

# The production and test of front-end electronics board (GEB) for CMS-GEM GE1/1 project in China

**Wei Shan, Shaokun He, Geng Chen,  
Yong Ban, Dayong Wang  
Peking University  
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Second China LHC Physics Workshop (CLHCP 2016)



# Outline

## □ Introduction

- CMS GE1/1
- GEM Detector technology
- GE1/1 Electronics System

## □ FPGA board for GEB test

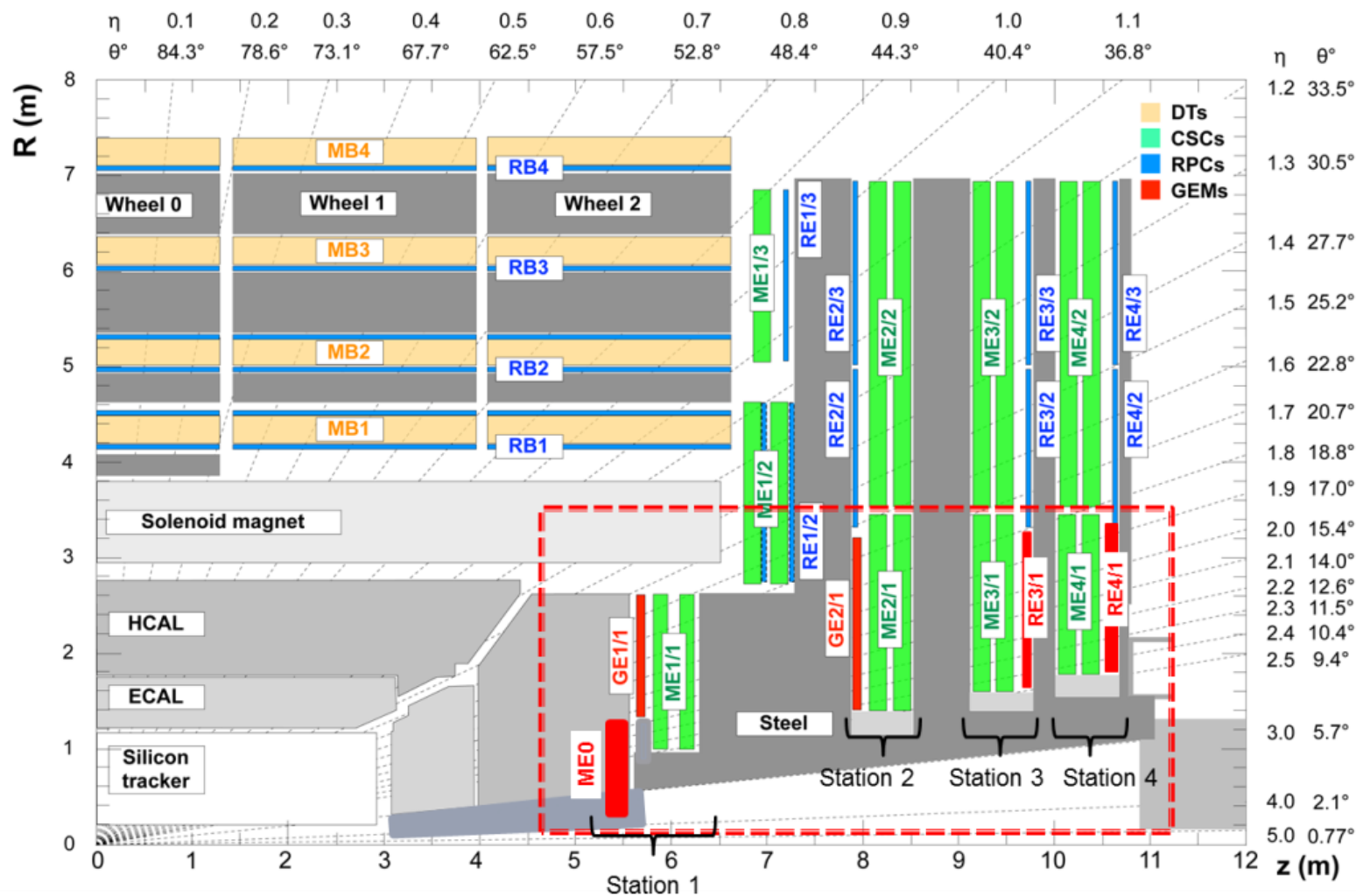
## □ Connectivity Test

## □ Production & Test Results

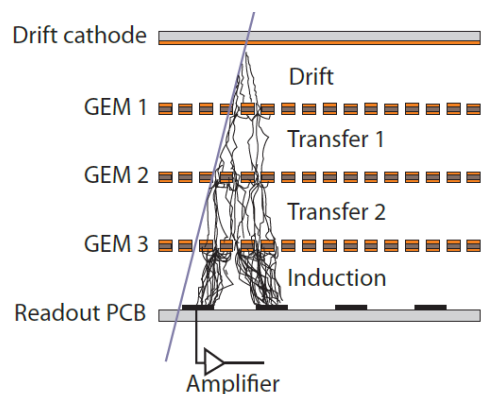
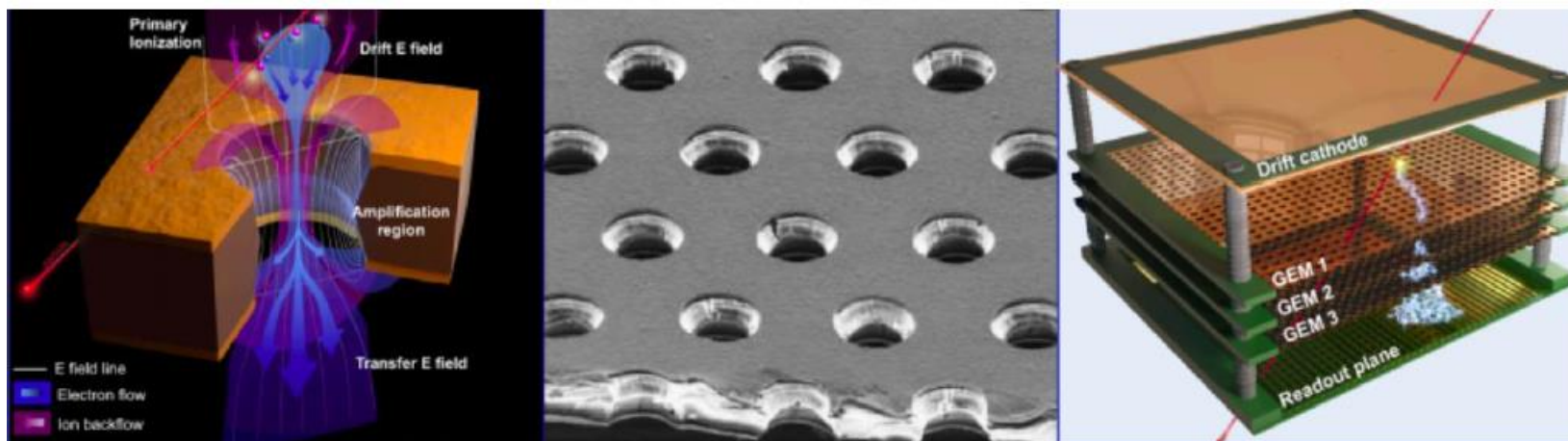
## □ Summary & Outlook

# Introduction

# Muon GEM upgrade: GE1/1



# GEM Detector technology

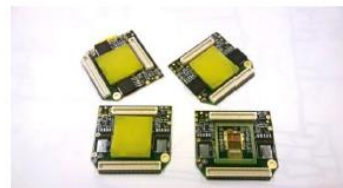
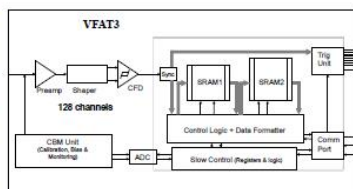
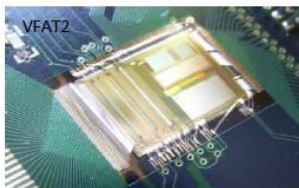


- ❑ **Single-Mask GEM Fabrication Technology**
- ❑ **Simple Assembly**
- ❑ **Eco friendly Gas mixture-Ar/CO<sub>2</sub> 70:30**
- ❑ **Performance Requirements commensurate with upgrade station**

# GE1/1 Electronics System

# GE1/1 Electronics System

## VFAT3



VFAT3 front-end ASIC development  
P. Aspell G. De Lentdecker  
F. Loddo.  
G. De Robertis  
& Team

MP7 / CTP7

## GEM Electronic Board (GEB)

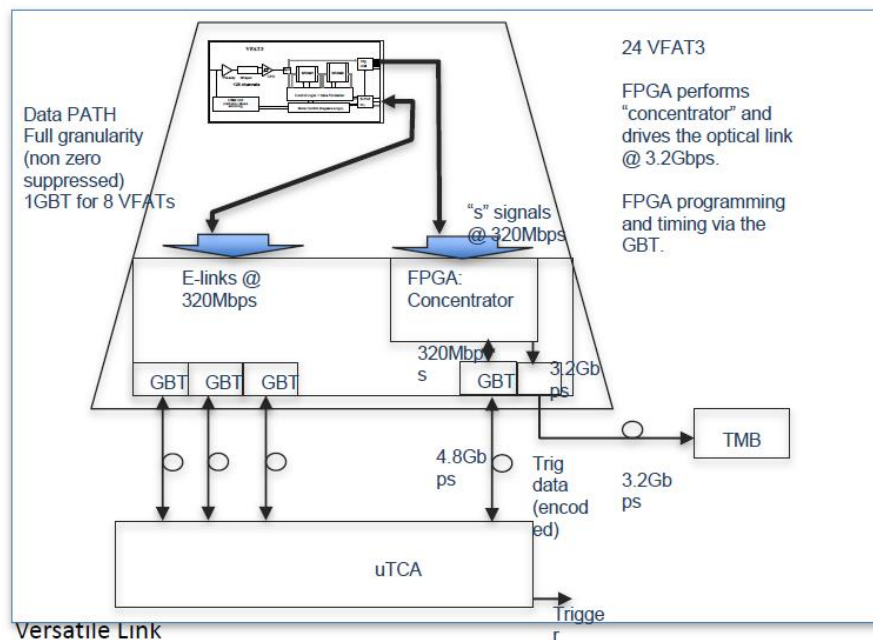
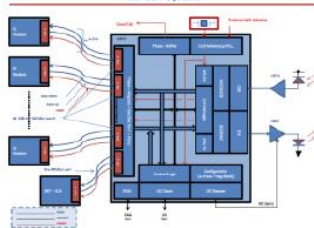


