Tohoku Mainz Meeting

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- Scintillator cut with a laser processing machine
- Overview of a new TOF wall

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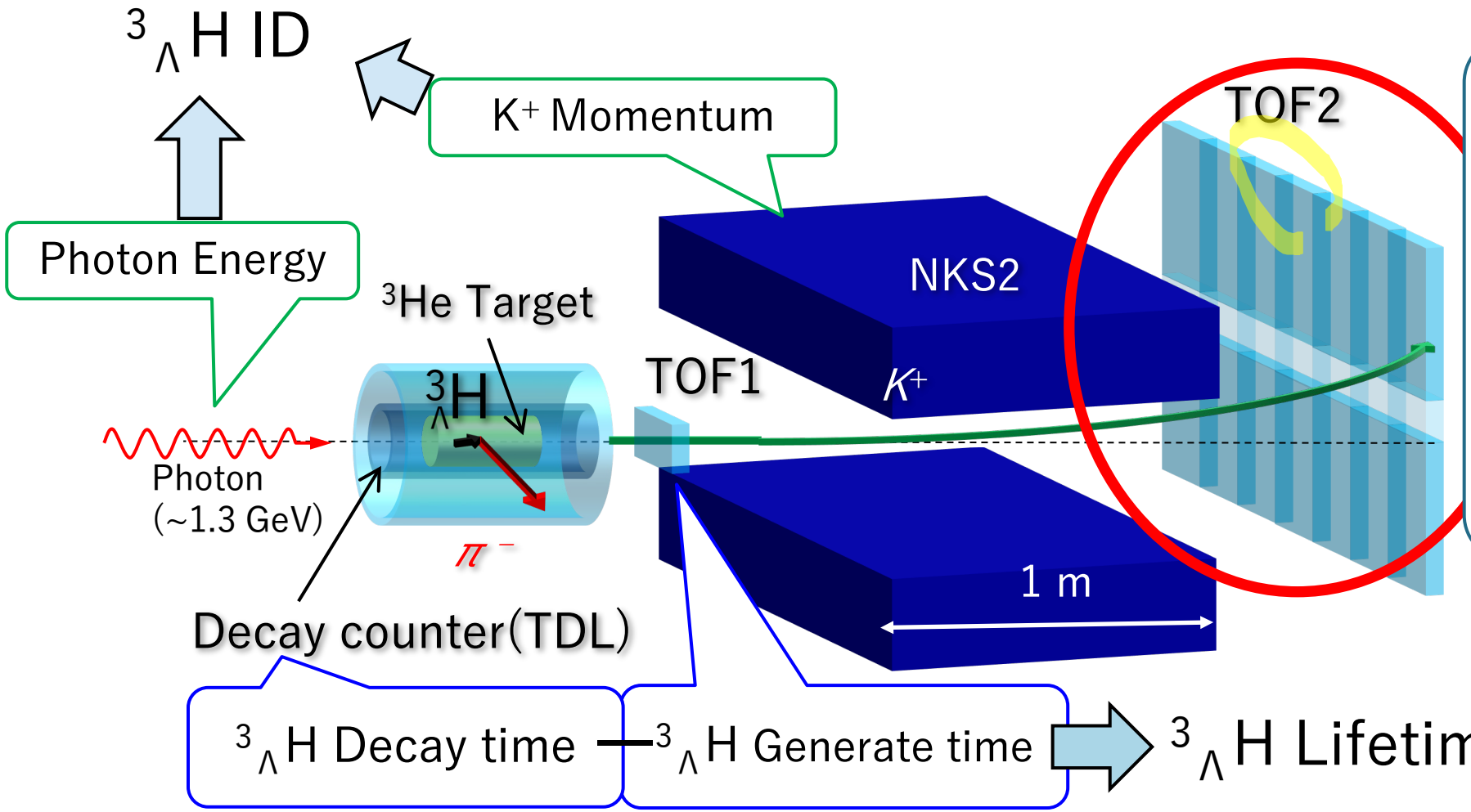
Dev. a new TOF wall.

