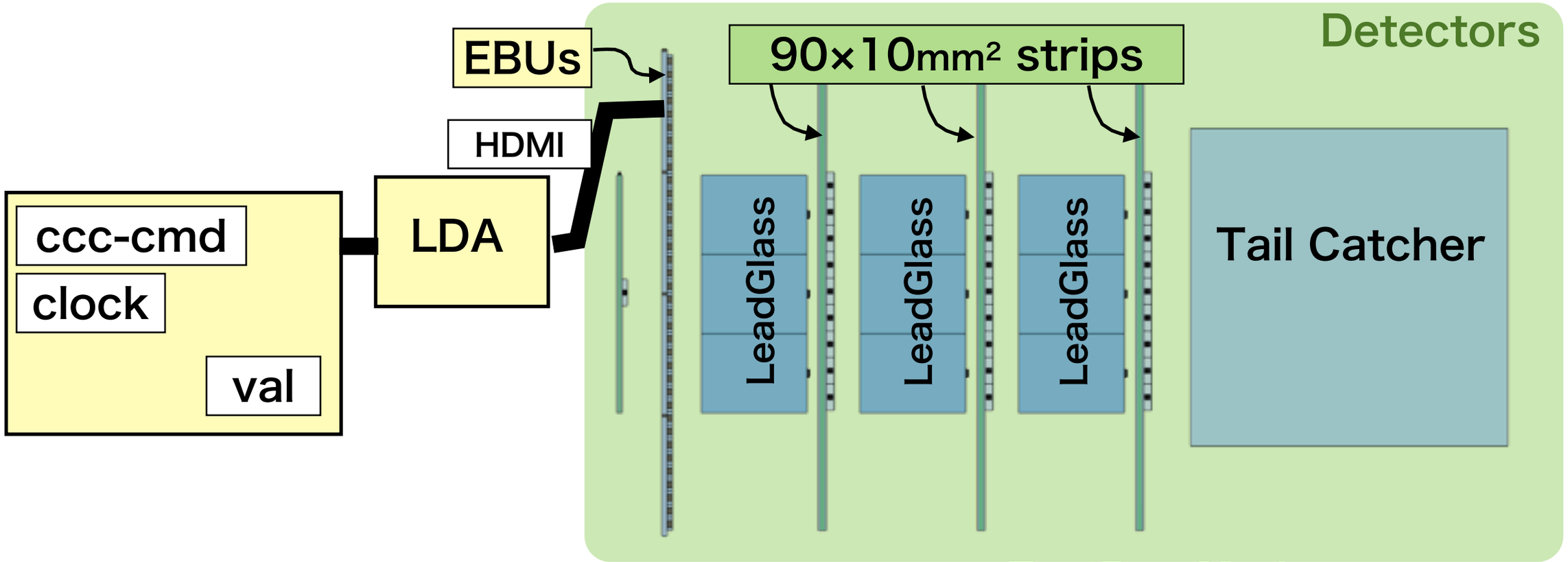
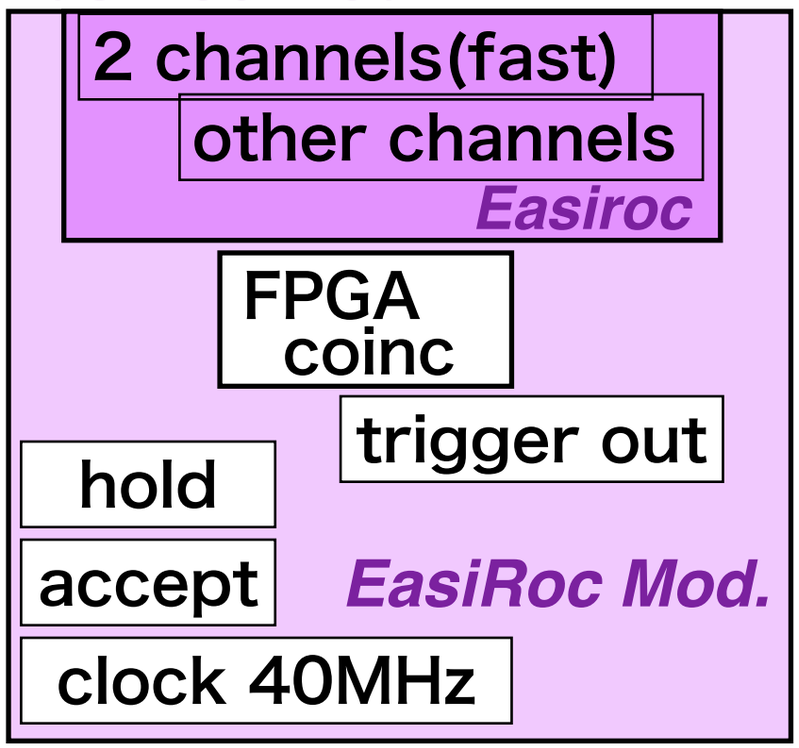
