KEK Beam test

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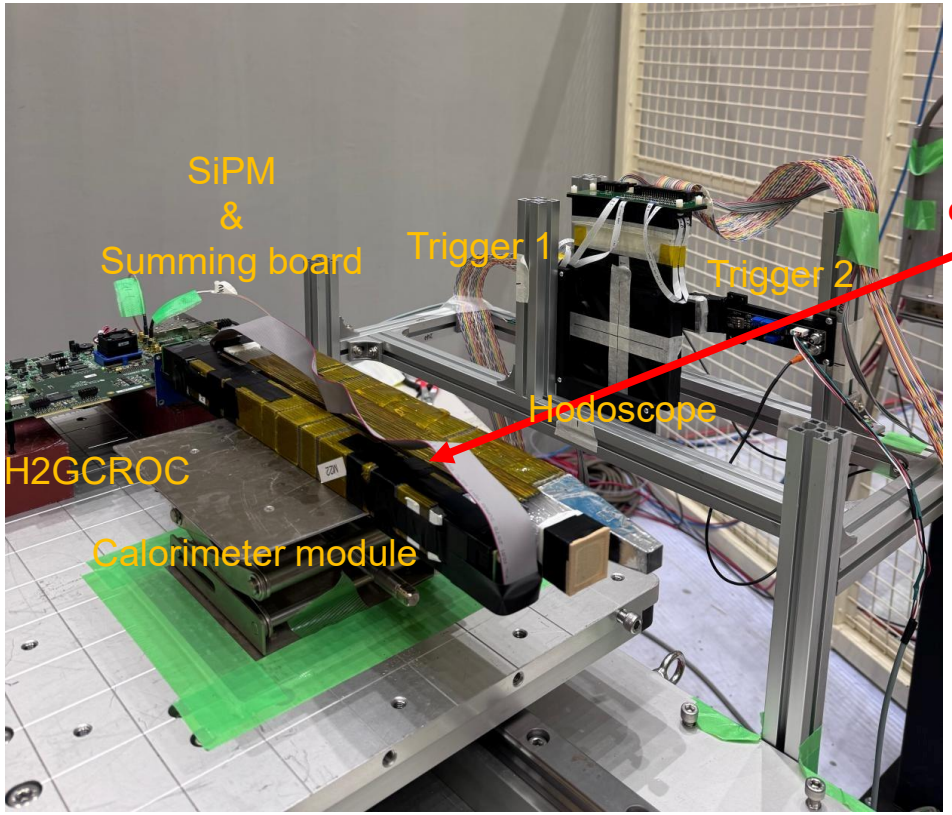
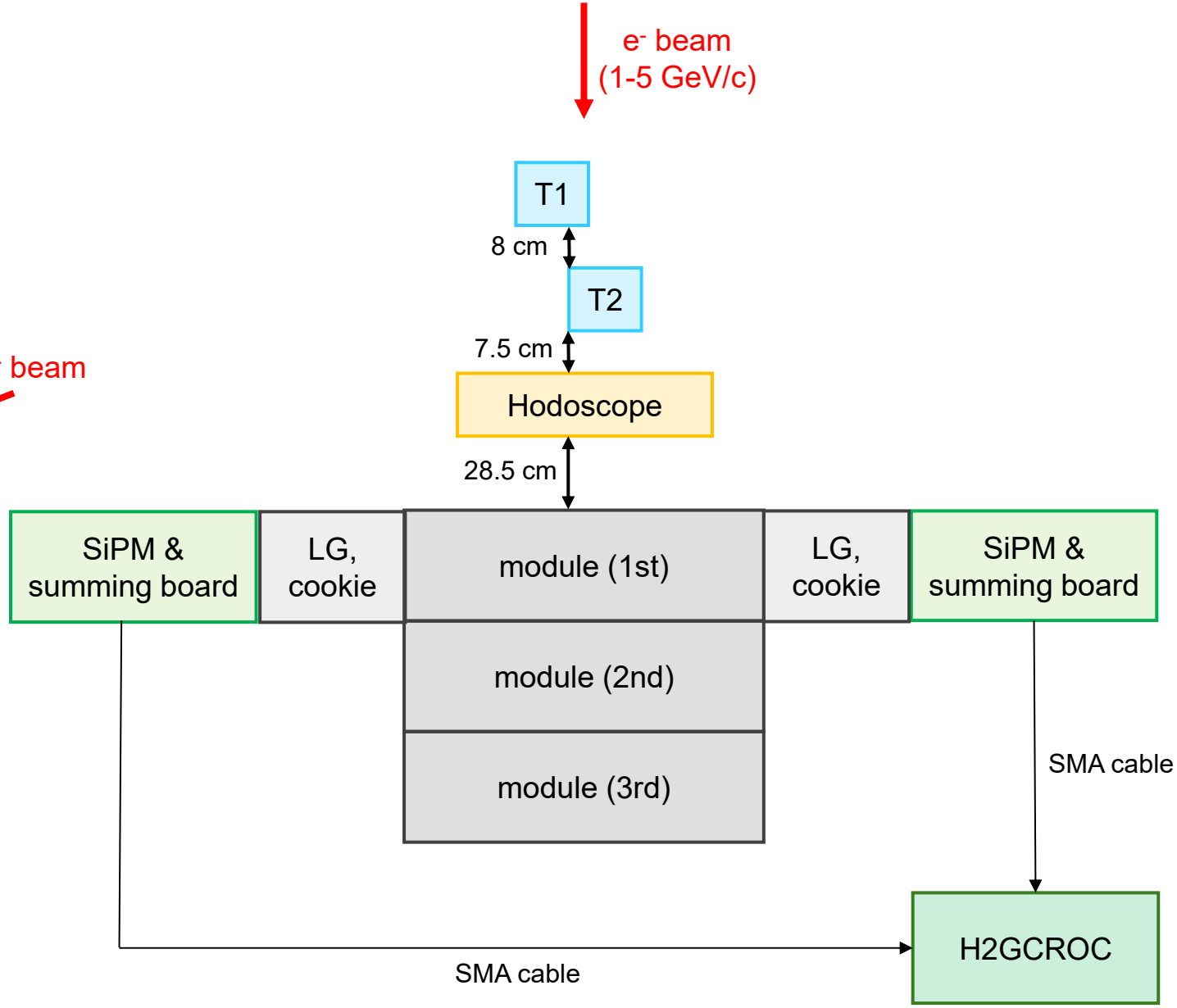
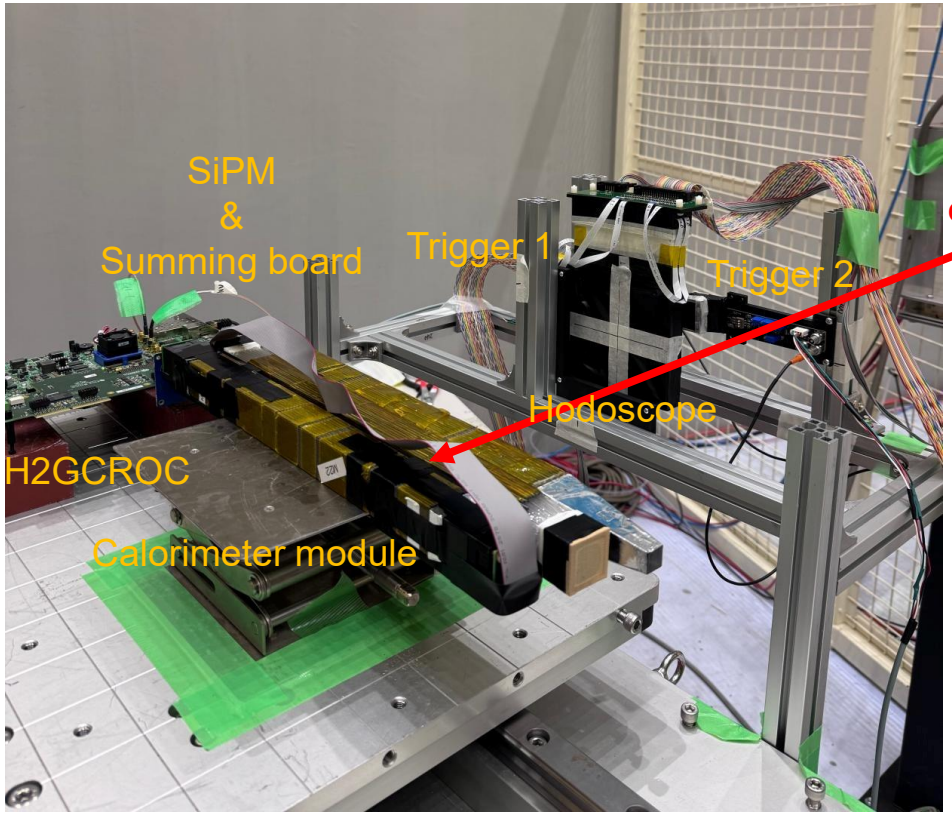
Department of Physics, Kyungpook National University

Setup


SiPM
&
Summing board
Trigger 1
Trigger 2
e- beam
Hodoscope
H2GCROC
Calorimeter module


e- beam
(1-5 GeV/c)
T1
8 cm
T2
7.5 cm
Hodoscope
28.5 cm
SiPM & summing board
LG, cookie
module (1st)
module (2nd)
module (3rd)
LG, cookie
SiPM & summing board
SMA cable
SMA cable
H2GCROC

