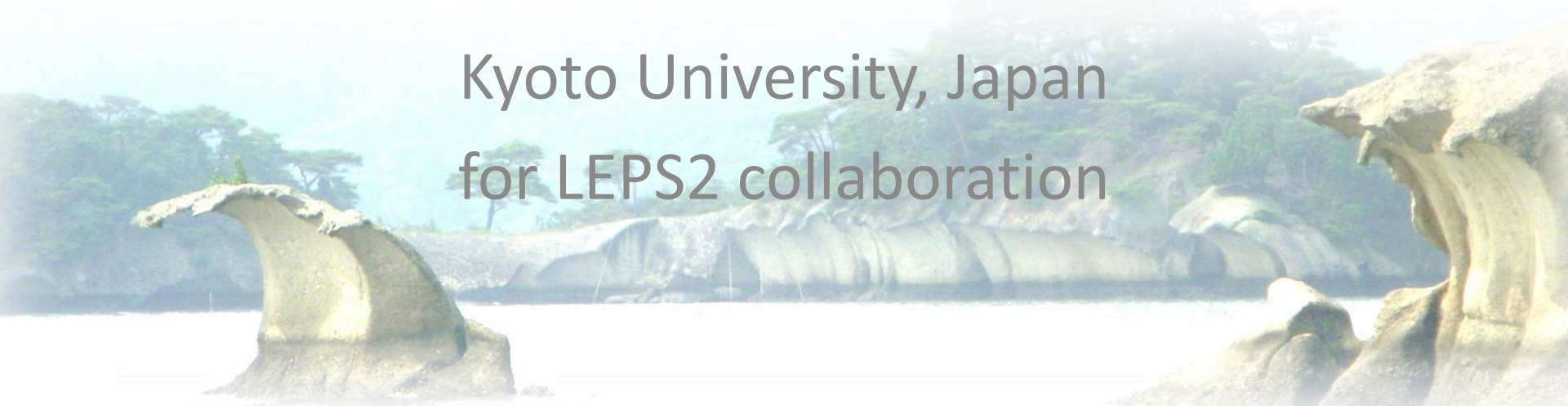


Design and performance of large area, high resolution RPCs for LEPS2 at SPring-8

Natsuki Tomida

Kyoto University, Japan
for LEPS2 collaboration



LEPS2

Laser Electron Photon experiment at SPring-8

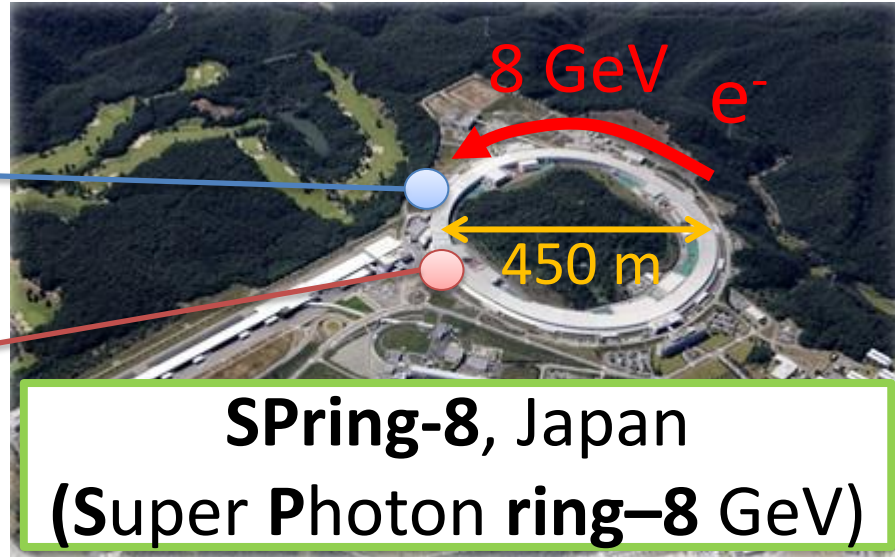
Hadron Physics

LEPS2

From 2013

LEPS

From 2000



Backward Compton Scattering

SP8

3.5 ~ 4.7 eV Laser

1.5 ~ 3.0 GeV γ -ray