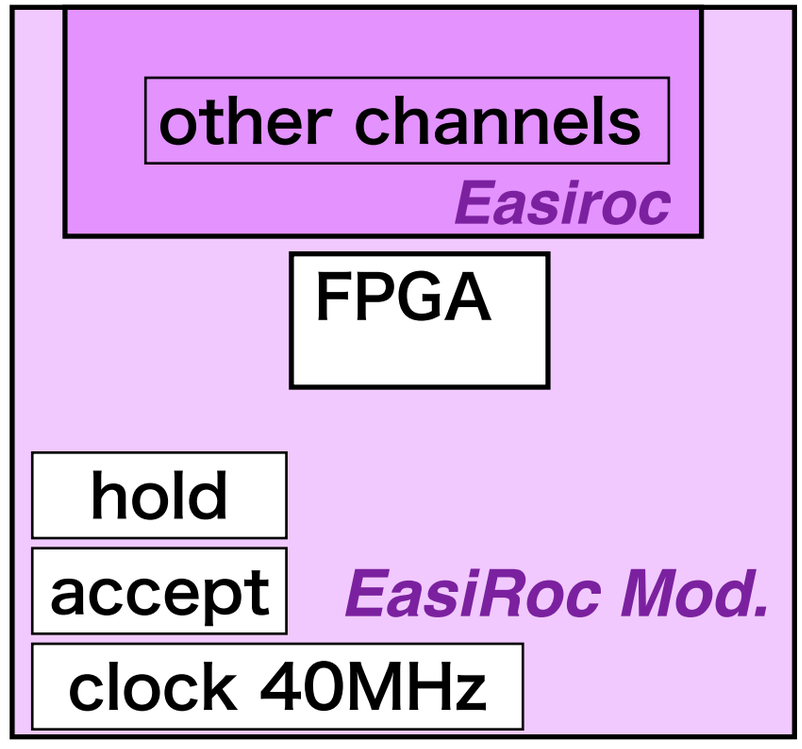
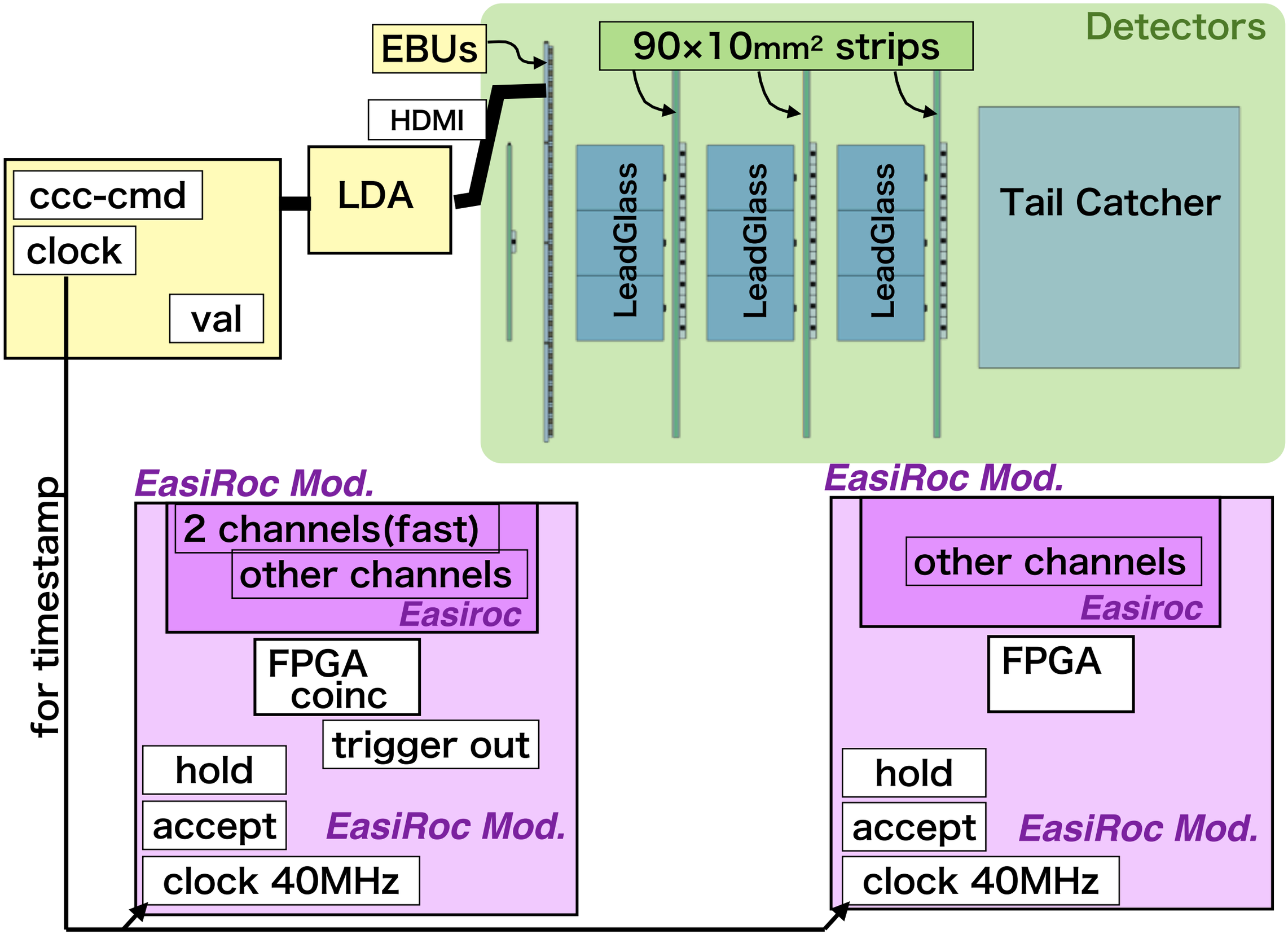