Setup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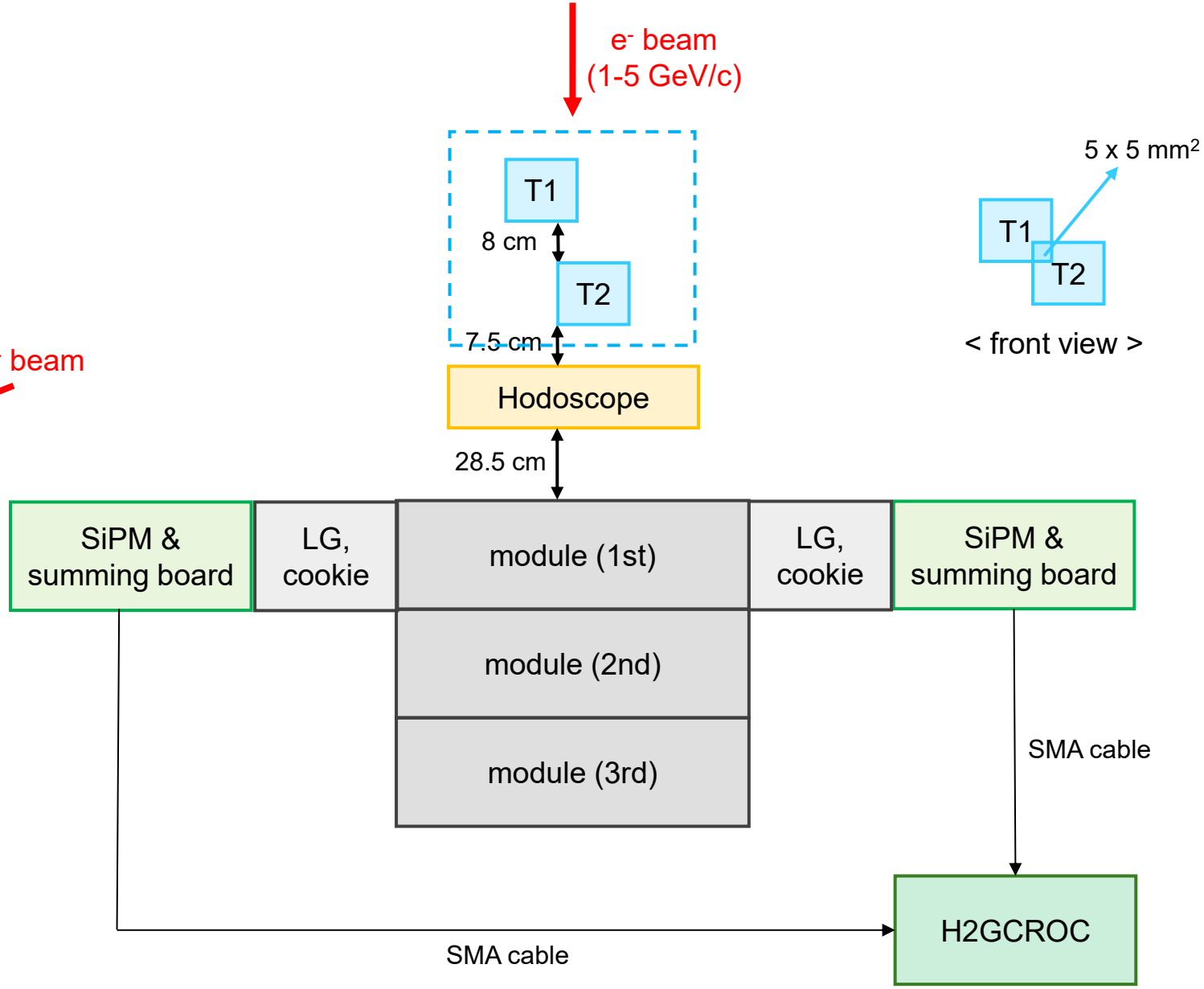
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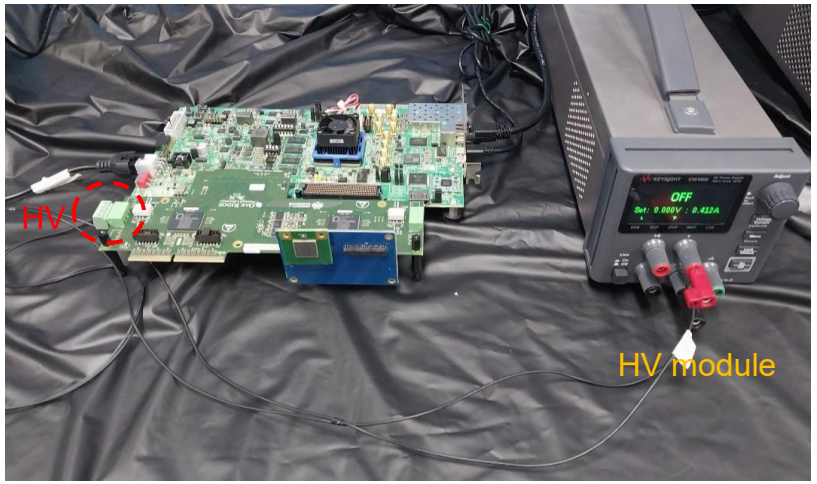
module (1st)
module (2nd)
module (3rd)
LG, cookie
SiPM & summing board
SMA cable
SMA cable
H2GCROC
5 x 5 mm2
T1
T2
< front view >

e-room tech board type

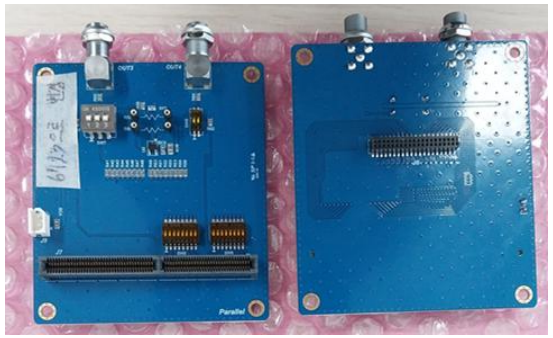
- Hybrid summing
  - w/o op amp, w/ op amp (Board #1, LMH6629)
  - w/o op amp, w/ op amp (Board #2, LMH6723)
- Parallel summing
  - w/o op amp, w/ op amp (Board #3, LMH6629)
  - w/o op amp, w/ op amp (Board #4, LMH6723)
- Individual
  - SiPM 16ch individual readout (Board #5, #6)



e-room Board

- **HV supplied by H2GCROC**
- output directly connected to H2GCROC
- outputs with and without Op Amp

Hybrid summing



Parallel summing

Individual

e-room tech board type

- Hybrid summing
  - w/o op amp, w/ op amp (Board #1, LMH6629)
  - w/o op amp, w/ op amp (Board #2, LMH6723)
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  - w/o op amp, w/ op amp (Board #3, LMH6629)
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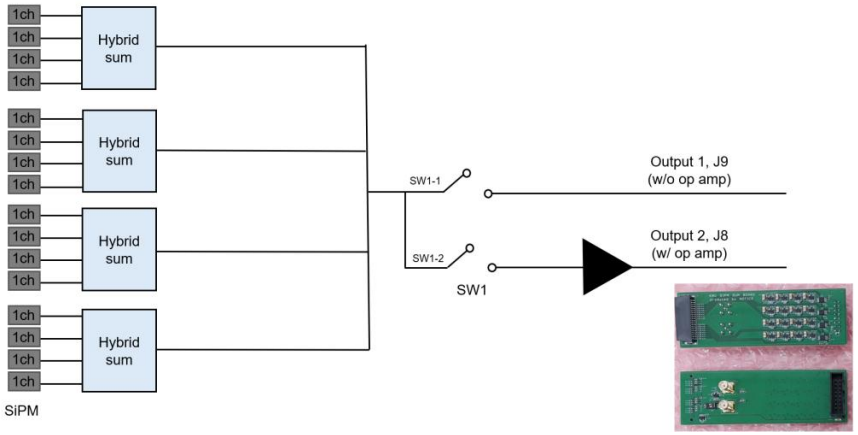
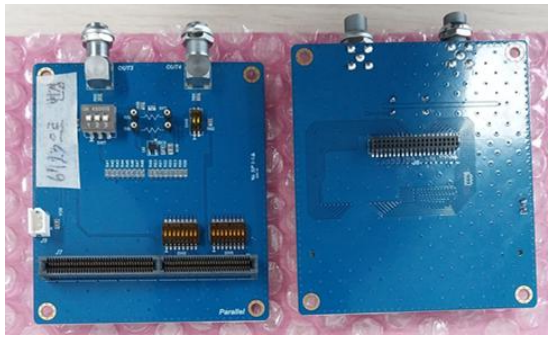
  - SiPM 16ch individual readout (Board #5, #6)



e-room Board

- **HV supplied by H2GCROC**
- output directly connected to H2GCROC
- outputs with and without Op Amp

Hybrid summing



Parallel summing

Individual

NOTICE board type

- Hybrid summing

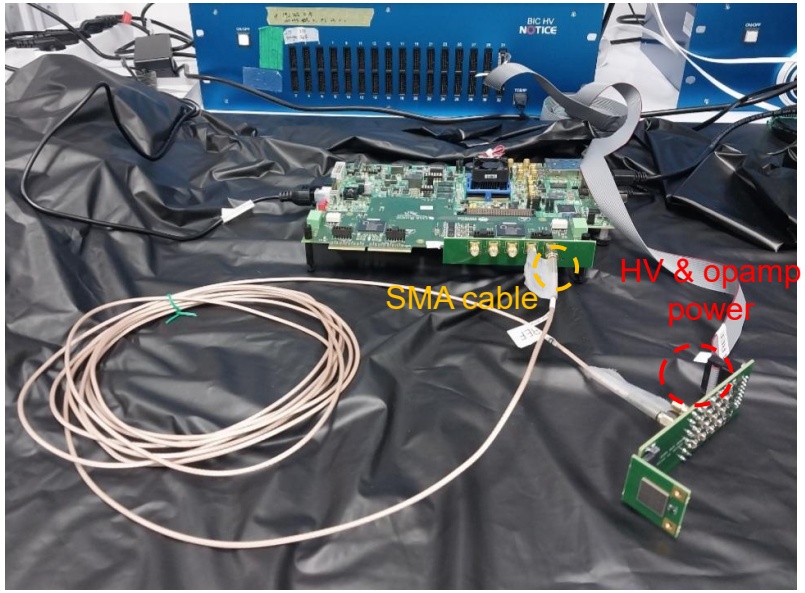
  - w/o op amp, w/ op amp (Board #7, #8)

- Parallel summing

  - w/o op amp, w/ op amp, 4ch summing (Board #9, #10)

- SMA to H2GCROC (Board #11, #12)