8 GeV e^-

Hadron
Photo Production

LEPS2

LEPS

LEPS / LEPS2

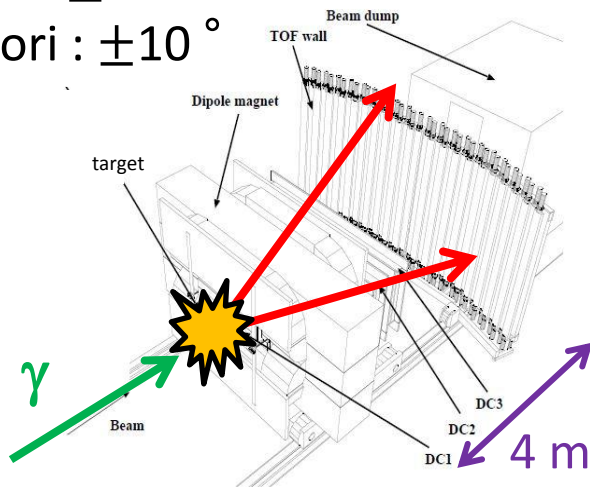
Hadron Photo-production Experiment

LEPS

Detectors only forward angle

Ver: $\pm 25^\circ$

Hori: $\pm 10^\circ$



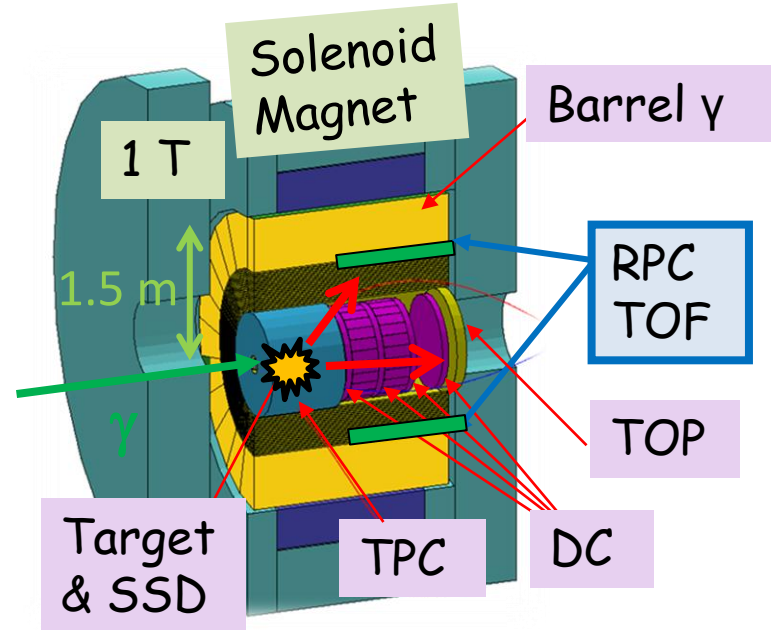
LEPS2

New beamline

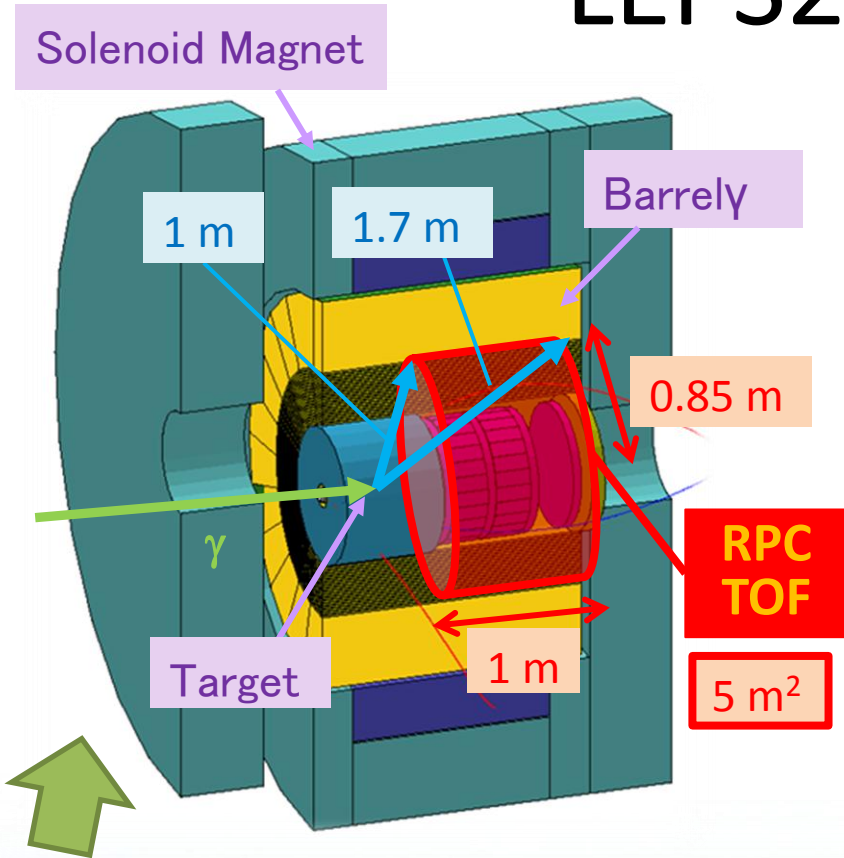
Detectors covering almost 4π

Beam intensity $10^7/\text{sec}$
(10 times larger than LEPS)