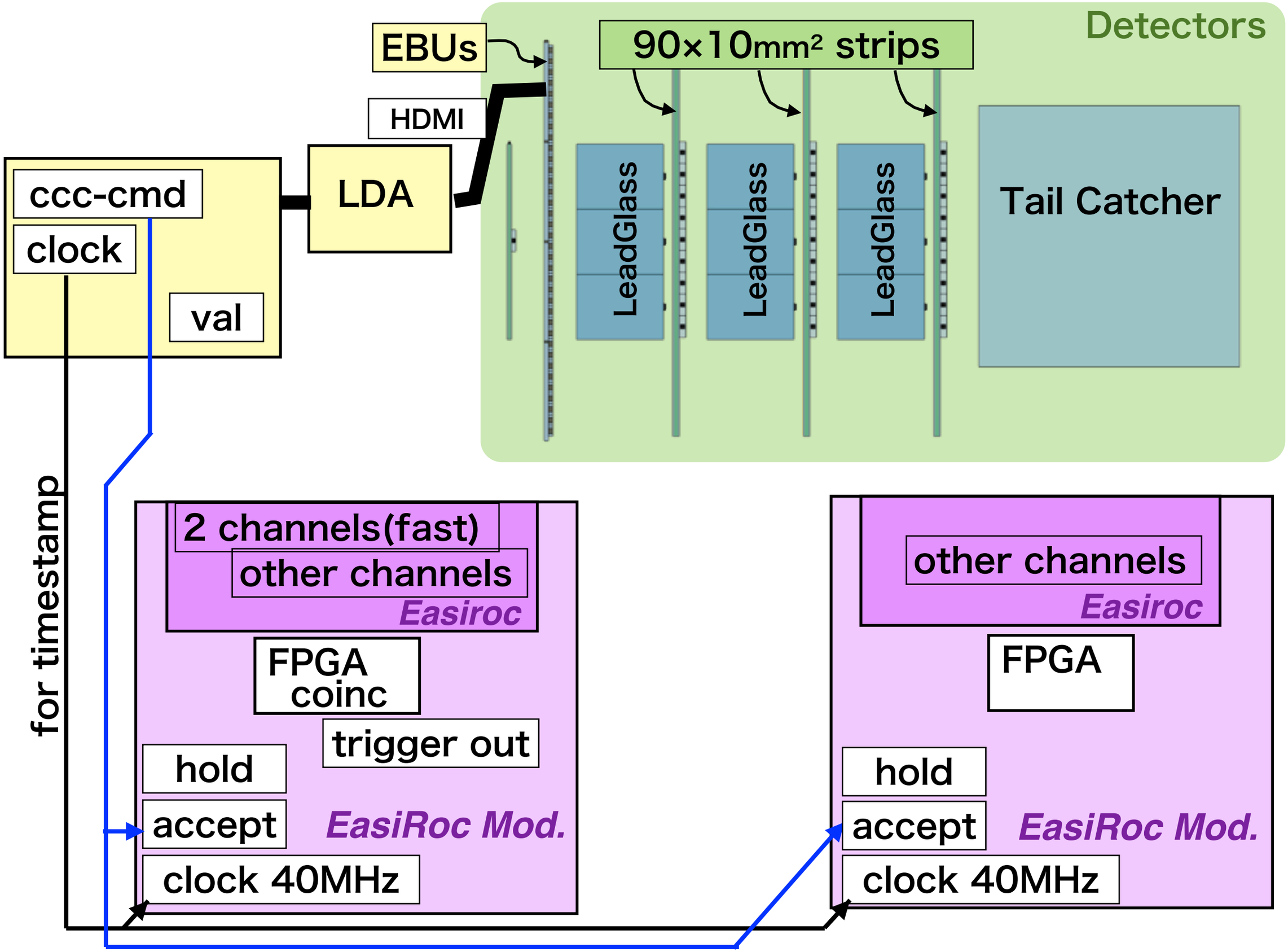




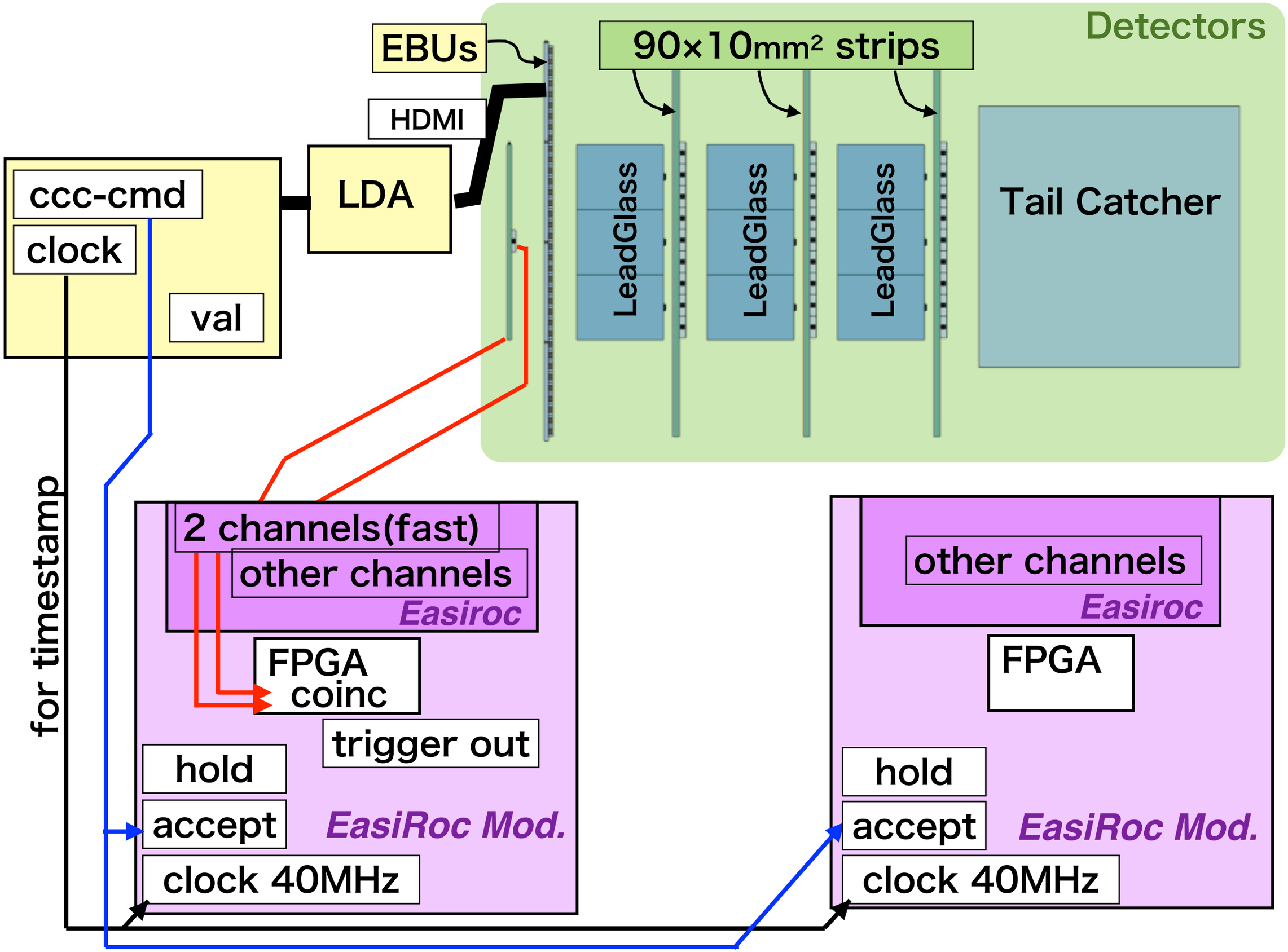
DAQ /synchronizations



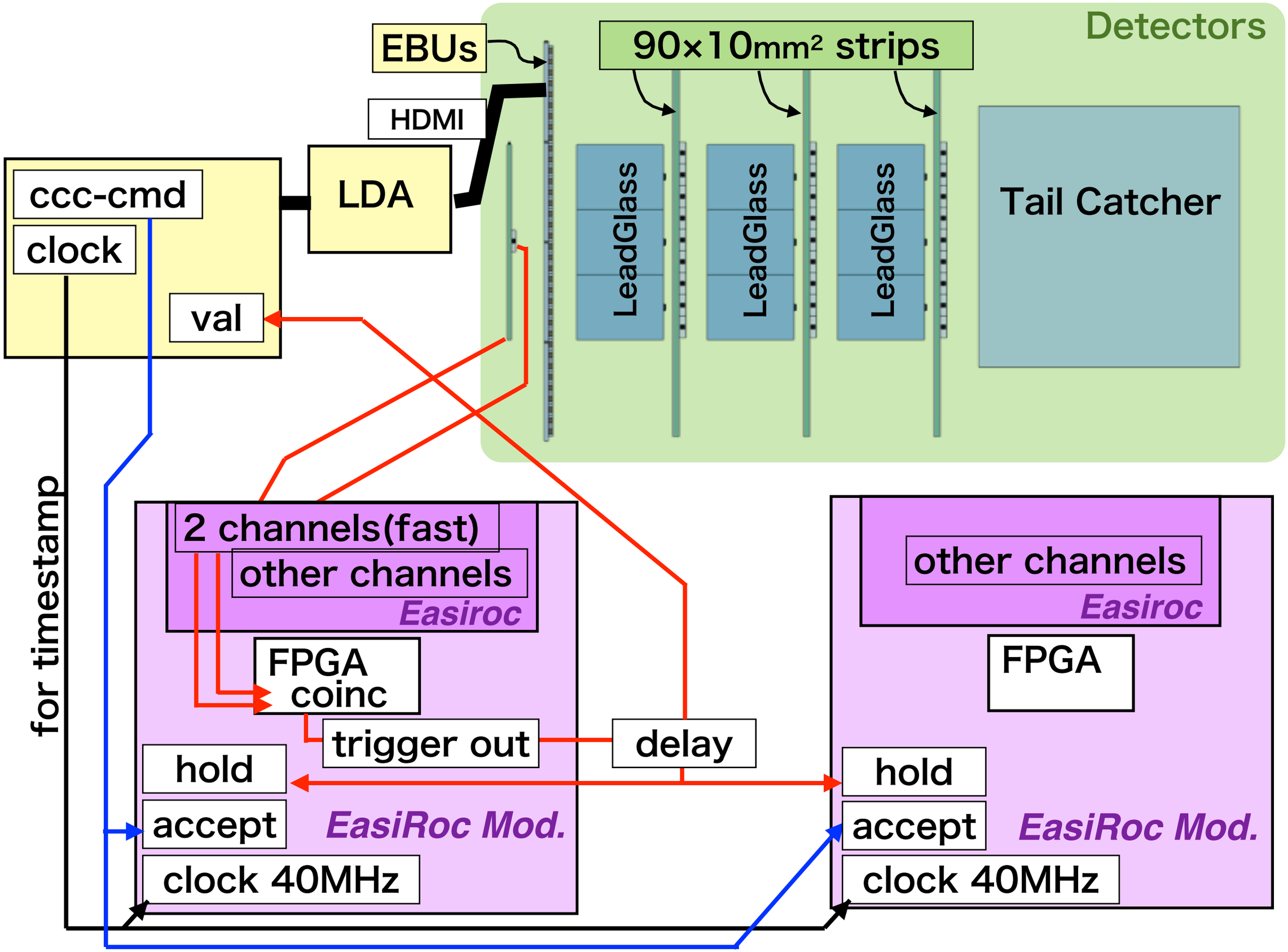
DAQ /synchronizations



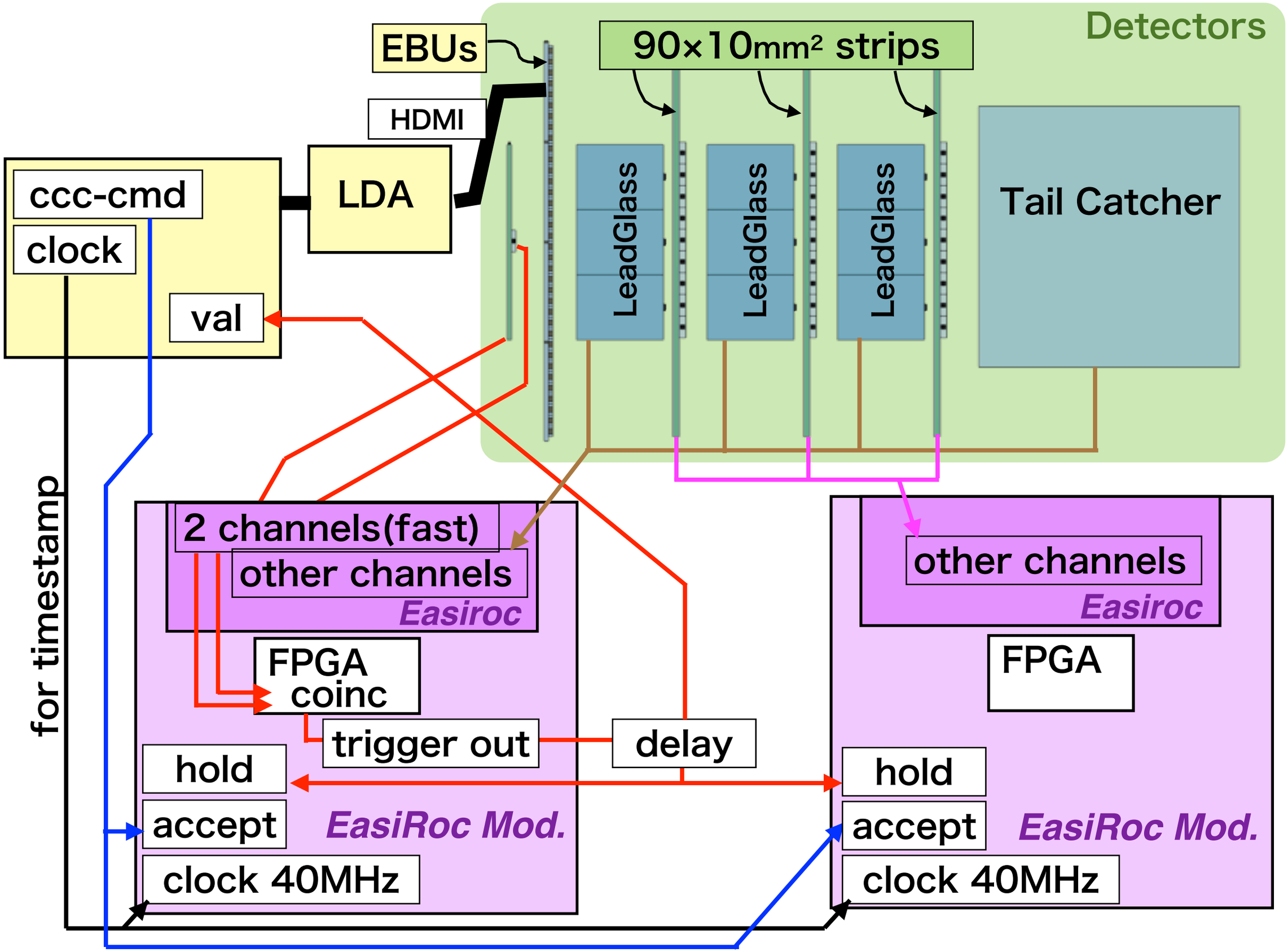
DAQ /synchronizations



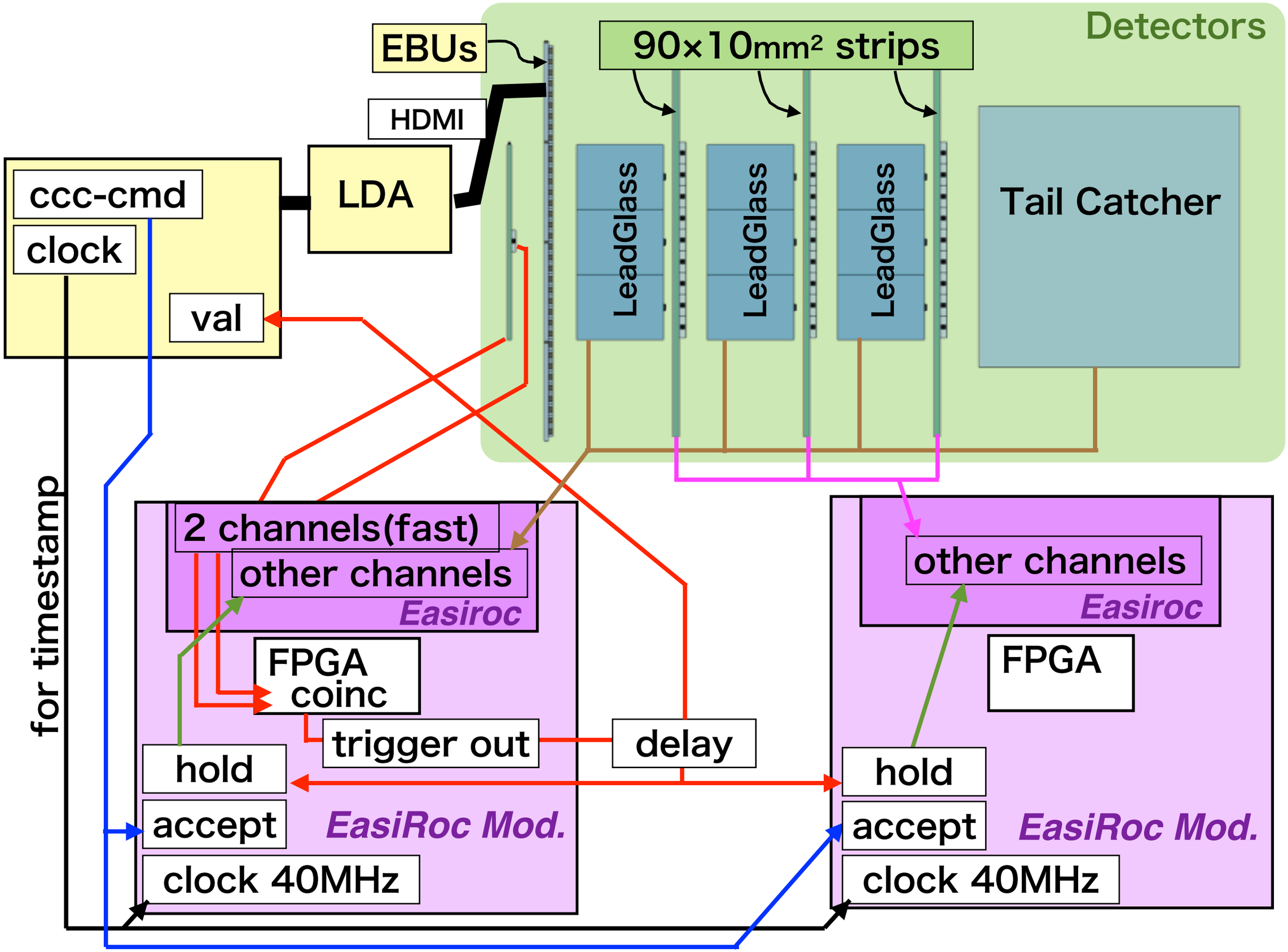
DAQ /synchronizations