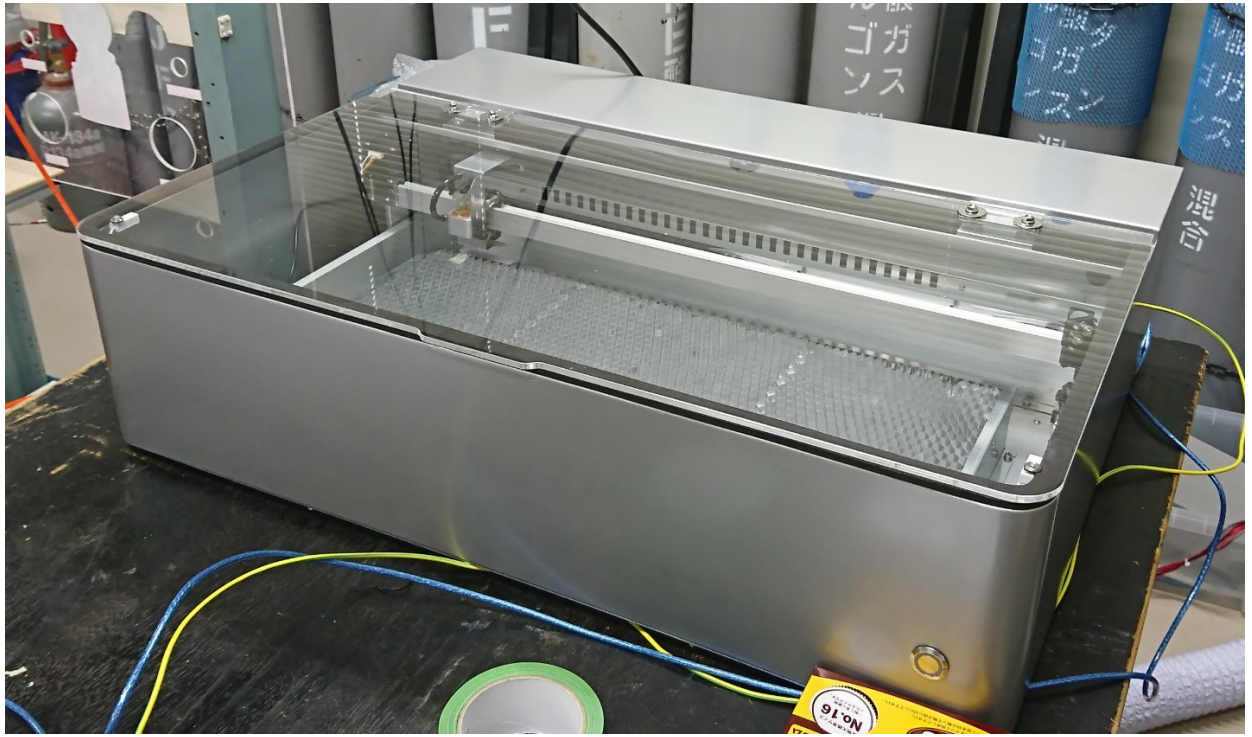


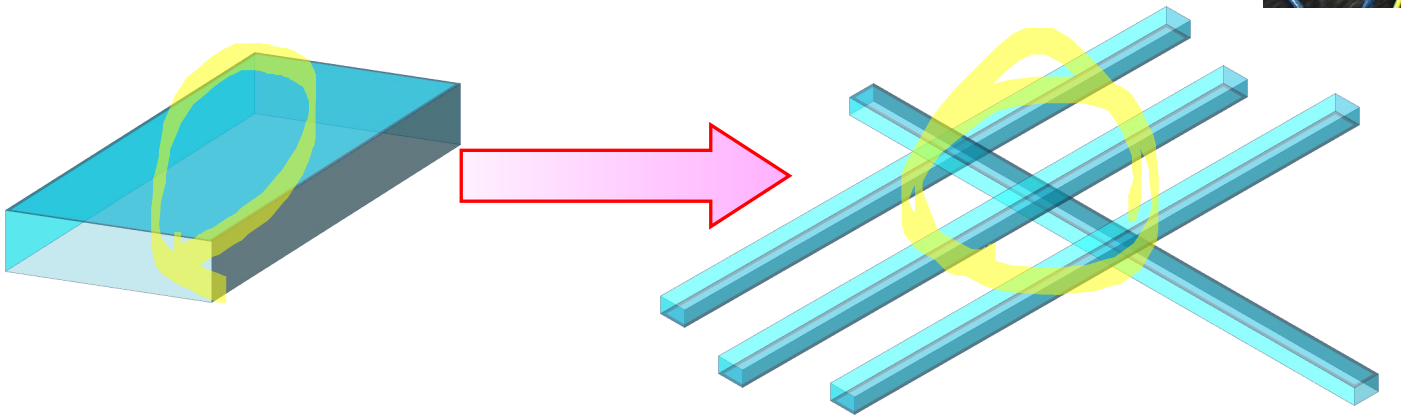
- Array of thin scintillators
- We need several 100 scintillators in total
- σ~100 ps resolution is necessary to distinguish K^+ with π^+.
- PMT doesn't work due to NKS2 magnetic field.

Laser Processing Machine

- We introduced the laser cutter to manufacture scintillators
- CO_2 type laser (λ~10.6 μm; IR region)
- Cutting acrylic (t~10 mm) works very well.
- Large scintillator plates (~5×100×450 mm^3)
  → thin scintillator bars (~5×10×450 mm^3)

If it works well...
Prototyping and mass production will make progress very well!



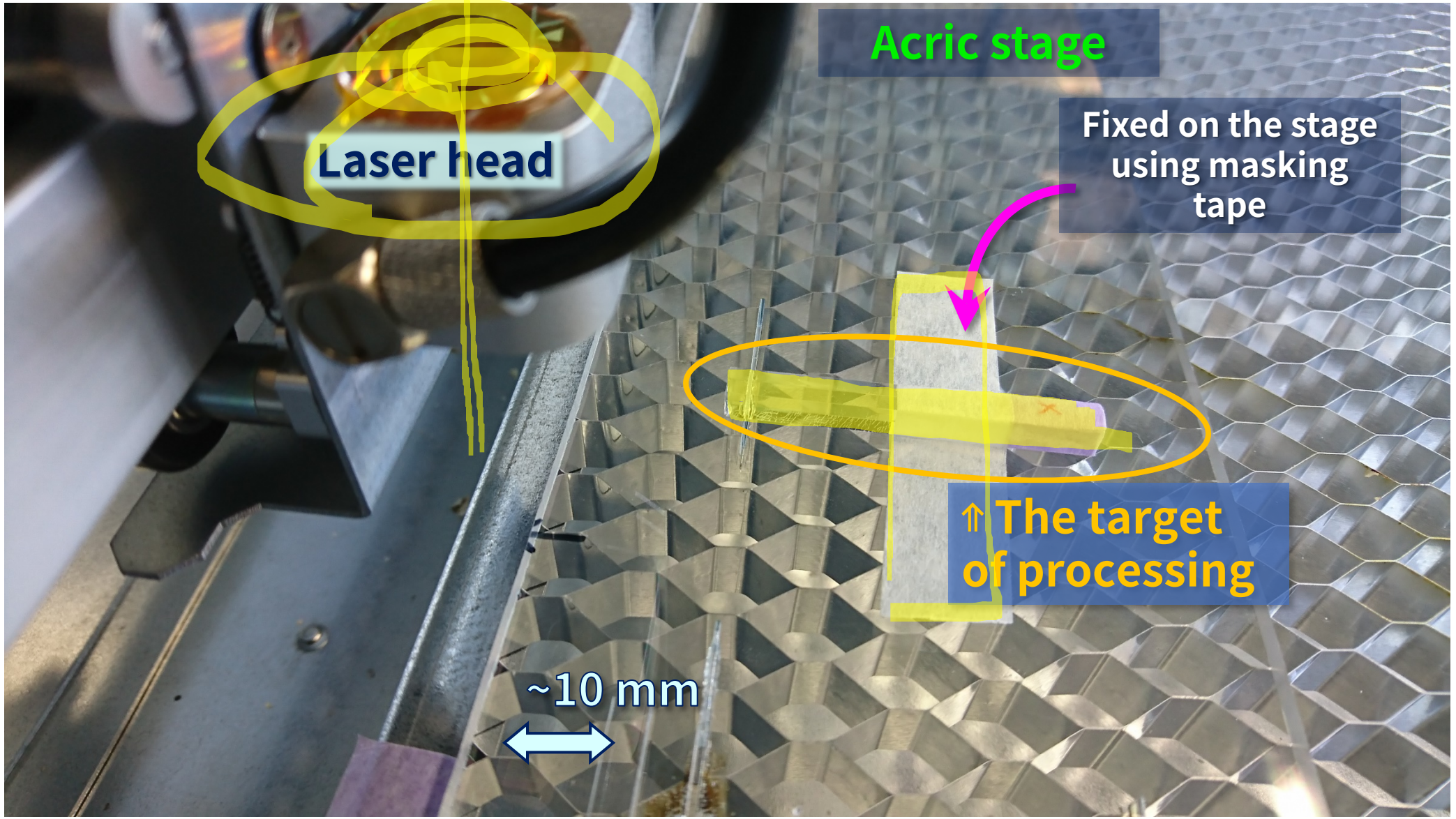


https://www.podea.net/podea-02

Param.		
Max power	[W]	40
Maximum processing size	[mm]	600×300
Maximum cuttable thickness	[mm]	10