RPC will be used as a TOF detector



LEPS2 TOF-RPC



Requirements

Flight length 1 - 1.7 m
1.1 GeV/c K/ π 3 σ separation



TOF resolution < 50 ps

Efficiency > 99%

Rate capability \sim 1 Hz/cm²

Less than 1000 channel



Read out pad size > 50 cm²/ch

Large pad, Good time resolution



Solenoid
Magnet

BNL-AGS
E787/E949

TOF at LEPS / LEPS2

START

RF signal

14~18 ps \ll 50 ps

STOP

RPC

TDC

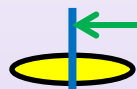
Amps

50 ps

Requirement



RF signal



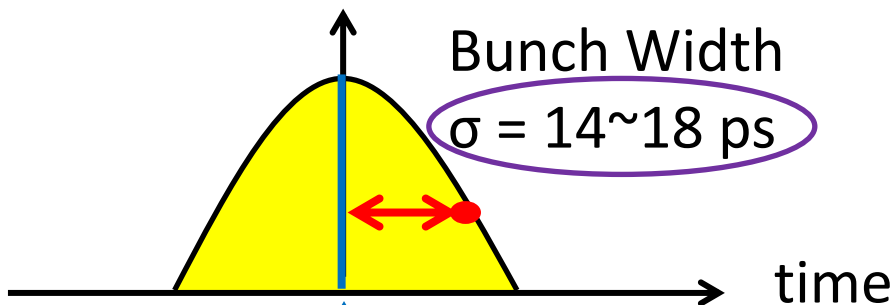
Bunch of electron

1966 ps

e- current

Bunch Width

$\sigma = 14\sim 18$ ps



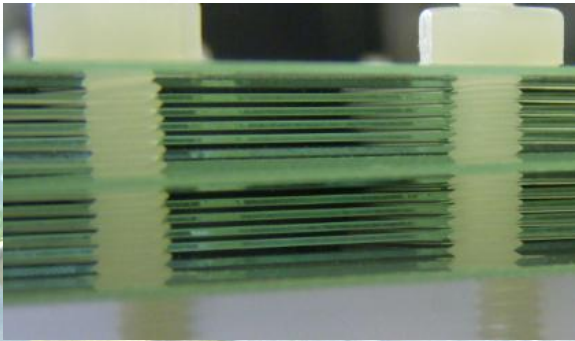
RF signal

Prototype RPC

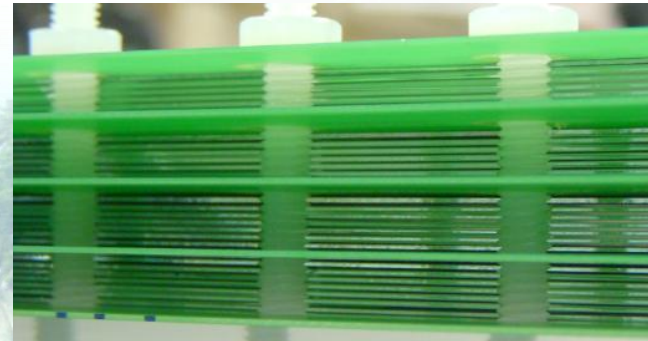
- Glass size : 10 cm * 50 cm
- Glass thickness : 400 μm
- Carbon Electrode : 500 Ω/sqcm
- Gas : R134a:SF6:Iso-butane = 90:5:5

Too Low ??

- | | | | |
|-----------------------------|-------------------|-------------------|-------------------|
| • <u>Gap width :</u> | 260 μm | 148 μm | 104 μm |
| • <u>Gaps per stack :</u> | 5 | 6 | 7 |
| • <u>Number of Stacks :</u> | 1,2 | 2,4 | 2 |



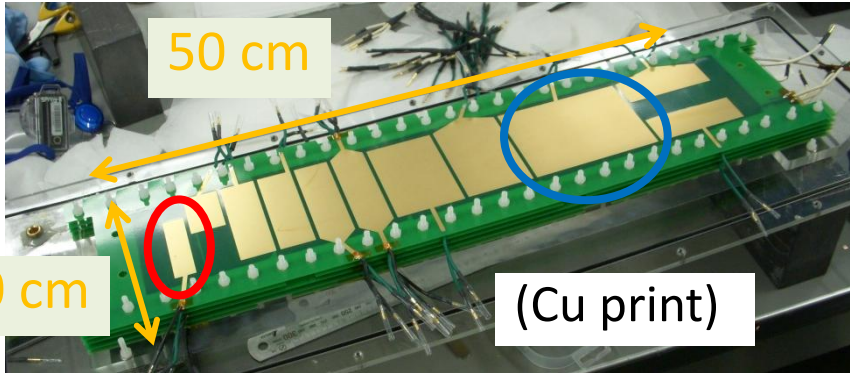
260 μm * 5 gaps * 2 stacks



148 μm * 6 gaps * 4 stacks

Prototype RPC

Pad Readout single end



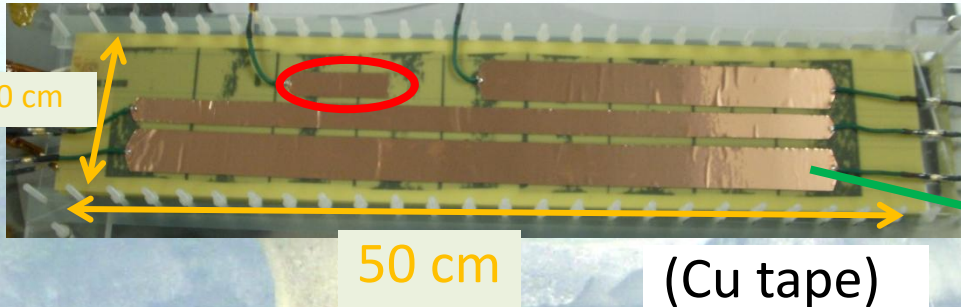
smallest

(Ch. at LEPS2)

- 1.5 cm * 5.5 cm (7000 ch)
- 3.7 cm * 2.5 cm (7000 ch)
- 7.4 cm * 2.5 cm (3000 ch)
- 7.4 cm * 5.0 cm (1500 ch)
- 7.4 cm * 10.0 cm (800 ch)

largest

Strip Readout both ends



smallest

(Ch. at LEPS2)