NOTICE power module



NOTICE Board

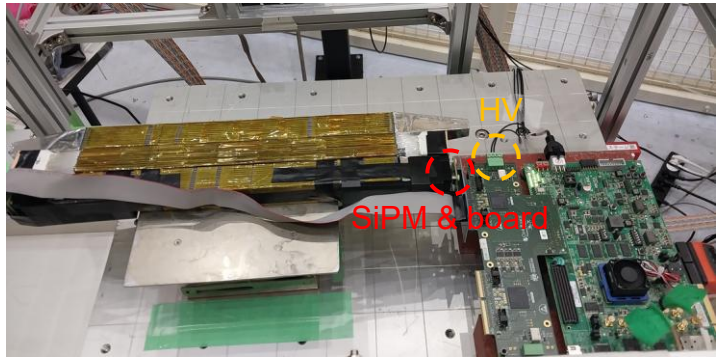
- **Independent HV control via NOTICE power module**
- transmit output via cable
- outputs with and without Op Amp
- Added 4ch summing to parallel board

Hybrid summing

Parallel summing

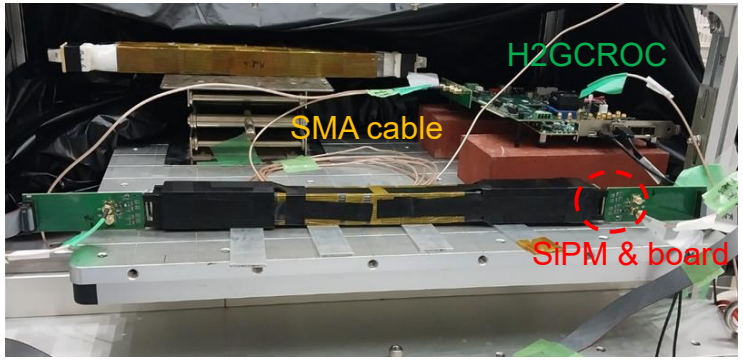
SMA to H2GCROC

Parameter scan



e-room Board

- **HV supplied by H2GCROC**
- output directly connected to H2GCROC
- outputs with and without Op Amp
- Added 4ch summing to parallel board



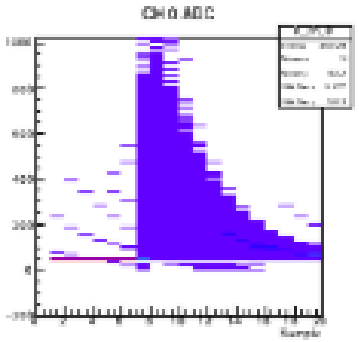
NOTICE Board

- **Independent HV control via NOTICE power module**
- transmit output via cable
- outputs with and without Op Amp

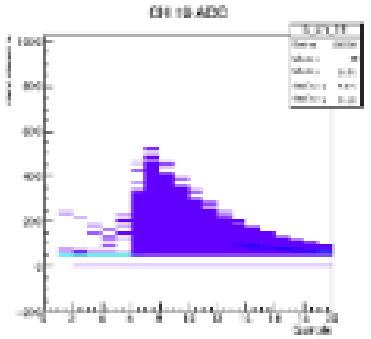
	summing	momentum	position	parameter (Rf-Cf-Gain conveyor-Cf comp)
e-room (#5,6)	Individual	1-5GeV/c	1st, 3rd	4-15-15-15 Default 15-4-15-15
Notice (#7,8) e-room (#1,2)	Hybrid	1-5GeV/c	1st, 3rd	4-1-1-15 Default 15-15-1-15 15-1-1-15 15-1-1-1 (gain min) ↓ gain↓
Notice (#9,10) e-room (#3,4)	Parallel + 4 ch	1-5GeV/c	1st, 3rd	4-1-1-15 Default 15-1-1-15 (gain min)

Parameter scan

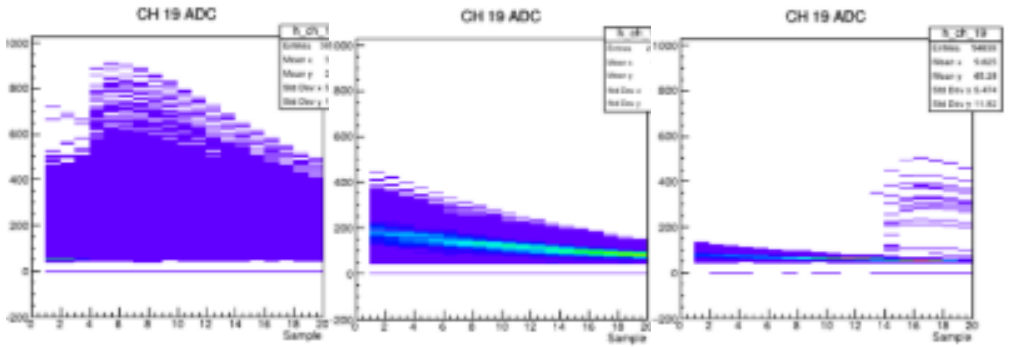
3rd, 3GeV/c (Further details by Bo Gyeong)



Individual
(default)



Hybrid summing
(15-1-15-15)



Parallel summing
(15-1-15-15)

	summing	momentum	position	parameter (Rf-Cf-Gain conveyor-Cf comp)
e-room (#5,6)	Individual	1-5GeV/c	1st, 3rd	4-15-15-15 Default 15-4-15-15
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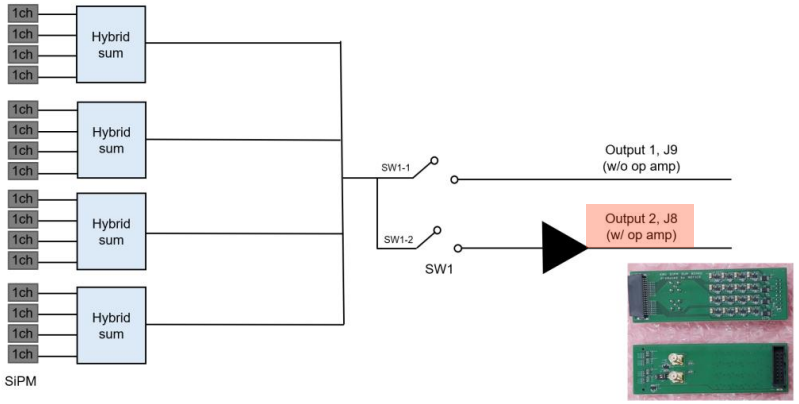
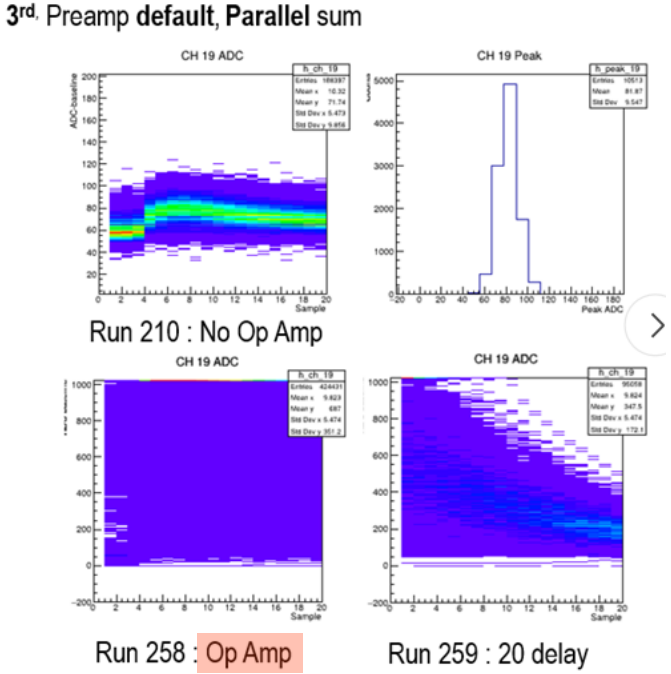
Notice (#9,10) e-room (#3,4)	Parallel + 4 ch	1-5GeV/c	1st, 3rd	4-1-1-15 Default 15-1-1-15 (gain min)

Parameter scan



- Without an op amp, the signal is lost due to cable attenuation
- Op amp performance ↔ Power dissipation (trade-off)
- Study cable attenuation and compare op amps