Setting

- **Setup**

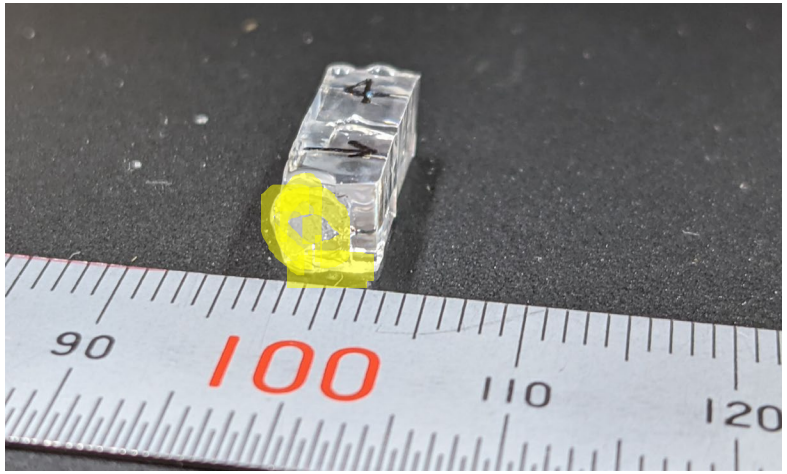


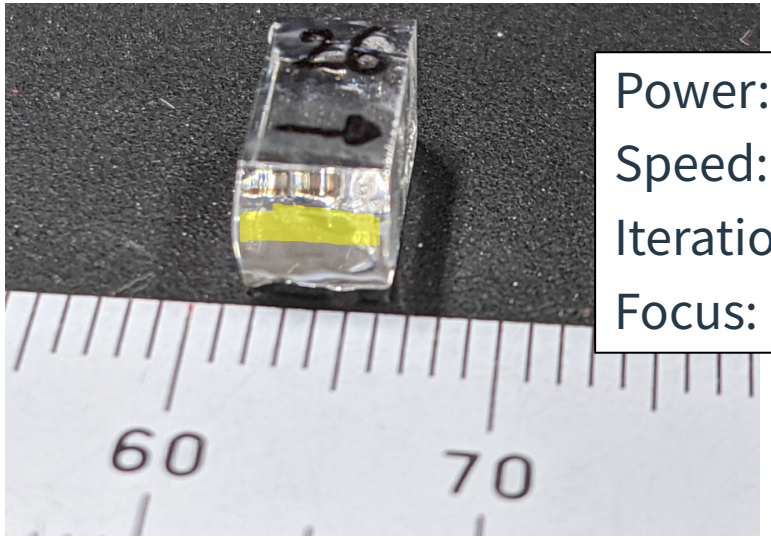
Impression

Laser processing machine is a useful tool to cut acrylic. It partially works cutting scintillator bars

- Cutting scintillator a little (~ a few cm) → Okay.
  - Deterioration is small.
- Cutting scintillator in a long distance → not works well.
  - Special coolant and stiff jig are necessary...

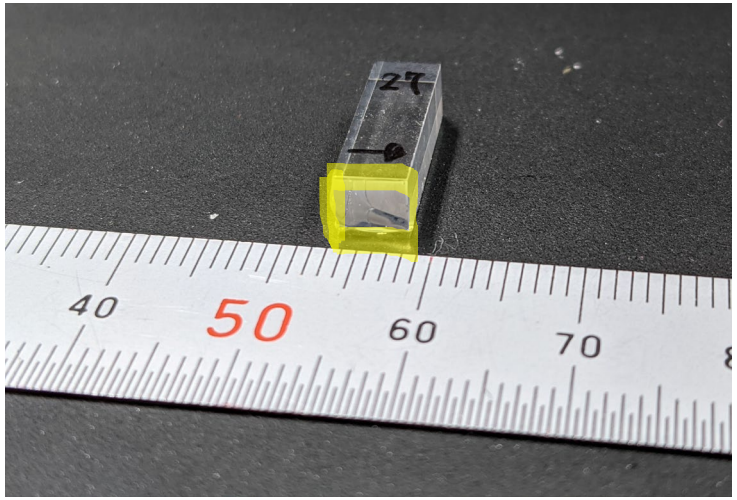
Some examples





Power: 36 W
Speed: 3.8 mm/s
Iteration: 1
Focus: Middle

Power: 20 W
Speed: 2 mm/s
Iteration: 1
Focus: Bottom



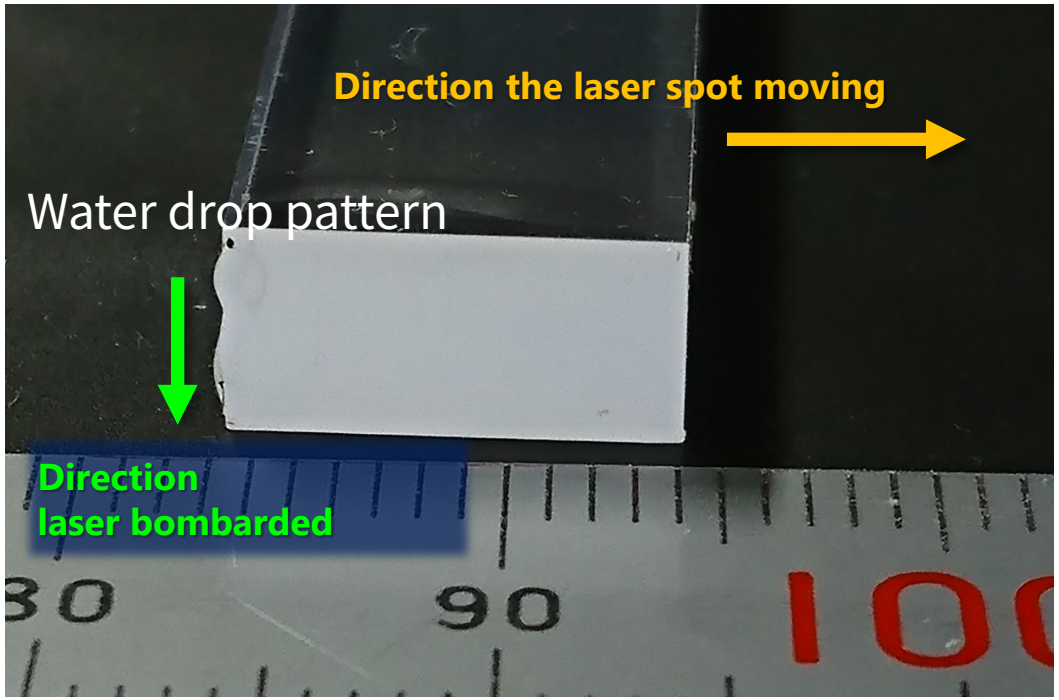
We got better results with a just one cut parameter.

