Status on INTT bus extender R&D

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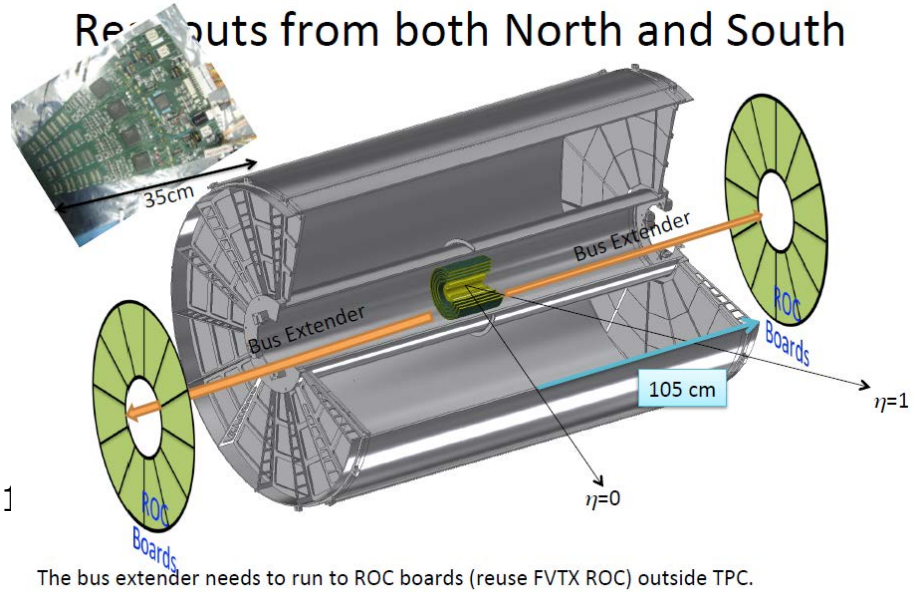
Introduction

- Requirement : 1m extender
  - ROC is placed at outside of the TPC cage
  - Comparing with FVTX
    - 27cm long
    - Made from multi-layer FPC board
      - 7 layer with signals
    - Same signal lines : 62 LVDS pairs (26 FPIX chips)
  - Idea is to Basically make FVTX extender but with 1
- Technology today
  - Very Long + Multi-layer FPC is not available in commercial
    - Single layer FPC can extend very long (~10m)
    - Multi-layer FPC is limited with 40cm due to the press machine
  - Long & multi-layer FPC is challenging
    - Very long & many lines
    - High speed (200MHz clock)
- R&D plan
  - We need extensive FPC simulations and proto-type for R&D
  - We collaborate with TIRI and REPIC corporation
    - TIRI: Tokyo Metropolitan Industrial Technology Research Institute
      - Engineering lab. to help small businesses and start-up companies
      - They has good skill for PCB simulation
      - Kohei Fujiwara is working at the lab, who made the VTX-PIXEL bus
    - REPIC
      - They are working on INTT HDI
  - Applying for the collaborating R&D by TIRI's public offer



The bus extender needs to run to ROC boards (reuse FVTX ROC) outside TPC.
Minimum length is 105cm – ladder length + distance to ROC board.

R & D plan

- Roles
  - RIKEN:
    - Make the spec. (thickness & width of F-PCB, width of signal line, layer arrangement)
    - Test the prototype
  - TIRI:
    - PCB simulation
    - Test the prototype
  - REPIC:
    - Make prototype F-PCB
    - Develop the new technique to make 1m FPC w/ multi-layer
- R & D procedure : 3 step development
  1. Long distance transfer
     - Single layer w/ some LVDS pairs
  2. Multi layer with Long distance transfer
     - multi layer w/ some LVDS pairs (probably 2-3 layers)
  3. Full model prototype (for production)
     - total verification
  - Option B
    - This collaborating R&D includes plan B for the case 1m FPC development is failed
    - Connect some 40cm F-PCB's to make 1m
- Schedule
  - Plan to finish by 2018 March
- I will keep updating the status

Some numbers for F-PCB

- Some numbers for the extenders by REPIC
  - Base PCB thickness : 12.5µm, 25µm, 50µm
  - Cu layer : 9µm, 18µm, 35µm
  - Bonding sheet thickness : 40µm
  - Line width / space width : 150µm/150µm
  - Through-hole/land radius : ϕ0.3mm/ ϕ 0.5mm
    - These numbers are given by the company REPIC contacted
    - The company had made FPC with these numbers before

- HDI case (for comparison)
  - Base Polyimide : 12.5µm, 25µm, 50µm
  - Cu layer : 9µm, 18µm (cover)
  - Bonding sheet thickness : 25µm
  - Line width / space width : 60µm/120µm
  - Through-hole/land radius : ϕ0.1mm/ ϕ0.3mm

- FVTX extender (for comparison)
  - Base PCB thickness : 20µm, 50µm
  - Cu layer : 12.5µm, 38µm(cover)
  - Bonding sheet thickness : 25µm
  - Line width / space width : 40, 60µm/150µm
    - based on gerber data