- 1.5 cm * 5.5 cm (7000 ch)
- 2.5 cm * 20 cm (2000 ch)
- 1.5 cm * 40 cm (1700 ch)
- 2.5 cm * 40 cm (1000 ch)

Distance between pads is 3 mm

Amplifier

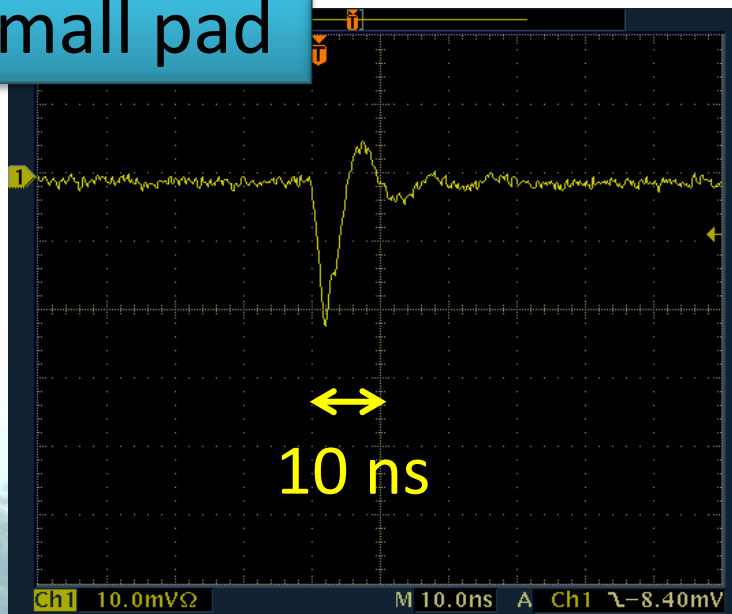
PMT amplifier

Input impedance 50Ω

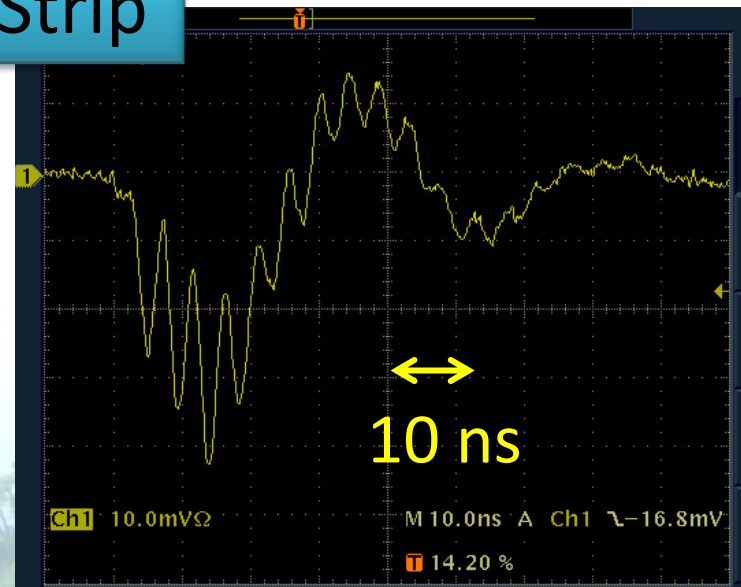
500 MHz / Gain 5

Read only anode signal

Small pad



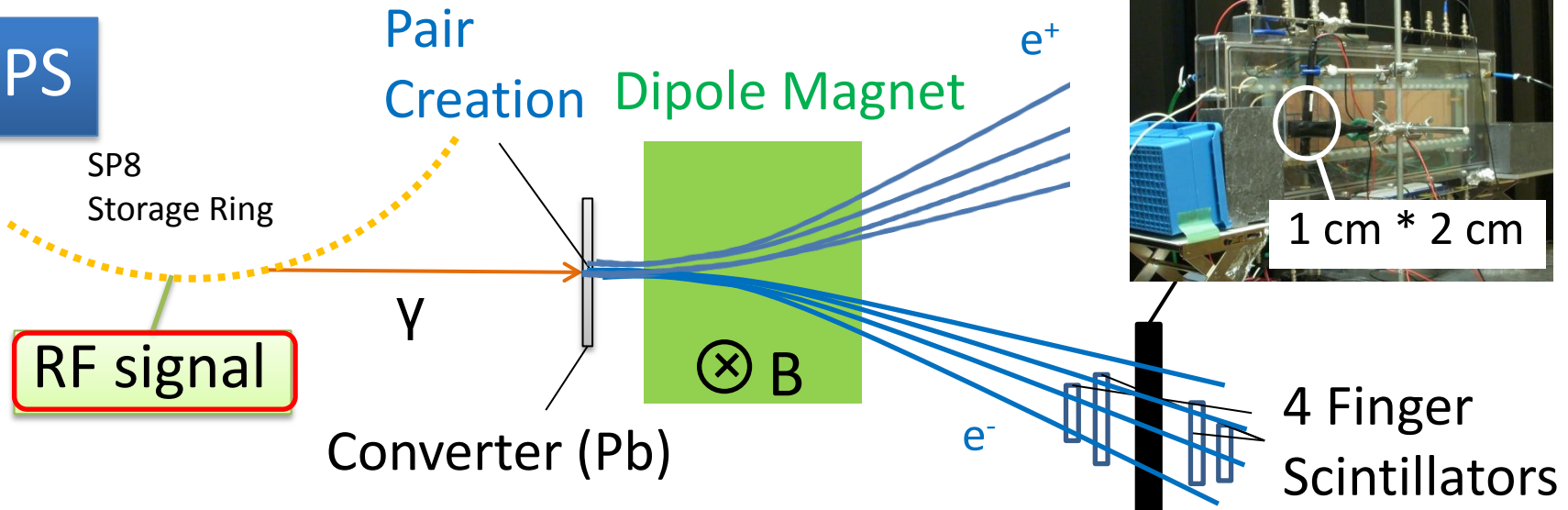
Strip



Impedance is not match

Beamtest