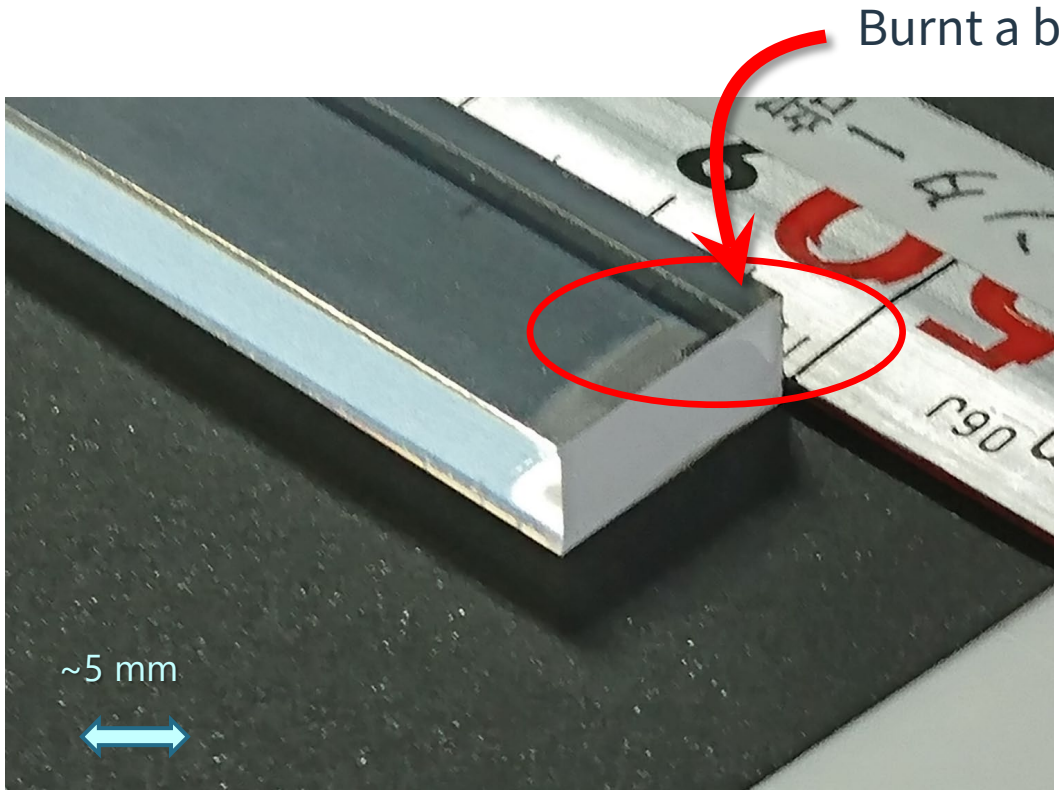
Slow & Low power: so-so

Fast & High power: better

Focus point is one of the most important parameter, that should be set in the middle of the scintillator.