	summing	momentum	position	parameter (Rf-Cf-Gain conveyor-Cf comp)
e-room (#5,6)	Individual	1-5GeV/c	1st, 3rd	4-15-15-15 Default 15-4-15-15
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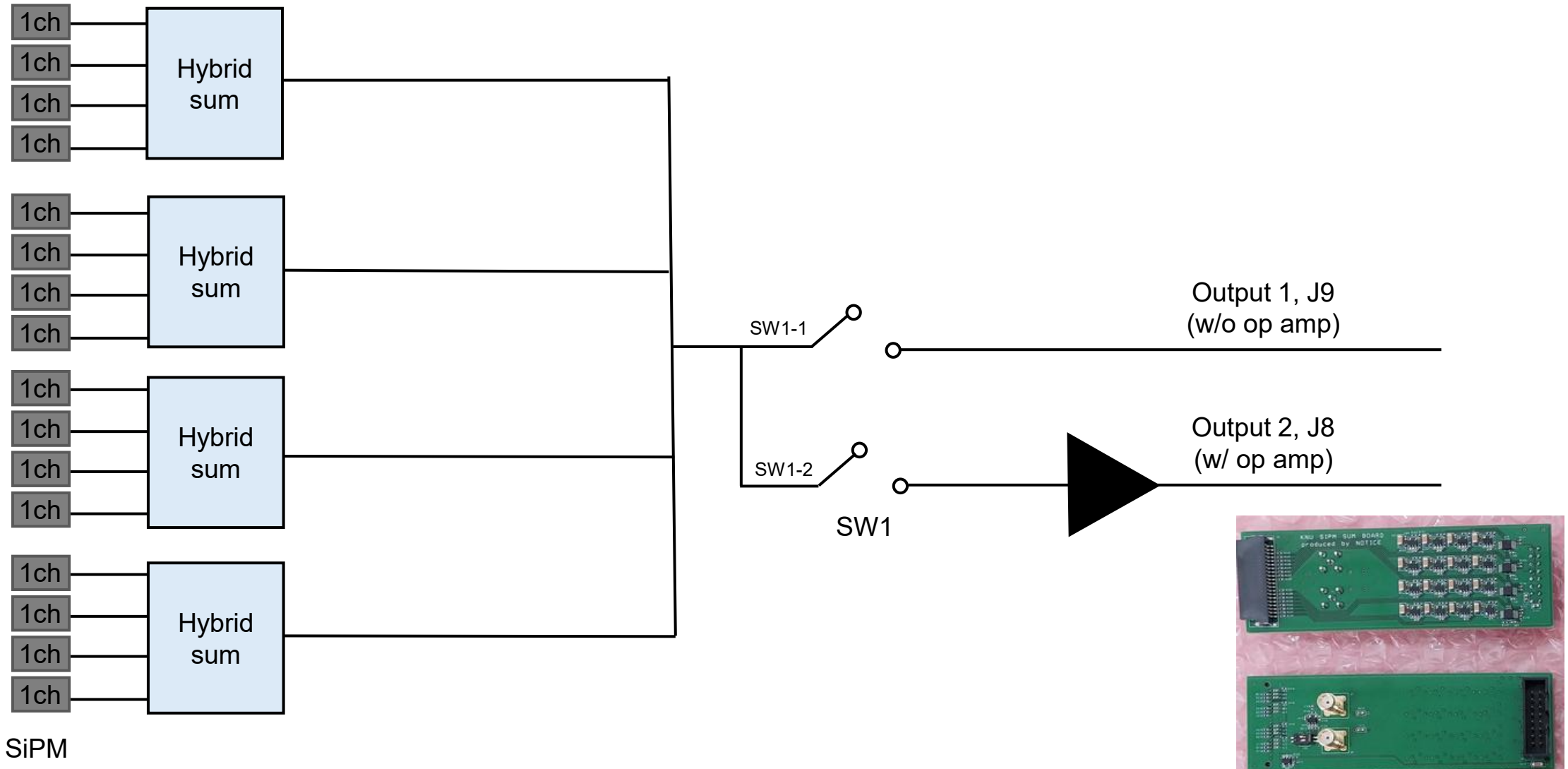
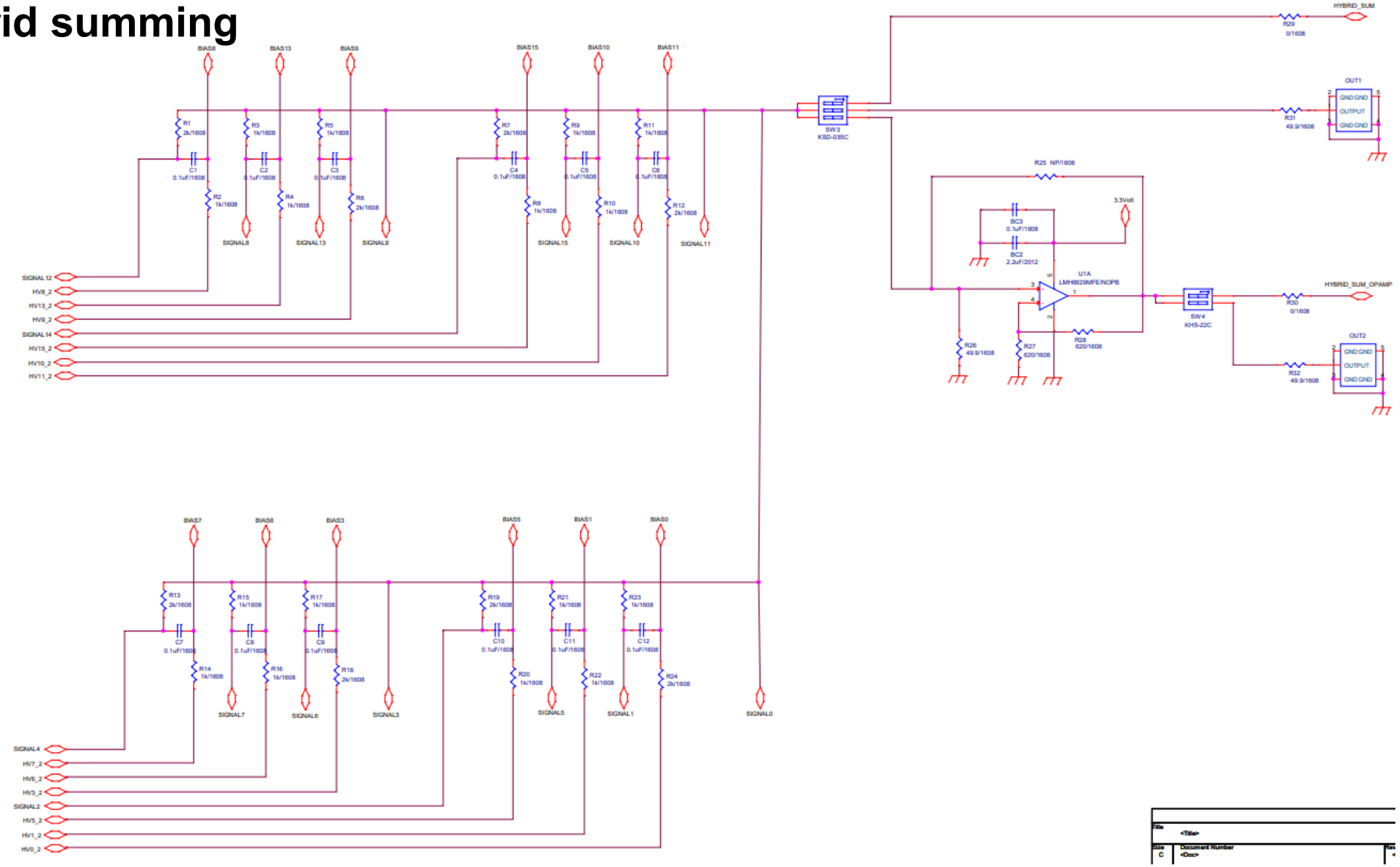
Notice (#9,10) e-room (#3,4)	Parallel + 4 ch	1-5GeV/c	1st, 3rd	4-1-1-15 Default 15-1-1-15 (gain min)