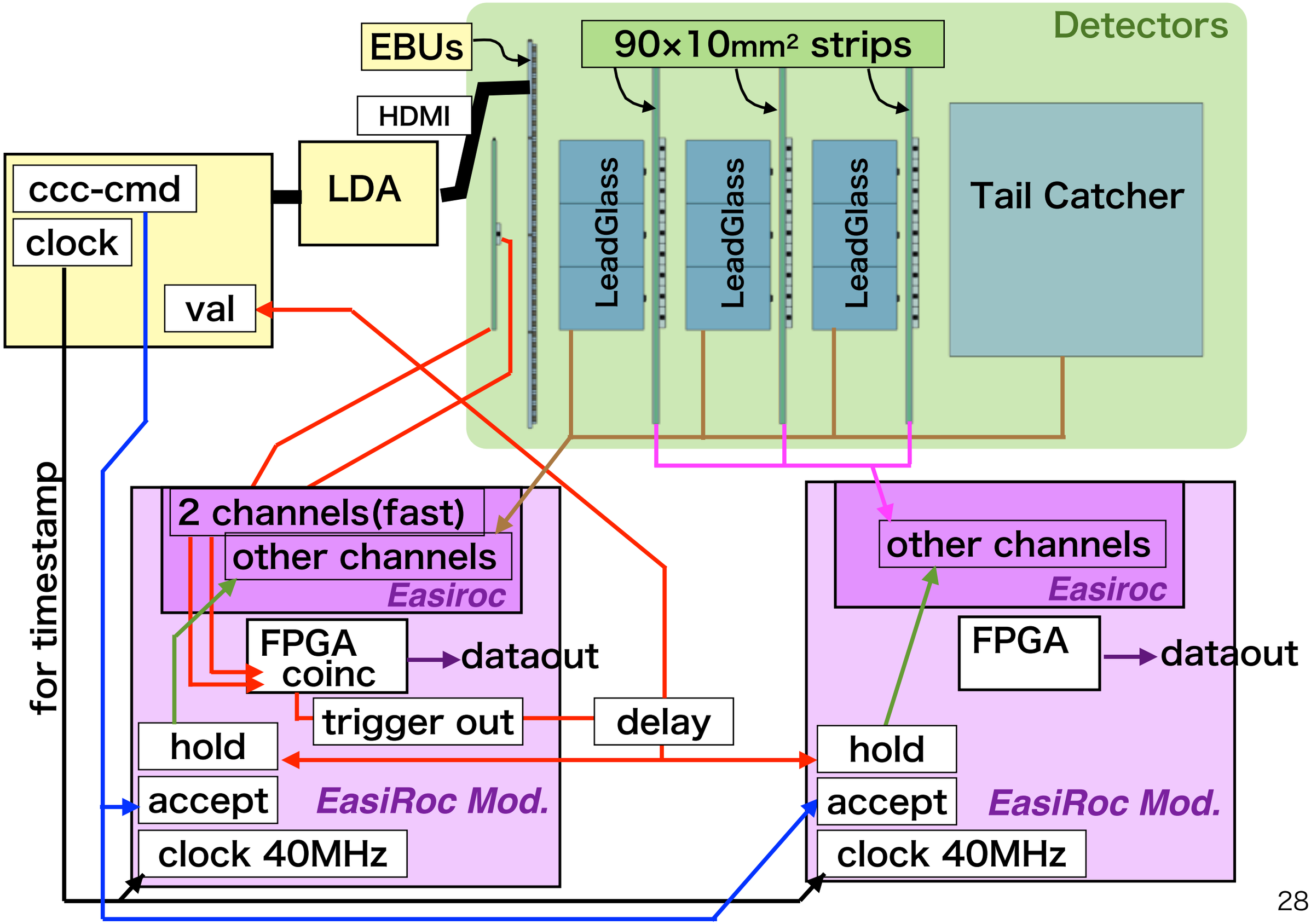
DAQ /synchronizations



DAQ /synchronizations



DAQ /synchronizations



Timing

CCC/EBU	mediation	Easiroc module
# cycle	CCC command	slow time stamp
# bunch crossing	40MHz clock	first time stamp

Things ToDo

- Adjust timing DAQ check with
CCC, LDA, EBU, Easiroc × 2,