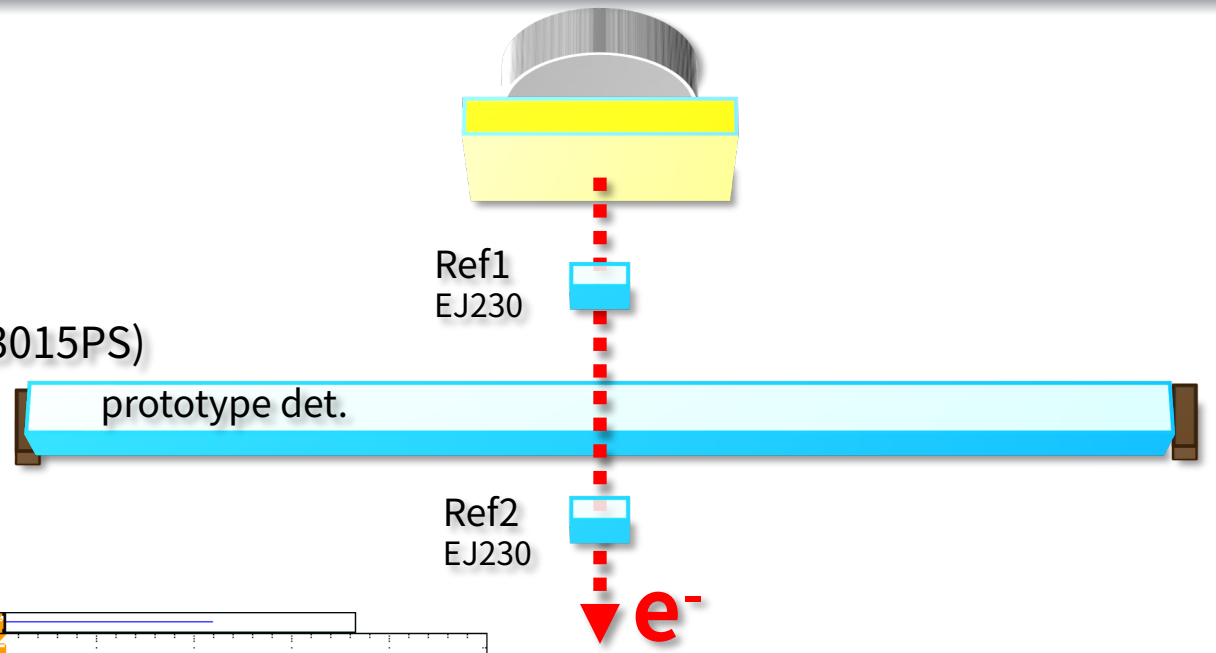
Good examples

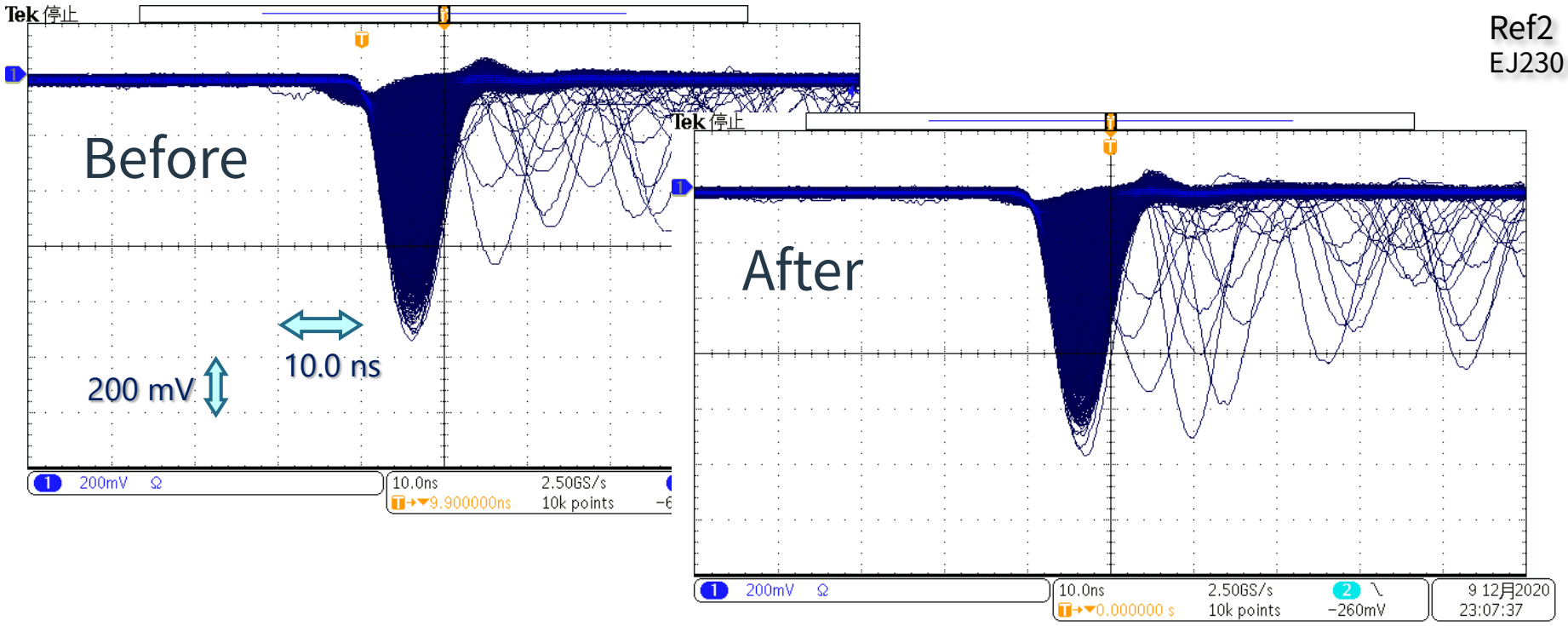


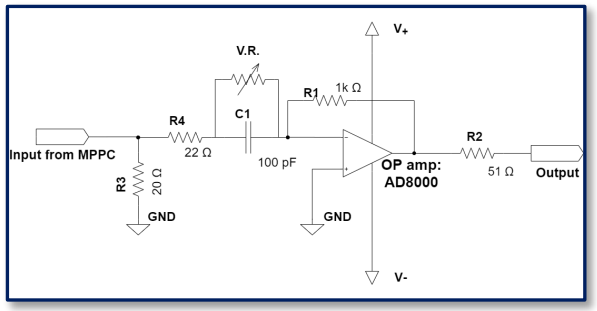


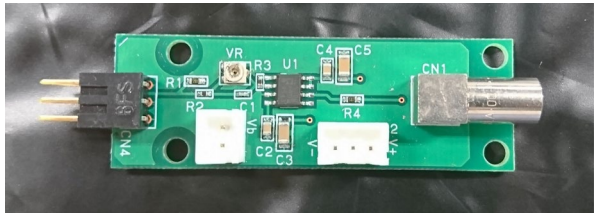
- Signal check
- MPPC: S14160-3015PS
- $V = V_{break} + 7V$ (38.7V)
- $^{90}Sr/^{90}Y$ β-ray source

- diff. amp + PM amp
- Reflector: Teflon (100 μm thickness)