## Opto-Hybrid (OH)



## GBT

The GBT System

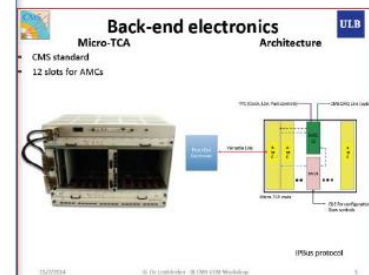


Use of many common developments such as GBT, Versatile Link,  $\mu$ TCA backend

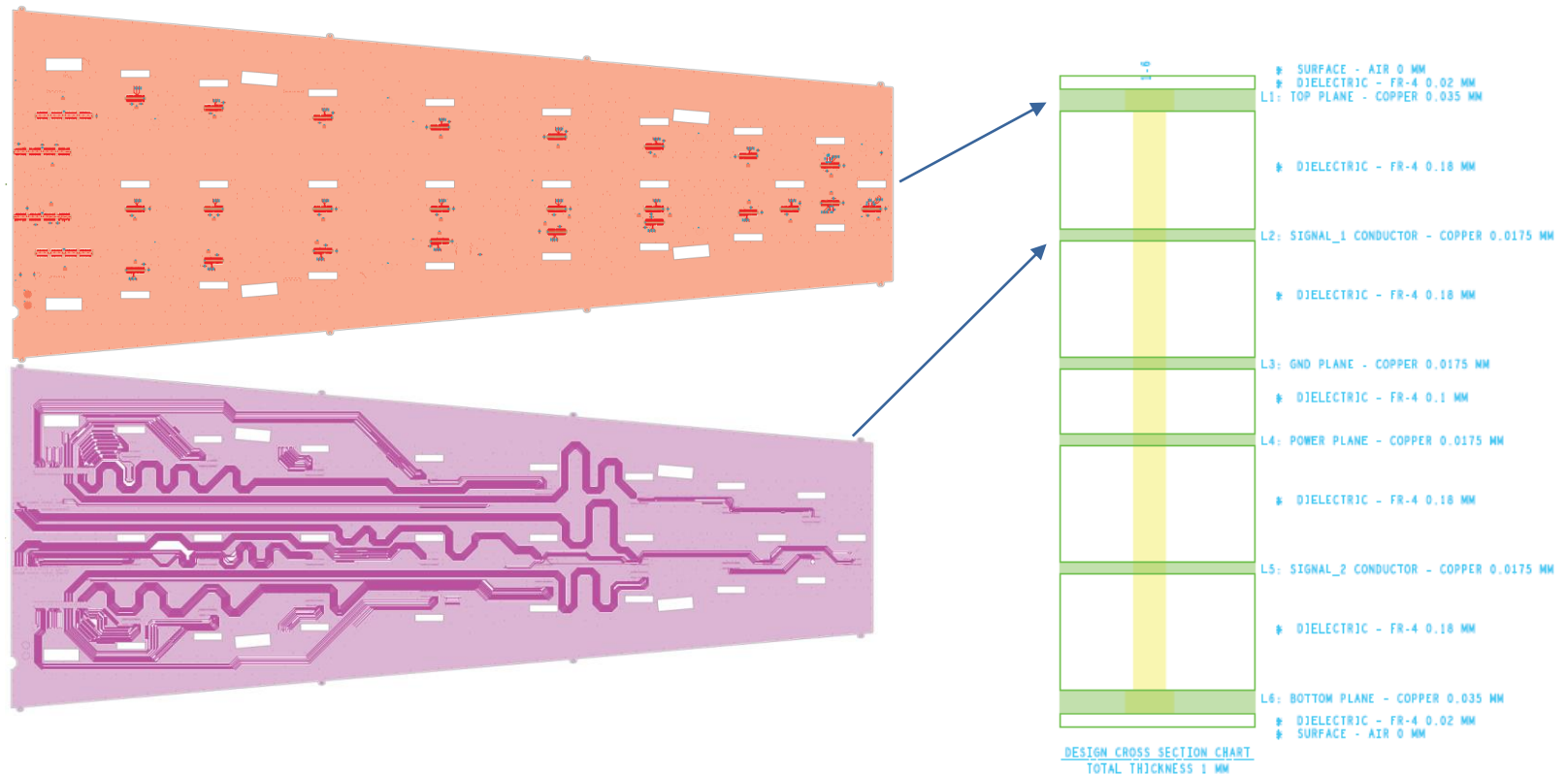
The control, readout and power to/from the VFAT3 hybrid are delivered via electrical signals (E-links) running through the GEB to the opto-hybrid.



$\mu$ TCA  
AMC13, MCH



# GEB (GEM Electronic Board)

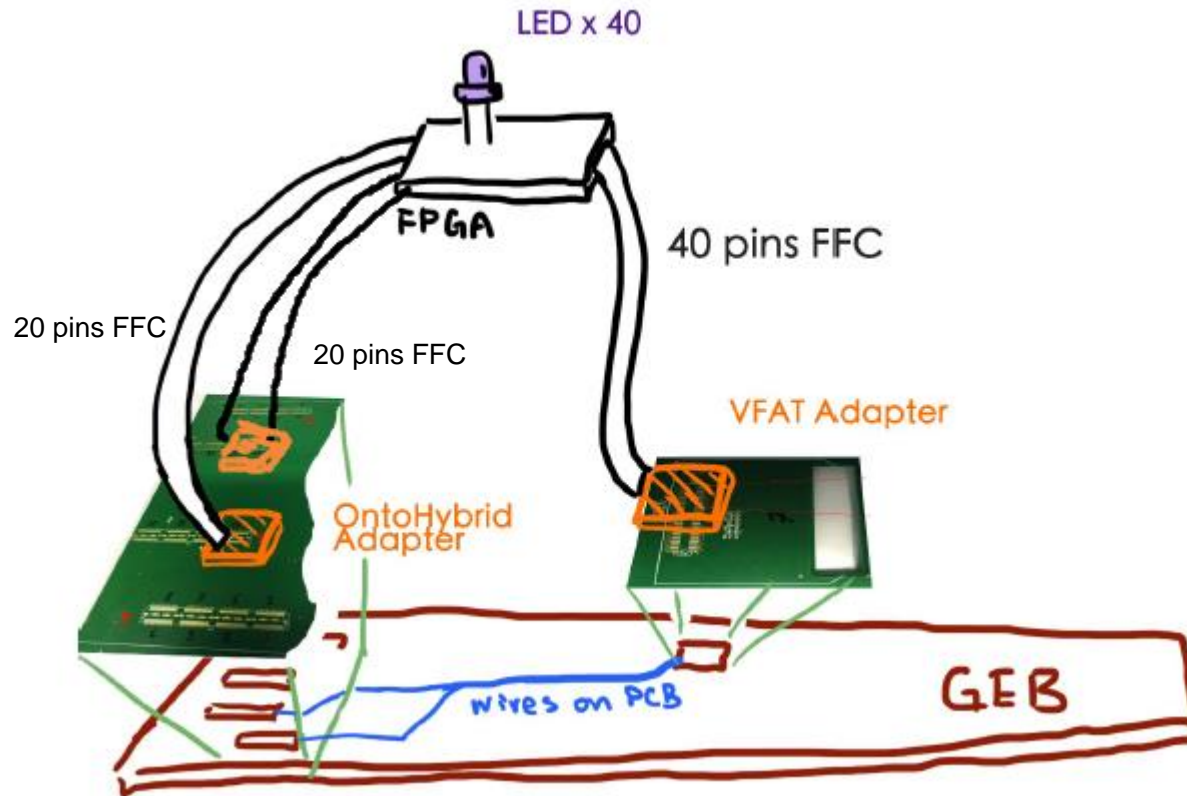


- GEB is fabricated as a single large multilayer PCB, lines on the board are intensive.
- The GEBs were designed by LUT(in Finland) and CERN.
- The GEBs were manufactured in Shenzhen.
- The connectivity of the GEBs was tested both by the factory and our PKU group.