Backup

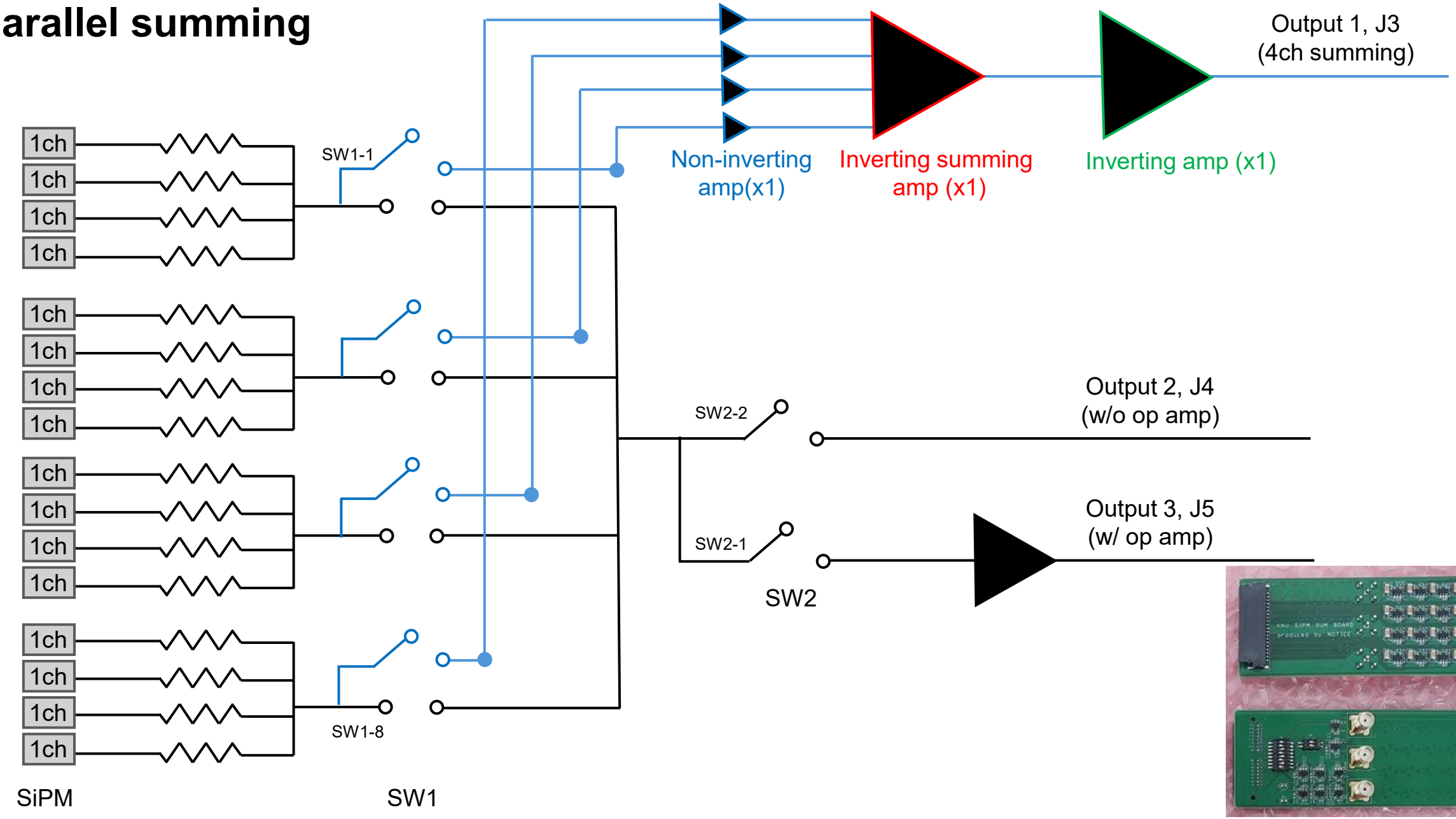
Hybrid summing



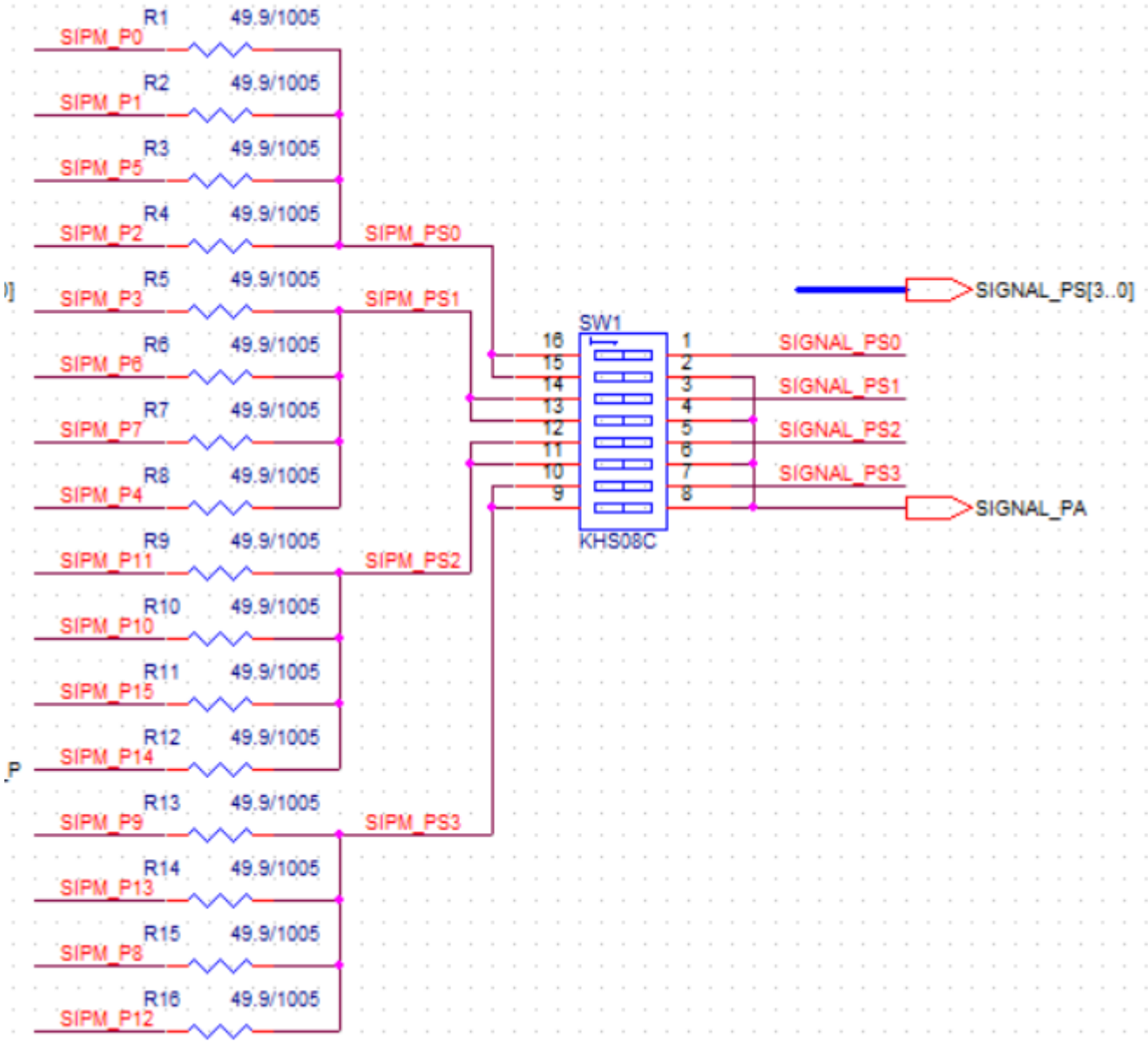
Hybrid summing



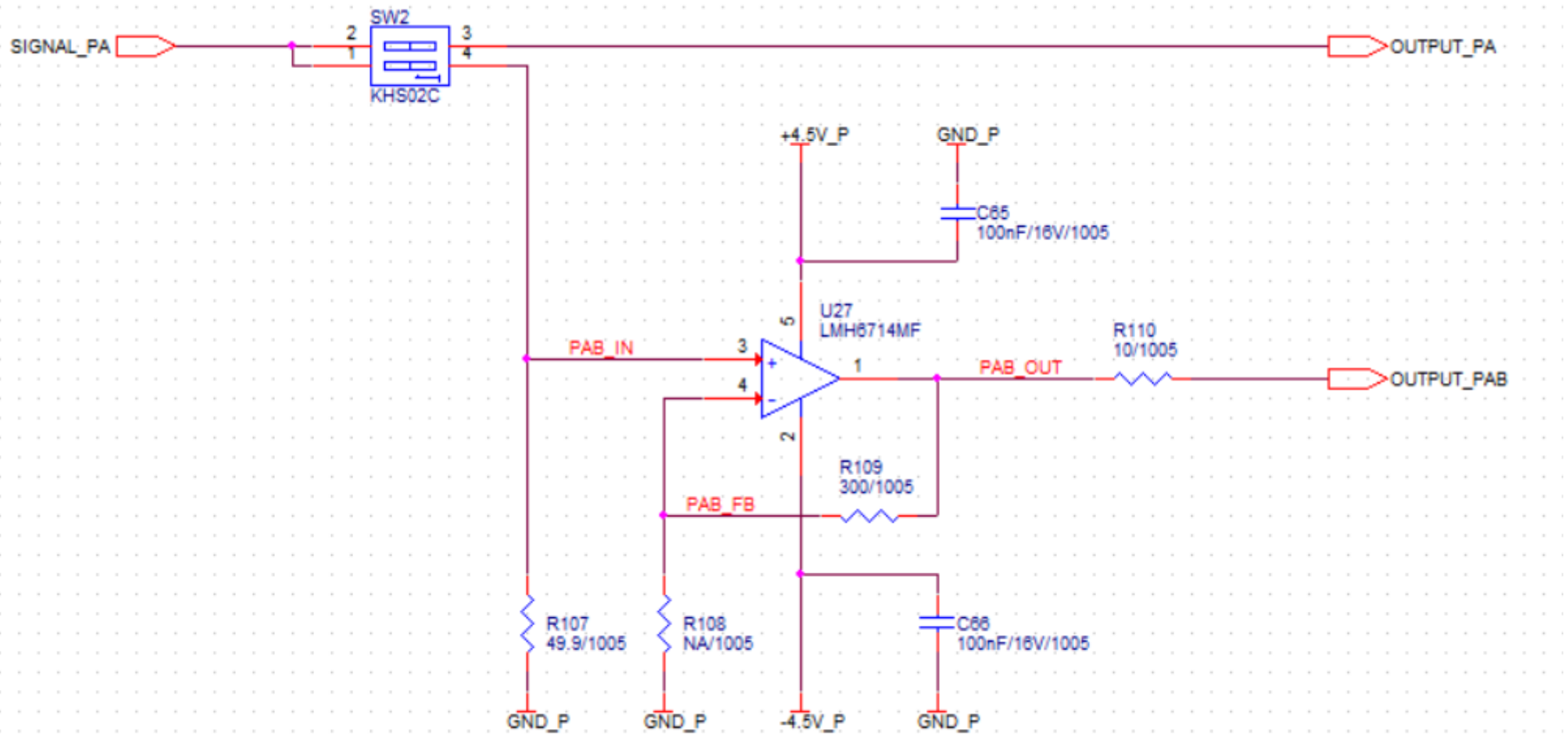
Parallel summing



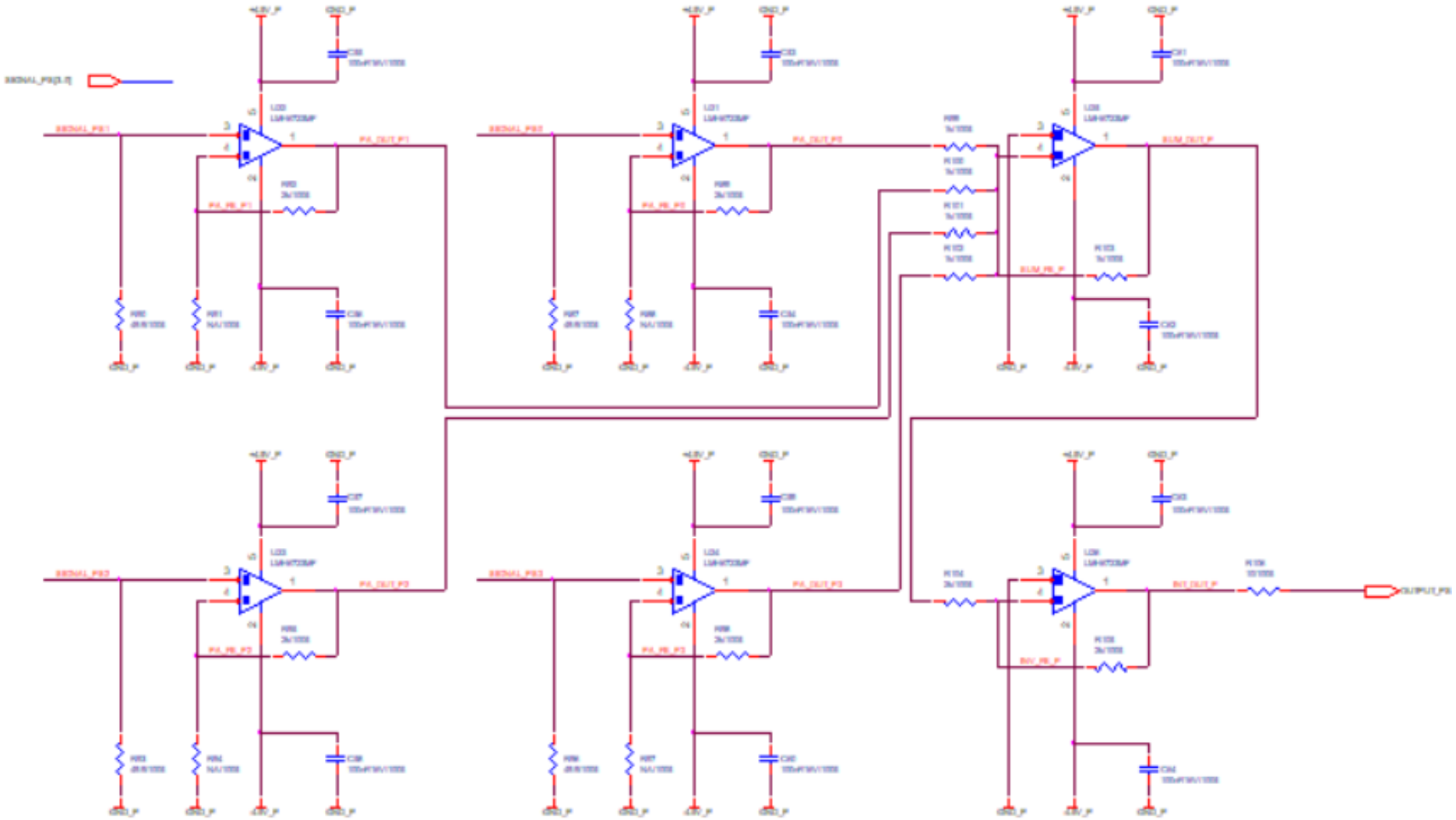
Parallel summing



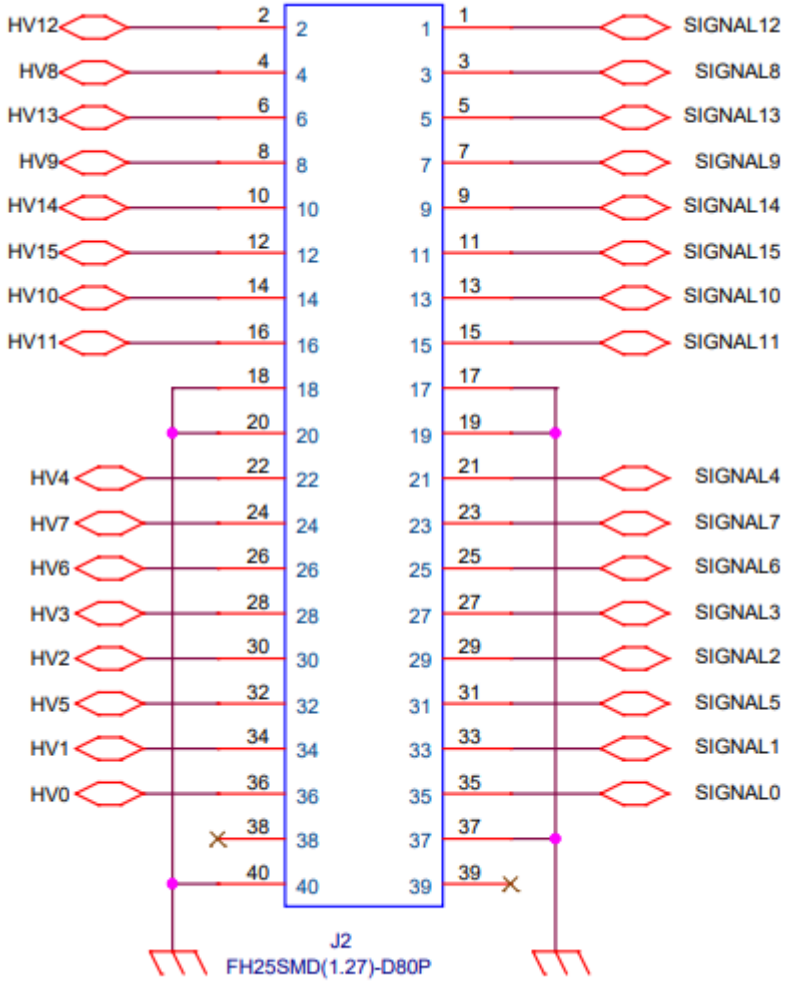
Parallel summing (16ch)

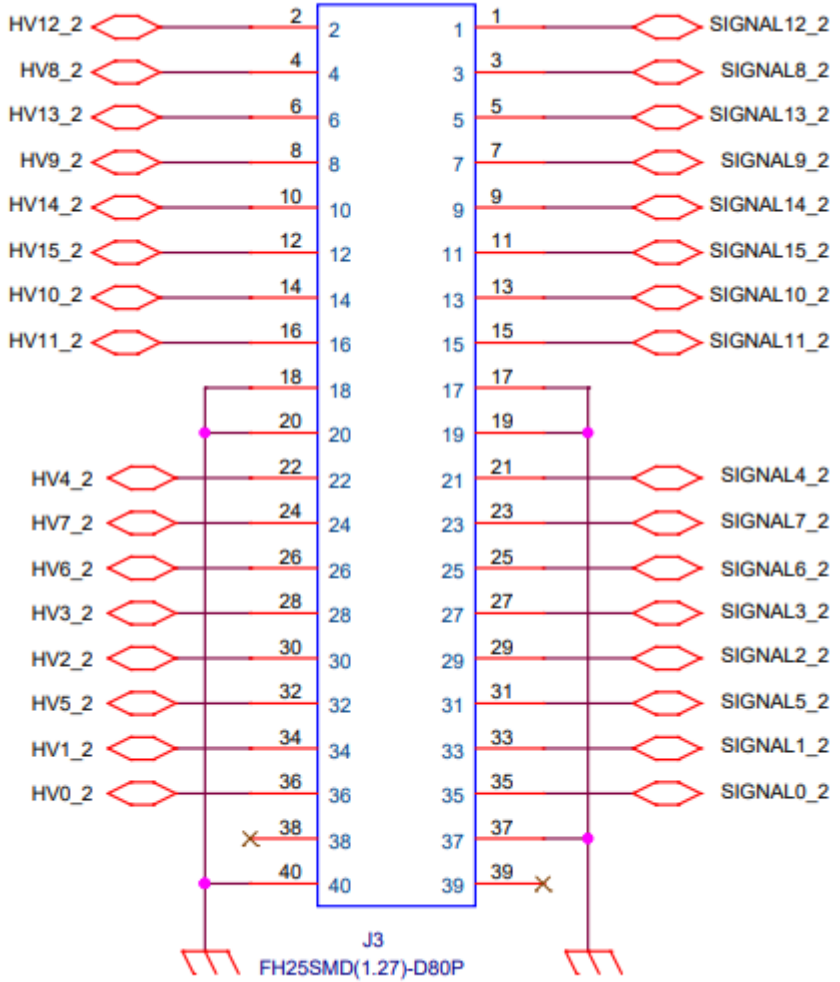


