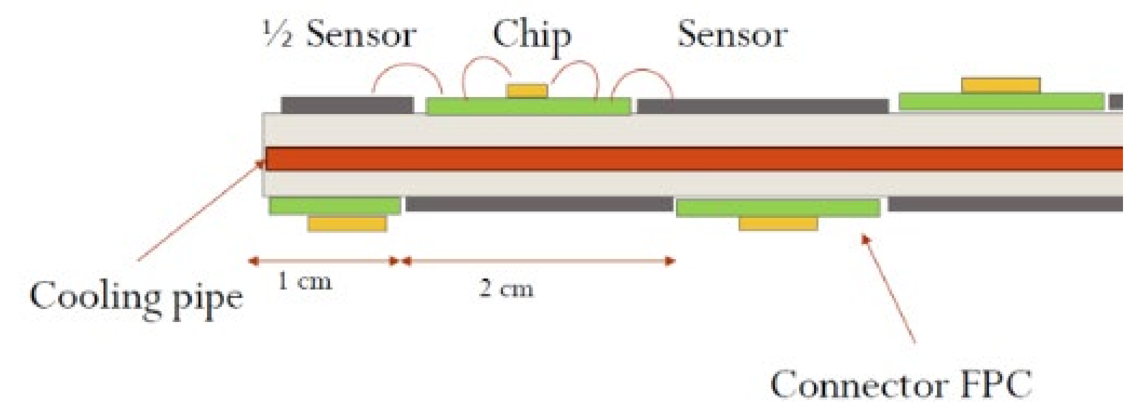
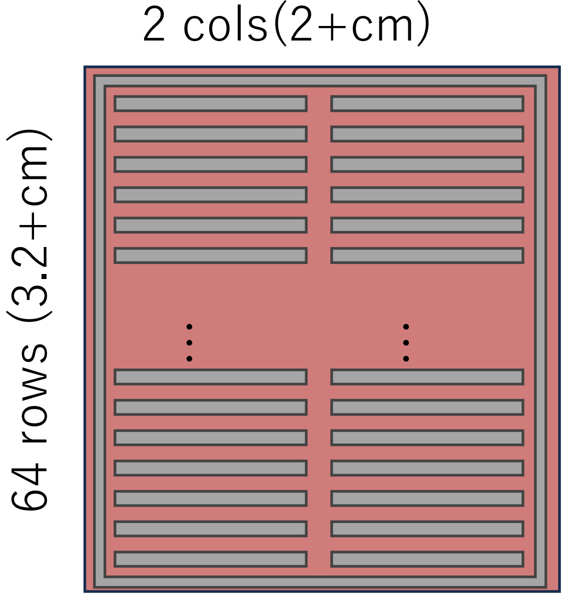
FPC設計の試み2

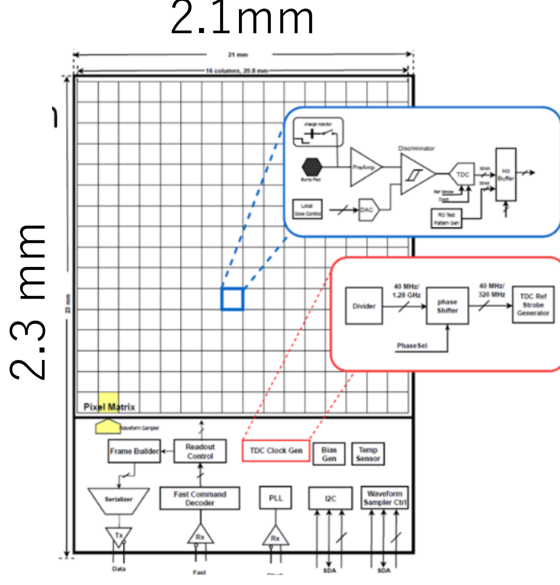
蜂谷　崇

Basic information

- BTOF Ladder structure
  - Sensor/ASIC on FPC are put at both front and back sides
    - 2 FPCs are necessary
- Sensor dimension
  - 64x2 strips as unit = 3.2 x 2 cm^2
    - Strip size : 0.5mm x 1cm
- ASIC: ETROC2 as 1st candidate
  - This is for CMS-pad-LGAD)
  - Size : 21x23mm^2
  - Analog inputs : 128 signals
    - Connected to 16x16 pixels on a sensor by bump bonding
- More ETROC2 info necessary for FPC design