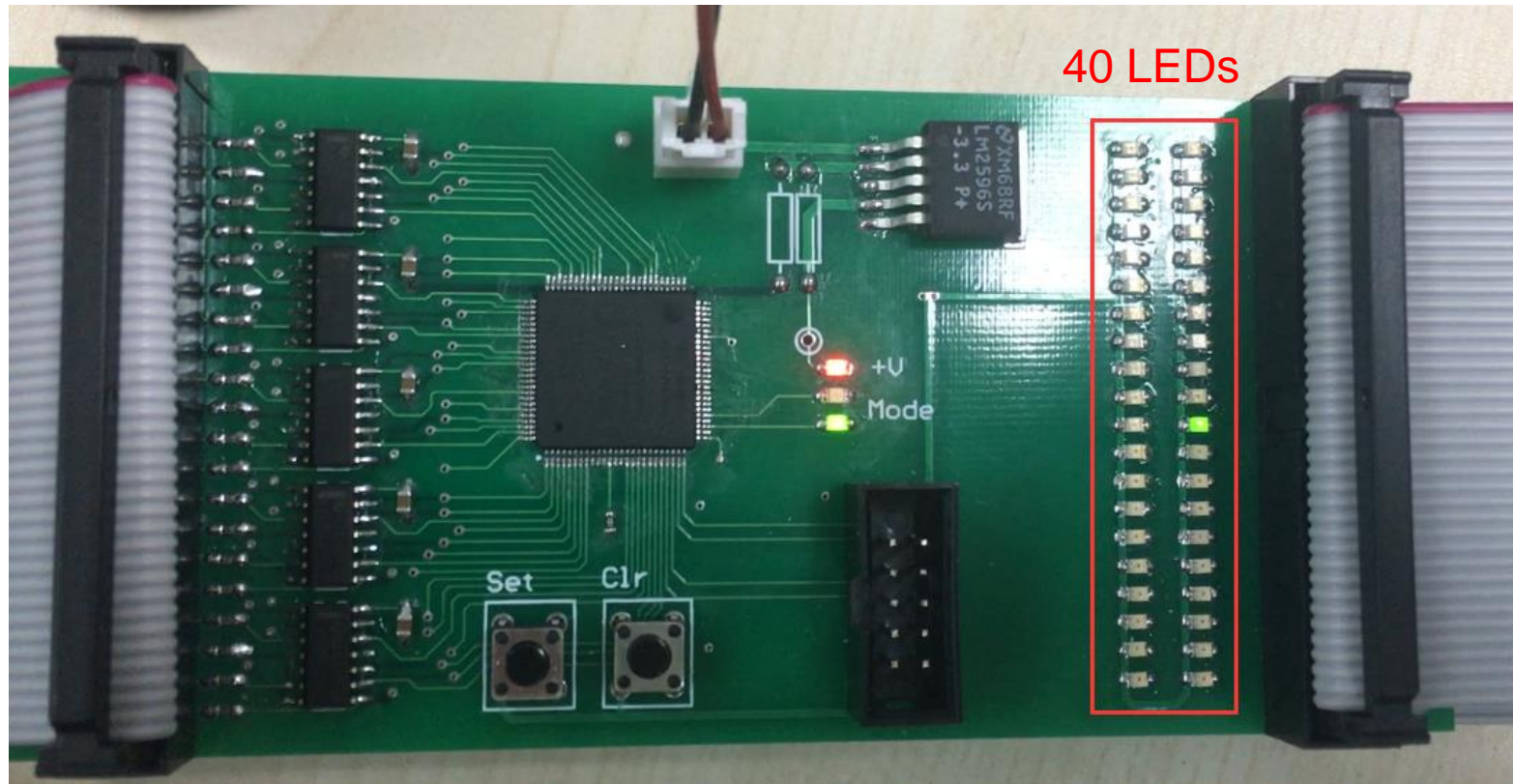
# FPGA board for GEB test

# The design concept of FPGA for GEB test



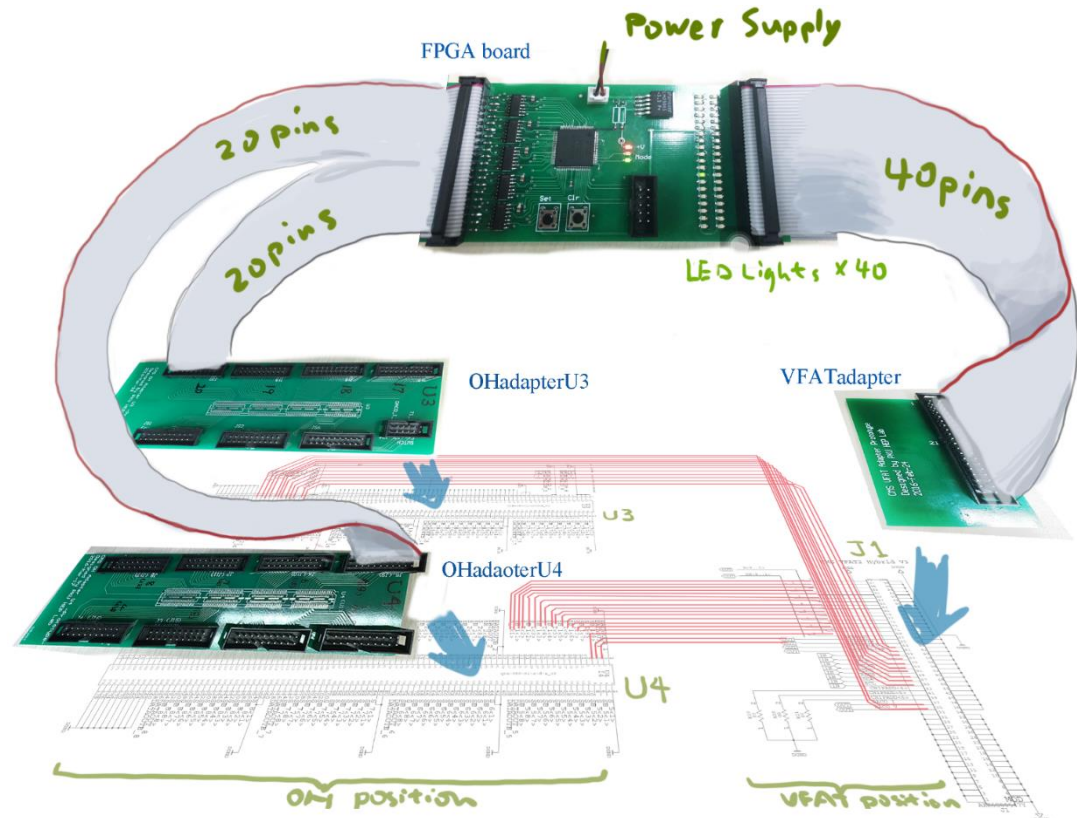
Check the connectivity between VFAT connector and OptoHybrid connector in the GEB

# Core function board(FPGA-based) for GEB test



# GEB testing utility

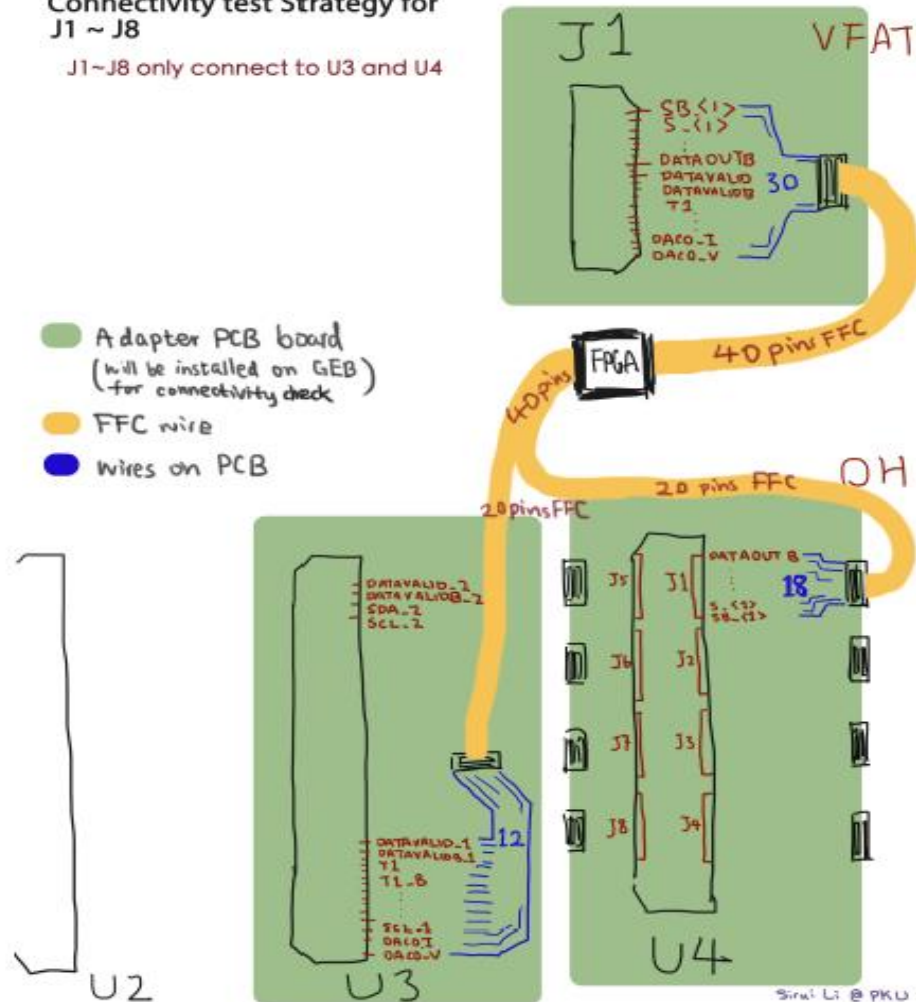
- FPGA Board
- VFAT Adapter
- OptoHybrid Adapter
- FFC wire