Parallel summing (4ch)

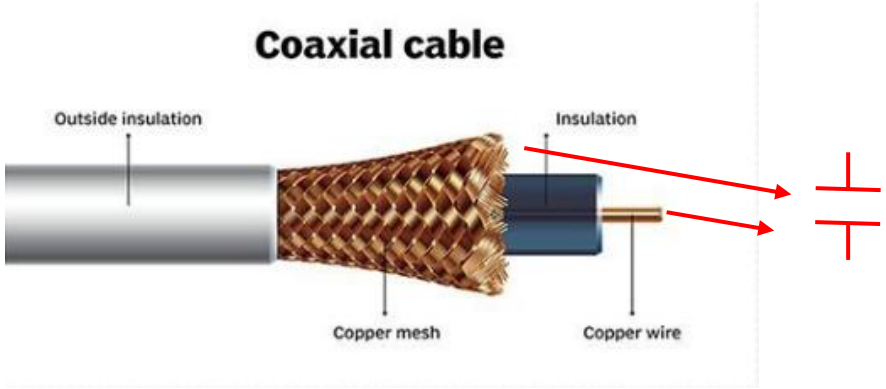


Individual

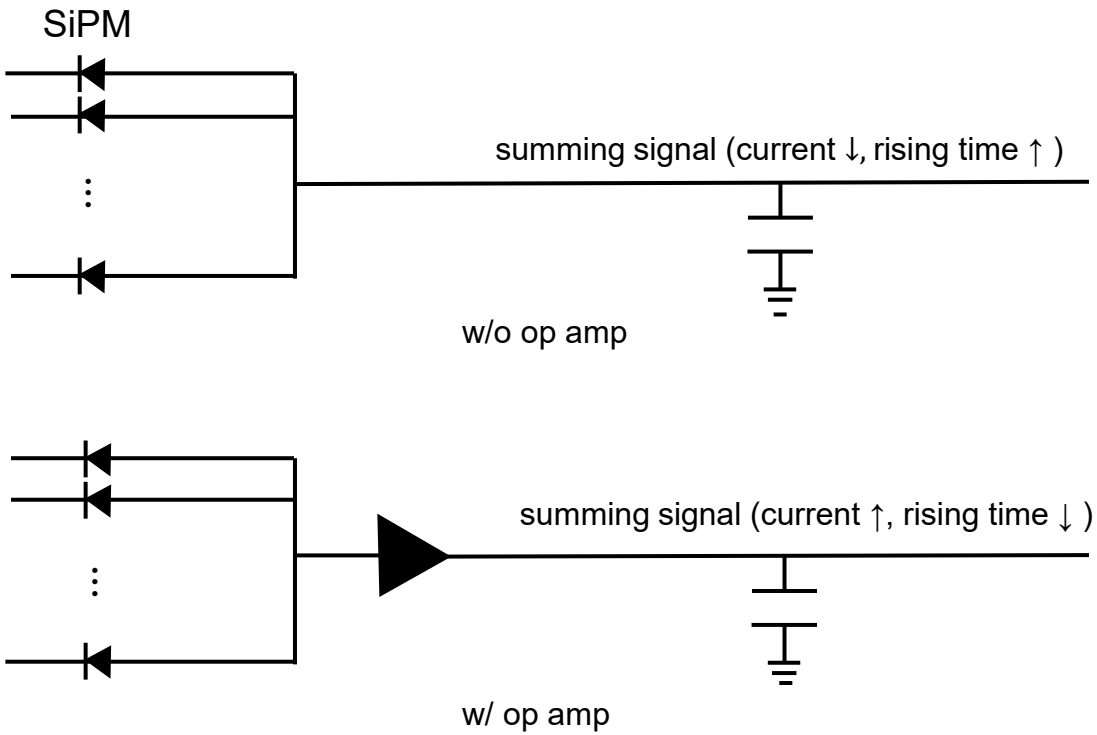

HV12
HV8
HV13
HV9
HV14
HV15
HV10
HV11
HV4
HV7
HV6
HV3
HV2
HV5
HV1
HV0
SIGNAL12
SIGNAL8
SIGNAL13
SIGNAL9
SIGNAL14
SIGNAL15
SIGNAL10
SIGNAL11
SIGNAL4
SIGNAL7
SIGNAL6
SIGNAL3
SIGNAL2
SIGNAL5
SIGNAL1
SIGNAL0
J2
FH25SMD(1.27)-D80P