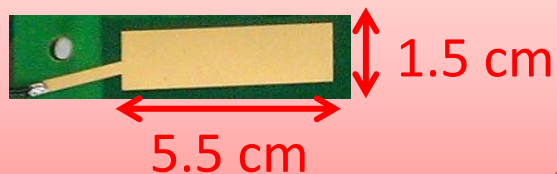
LEPS



- Gap width dependence
 - Number of Stacks dependence
 - Pad size dependence
 - Position dependence
 - Rate dependence
 - Gas dependence
- On 9/2
by C.Hsieh

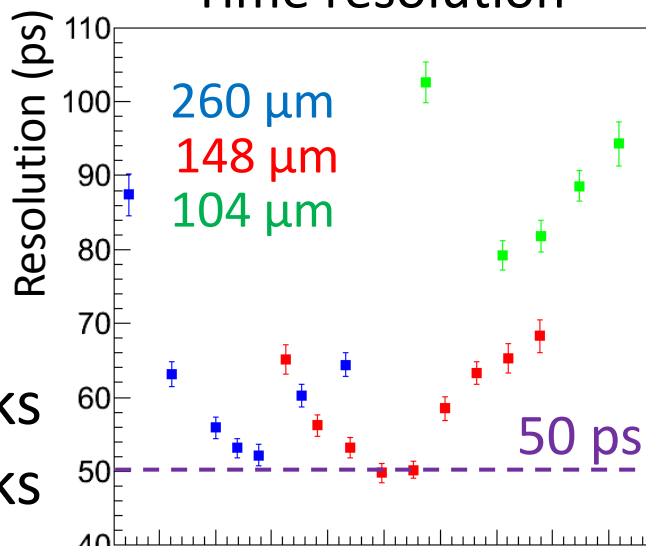
Gap width dependence

Small pad



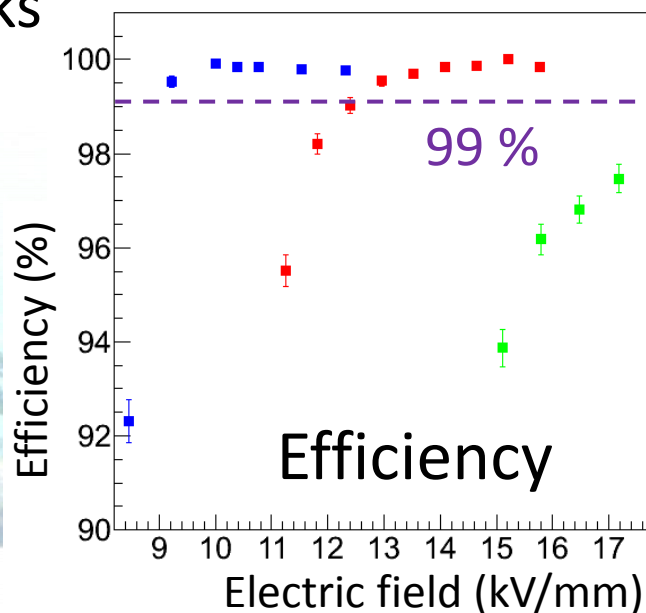
- 104 μm * 7 gaps * 2 stacks
- 148 μm * 6 gaps * 2 stacks
- 260 μm * 5 gaps * 2 stacks