# Connectivity test Strategy

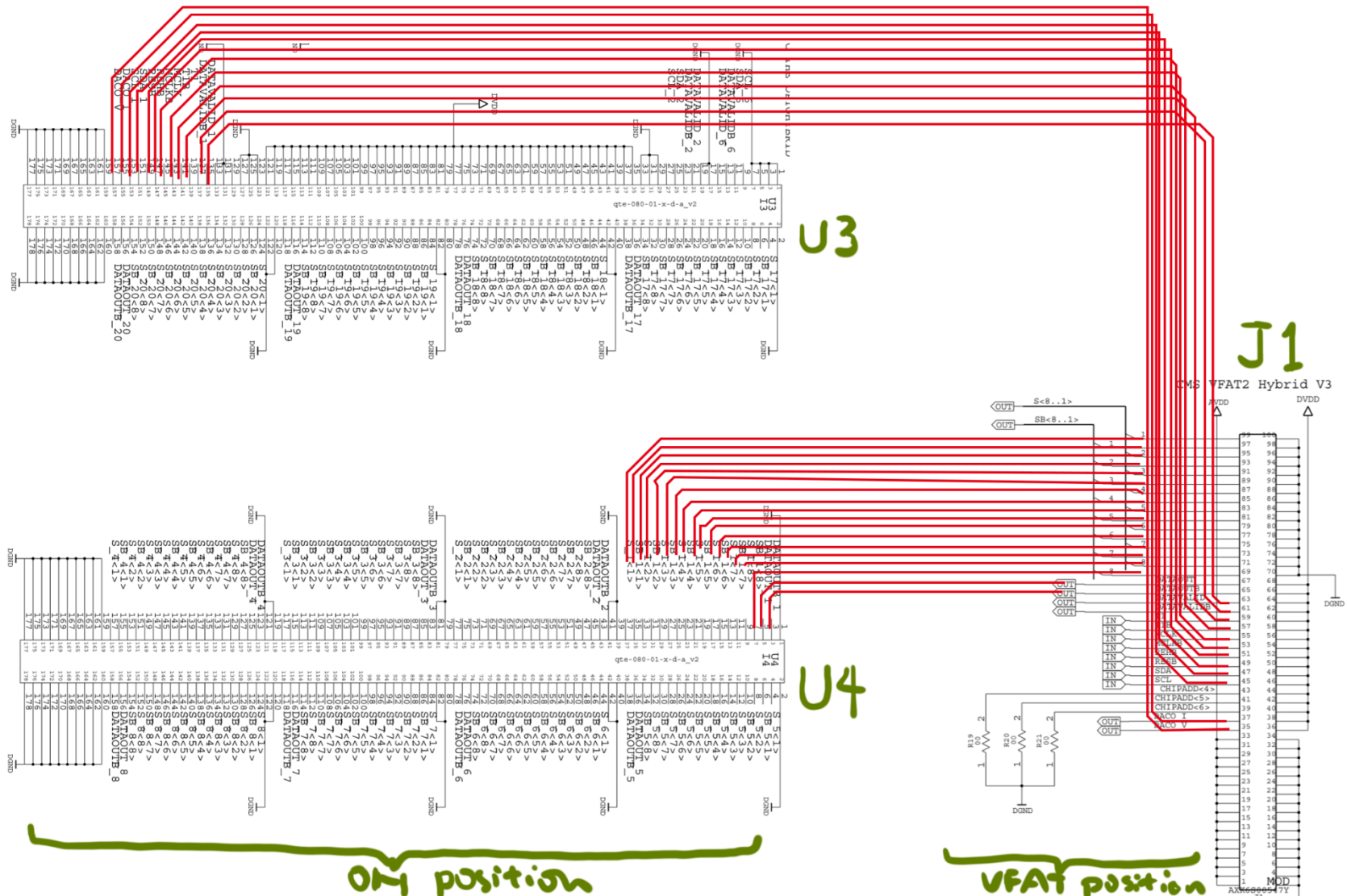
## Connectivity test Strategy for J1 ~ J8

J1~J8 only connect to U3 and U4



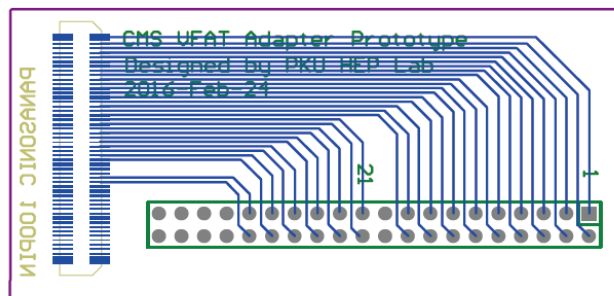
# Connection Between one VFAT position and OH position on GEB

— line on GEB





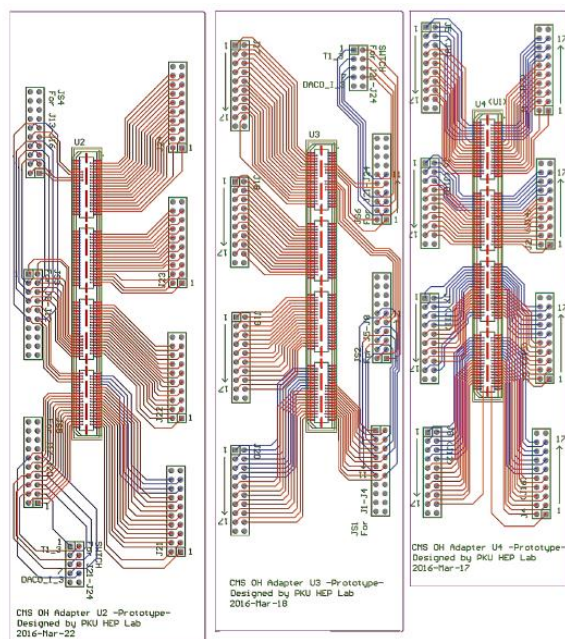
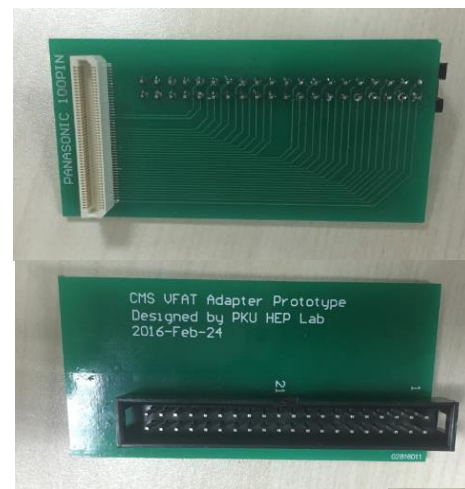
# VFAT Adapter/ OH Adapter PCB



Back side

VFAT Adapter

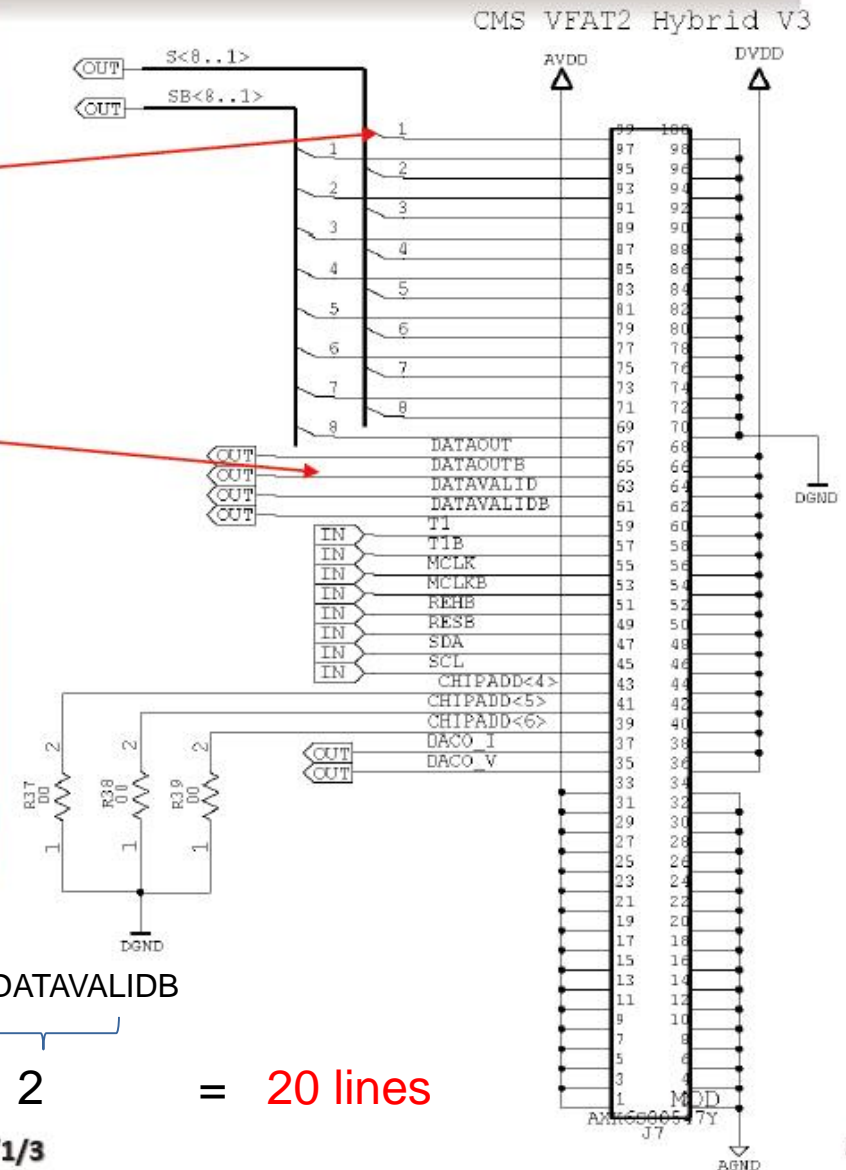
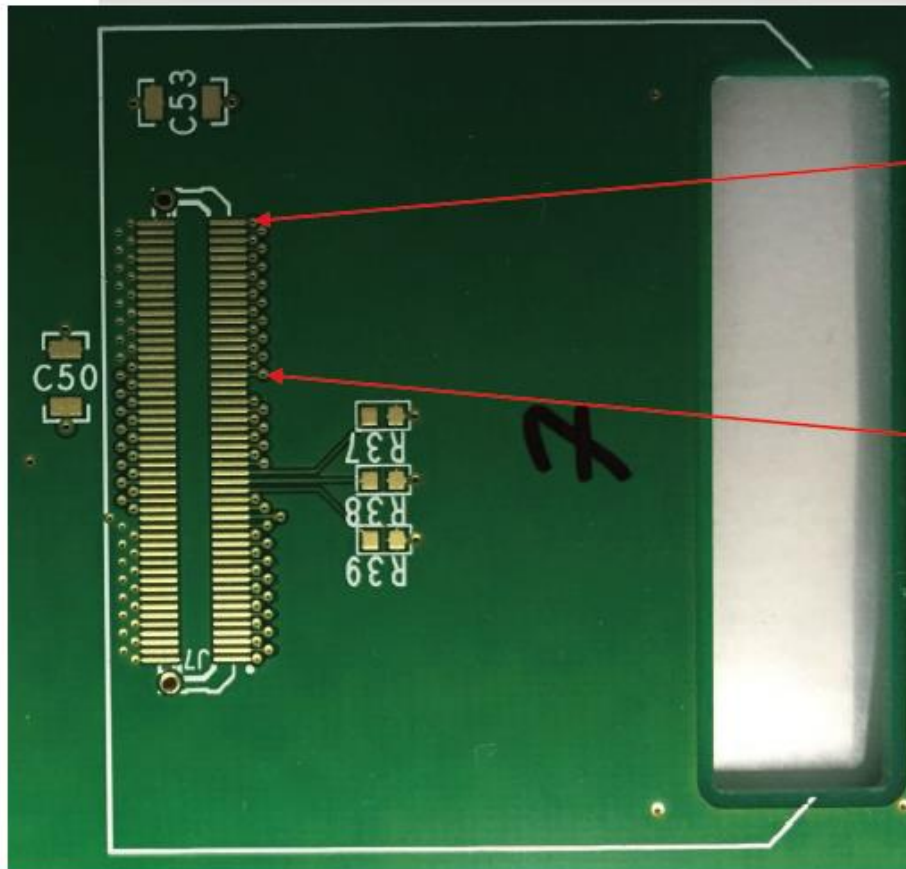
Front side