HV12_2
HV8_2
HV13_2
HV9_2
HV14_2
HV15_2
HV10_2
HV11_2
HV4_2
HV7_2
HV6_2
HV3_2
HV2_2
HV5_2
HV1_2
HV0_2
SIGNAL12_2
SIGNAL8_2
SIGNAL13_2
SIGNAL9_2
SIGNAL14_2
SIGNAL15_2
SIGNAL10_2
SIGNAL11_2
SIGNAL4_2
SIGNAL7_2
SIGNAL6_2
SIGNAL3_2
SIGNAL2_2
SIGNAL5_2
SIGNAL1_2
SIGNAL0_2
J3
FH25SMD(1.27)-D80P

Op-amp comparison

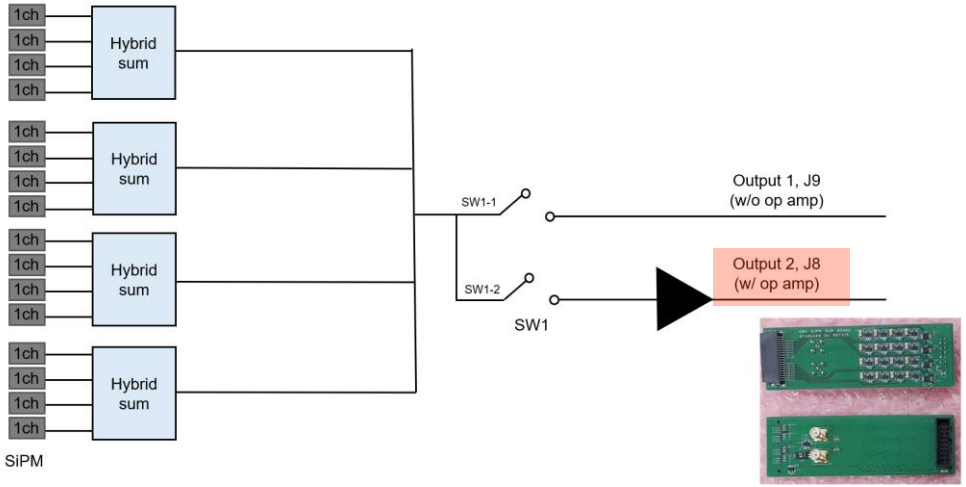


Cable capacitance may increase the rise time

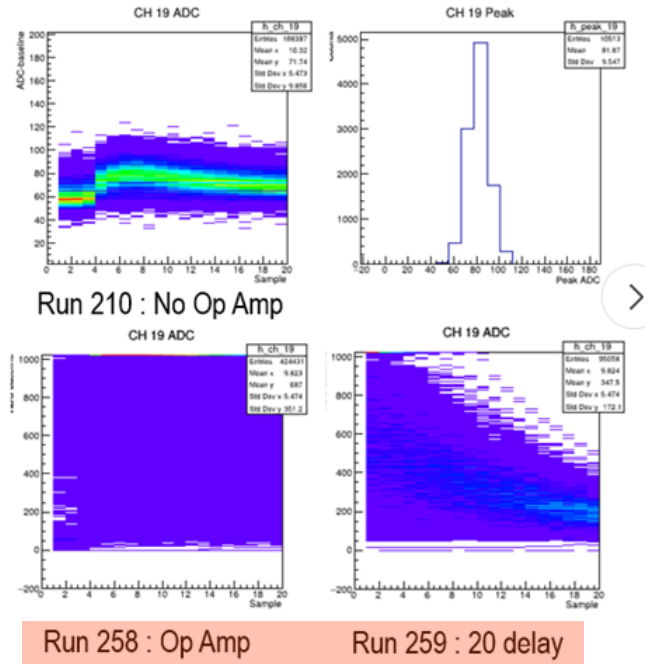


Product	Small signal Bandwidth (MHz)	Noise level (nV/√Hz)	Slew rate (V/μs)	Power (W/cm²)	Price (USD)	Remark
LMH6714	400 @ gain = 2	3.4	1800	1.21	2.87	CFA, V_{op} = 10V
LMH6723MF	290 @ gain = 1	4.3	400	0.124	3.5	CFA, V_{op} = 5V
OPA 656	550 @ gain = 1	6	400	3.23	12.7	VFA, V_{op} = 10V
LMH6629MFE	950 @ gain = 10	0.69	1100	1.005	6.5	VFA, V_{op} = 3.3V

Op-amp comparison



3rd. Preamp **default**, **Parallel** sum



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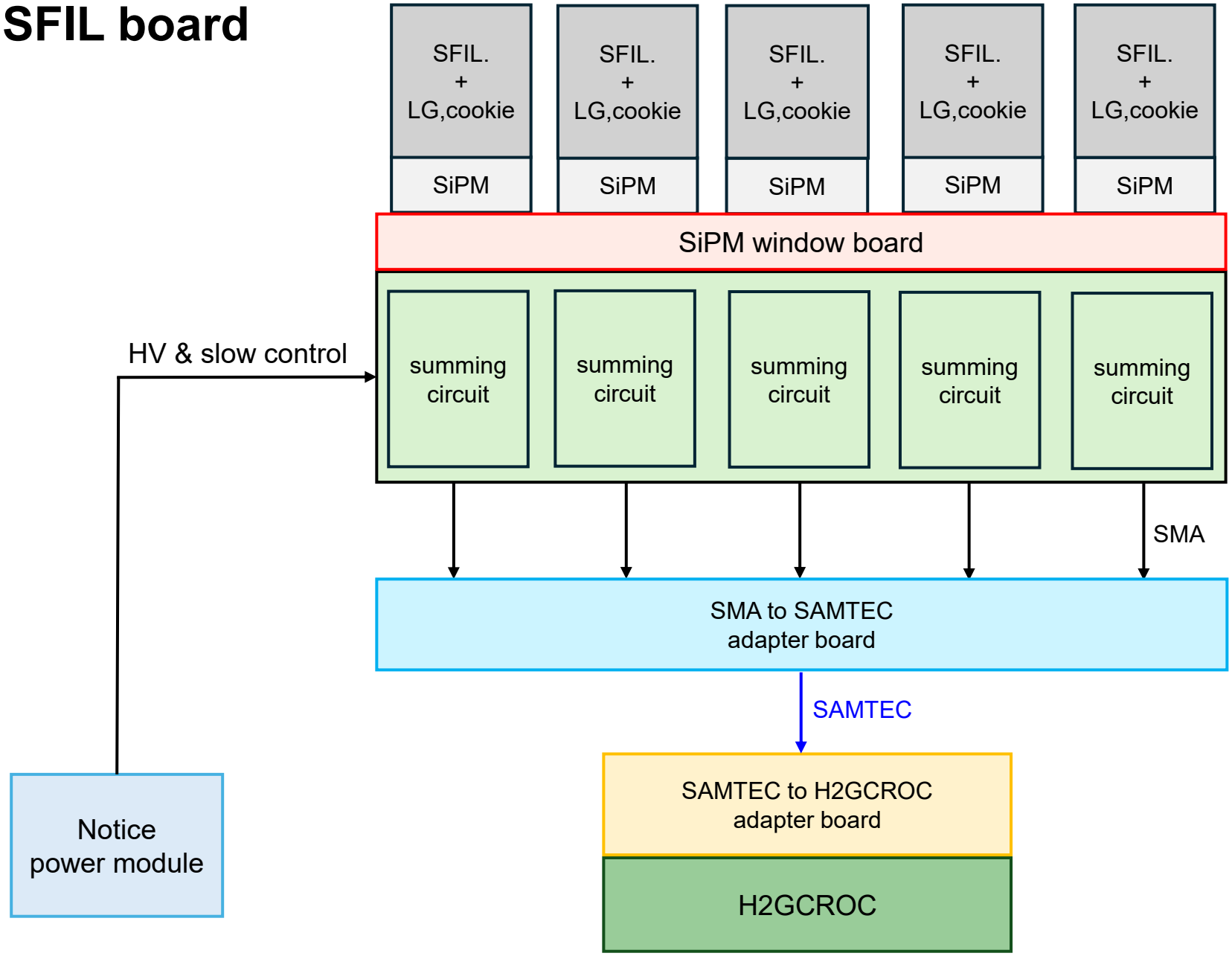
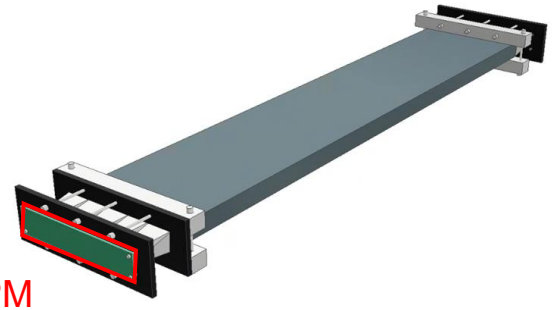
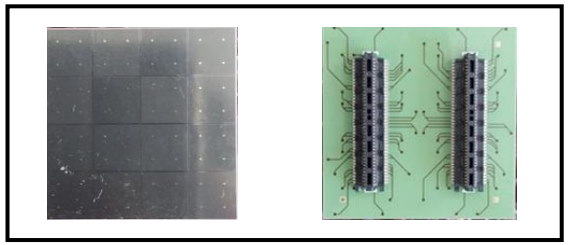
SFIL board