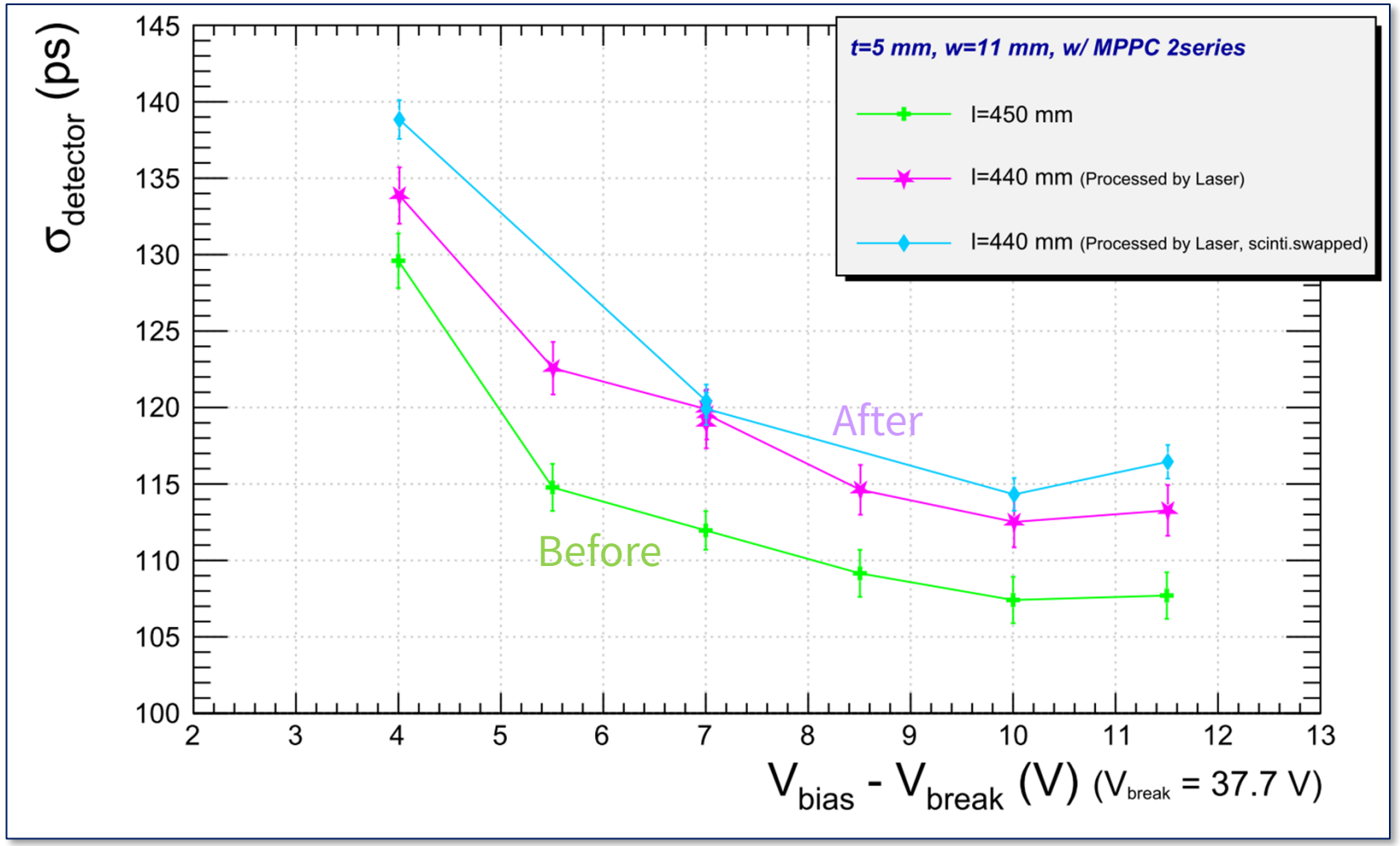








Results



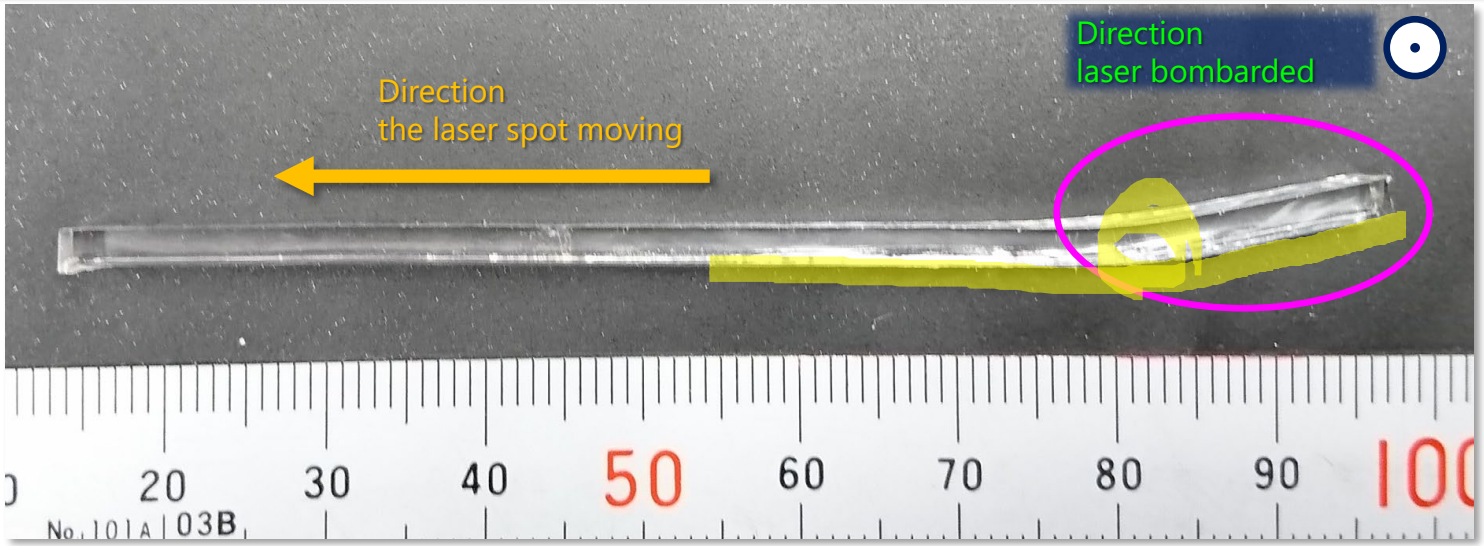
Time resolution: 115~120 ps

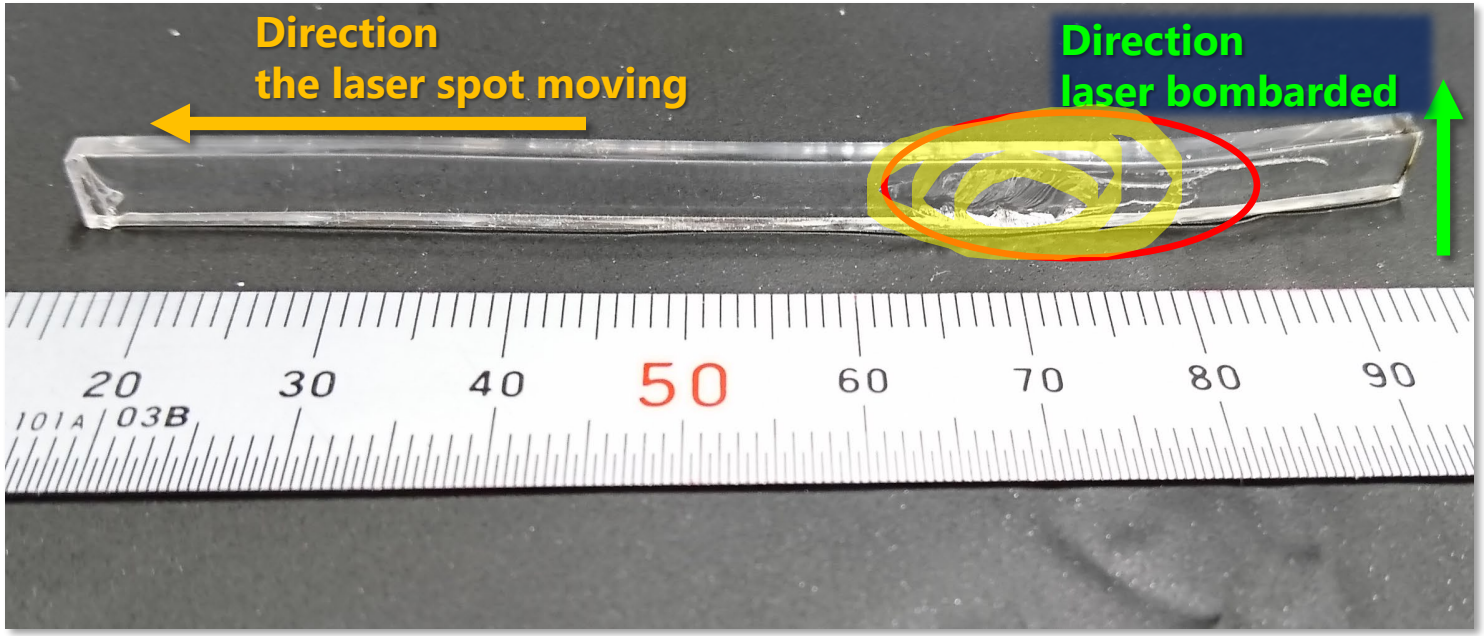
Getting worse ~ 10 ps

Syst. error ~ 10 ps

Laser cut effect is not so serious.