- Easiroc Firmware for TDC;
Coincidence for triggers has been done,

- Fabricate 27 lead-glass Čerenkov counter,

- assembly of detectors in a frame.

Summary

- Segmented lead-glass Čerenkov calorimeter and 90×10mm2 scintillator strip calorimeter will be tested with ~1 GeV electron beam at ELPH of Tohoku U.

- EBU will be used as a position finder and practice of DAQ.

- two Easiroc module and two EBUs are combined with a DAQ synchronization.

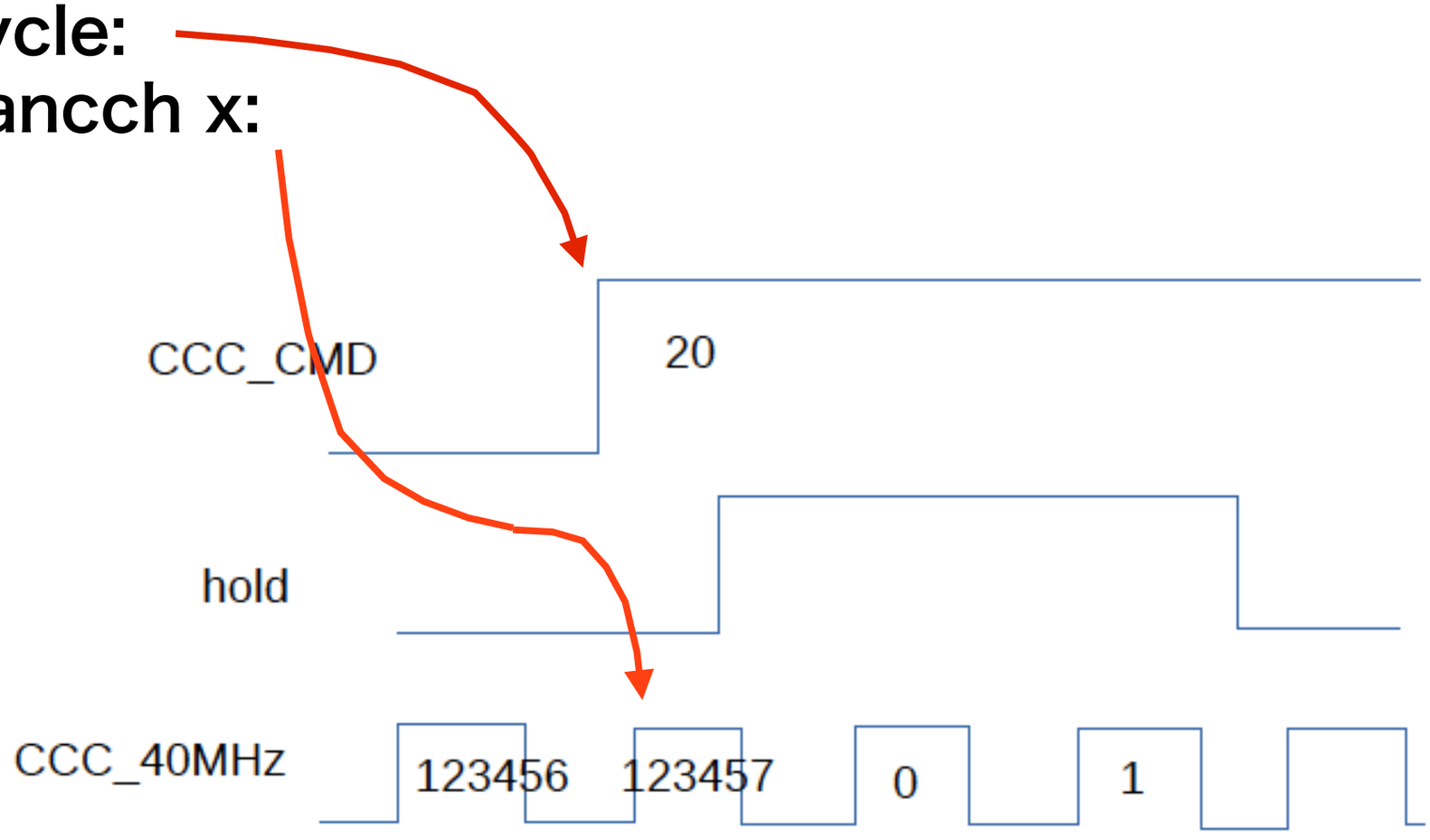
- Easiroc firmware is modified for the above purpose.

- This experiment use only SiPM as the photon detectors.