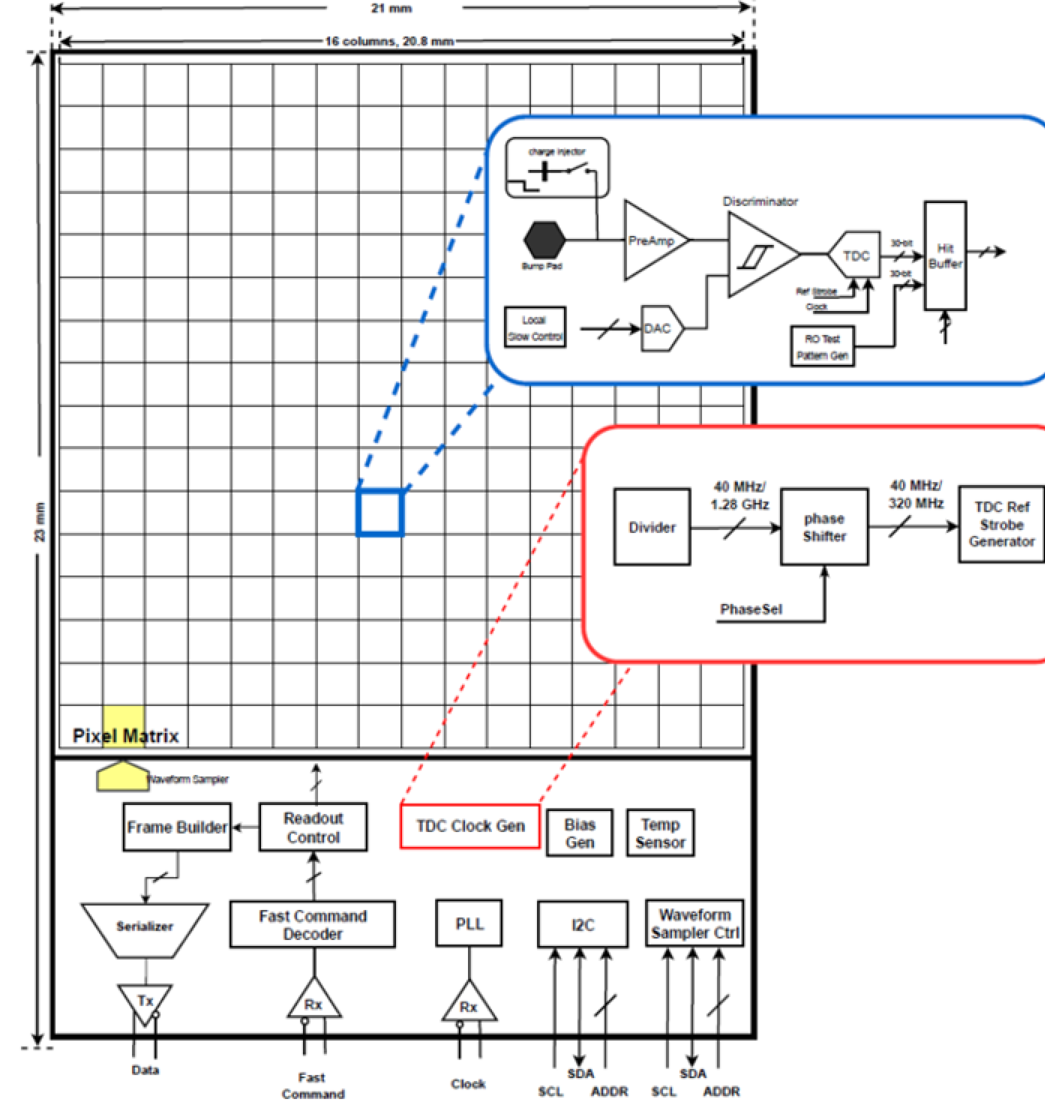






More ETROC2 info

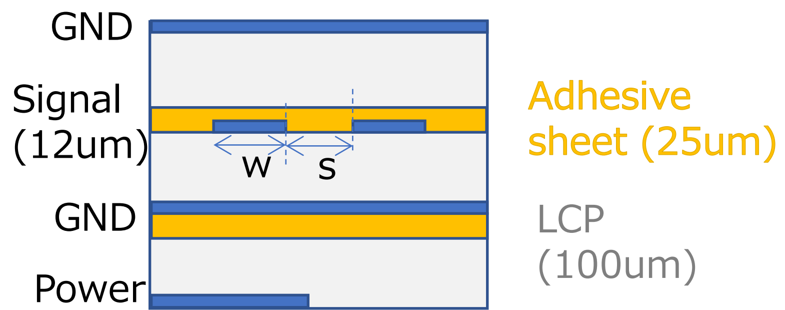
- Size : 21x23mm^2 since 2D for the pixels
  - I/O part is placed at bottom
- Npads : 124 for wire bonding
  - Digital lines: 18 lines -> ~10 or 11 lines
    - Tx: DataOut (LVDS) x 2 → DataOut (LVDS) x 1 p2p
    - Rx: *CLK40 (LVDS)* → *p2p*
    - Rx: *FastCom (LVDS)* → *bus w/ 2 or 3 chips (not p2p)*
    - Rx: **I2C (2 lines, SCK, SDA)** → *bus w/ 15~20 chips*
    - Rx: I2C addr (5bits) → 5 or 6 bits (depending on FPC conf.)
    - Rx: **RSTn (1line)** → **bus for all chips**
    - Rx: CLK1280 (LVDS) : debug → not needed
  - Analog : 1 line (Vtemp) → needed
  - Power/GND/others : **105 lines**
  - No connection of waveform sampling part assumed
- 130 cm FPC = 32 or 33 sens/side (x2 FPCside x 2cm/sens)
  - 32 or 33 ASICs are necessary
  - If 150cm FPC, ~40 sens
- If 33 ASIC's are in a side, 33 x 11= 366 lines
  - 122 lines for INTT (3times more than INTT)