Difficulties

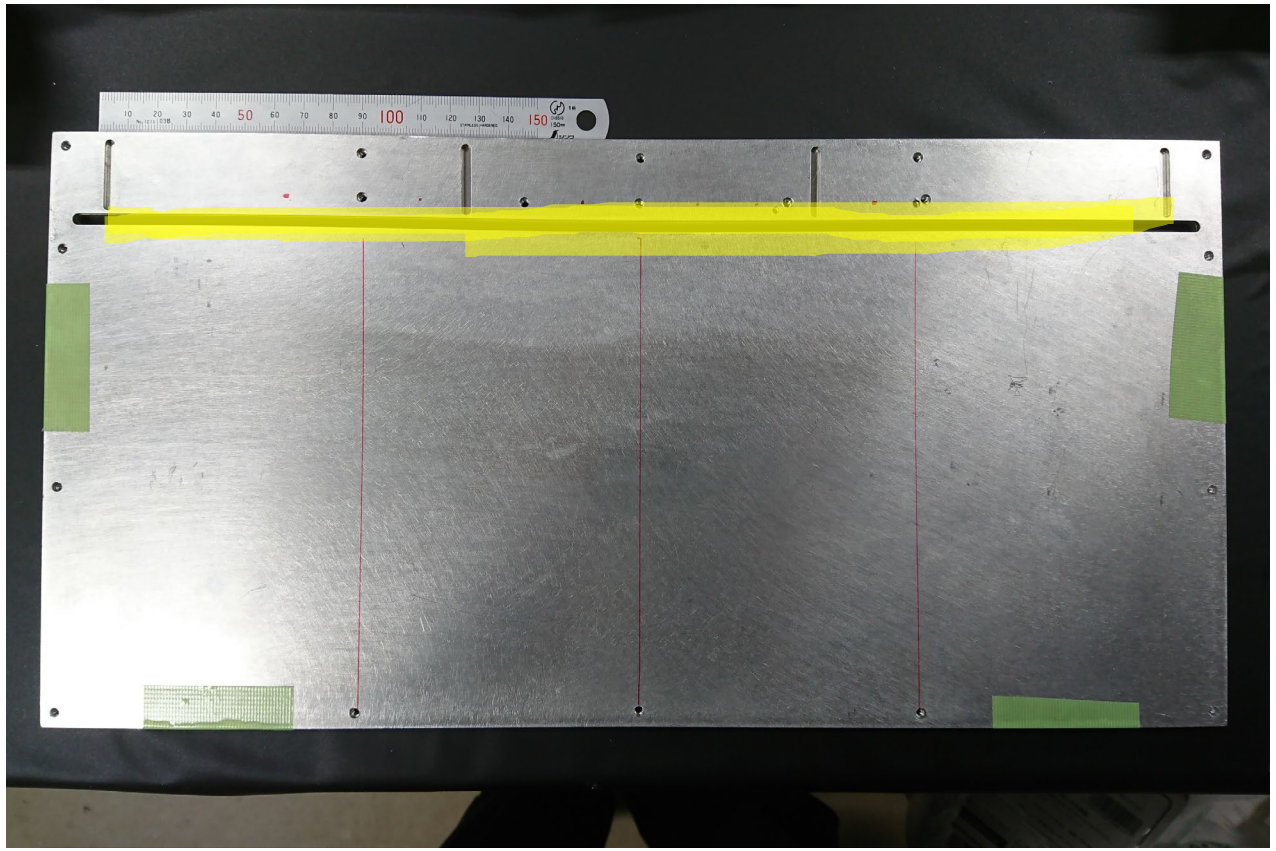


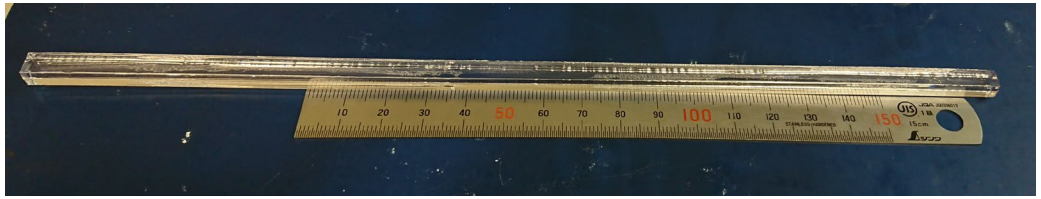


Long and thin scintillator deforms during the laser cutting due to its heat deposition.

Scintillator takes longer time to harden than acrylic. Scintillators glue each other after the cutting. Viscosity and harden time is different with acrylic.

Difficulties





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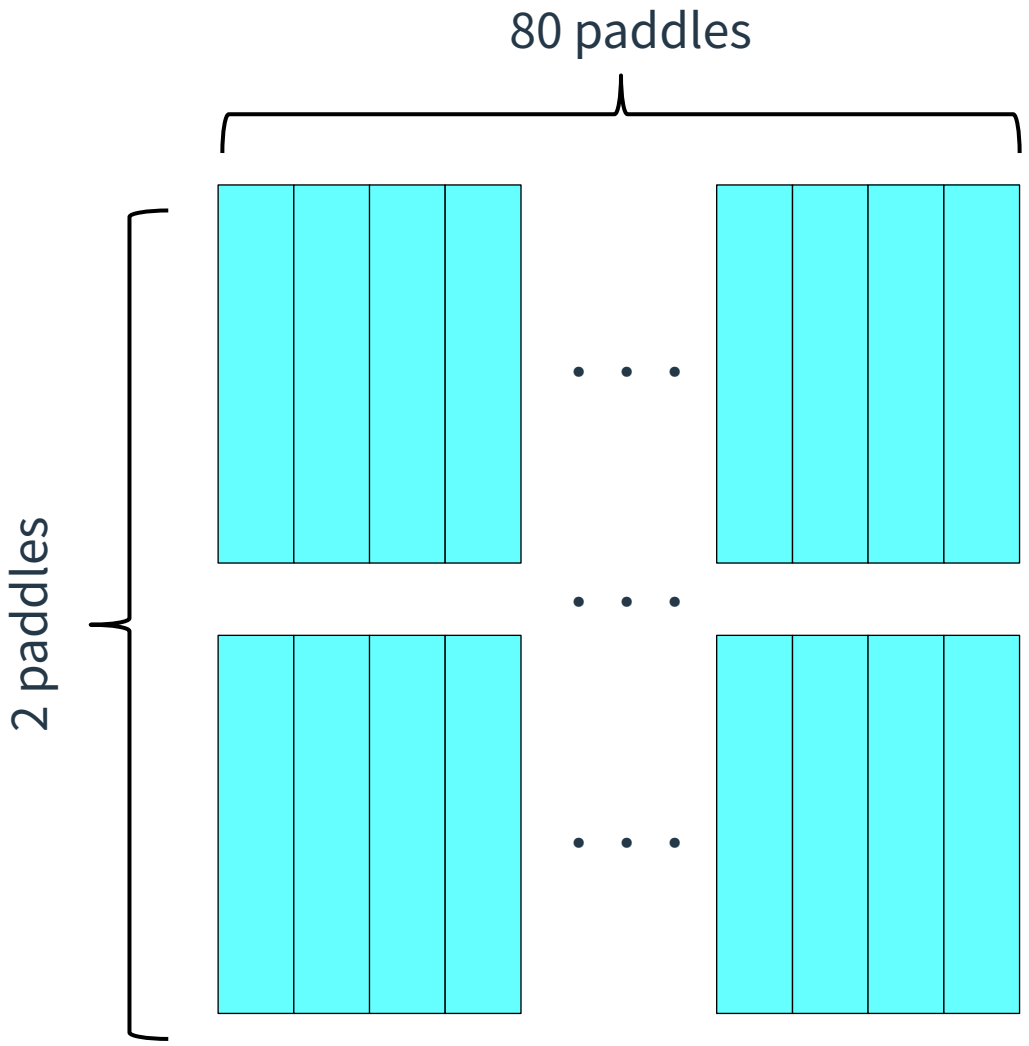
Deformation would be improved after mounting a jig made of aluminum, while yield is <50%. We expect the yield would be improved much more with the much more stiff jig.

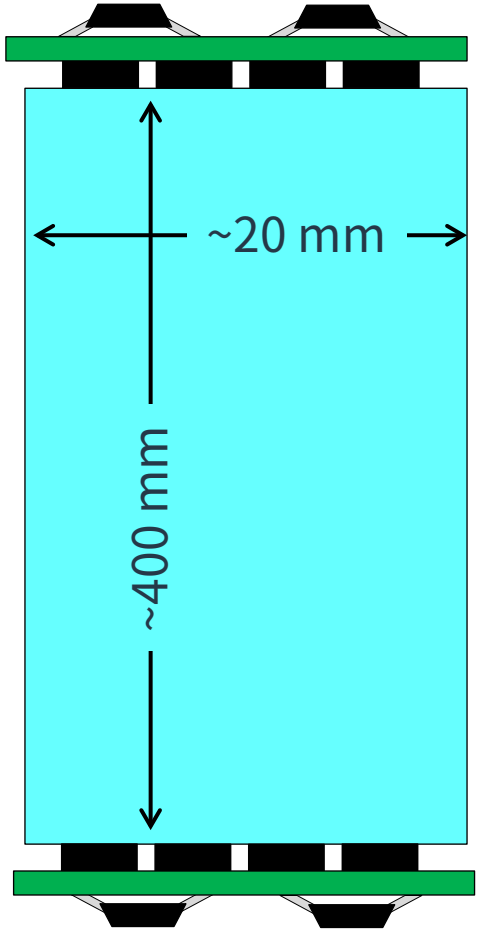
We will proceed this study in the background because this is not worth the time cost. There is also outgas problem. We will ask mass production to a vendor.