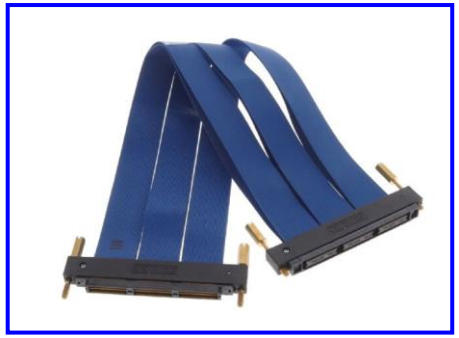




SiPM window board

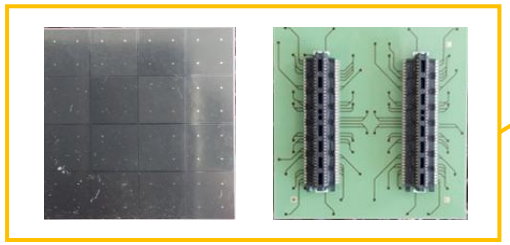


SiPM



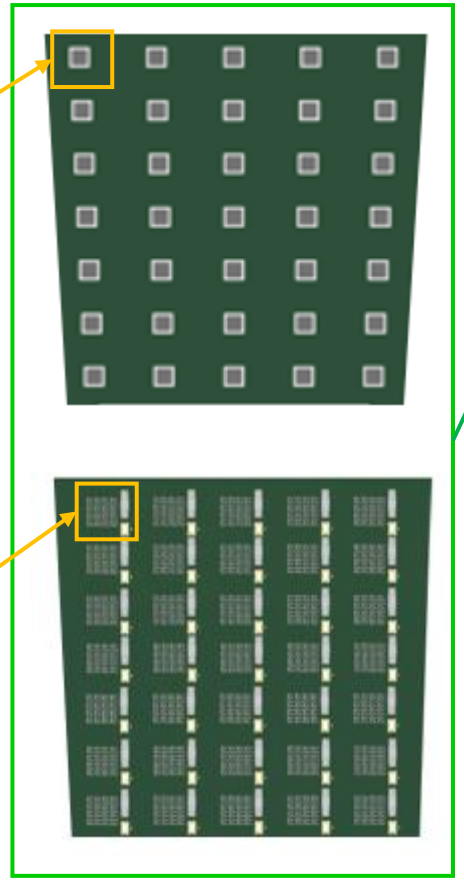
SAMTEC cable

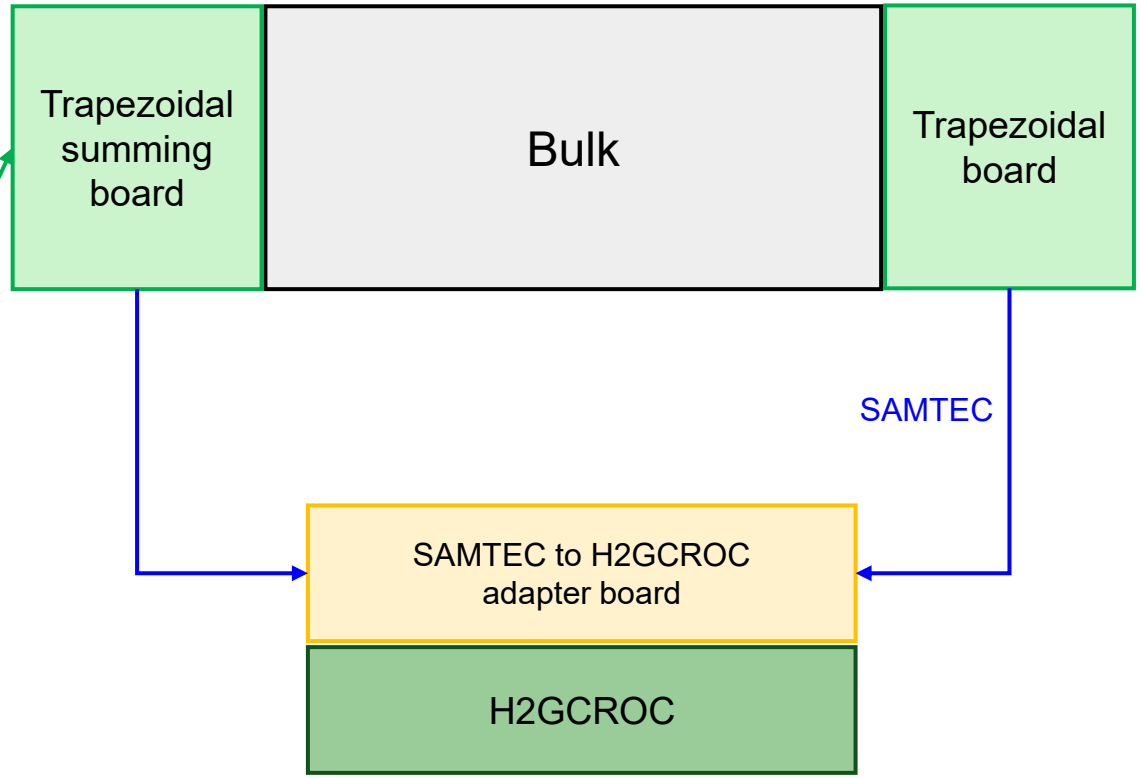
Trapezoidal board



SiPM

Summing circuit

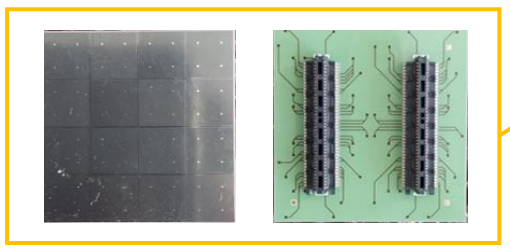




Trapezoidal board mounted on the bulk

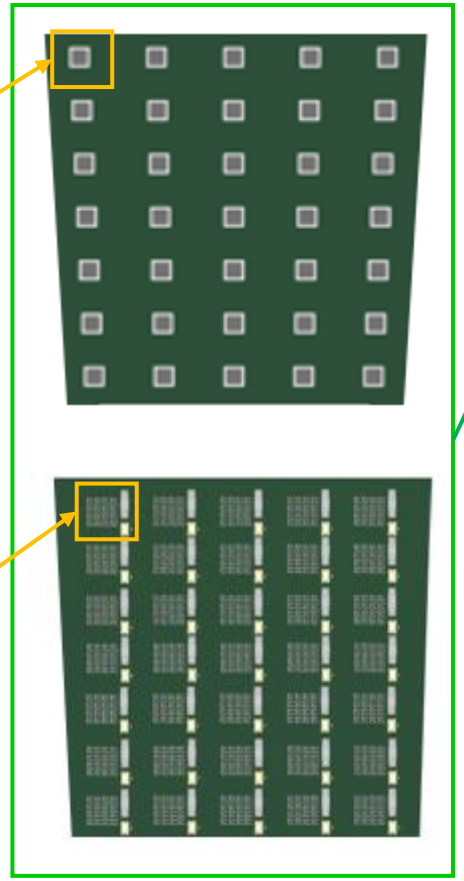
Fabricate a bulk mounted trapezoidal board after the circuit is determined

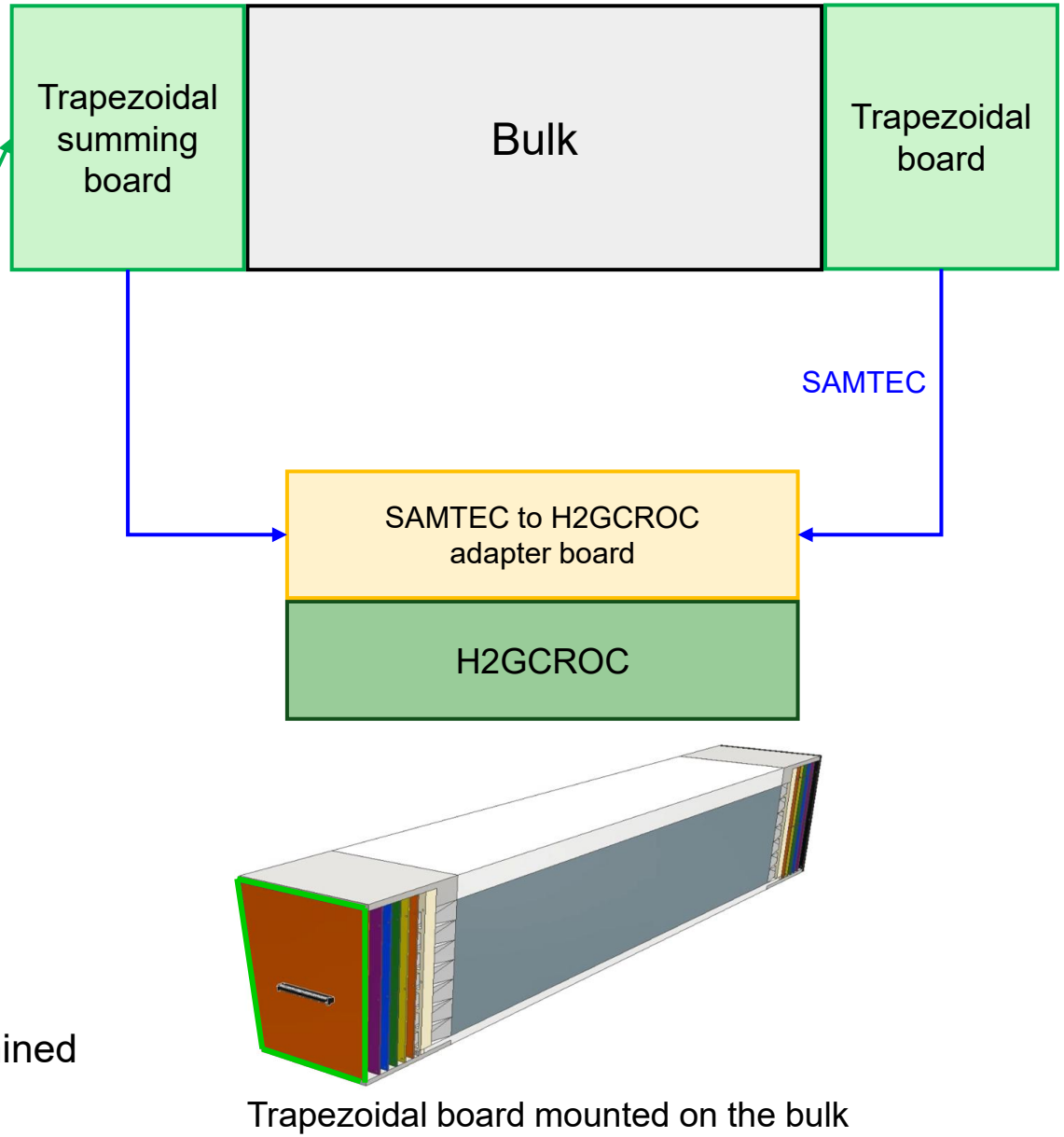
Trapezoidal board



SiPM

Summing circuit





Fabricate a bulk mounted trapezoidal board after the circuit is determined

Trapezoidal board mounted on the bulk