OH Adapter

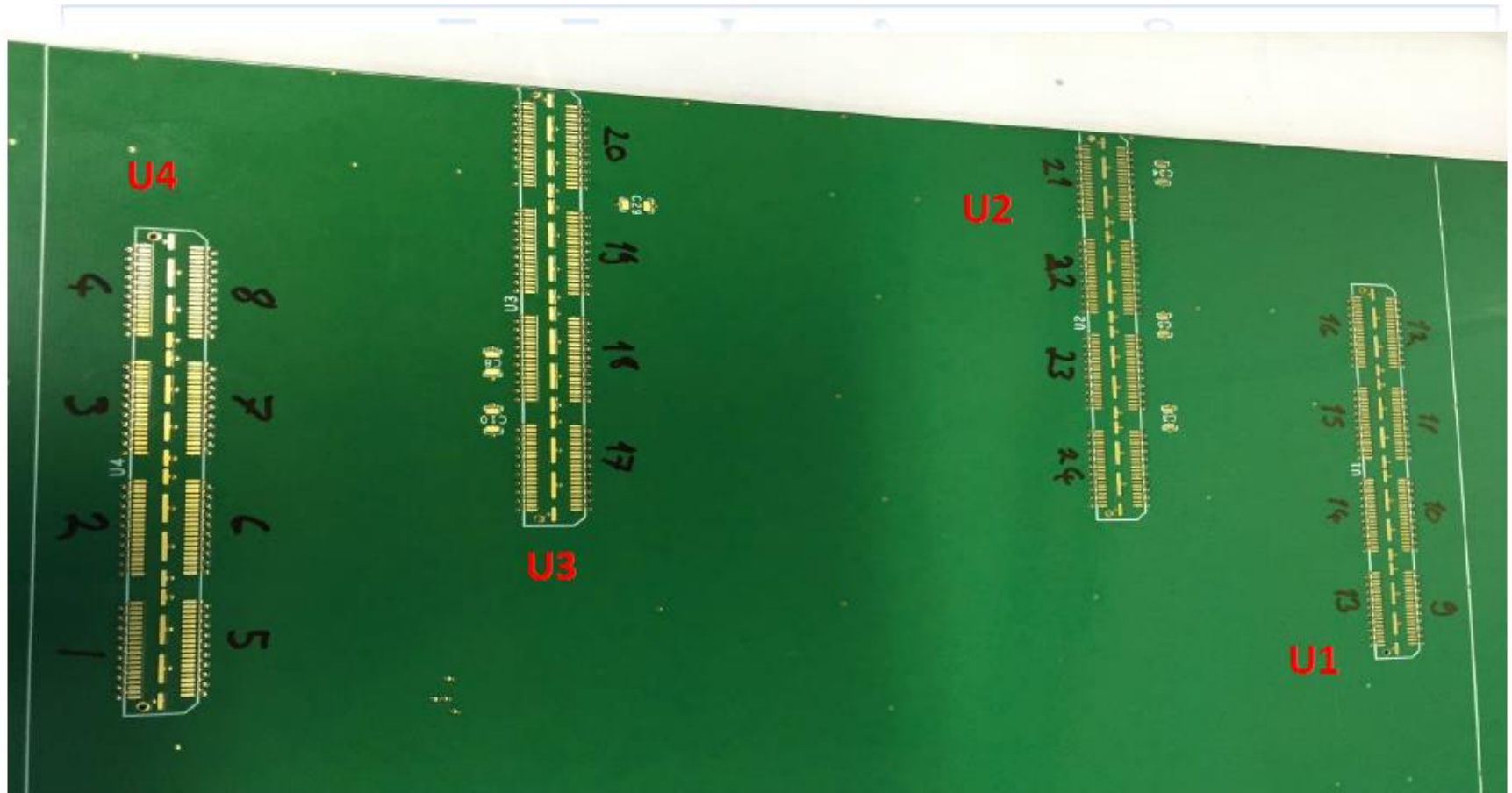


# GEB\_V2\_L VFATs





# Optohybrid region



# Mapping from VFAT to OptoHybrid

Strips on Hybrid (VFAT) Region	Strips on OptoHybrid region(U2, U3) Corresponding to different VFATs					
	12/30 lines tested					
	1 - 4	5 - 8	9 - 12	13 - 16	17 - 20	21 - 24
T1, T1B	T1, T1B		T1_2, T1B_2		T1_3, T1B_3	
MCLK, MCLKB	MCLK, MCLKB		MCLK_2, MCLKB_2		MCLK_3, MCLKB_3	
REHB, RESB	REHB, RESB		REHB_2, RESB_2		REHB_3, RESB_3	
SDA, SCL	SDA_1, SCL_1	SDA_2, SCL_2	SDA_3, SCL_3	SDA_4, SCL_4	SDA_5, SCL_5	SDA_6, SCL_6
DACO_I, DACO_V	DACO_I, DACO_V		DACO_I_2, DACO_V_2		DACO_I_3, DACO_V_3	

Only VFAT **1, 5, 9, 13, 17, 21** have the strips for DATAVALID, DATAVALIDB; corresponding to OptoHybrid region \*\_1, \*\_2, \*\_3, \*\_4, \*\_5, \*\_6, respectively.

\* Stands for DATAVALID and DATAVALIDB.



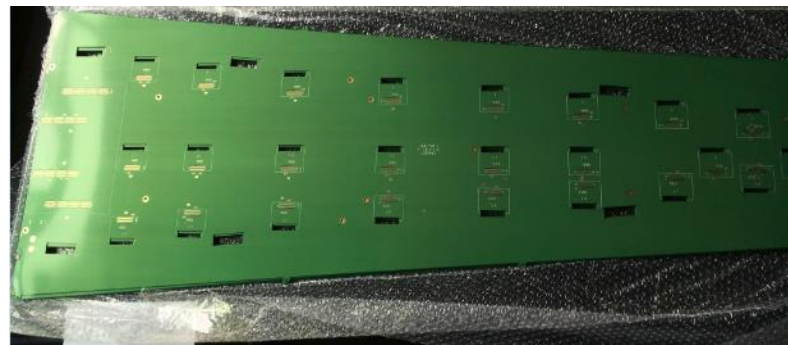
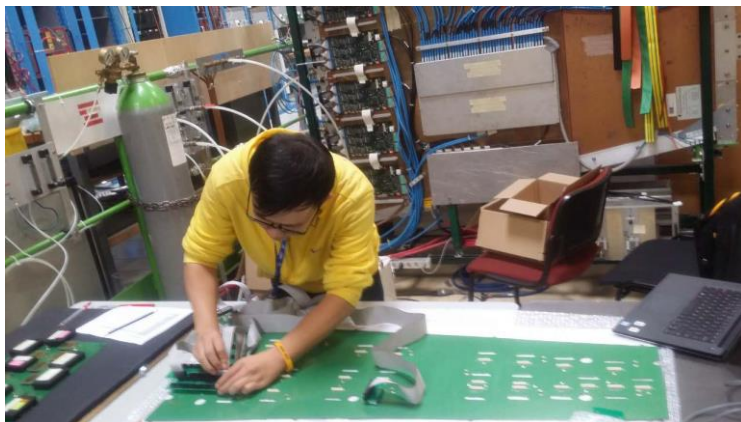
# Checklist

## Checking List 1/3

about the checking box:  
☐ : no open circuit    ☐ : no short circuit

GEB No. <b>1</b>	VFAT region : J1 ~ J8 OH region : U3, U4	DATE: <b>2016-07-13</b>	RESULT: <b>all pass</b>	Note													
Adapters: VFATadapter, OHadapterU3, OHadapterU4																	
21~40 pins of Ribbon cable	JS1								JS2								
VFAT region / 1~20 pins of Ribbon cable	J1	J2	J3	J4	J5	J6	J7	J8	J1	J2	J3	J4	J5	J6	J7	J8	
LED 1 S1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
LED 2 SB1	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
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LED 6 SB3	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
LED 7 S4	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
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LED 15 S8	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
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LED 27 REHB	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
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LED 31 DACO_I	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
LED 32 DACO_V	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Note	T1, T1B, connected by $R_3 = 100.2\Omega$ MCLK, MCLKB connected by $R_4 = 100.3\Omega$ .																Signature Sirui Li

# GEB test at CERN



# Production & test results

Time	GEBs	Total yields	Finished product	Yield rate
April, 2016 July, 2016	Long GEB	40	8	20%
Oct, 2016	Short GEB	40	10	25%

- Taking into account Mr. Xue (an engineer in PKU HEP group)'s comments, the design for the short GEB is slightly changed and the yield rates for the short GEBs are improved.
- From the final test results at CERN, 7 long GEBs and 9 short GEBs work very well, the others are found to have some short circuits. All those boards are taken as the prototypes and meet requirements of the Slice Test at CERN.