Time resolution



No big difference
Between
148 μm / 260 μm

104 μm is too thin



148 μm / 260 μm
50 ps / >99 %
Achieved LEPS2
Requirement

Number of stacks dependence

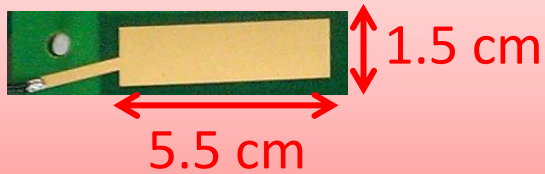
260 μm

148 μm

Time resolution

Time resolution

Small pad

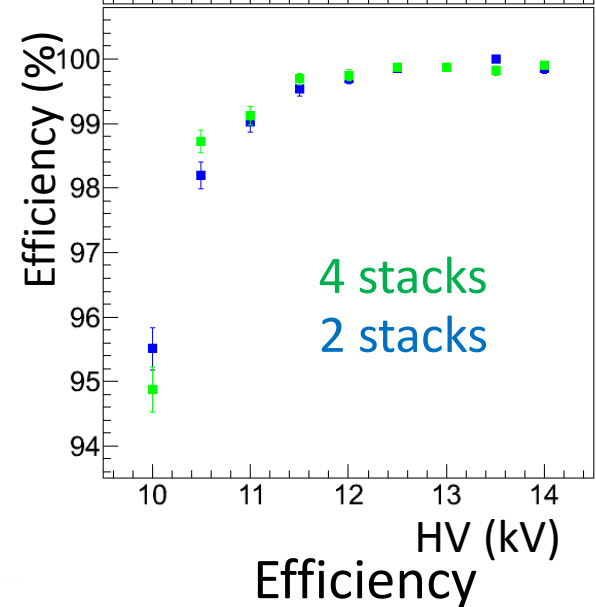
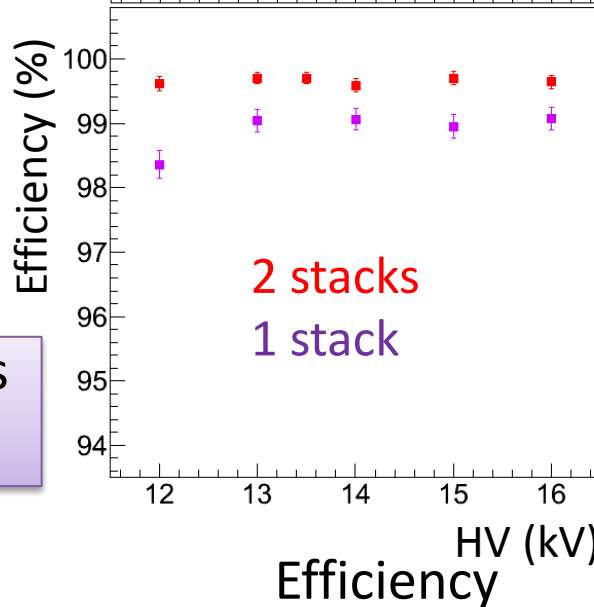
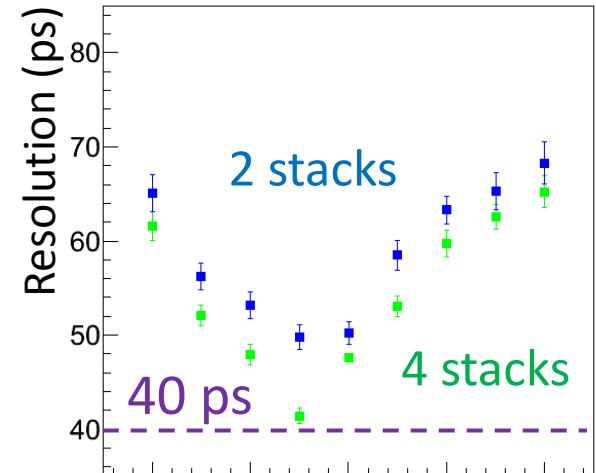
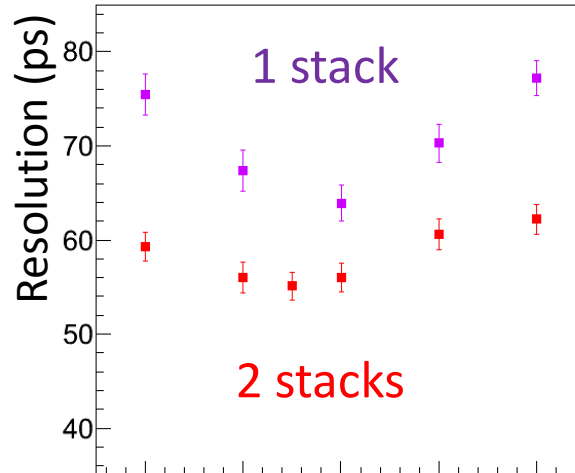


