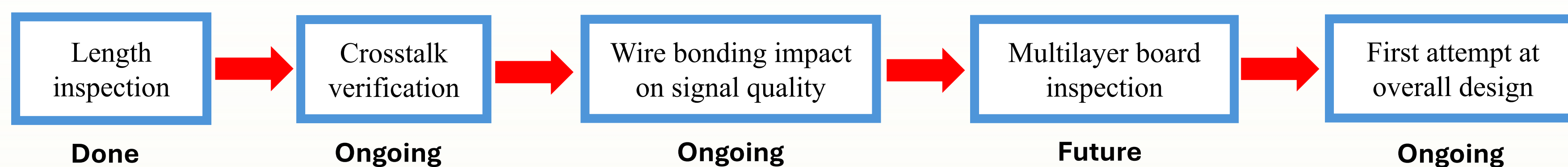
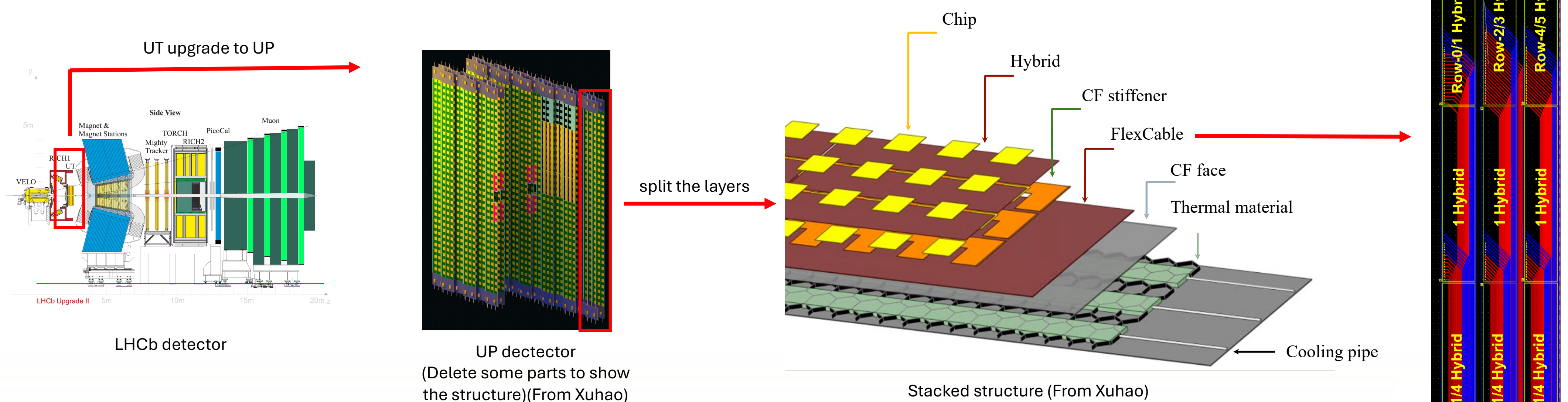


## Introduction

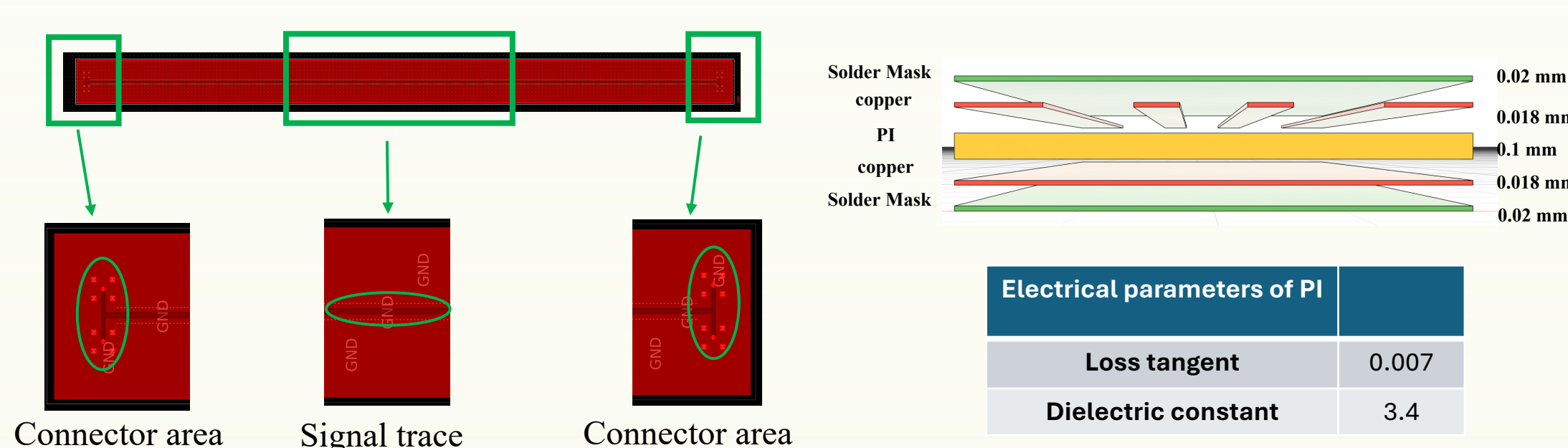
For the higher luminosity and pile-up of the HL-LHC, LHCb plans to replace the UT with the pixelated UP; consequently, the ~70 cm flex leads between the front end and back end at multi-Gb/s introduce channel loss, reflections, and crosstalk, making signal integrity the key bottleneck and driving a redesign of the readout chain and the flex cable.