Configuration of a new TOF wall



No. CHs = 160 paddles × 2 readouts = 320 channels

Configuration of one paddle



Circuit Board

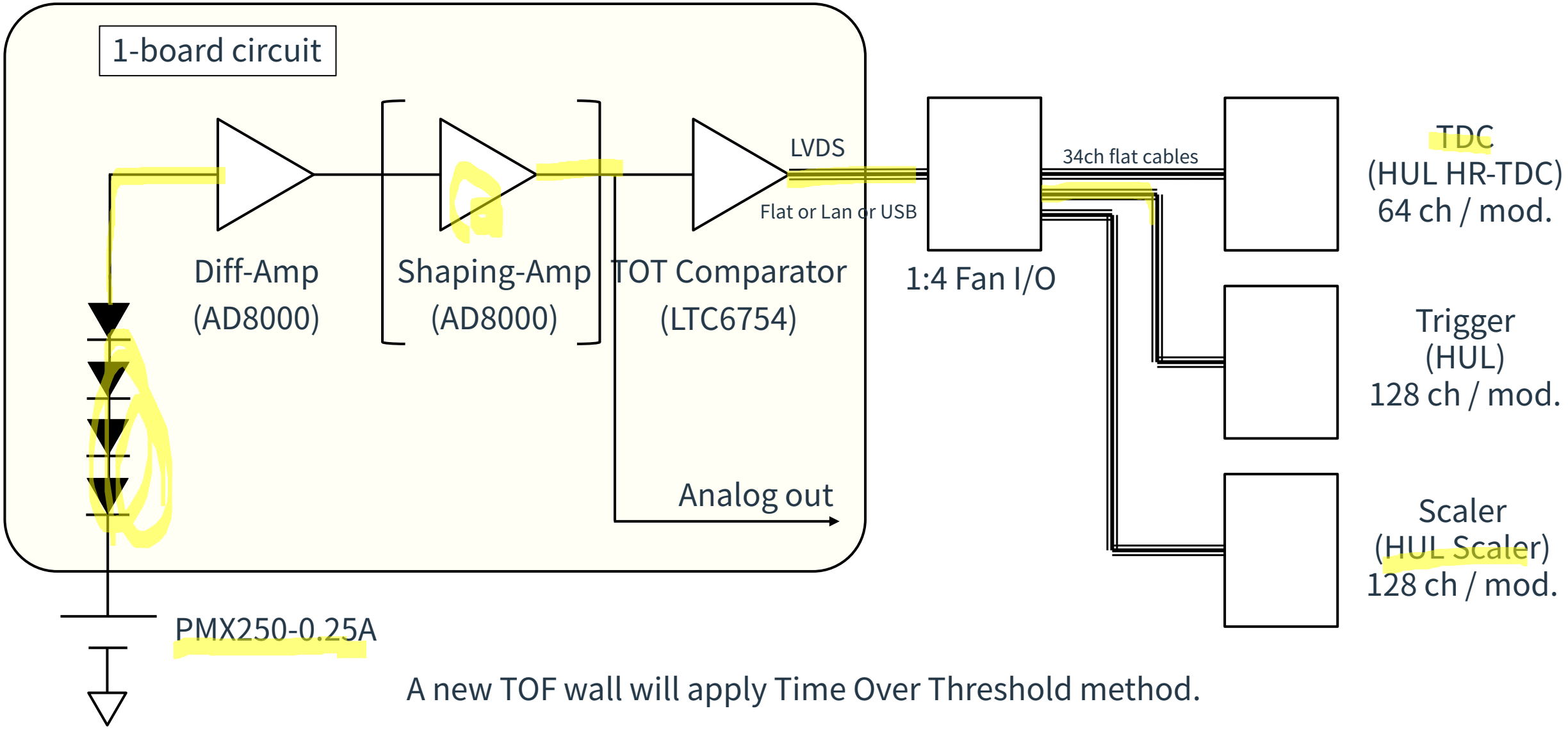
Photon Detector

MPPC: S13360-3050PE

Plastic Scintillator

Eljen: EJ-230

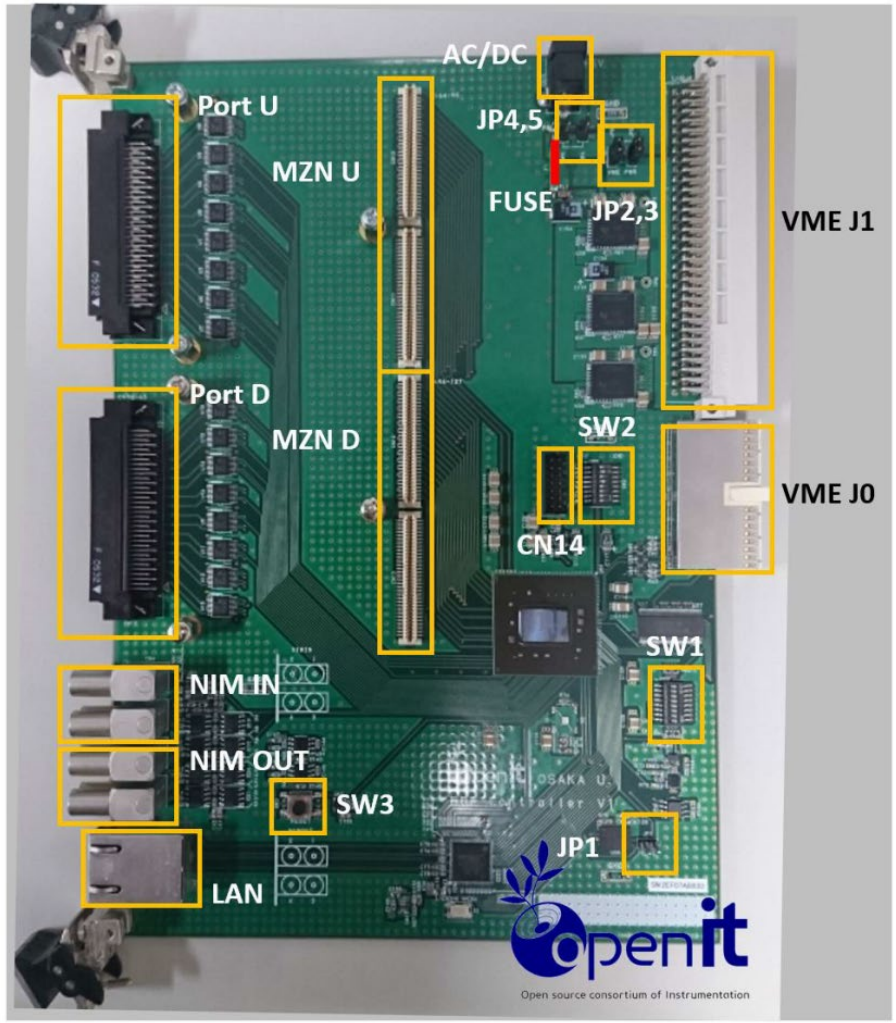
Circuit diagram



A new TOF wall will apply Time Over Threshold method.

Readout board (HUL)

Hadron Universal Logic



- Max. 128ch I/O
- 64ch high resolution TDC (25ps/ch)
- Leading and Trailing edge TDC
  Comparable with CAEN V1290
- 100 μs deadtime
- TCP control

Summary

- Application of a laser processing machine partially works to cut scintillators.
- We will start mass production.
- A new circuit HUL will be applied as TDC.