# Summary & Outlook

- ▣ 8 Long GEBs and 10 short GEBs were manufactured in Shenzhen.
- ▣ The FPGA-based test boards were developed by PKU HEP group independently. It worked well for the test of the connectivity of the GEBs.
- ▣ The test for GEBs went very well both in China and at CERN.  
7 long GEBs and 9 short GEBs work very well, All of them meet requirements of the Slice Test.
- ▣ Final version of the GEBs will be done in 2017.

# Thank you!

# Back up

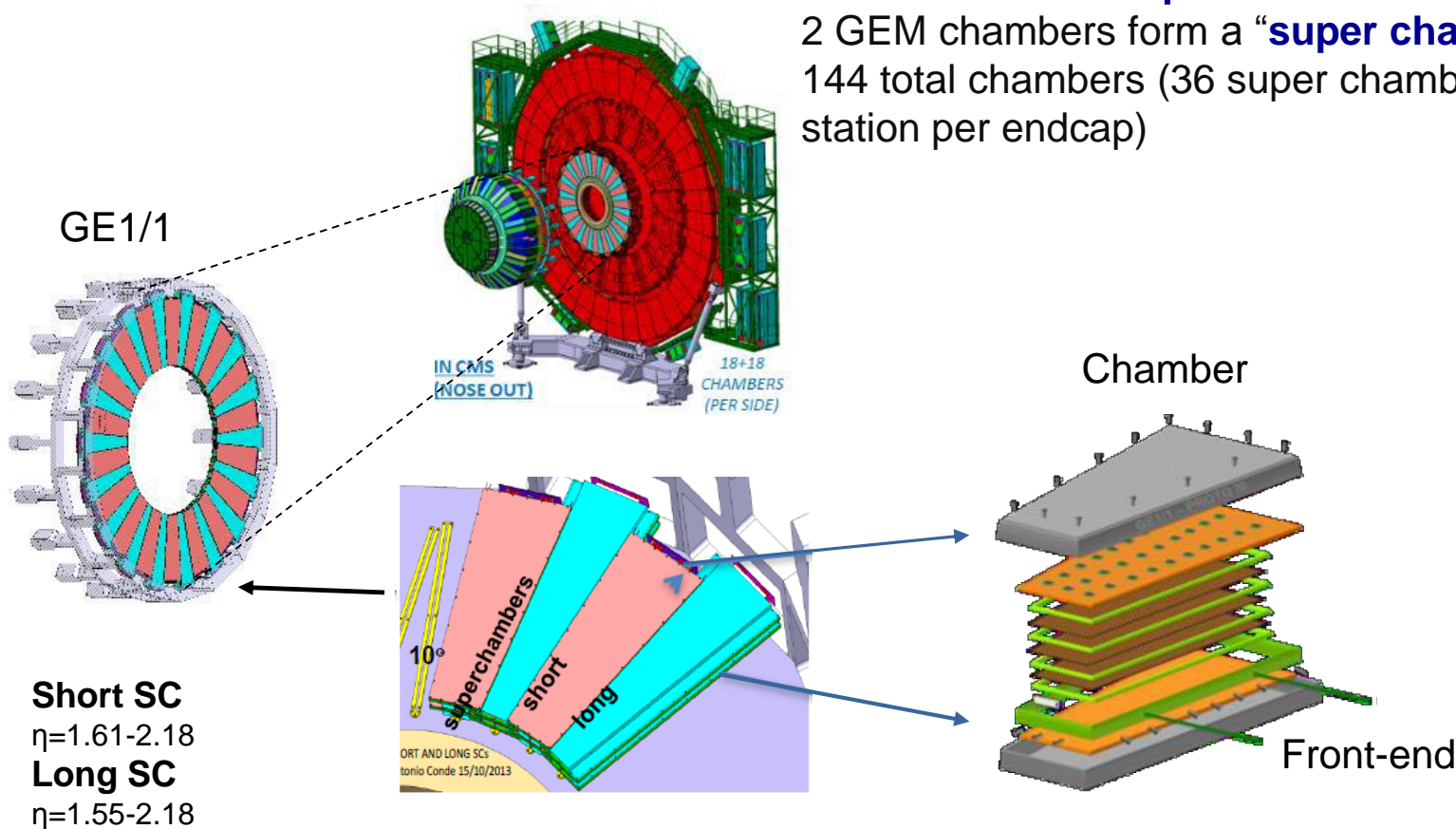


# GE1/1 Station

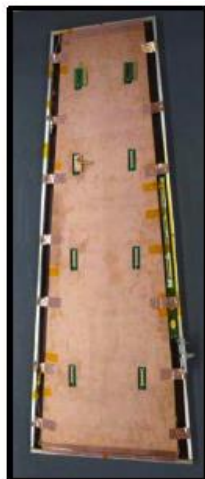
GE1/1 :  $10^\circ$  in  $\Phi$  **triple-GEM**

2 GEM chambers form a “**super chamber (SC)**”;

144 total chambers (36 super chambers in one station per endcap)



# Chambers



2010



2011



2012



2013



2014



2015

R&D phase

Toward production phase

TDR

## GE1/1-I

- > first 1m-class GEM detector ever built
- > single-mask technology
- >  $99 \times (22-45) \text{ cm}^2$
- > 1024 readout channels
- > gap config. 3/2/2/2
- > use of spacer grid and glue

## GE1/1-II

- > Optimization of the electric field configuration
- > single-mask technology
- >  $99 \times (22-45) \text{ cm}^2$
- > 3072 readout channels
- > gap config. 3/1/2/1
- > use of spacer grid and glue

## GE1/1-III

- > first use of the self-stretching technique
- > single-mask technology
- >  $99 \times (22-45) \text{ cm}^2$
- > 3072 readout channels
- > gap config. 3/1/2/1
- > No spacers but glue on the external frame

## GE1/1-IV

- > Optimization of the mechanics and assembly
- > single-mask technology
- >  $99 \times (22-45) \text{ cm}^2$
- > 3072 readout channels
- > gap config. 3/1/2/1
- > No glue/no spacers

## GE1/1-V

- > Optimization of the mechanics
- > stretching apparatus inside the gas volume
- > single-mask technology
- >  $99 \times (22-45) \text{ cm}^2$
- > 3072 readout channels
- > gap config. 3/1/2/1
- > No glue/no spacers

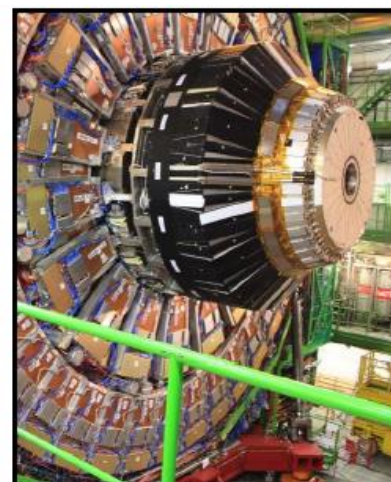
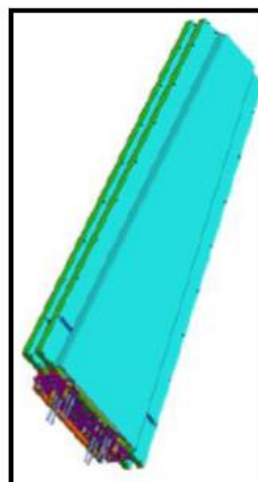
## GE1/1-VI

- > Optimization of the mechanics
- > single-mask technology
- > design for long and short detectors
- >  $99 \times (22-45) \text{ cm}^2$
- >  $120 \times (20-50) \text{ cm}^2$
- > 3072 readout channels (new mapping)
- > gap config. 3/1/2/1
- > No glue/no spacers

# Super Chambers



First SC



2016

2017

2018

2019

2020

Slice test installation

Production phase & installation

## GE1/1-VII (slice test)

- > Optimization of the mechanics
- > Optimization of the grounding
- Optimization of the HV distribution
- > single-mask technology
- > 99x(22-45) cm<sup>2</sup>
- > 120x(20-50) cm<sup>2</sup>
- > 3072 readout channels
- > gap config. 3/1/2/1
- > No glue/no spacers

## GE1/1-VIII (LS2)

- > External (w.r.t. CERN) production sites
- certification and chamber components shipment
- > GE1/1 chamber assembly and certification
- > Super chamber mechanics optimization
- > First test with final front-end electronics

- > GE1/1 super chamber assembly and certification with final front-end electronics
- > First batch of Superchamber shipped to P5

- GE1/1 super chambers ready in P5 for installation
- Installation and cabling of all super chambers
- Commissioning in situ with cosmic muons
- Super chamber characterization in situ with cosmic muon
- First data with LHC beam

# GEB PCB inspection & testing

- Visual check
- **AOI(Automated optical inspection)**
- **Flying probe**
- FPGA based test



# AOI

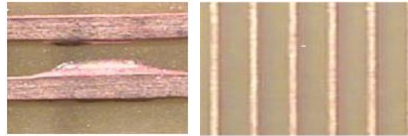
## AOI(Automated optical inspection)

### Bare PCB inspection

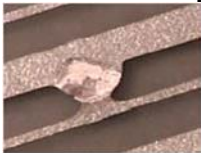
- Line width violations.