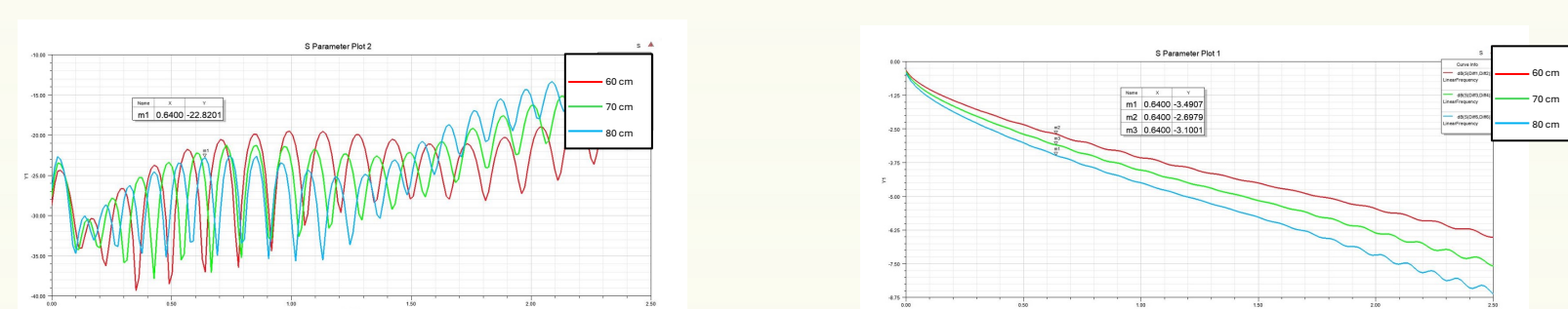
## First version for length inspection

— Length and line parameters verification

### Design



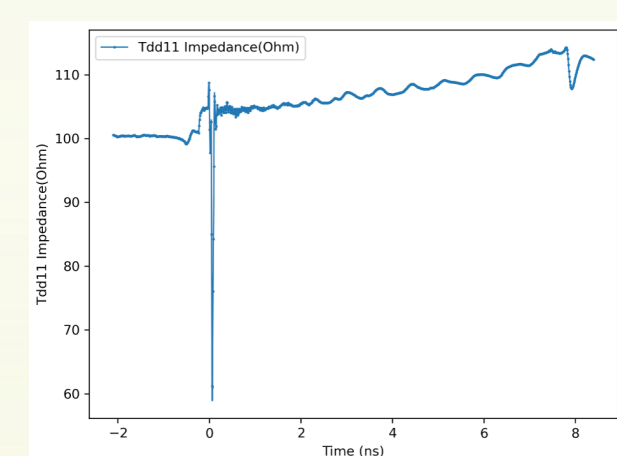
### Simulation



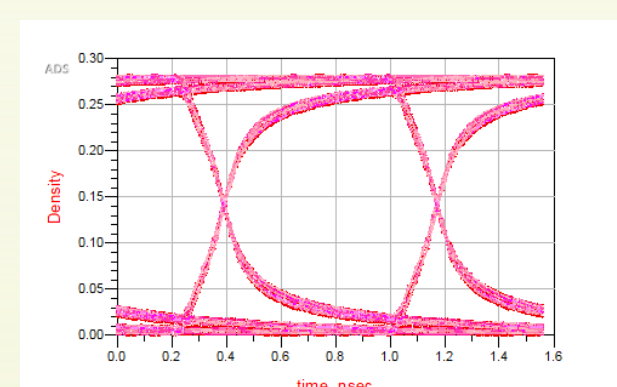
Requirements:  
Return loss < -20dB  
Insertion loss > -3dB  
The eye diagram is clear and open.

70cm ✓

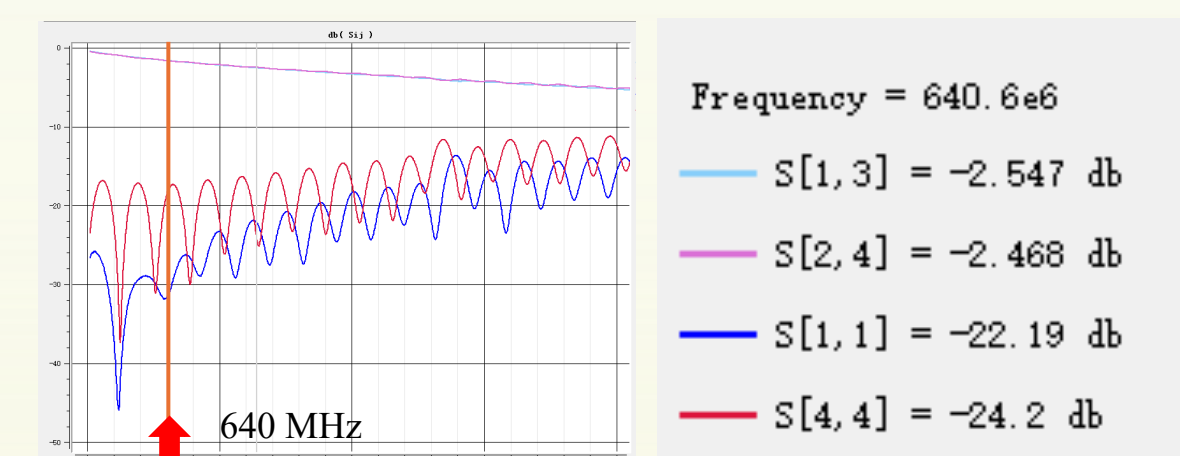
### Eye diagram



### Impedance



### Eye diagram in 1.28Gbps



### Insertion loss & return loss

| Item                   | value                   |
|------------------------|-------------------------|
| Test time              | ~45 min                 |
| N bits                 | $3.4 \times 10^{12}$    |
| NUM. Error bits        | 0                       |
| Bit Error Rate (95%CL) | $< 8.8 \times 10^{-13}$ |

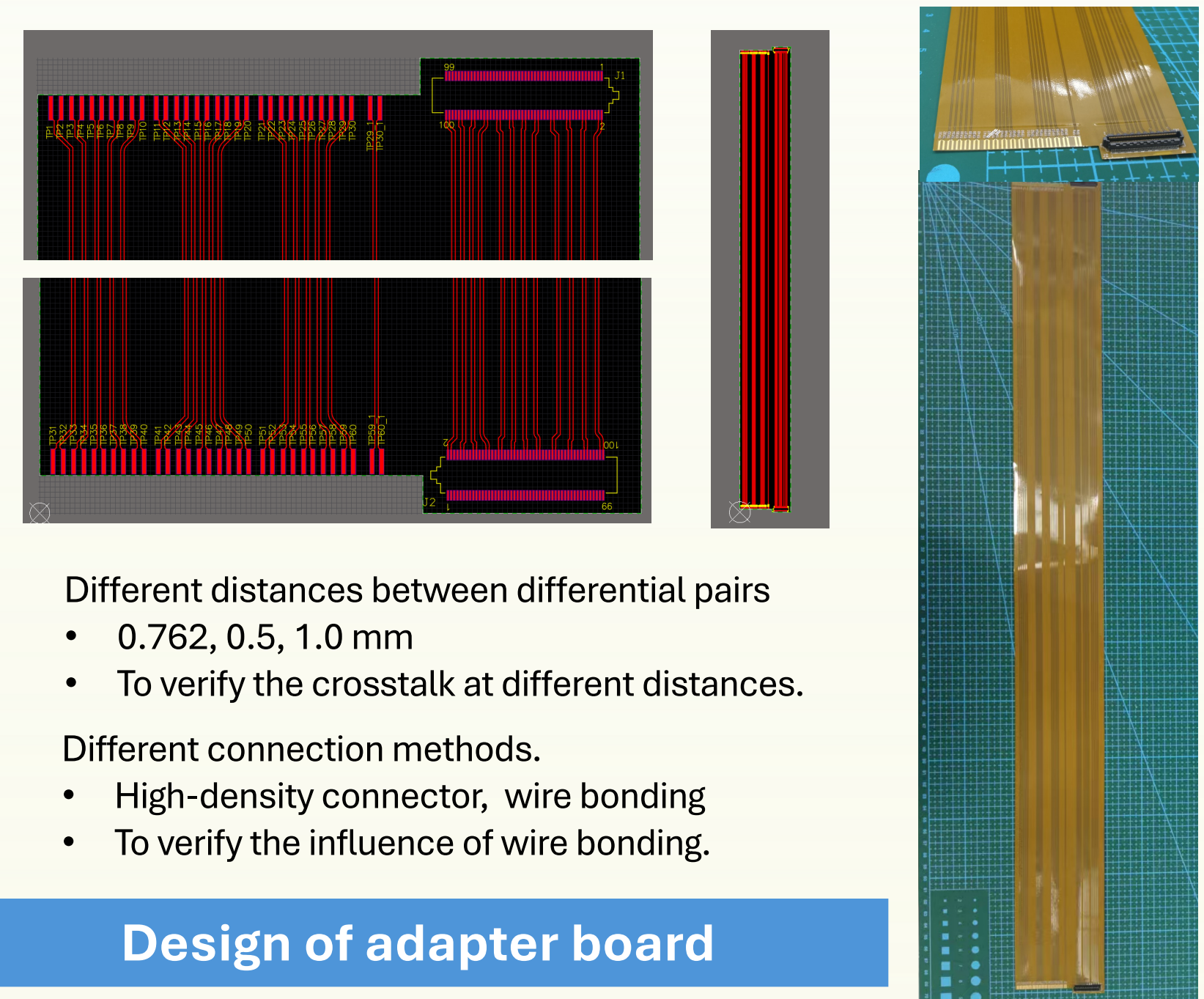
### Bit Error Rate Tests (from CCNU)

70cm ✓

## Second version for crosstalk and wirebonding

— Cross talk and wire bonding tests

### Design of flex cable



Different distances between differential pairs

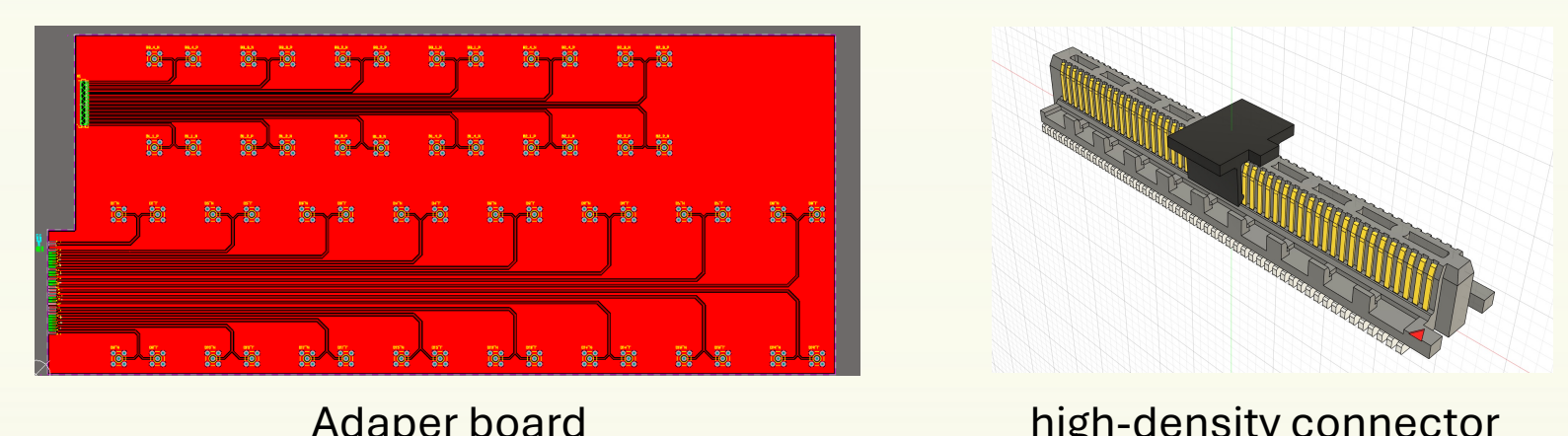
- 0.762, 0.5, 1.0 mm
- To verify the crosstalk at different distances.

Different connection methods.

- High-density connector, wire bonding
- To verify the influence of wire bonding.

### Design of adapter board

- The adapter board converts signals from a high-density plug-in interface to SMA connectors, then connect to the test instruments.



## Same job for hybrid

The hybrid's signal-integrity verification is similar to that of the flex cable. The initial design is still ongoing; experimental tests will be carried out.

Ongoing