backup

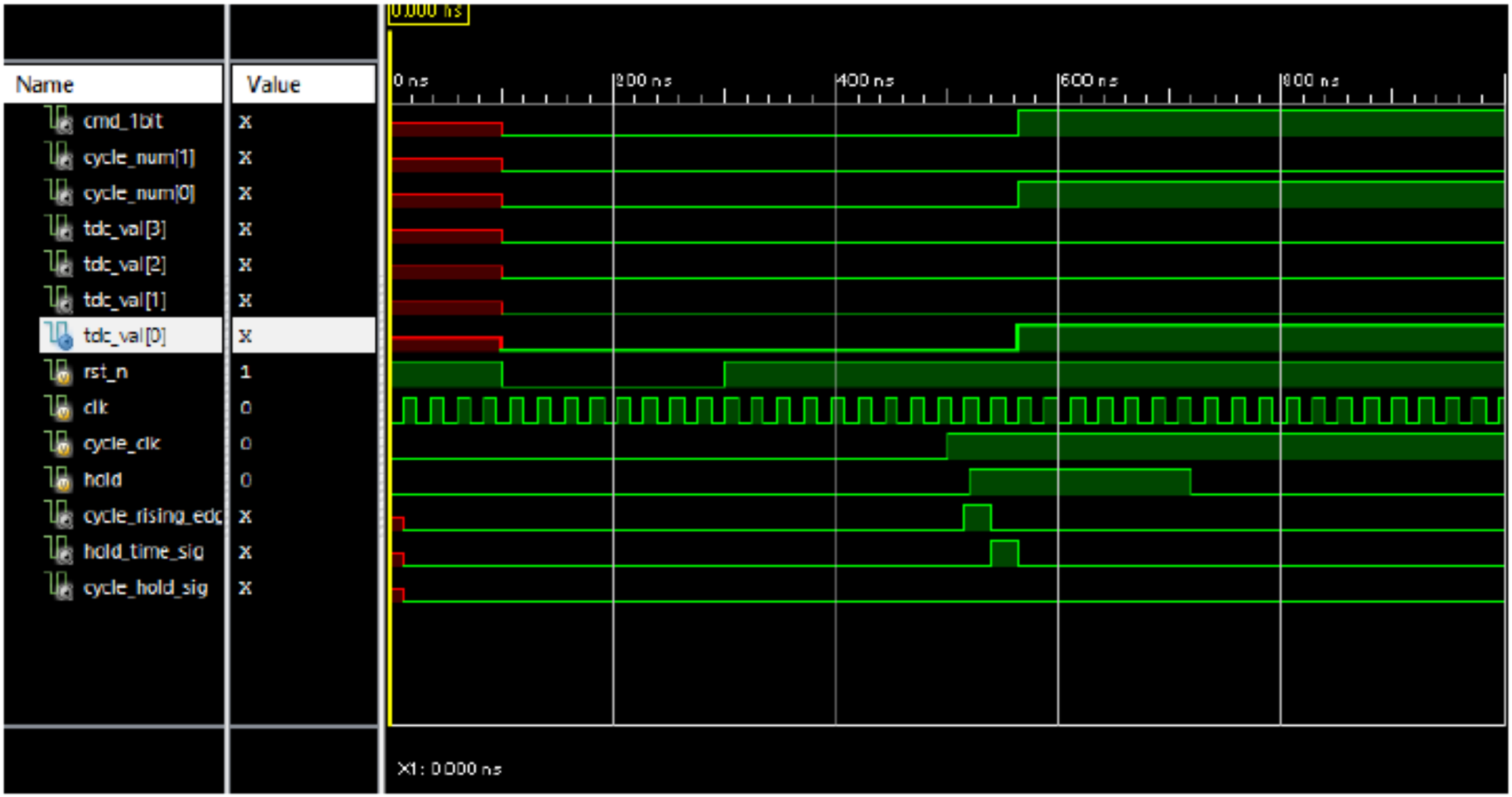
Timing

two Time stamp:
- cycle:
- bancch x:



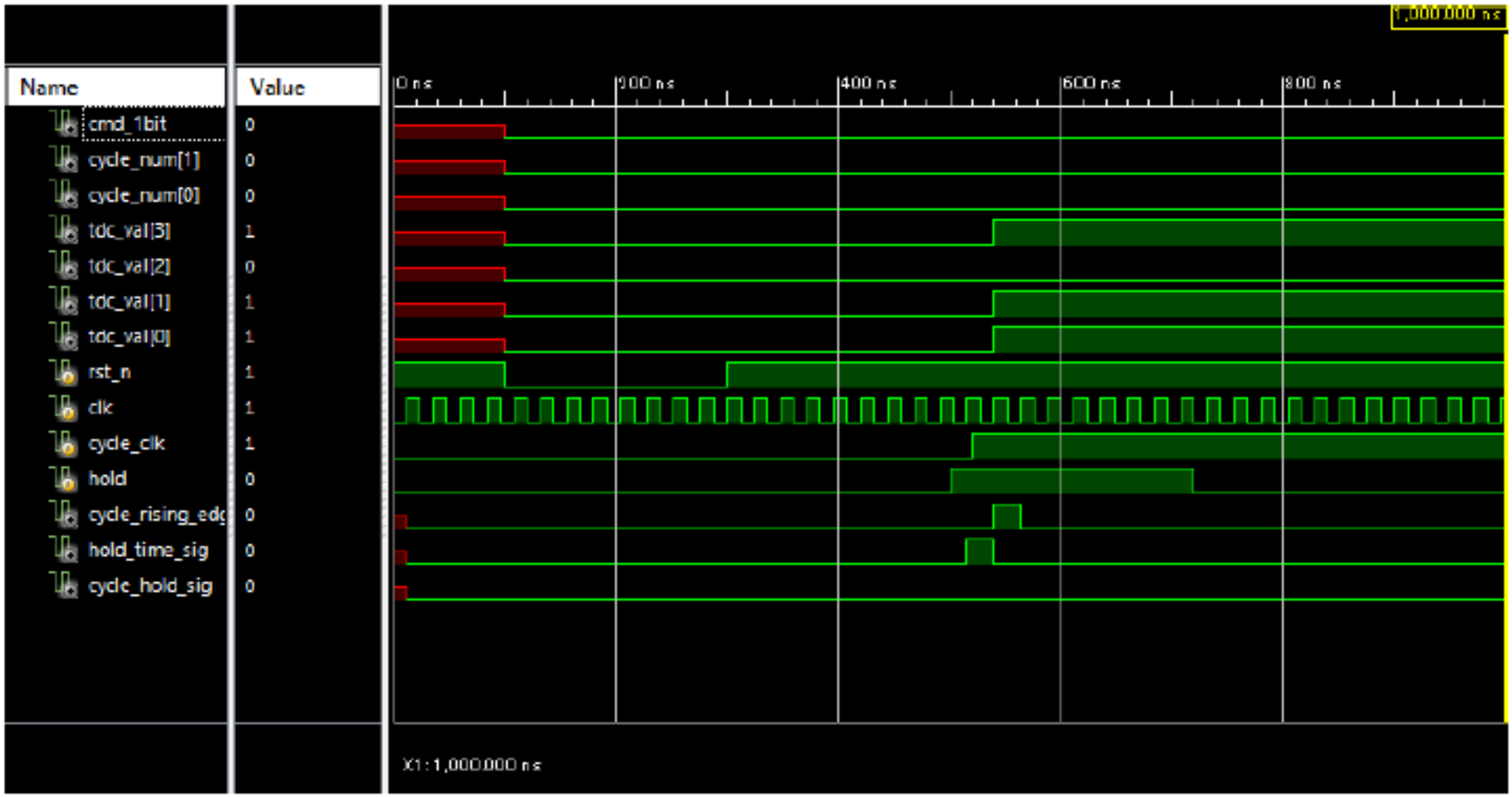
Timing simulation

cycle_clk(CCC_CMD) の次に hold



Timing simulation

holdの次にcycle_clk



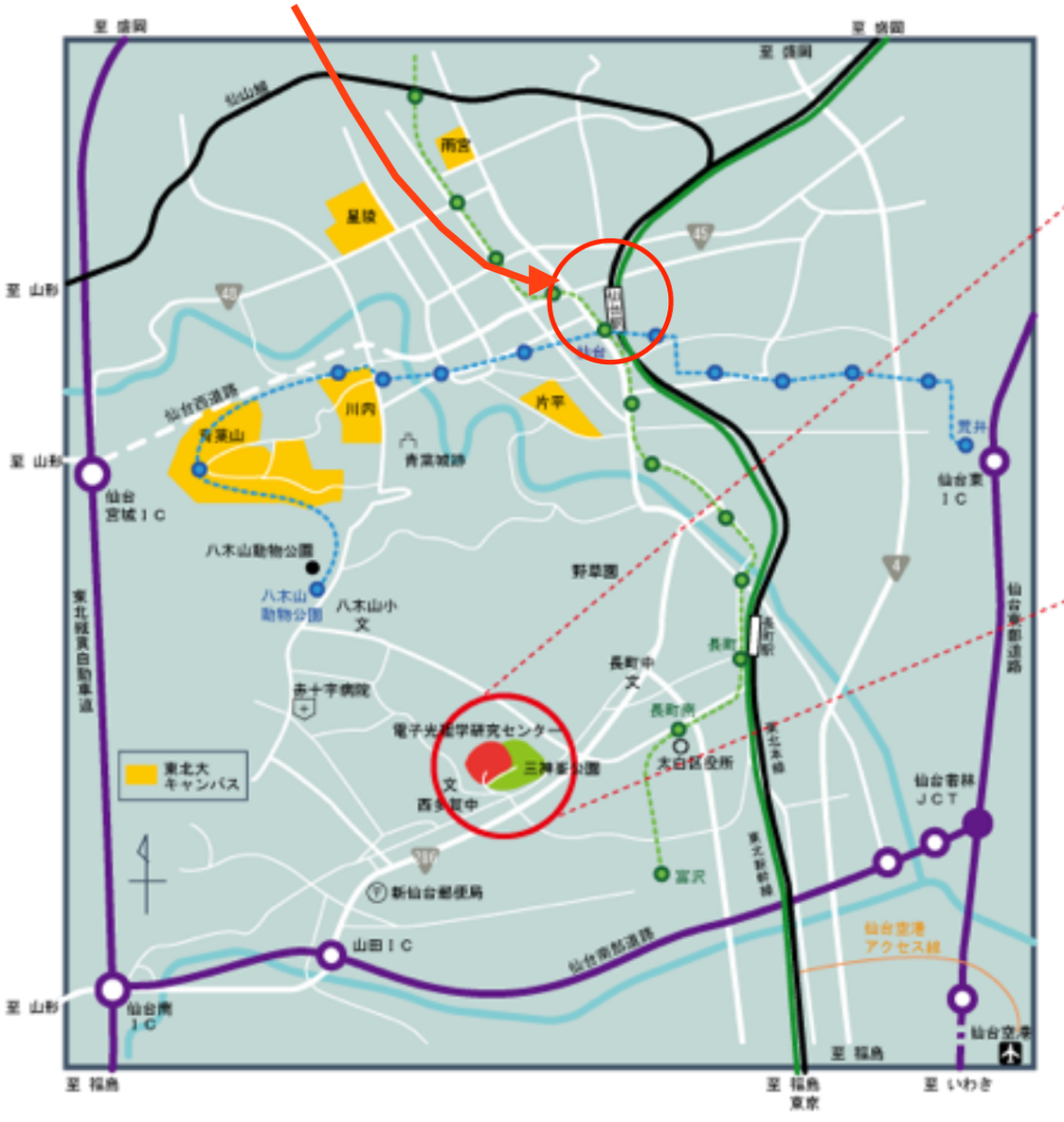
Timing simulation

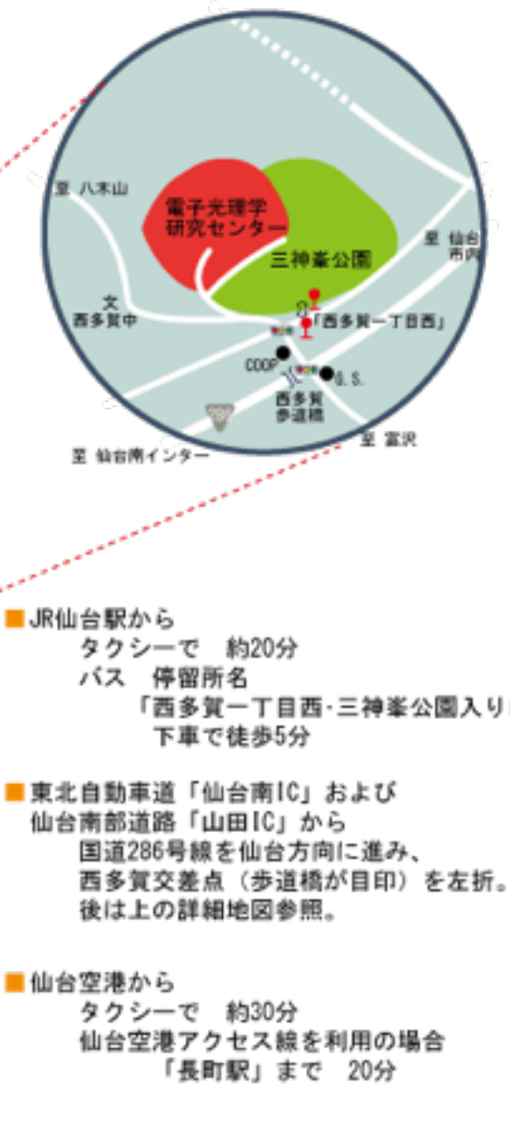
cycle_clk と同時に hold

Angular measurement

Research Center for ELectron PHoton Science in Tohoku Uni.

Sendai Station





■JR仙台駅から
　タクシーで　約20分
　バス　停留所名
　　「西多賀一丁目西･三神峯公園入り口」
　　下車で徒歩5分

■東北自動車道「仙台南IC」および
仙台南部道路「山田IC」から
　国道286号線を仙台方向に進み、
　西多賀交差点（歩道橋が目印）を左折。
　後は上の詳細地図参照。

■仙台空港から
　タクシーで　約30分
　仙台空港アクセス線を利用の場合
　　「長町駅」まで　20分