148 μm *6 gaps

260 μm *5 gaps

No. of stacks
effect is large

148 μm *6 gaps*4 stacks
Achieved 40 ps



Large pad / Size & Position dependence

148 μm *6 gaps * 2stacks

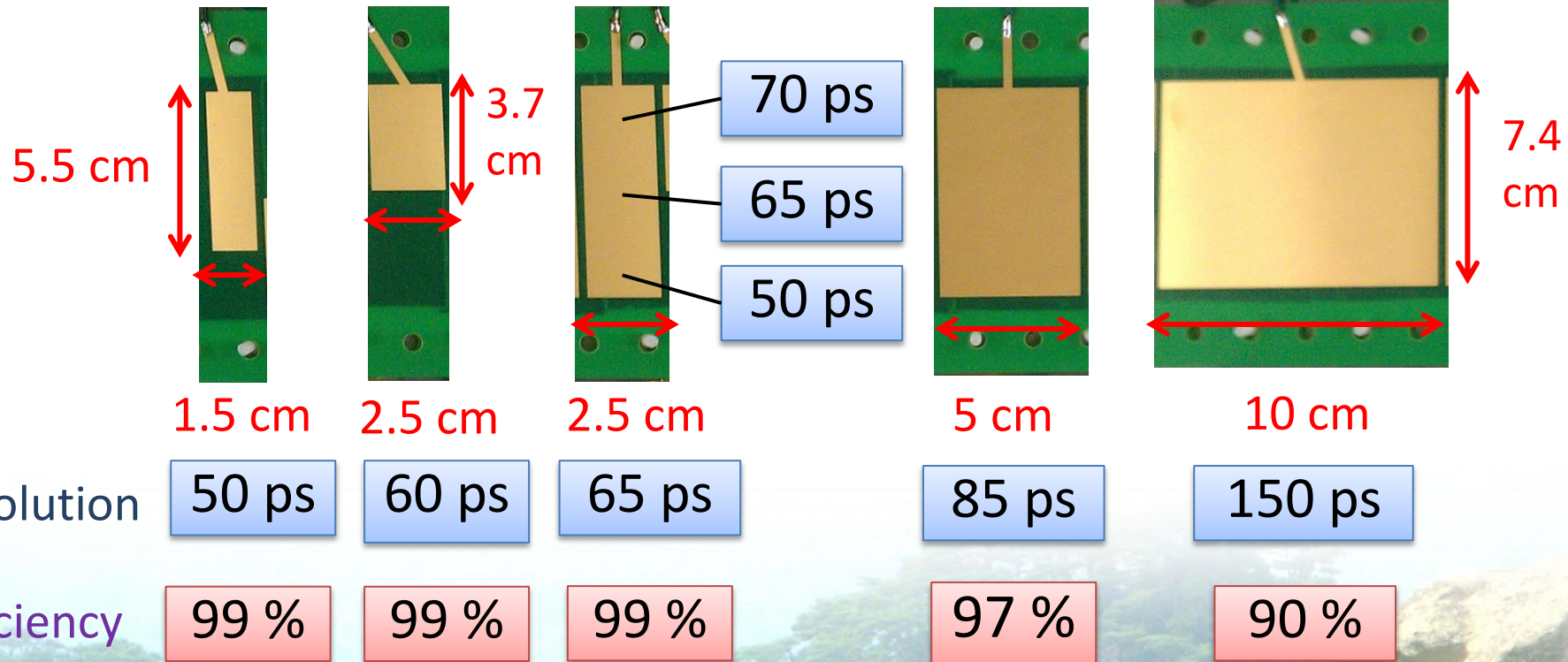
7000 ch

6500 ch

3000 ch

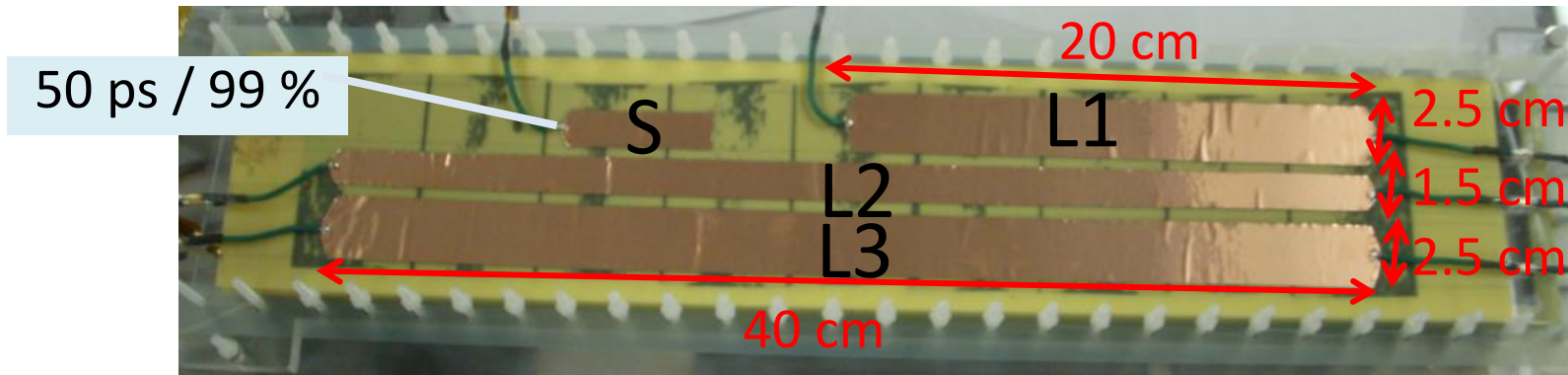
1500 ch

800 ch



Resolution / Efficiency become worse at larger pad
Large position dependence

Strip readout / Size dependence

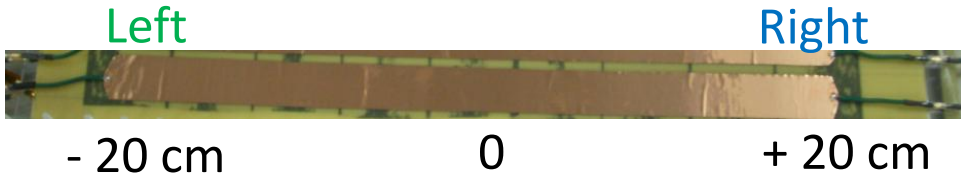


Gap	Pad	Channel	Resolution	Efficiency
148 μm	L1	2000	61 ± 3 ps	93 %
6 gaps	L2	1700	62 ± 2 ps	96 %
2 stacks	L3	1000	63 ± 2 ps	90 %
260 μm	L1	2000	56 ± 2 ps	99 %
5 gaps	L2	1700	64 ± 2 ps	98 %
2 stacks	L3	1000	61 ± 2 ps	99 %