https://etl-rb.docs.cern.ch/Specifications/etroc-test-card/#Specifications

INTTのFPCとの比較

- INTT 長尺FPC
  - 130 & 130um
  - 124 lines / layer w/ GND sandwiched



- BTOF:　366 lines

-> 3 signal layers +

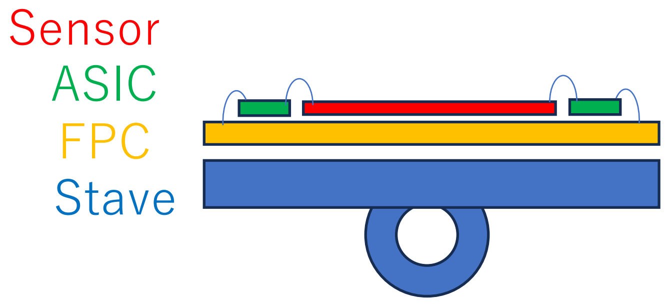
at least 4 GND/ power layers

X = 1.2%, 厚み0.8mm

- INTT HDI　(ただし最長50cm)
  - 50um & 50um（100um/line)
  - 7層、2 sig layers

2GND + A/D power +　Bias + 3 signal

  - 350 lines / layer (3.5cm幅に収める)が可能？　計算上

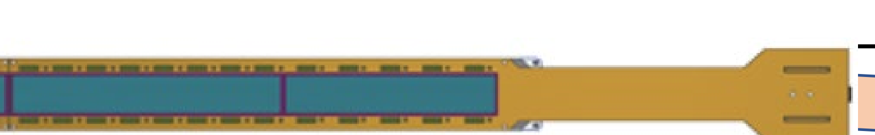


- BTOF：366 lines

-> 2 layers at least 3 GND/PW layers, probably more