- Spacing violation.



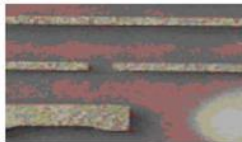
- Excess copper.



- Shorts circuits



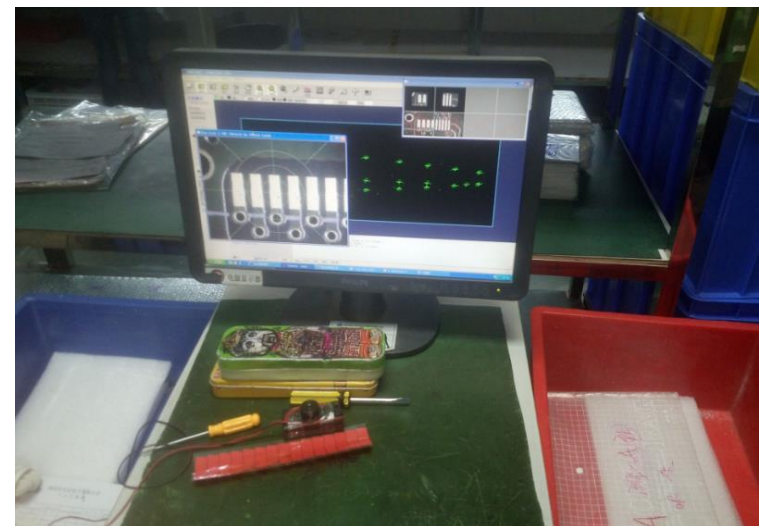
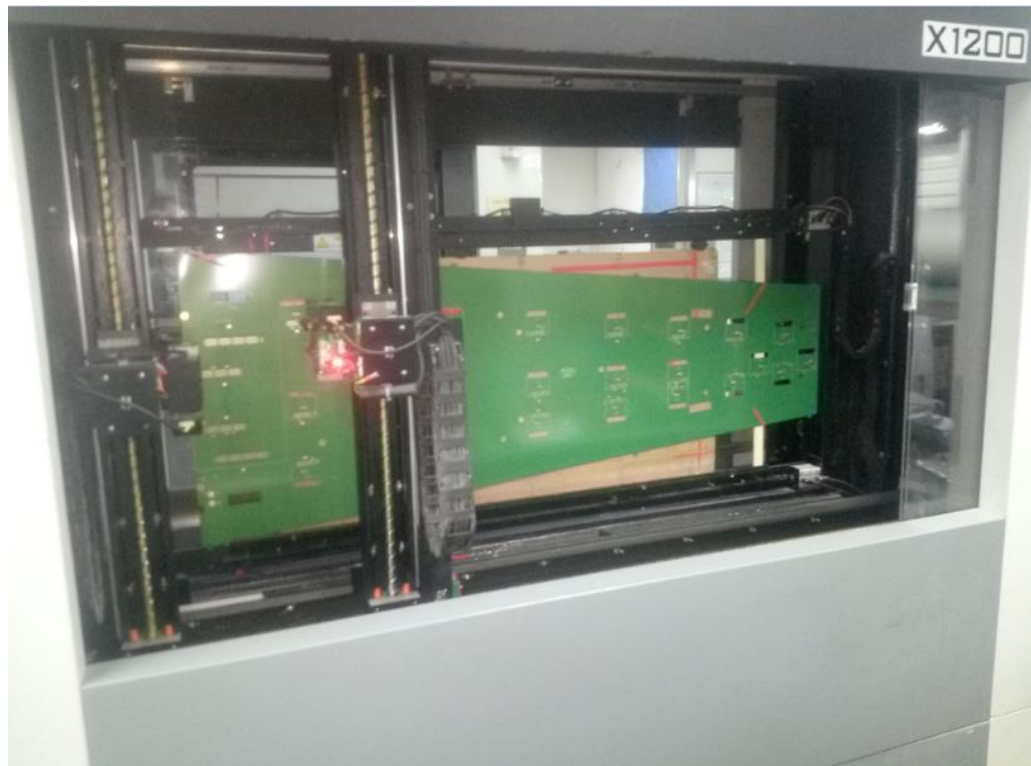
- Cuts



- Hole breakage – a drilled hole (via) is outside of its landing pad.
- wrong mounting components identified