Close to
LEPS2
Requirement
1000 ch
50 ps / 99 %

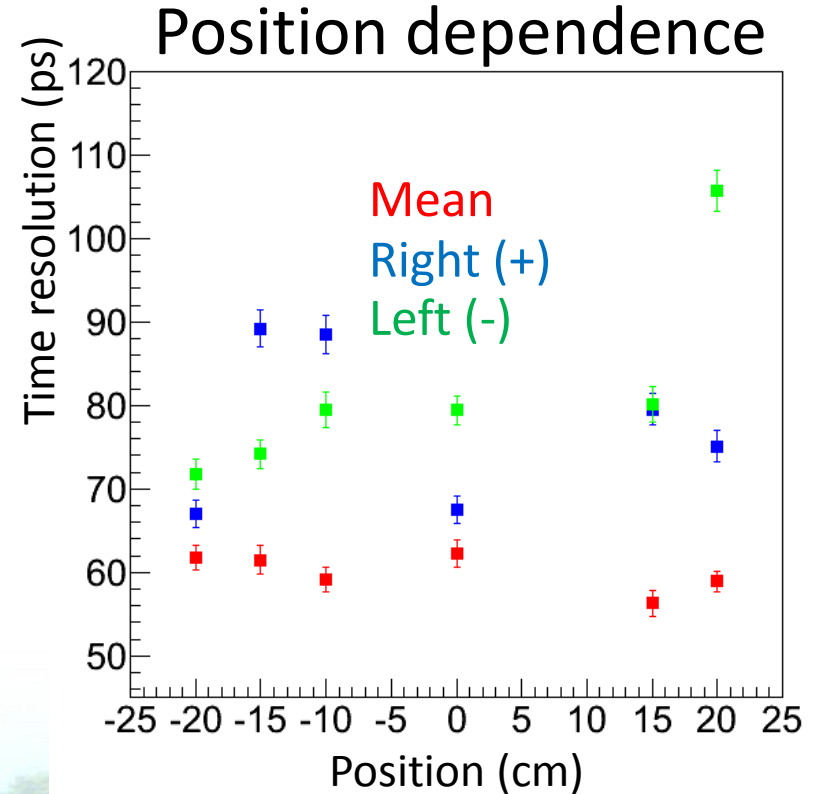
Resolution is almost the same
Efficiency of 148 μm RPC is not enough

Position dependence



Large position dependence
on each readout time resolution

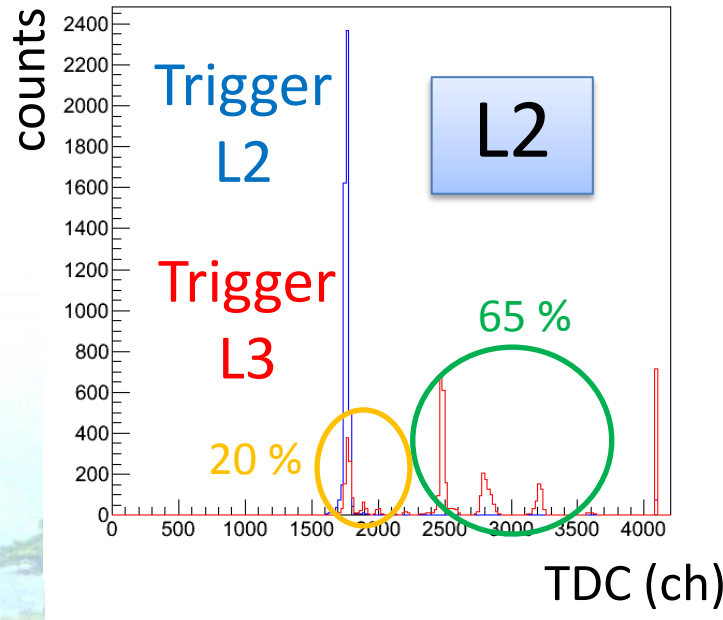
No position dependence
on mean time resolution



Cross talk

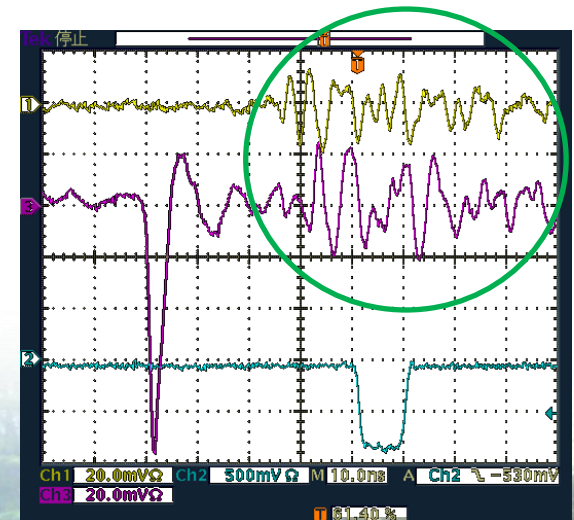


Time Distribution of L2 Pad



20 % cross talk

65 % delayed cross talk by reflection



Summary

- Large read out pad & high time-resolution RPC for LEPS2
- 260 μm *5 gaps*2 stacks RPC achieved 60 ps / 99 %
with 2.5 cm * 40 cm strip (50 cm^2/ch)
- Almost satisfy the requirements of LEPS2
(>50 cm^2/ch , 50 ps, 99 %)

Future

- Amplifier
Large band width, Low noise, Impedance match
- Larger pad with 1 m * 15 cm glass
- Install to LEPS2 in 2013

Thank you very much