X=1%, 厚み0.6mm

INTTの構造



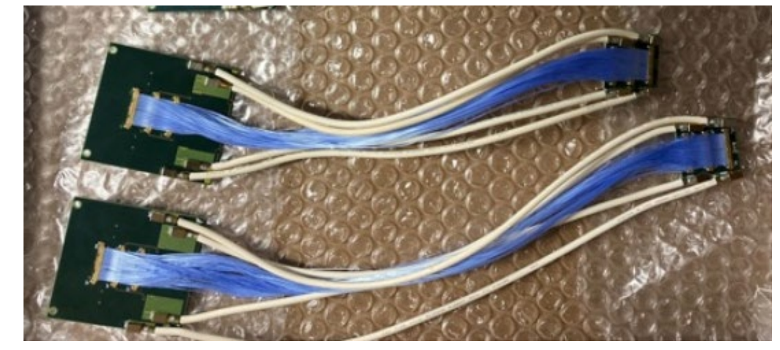
Bias

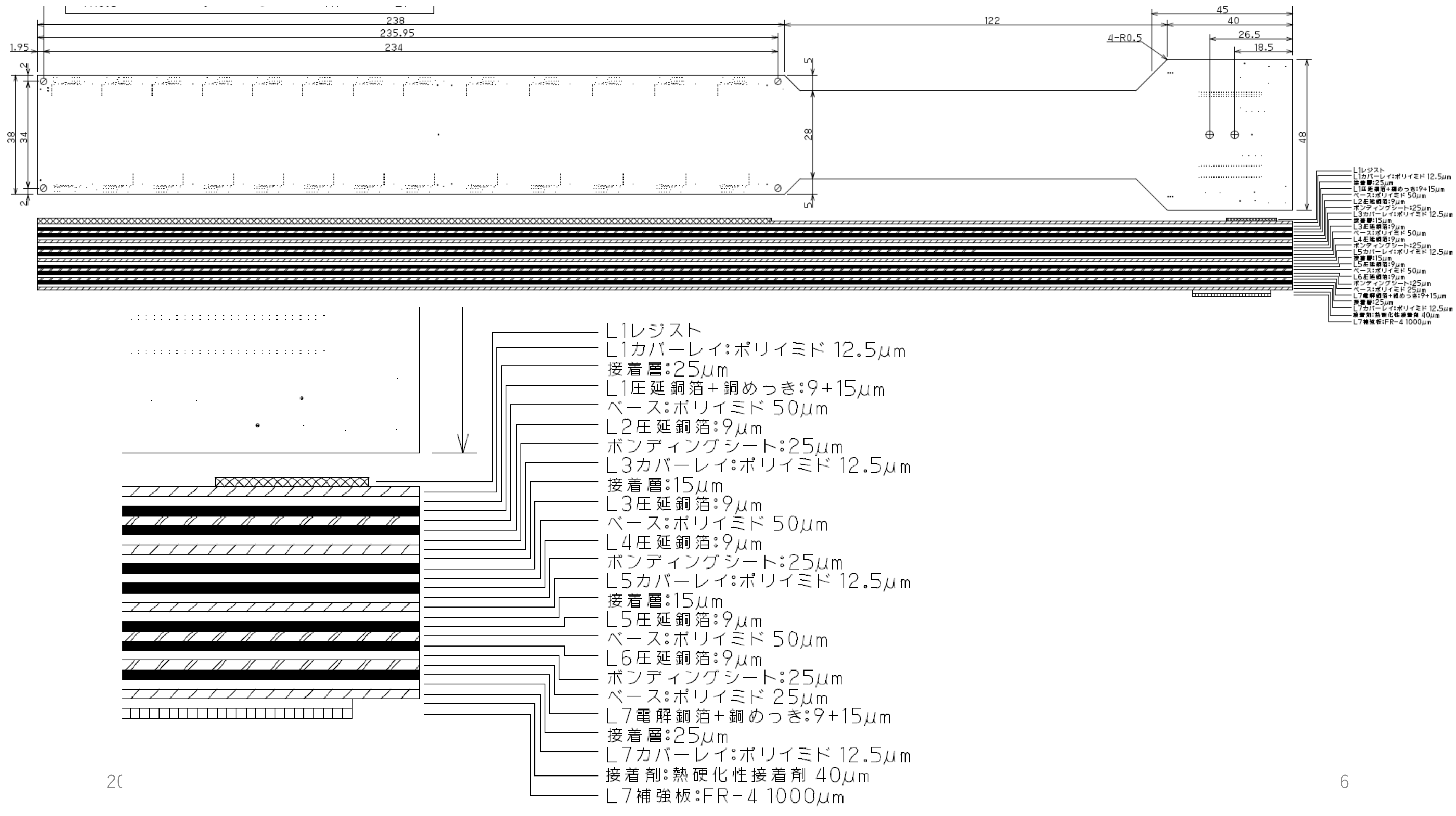
BEX

20cm

- BEX: 120cm FPC
  - 4 layers (Digital Power, Analog Power, GND, Signal)
    - Signal layer contains 62 LVDS pairs)
  - Signal line/space : 130um/130um
- Bias cable
  - 2 Coax for sensor A/B
- Micro-Coax (20cm)
  - Curving path
- Half ladder (40cm)
  - 26 ASIC : each ASIC has 2 data outputs (2 LVDS pairs)
  - 7 layers
    - Analog, Digital, Bias, GND, signal x 2
    - Signal layer : line/space 50um/50um