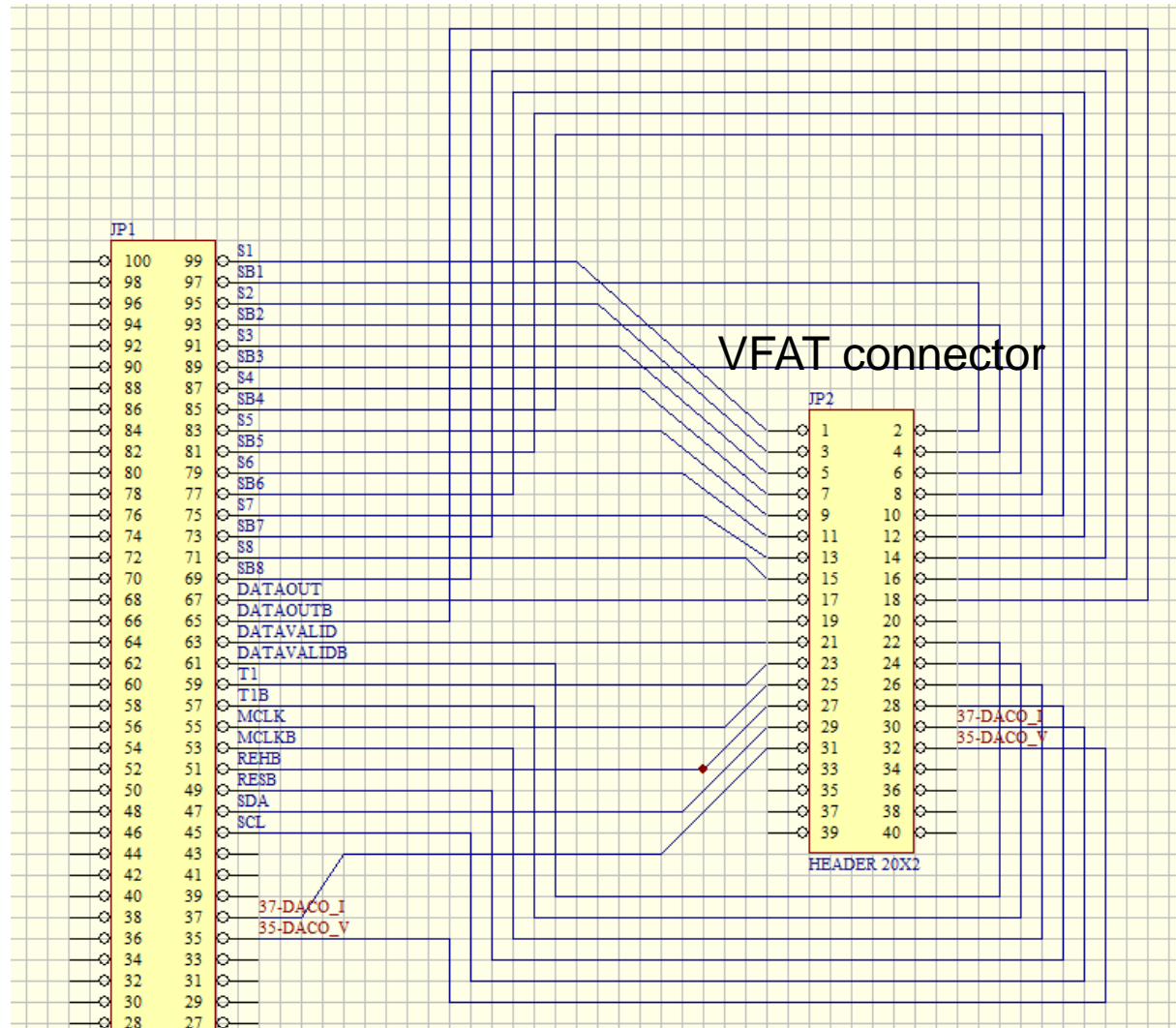
# Flying Probe Test



# Flying Probe

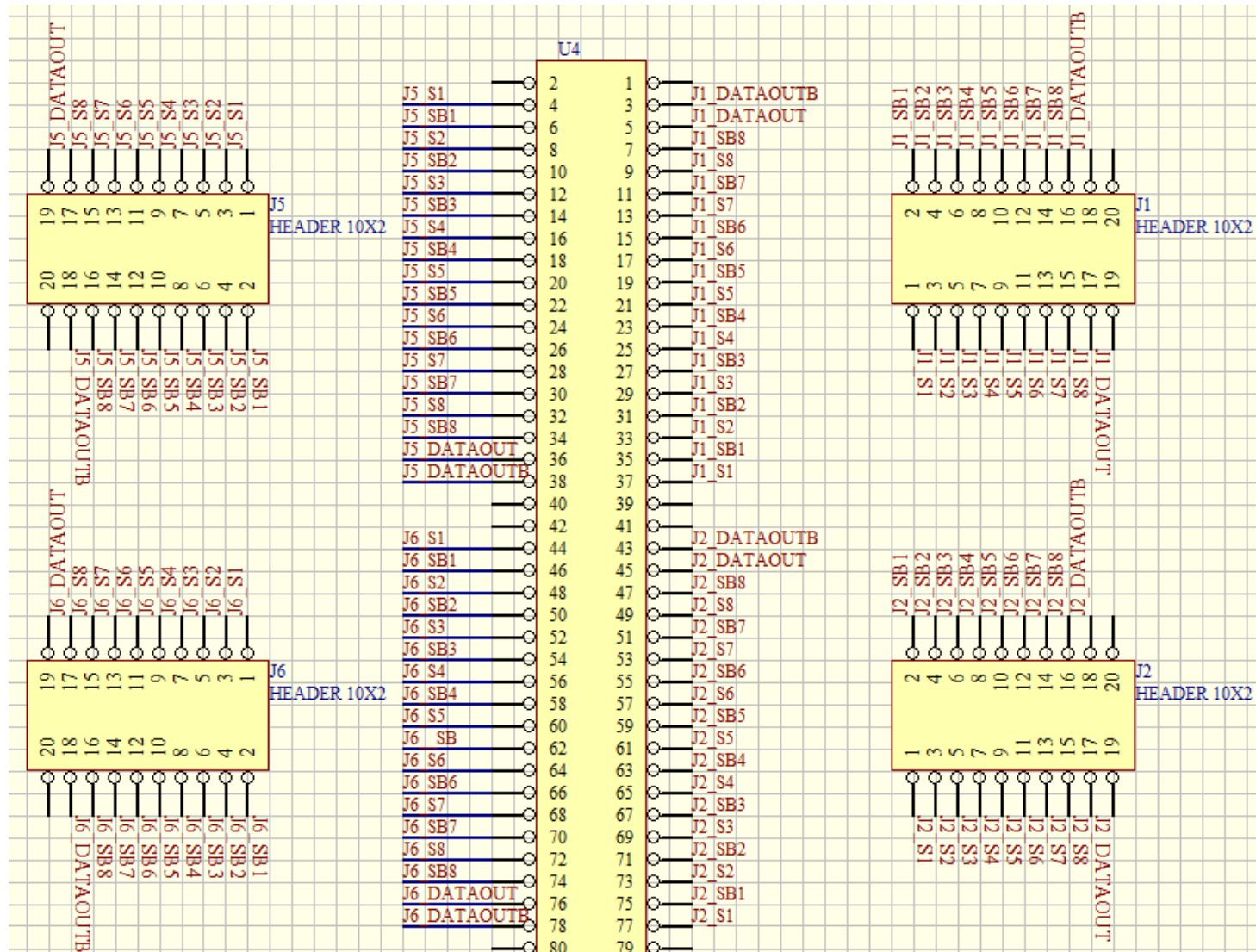
Specification	SURPASS X1200
Test method	Resistance, phase deviation
Min. test area	76X76mm
No. of Flying Probe	2 front, 2 rear
No. of CCD Camera	2 front, 2 rear
Positional accuracy	$\pm 5\mu\text{m}$
Resolution	$2\mu\text{m}$
Max. Test area	1200x700mm
Board Thickness	0.3-13mm
Min. Pad pitch	$150\mu\text{m}$
Min. Pad size	$75\mu\text{m}$

# VFAT Adapter Scheme

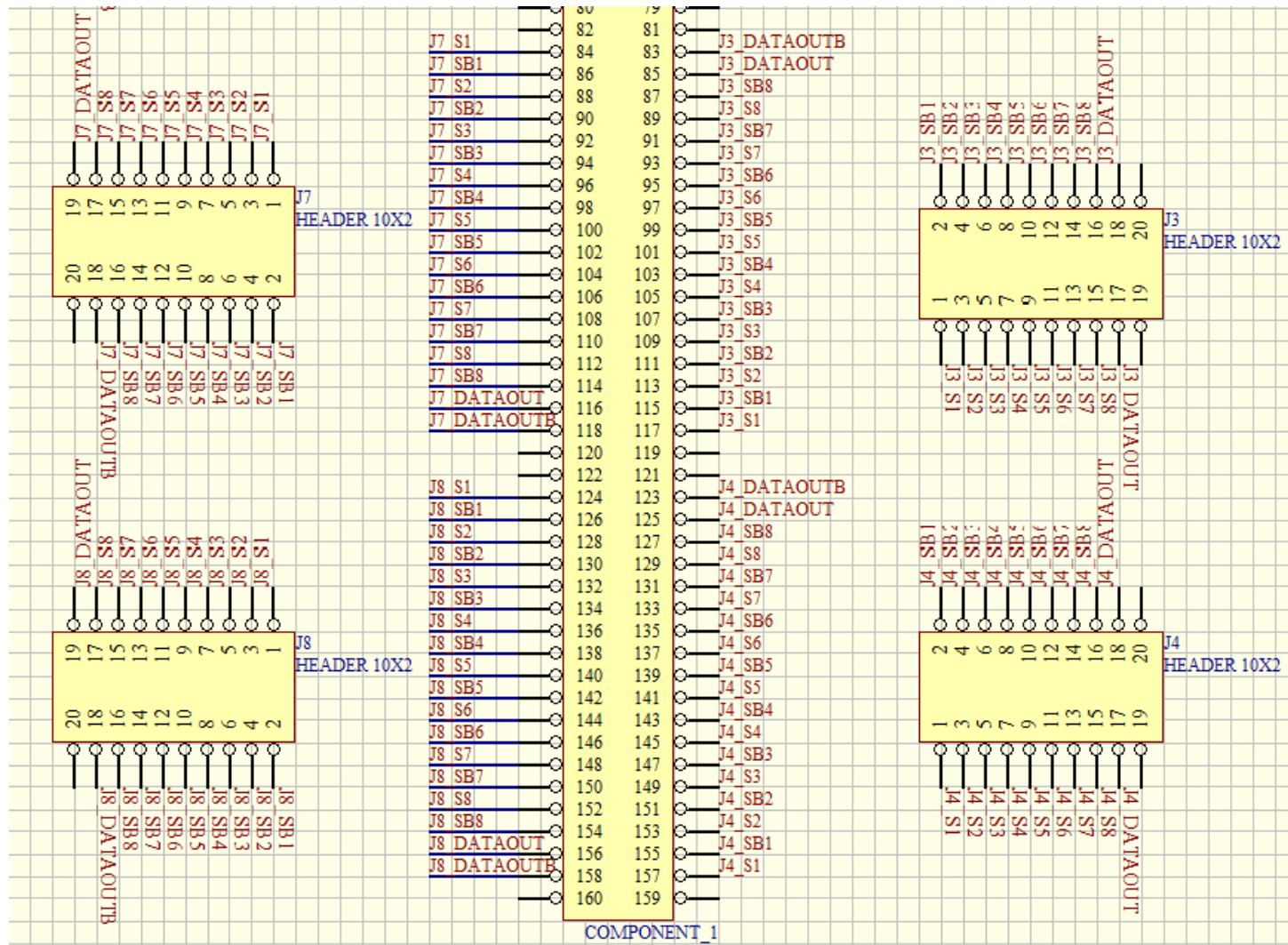




# OHAdapter Scheme



# OHAdapter Scheme



# Checklist 1/3

## Checking List 1/3

about the checking box:  
☐ : no open circuit    ☐ : no short circuit

GEB No.		VFAT region : J1 ~ J8 OH region : U3, U4		DATE:		RESULT:				Note
Adapters		VFATadapter, OHadapterU3, OHadapterU4								
21~40 pins of Ribbon cable		JS1				JS2				
VFAT region / 1~20 pins of Ribbon cable		J1	J2	J3	J4	J5	J6	J7	J8	
LED 1	S1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 2	SB1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 3	S2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 4	SB2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 5	S3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 6	SB3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 7	S4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 8	SB4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 9	S5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 10	SB5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 11	S6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 12	SB6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 13	S7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 14	SB7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 15	S8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 16	SB8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 17	DATAOUT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 18	DATAOUTB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 21	DATAVALID	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 22	DATAVALIDB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 23	T1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 24	T1B	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 25	MCLK	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 26	MCLKB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 27	REHB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 28	RESB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 29	SDA	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 30	SCL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 31	DACO_J	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 32	DACO_V	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Note										Signature

# Checklist 2/3

## Checking List 2/3

Attention : OHadapterU4 is to be connected with U1 region on GEB

GEB No.		VFAT region : J9 ~ J16 OH region : U1, U2		DATE:		RESULT:				Note
Adapters		VFATadapter, OHadapterU4, OHadapterU2								
21~40 pins of Ribbon cable		JS3				JS4				
VFAT region / 1~20 pins of Ribbon cable		J9	J10	J11	J12	J13	J14	J15	J16	
LED 1	S1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 2	SB1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 3	S2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 4	SB2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 5	S3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 6	SB3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 7	S4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 8	SB4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 9	S6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 10	SB5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 11	S6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 12	SB6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 13	S7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 14	SB7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 15	S8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 16	SB8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 17	DATAOUT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 18	DATAOUTB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 21	DATAVALID	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 22	DATAVALIDB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 23	T1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 24	T1B	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 25	MCLK	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 26	MCLKB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 27	REHB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 28	RESB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 29	SDA	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 30	SCL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 31	DACO_I	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 32	DACO_V	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Note										Signature:

# Checklist 3/3

## Checking List 3/3

Attention : There is a connector (SWTCH) on both OHadppterU2 and OHadapterU3. They should be connected using 10 pins cable beforehand.

GEB No.		VFAT region : J17 ~ J24 OH region : U2, U3		DATE:		RESULT:		Note		
Adapters		VFATadapter, OHadapterU2, OHadapterU3								
21~40 pins of Ribbon cable		JS5				JS6				
VFAT region / 1~20 pins of Ribbon cable		J17	J18	J19	J20	J21	J22	J23	J24	
LED 1	S1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 2	SB1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 3	S2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 4	SB2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 5	S3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 6	SB3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 7	S4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 8	SB4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 9	S5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 10	SB5	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 11	S6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 12	SB6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 13	S7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 14	SB7	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 15	S8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 16	SB8	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 17	DATAOUT	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 18	DATAOUTB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 21	DATAVALID	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 22	DATAVALIDB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 23	T1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 24	T1B	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 25	MCLK	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 26	MCLKB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 27	REHB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 28	RESB	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 29	SDA	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 30	SCL	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 31	DAC0_I	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
LED 32	DAC0_V	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Note										Signature: