Study of Opto-Box

K.K. Gan, H. Kagan, R. Kass, J. Moore, D.S. Smith
The Ohio State University

April 20, 2016

Outline

- Radiation Length of Electrical Links

- Opto-Box with GBT

- Opto-Box with Low-Speed Downlinks

- Opto-Box with GBT Array

Radiation Length of Electrical Links

- Up-links: AWG30 Cu-clad Al TwinAx: $X/X_0 = 0.076\%$
- Down-Links: AWG36 twisted pair: $X/X_0 = 0.0086\%$
  - all smeared over 1 cm at normal incident
- If each pixel module is served by one up and one down links
  ⇨ down link contributes 10% of the radiation length
- one down link can serve 4 FE chips
  - Layer 1: reduce wire counts by a factor of 4
  - Layer 2: reduce wire counts by a factor of 2
  - Layer 3-5: each module contains 4 FE chips
- having one down link serving more than 4 FE chips
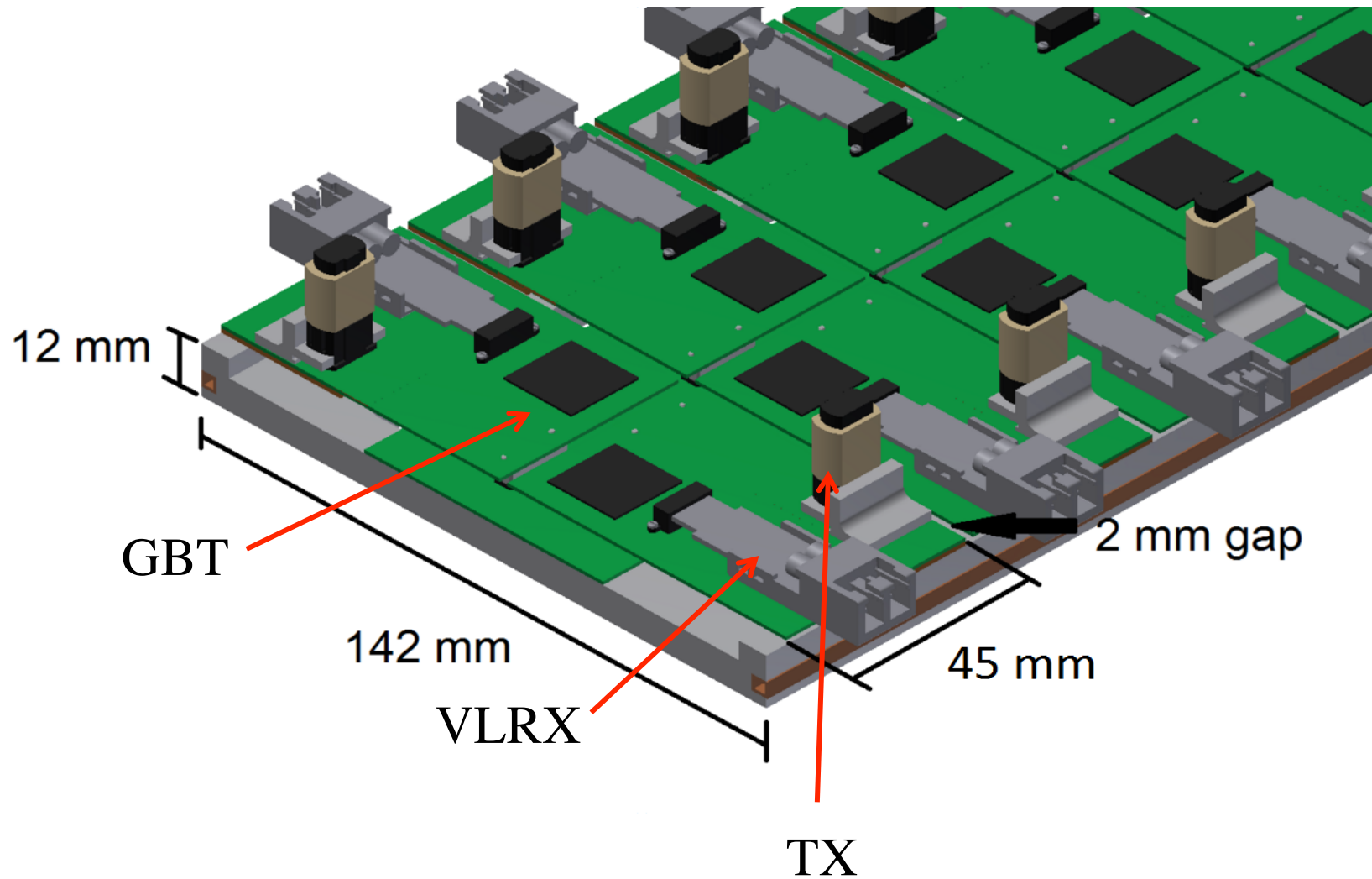 will result in large loss of solid angle if one link is broken

Opto-Box with GBT

- Basic assumptions:
  - up-links: use 12-channel VCSEL array operating at 5 Gb/s
  - down-links: use one GBT
    - send 160 Mb/s signal to modules
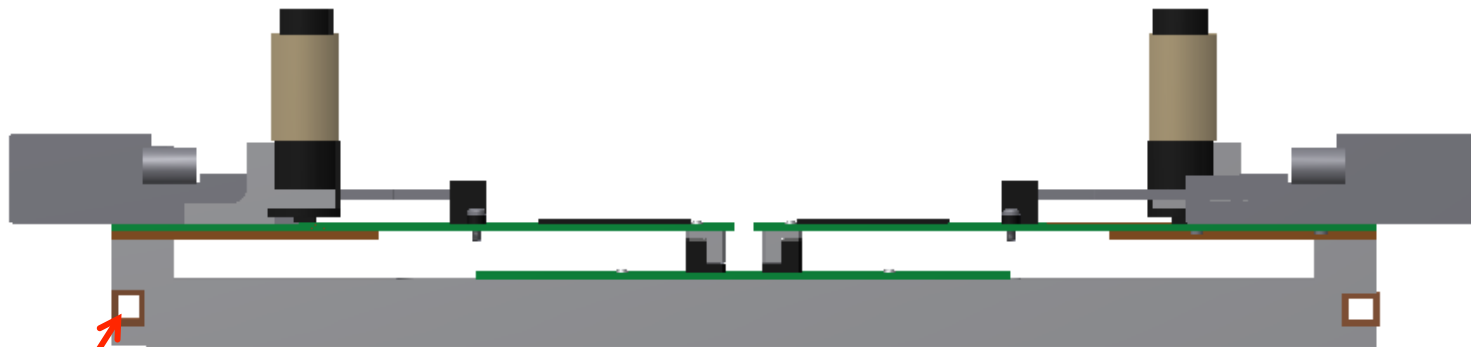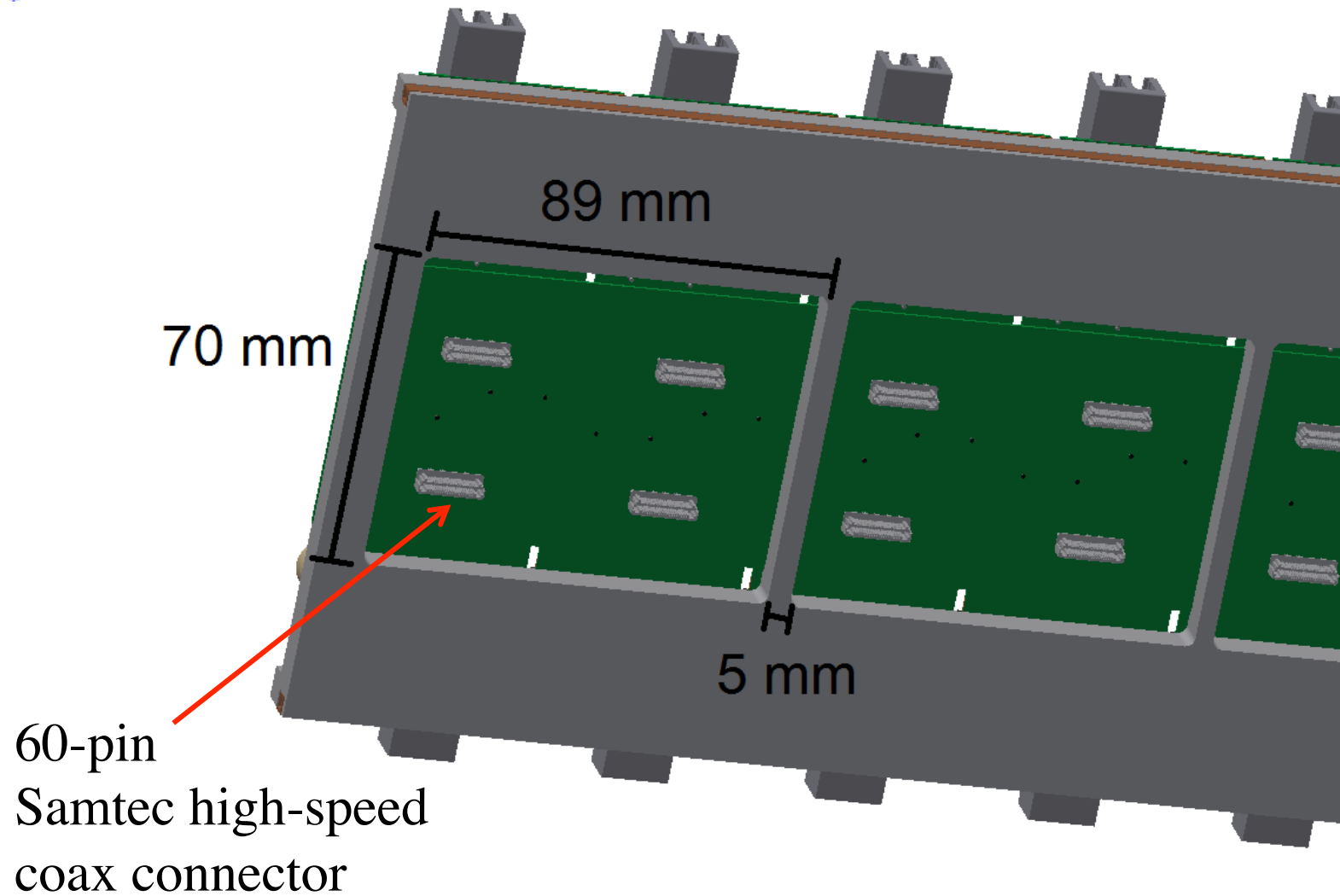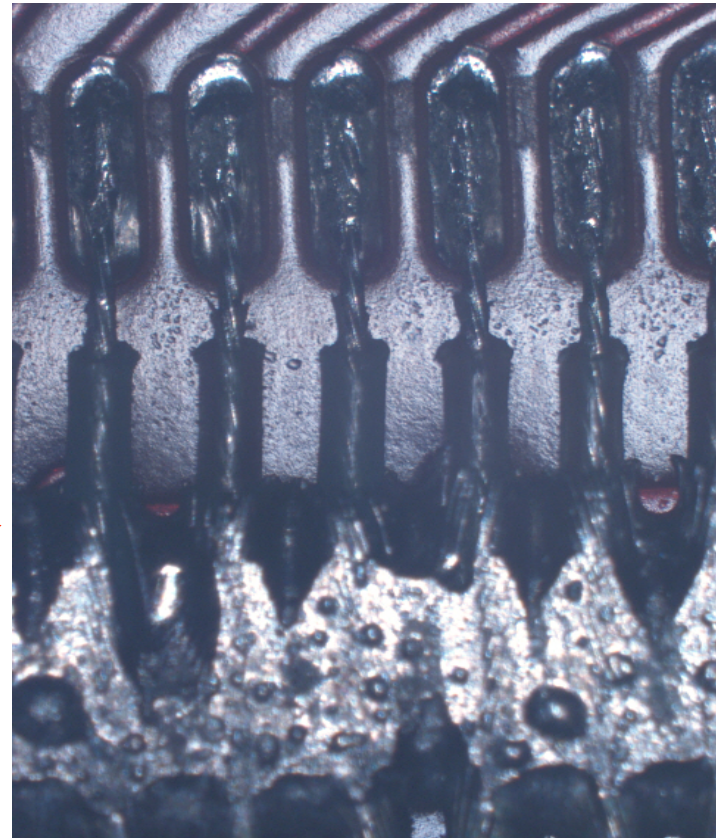
Opto-Box with GBT

12 mm

GBT

142 mm

VLRX

TX

2 mm gap

45 mm

Side View

Cooling pipe

Bottom View

89 mm

70 mm

5 mm

60-pin
Samtec high-speed
coax connector

Samtec High-Speed Coax Connector

Opto-Box

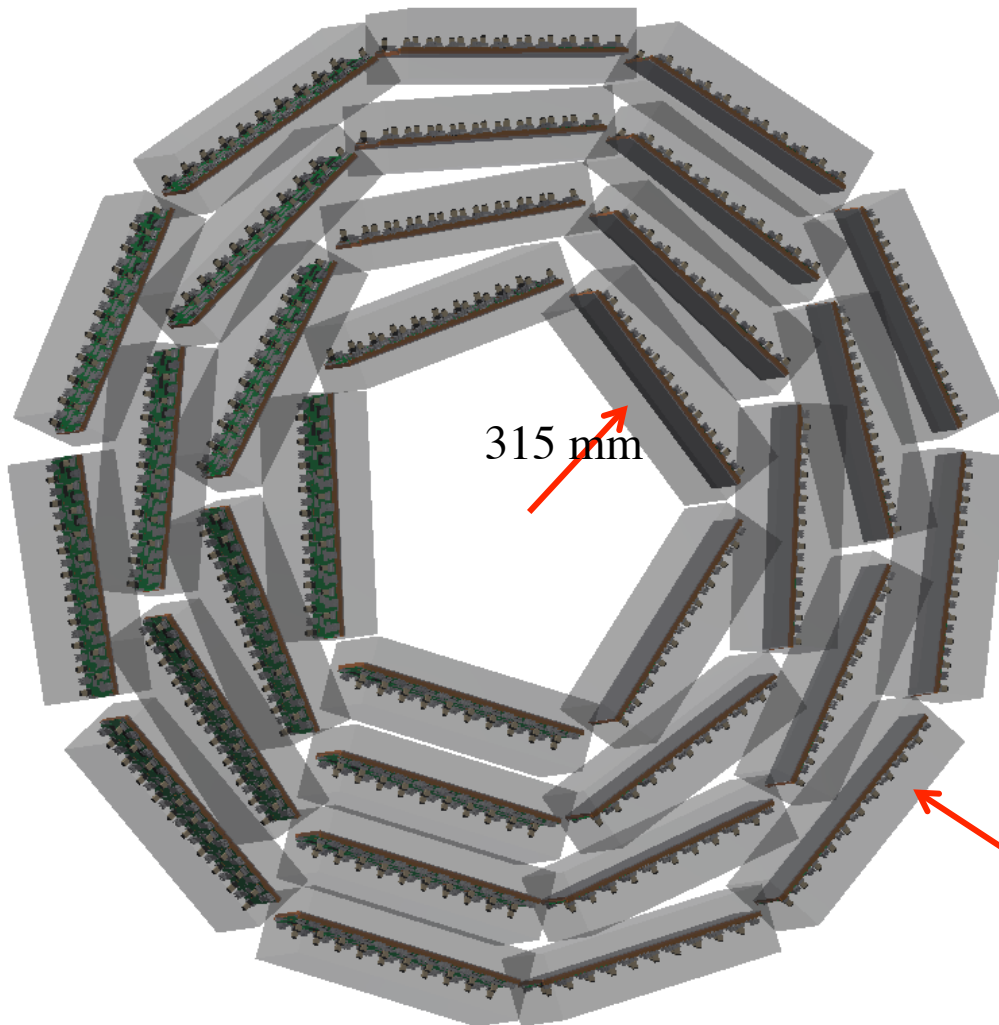10 opto-boards per side

478 mm
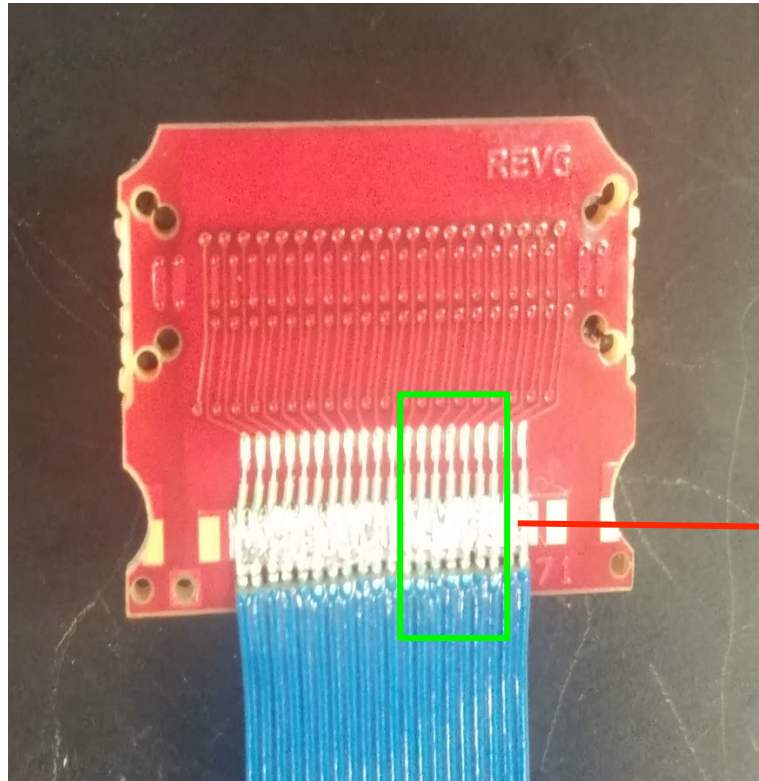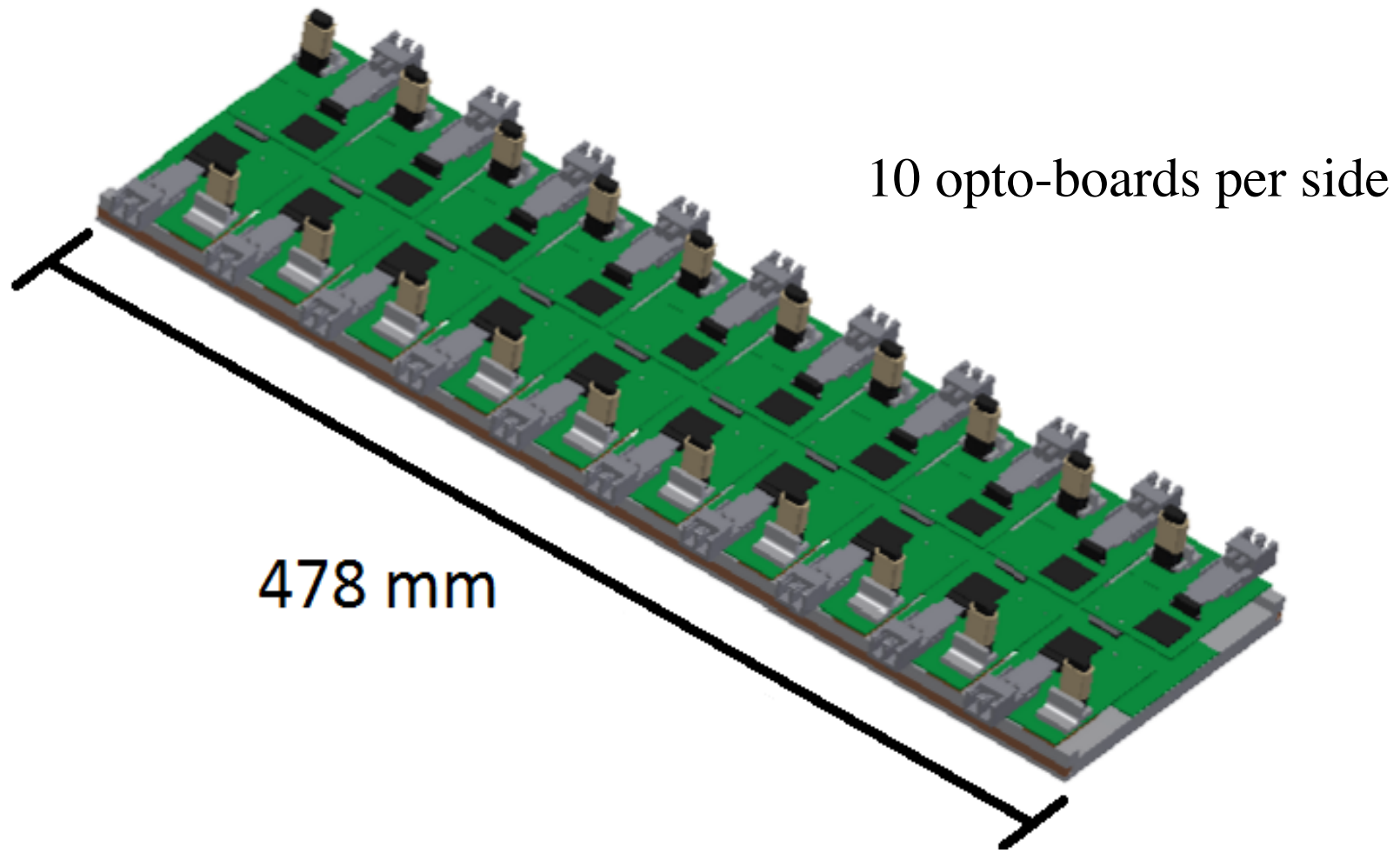
Opto-Box at ID Endplate

32 opto-boxes
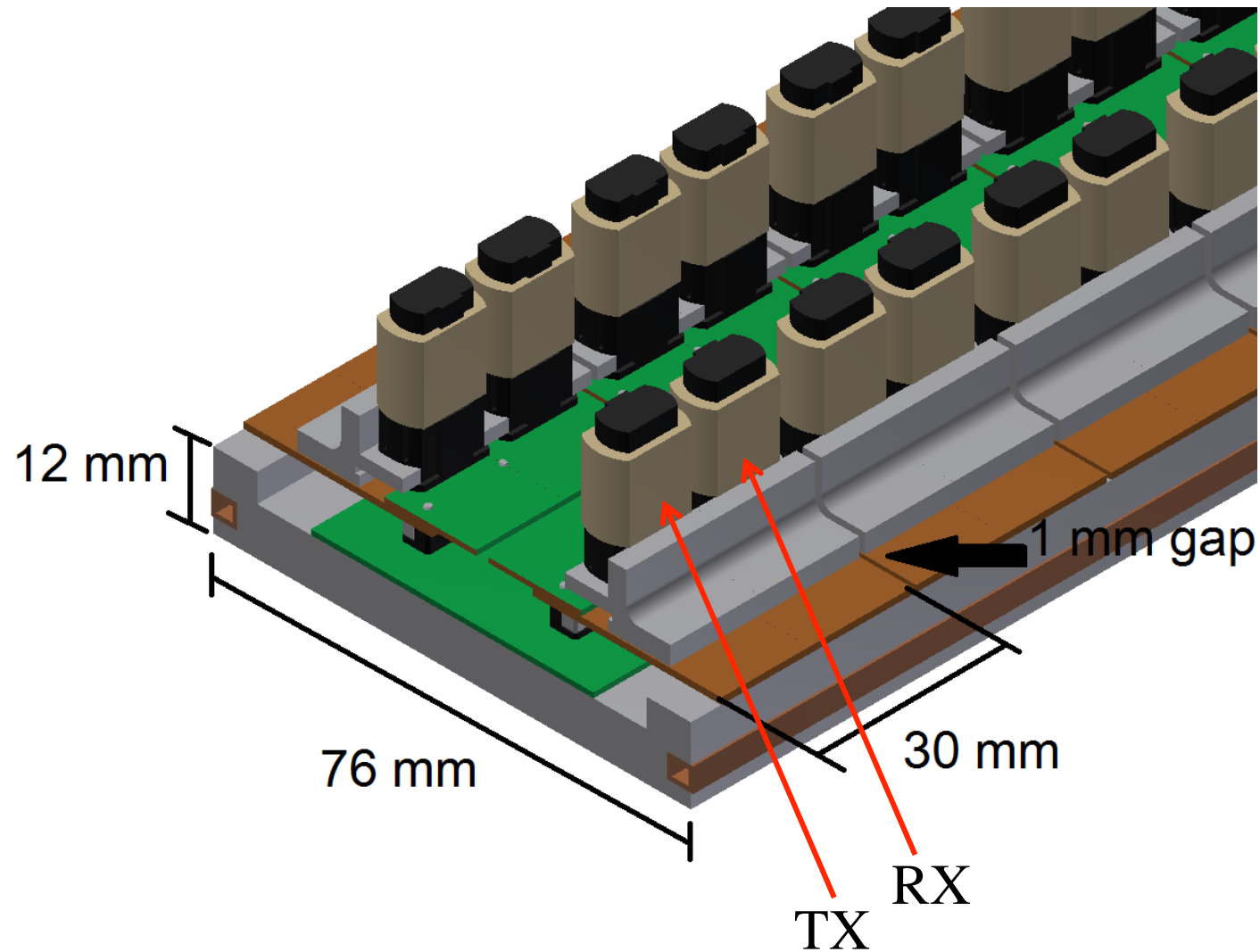2 x 10 opto-boards/box
640 opto-boards

315 mm

1020 mm

Opto-Box with Low-Speed Downlinks

● Basic assumptions:

   ◆ up-links: use 12-channel VCSEL array operating at 5 Gb/s

   ◆ down-links: send 12 channels of 8b/10b signals at 160 Mb/s
     from counting room to opto-box

     ■ not a technical challenge to program FPGA in counting room
       and to develop low-speed ASIC for the opto-board

     ■ send 160 Mb/s signal to modules

     ☺ one opto-board flavor with up- and down-links
       using MTP connectors as in current opto-board
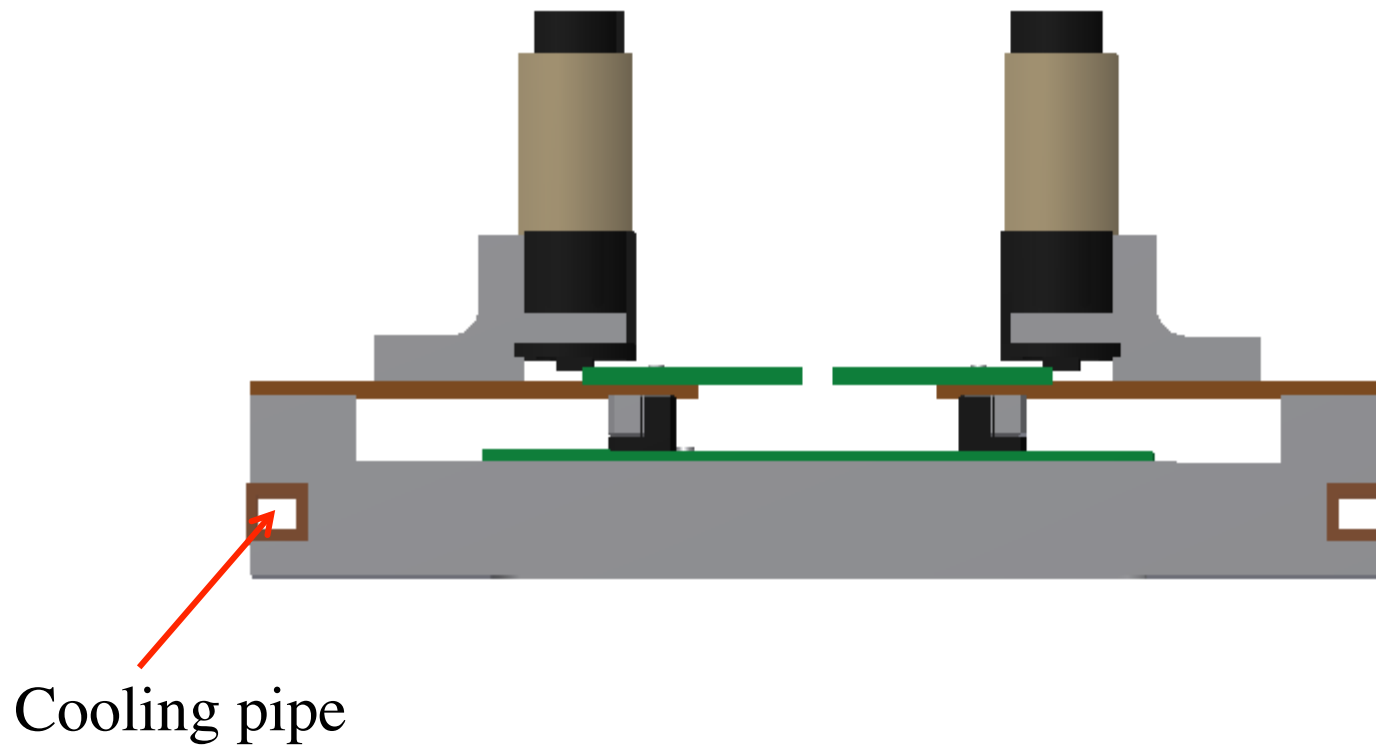
     ☺ use relative old/proven technology

Opto-Box with Low-Speed Downlinks
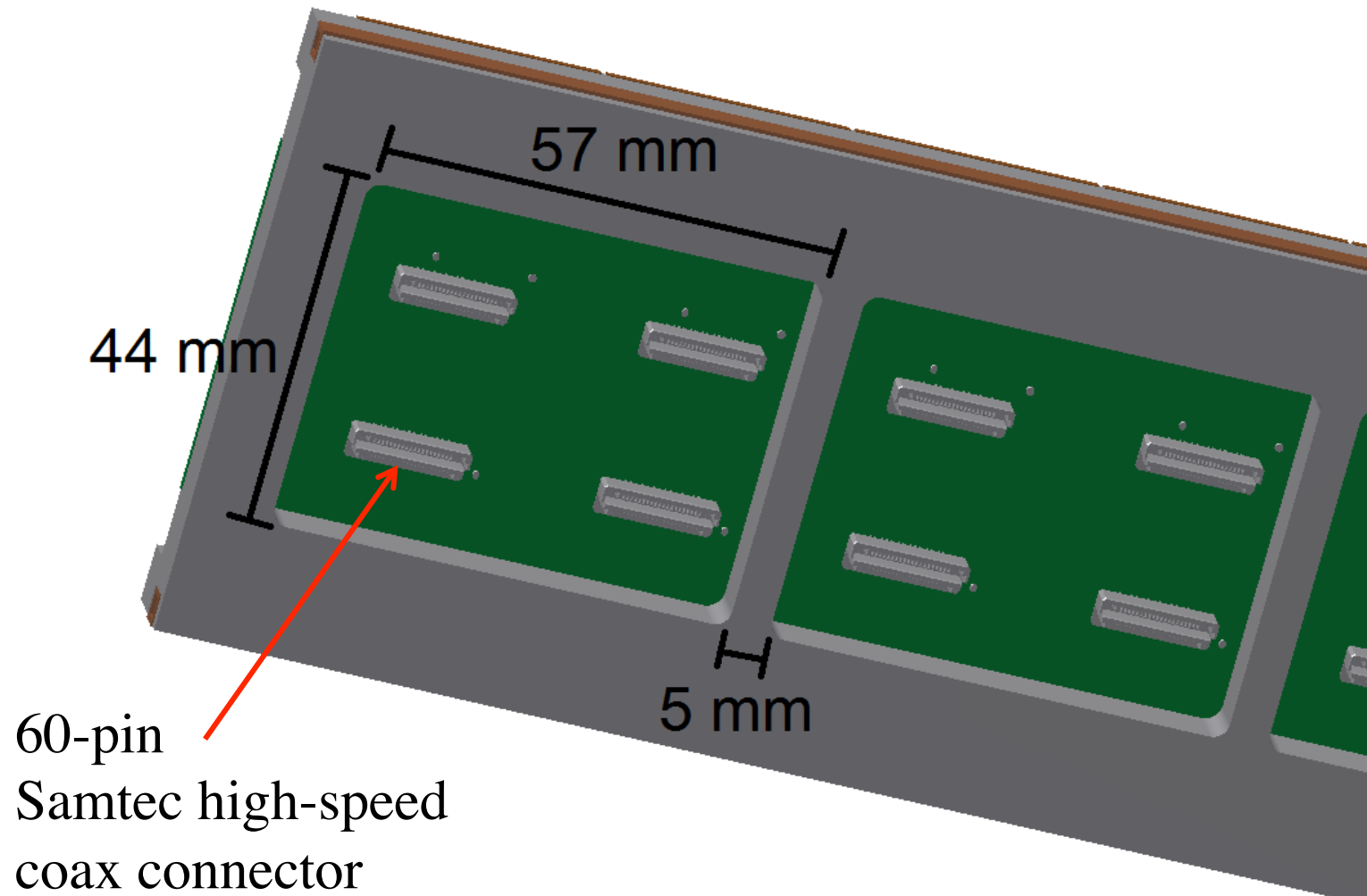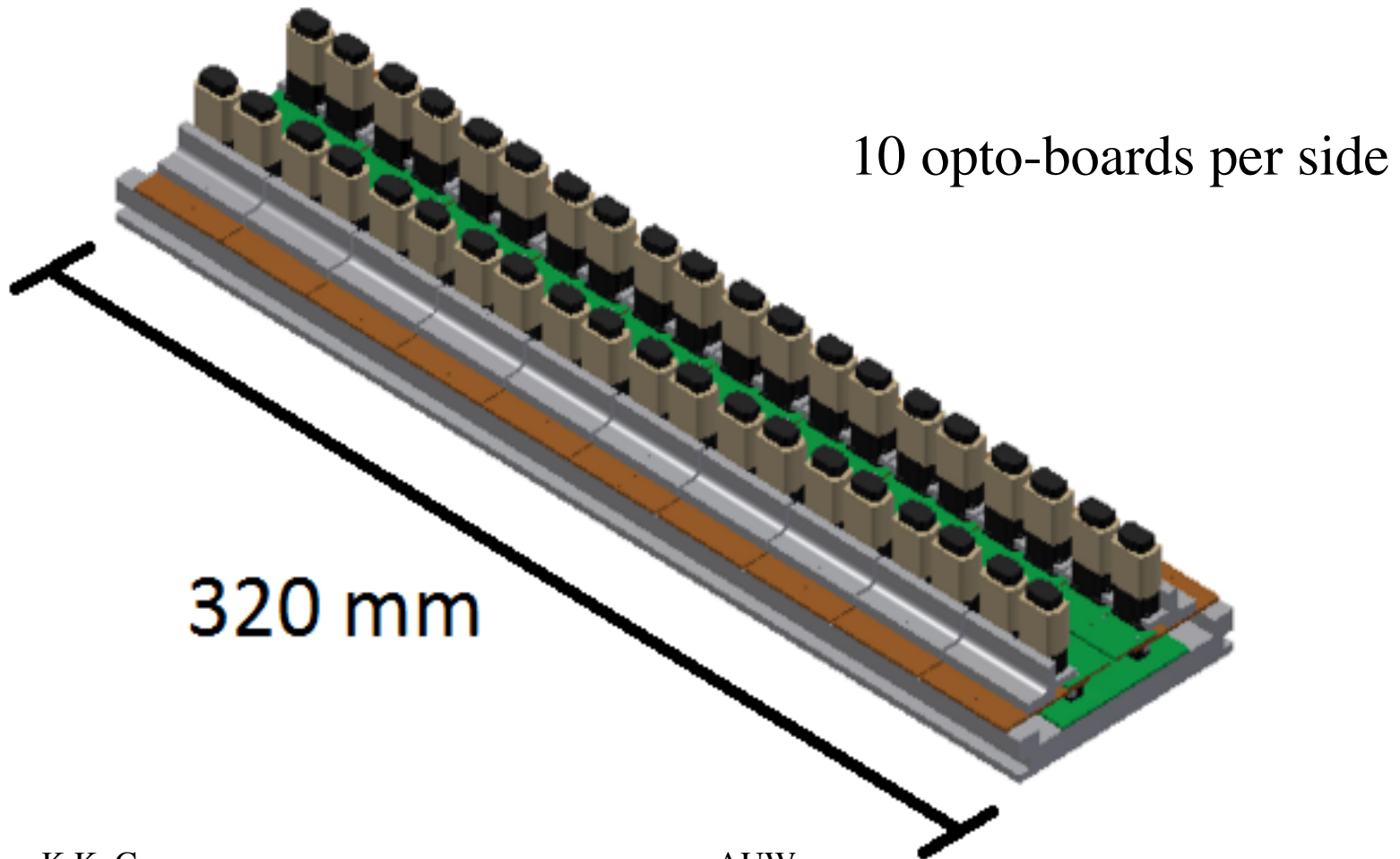
12 mm

76 mm

1 mm gap

30 mm

RX

TX

Side View

Cooling pipe

Bottom View

57 mm

44 mm

5 mm

60-pin
Samtec high-speed
coax connector

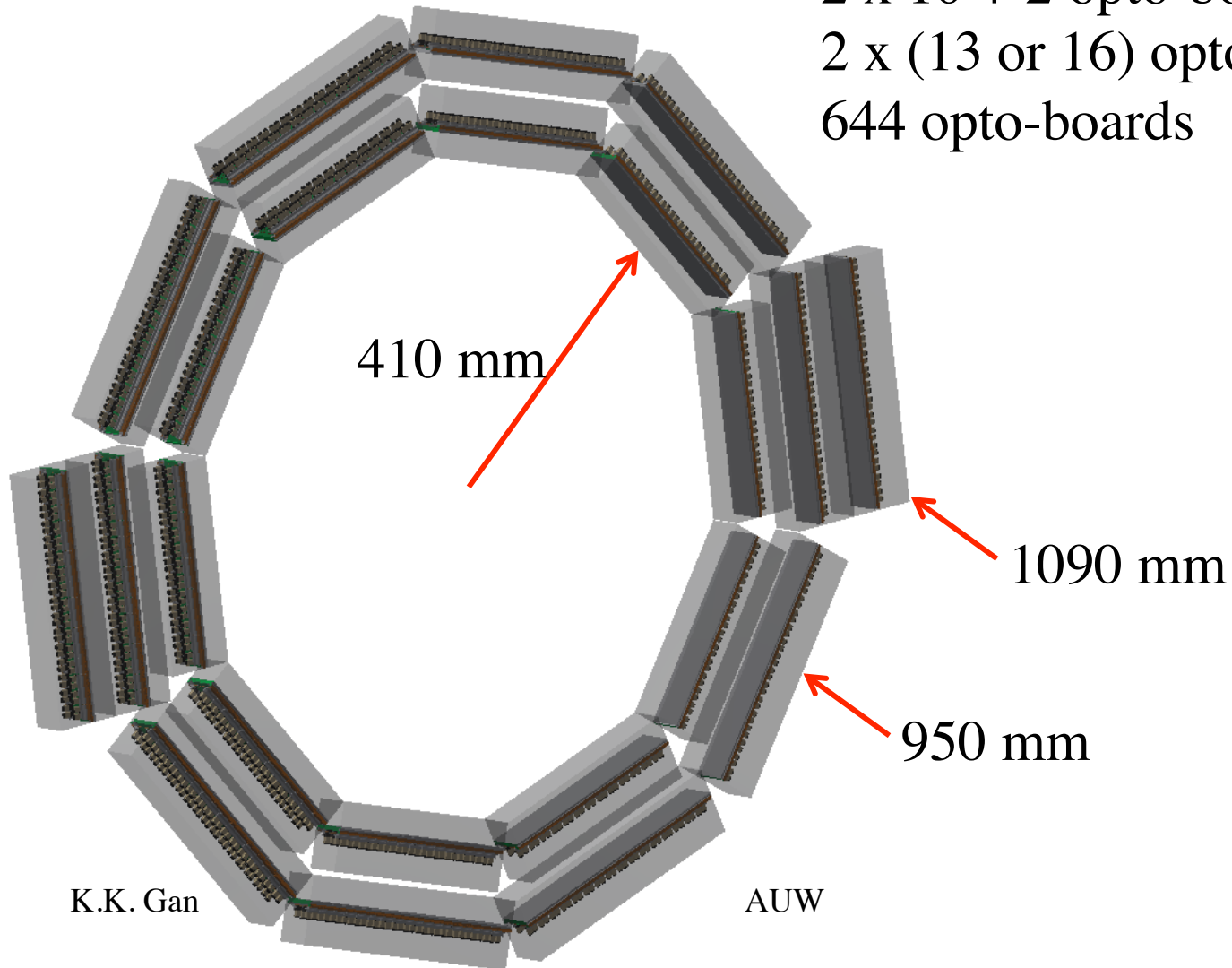# Opto-Box

10 opto-boards per side

320 mm

Opto-Box at ID Endplate

2 x 10 + 2 opto-boxes
2 x (13 or 16) opto-boards/box
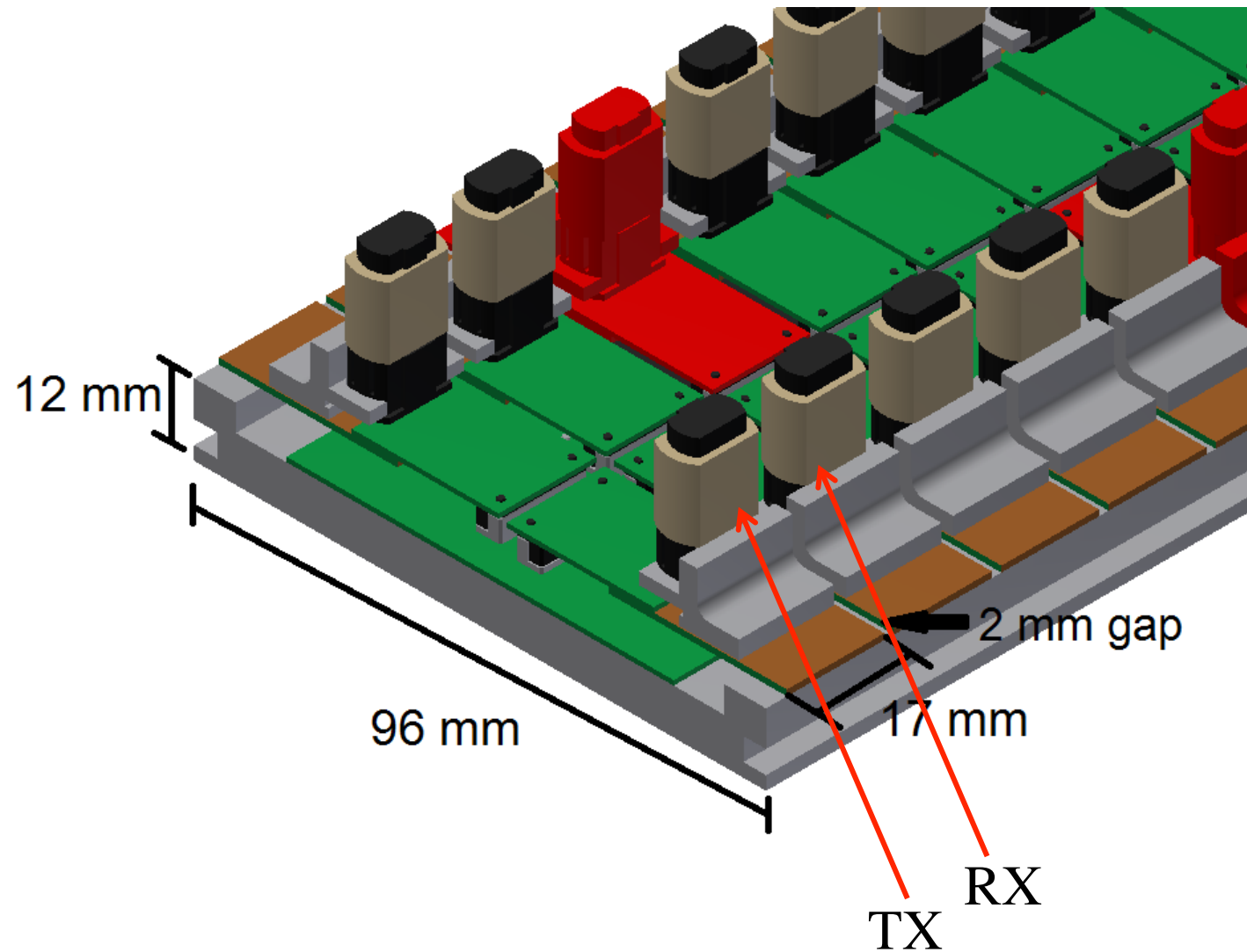644 opto-boards

410 mm

1090 mm

950 mm

Opto-Box with GBT Array

- Basic assumptions:
  - ◆ up-links: use 12-channel VCSEL array operating at 5 Gb/s
  - ◆ down-links: take de-serializer in GBT and layout in array format
    - ■ send 160 Mb/s signal to modules
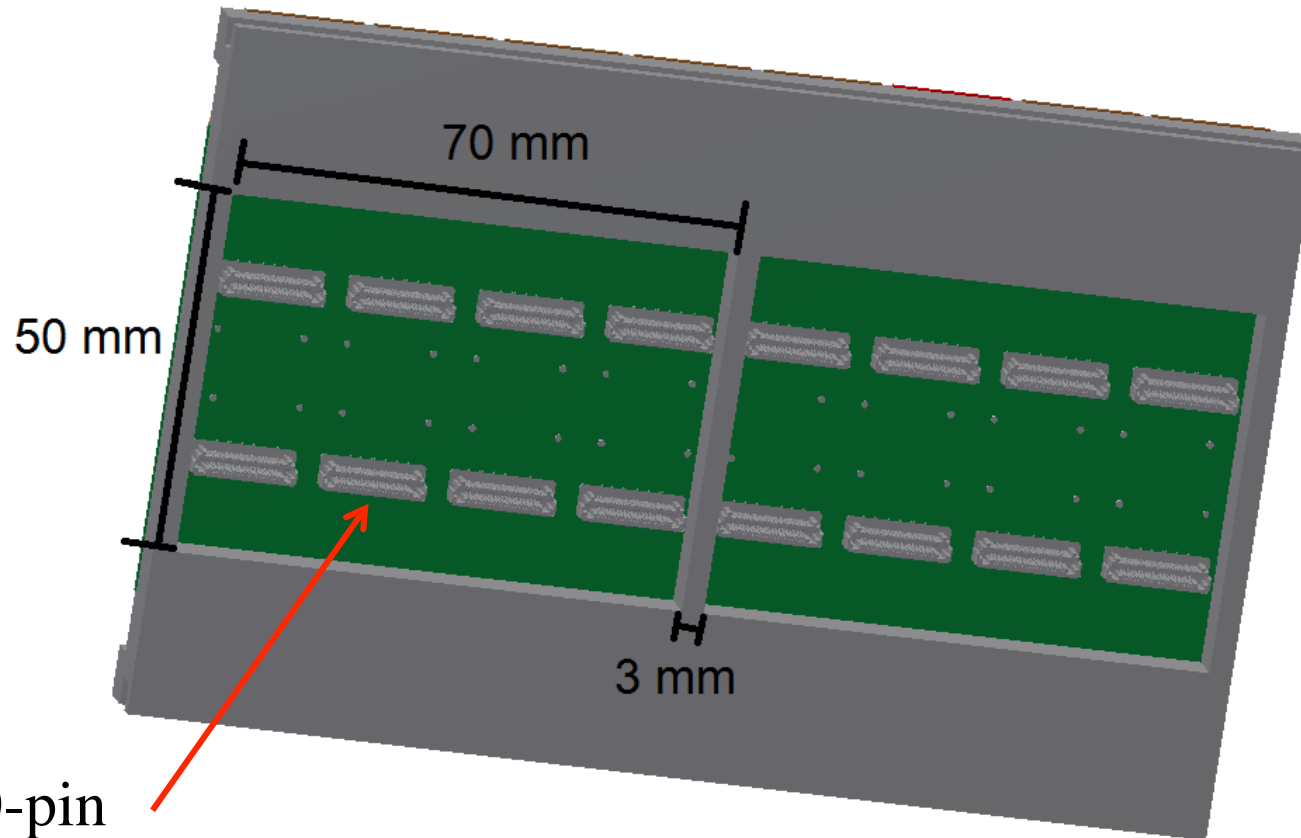 - ◆ one down-link opto-board for every seven up-link opto-boards
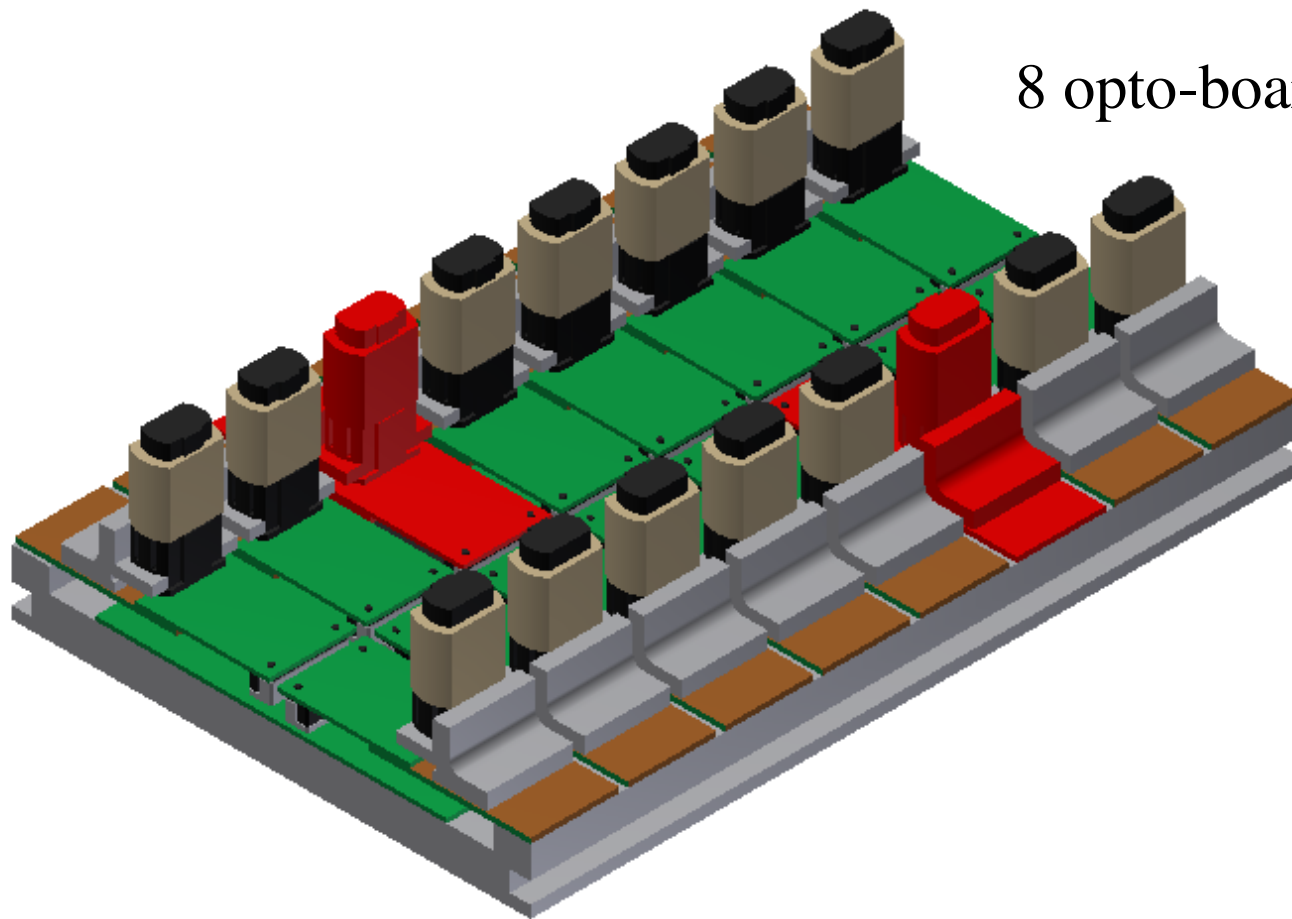
Opto-Box with GBT Array

12 mm

96 mm

2 mm gap

17 mm

RX

TX

Bottom View

70 mm

50 mm

3 mm

60-pin
Samtec high-speed
coax connector

Opto-Box

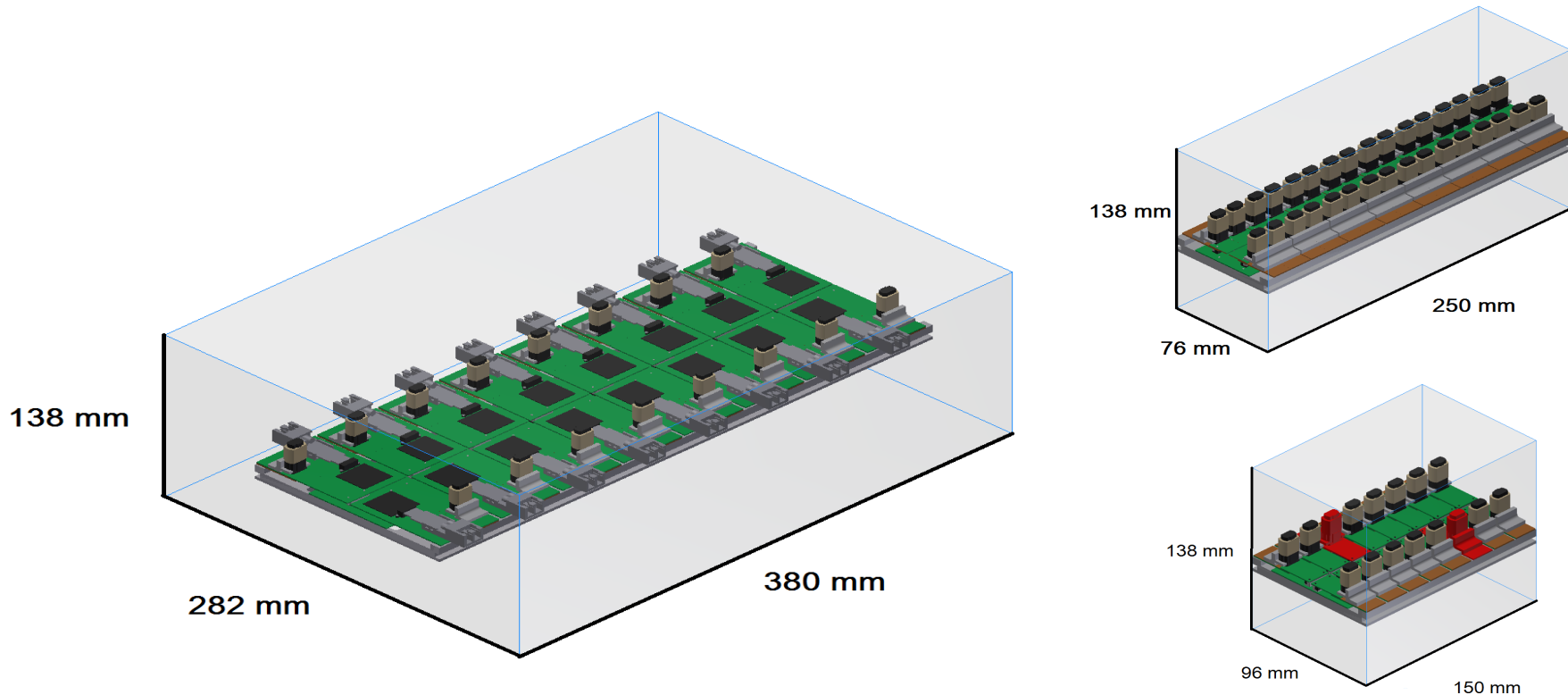8 opto-boards per side

Opto-Box at ID Endplate

644 opto-boards

350 mm

770 mm
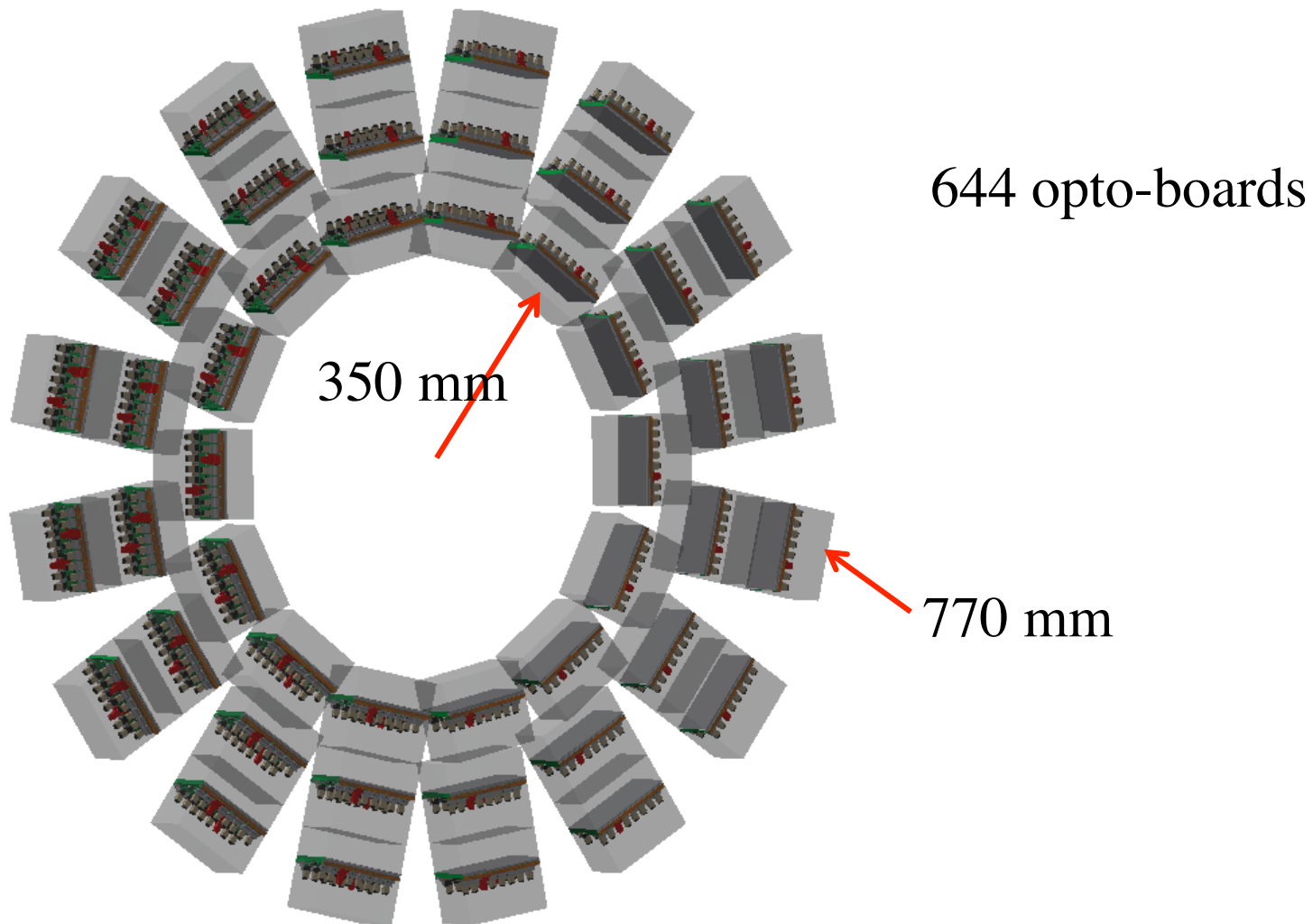
Opto-Box at ID Endplate

- 2 x 8 opto-boards/box for comparison
- 5 to 7 cm of clearance on the sides for cable/fiber routing & access
- opto-box with GBT arrays is smallest

Summary

- preliminary estimate of the physical size of opto-boxes
- opto-box with GBT arrays is the smallest