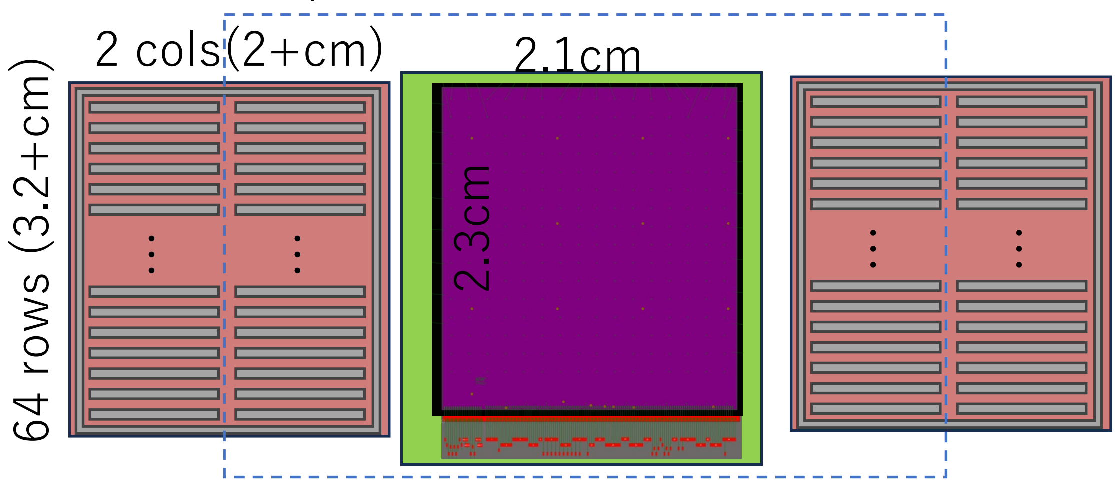
Micro-Coax



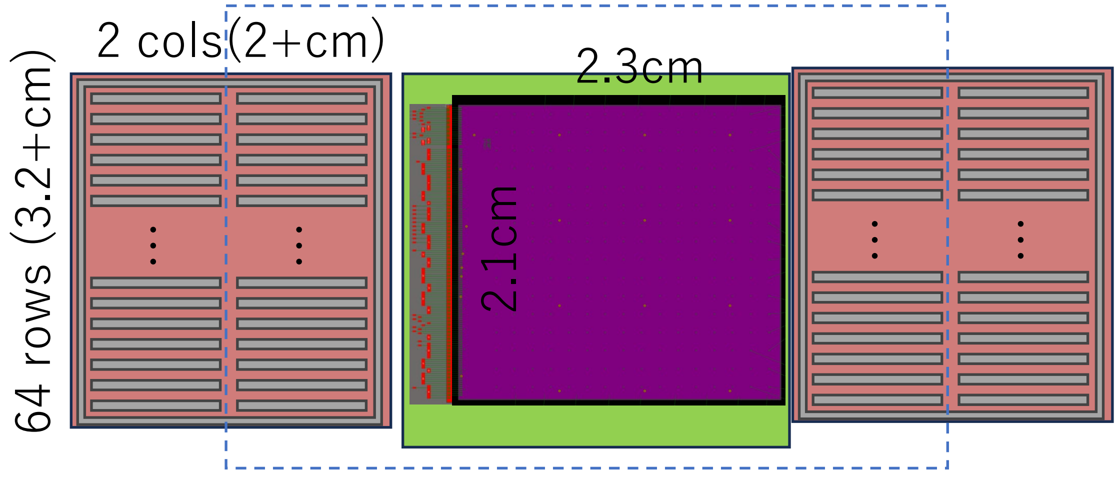

238
235.95
234
1.95
122
45
40
26.5
18.5
4-R0.5
2
38
34
5
28
48
L1レジスト
L1カバーレイ:ポリイミド 12.5μm
接着層:25μm
L1圧延銅箔+銅めっき:9+15μm
ベース:ポリイミド 50μm
L2圧延銅箔:9μm
ボンディングシート:25μm
L3カバーレイ:ポリイミド 12.5μm
接着層:15μm
L3圧延銅箔:9μm
ベース:ポリイミド 50μm
L4圧延銅箔:9μm
ボンディングシート:25μm
L5カバーレイ:ポリイミド 12.5μm
接着層:15μm
L5圧延銅箔:9μm
ベース:ポリイミド 50μm
L6圧延銅箔:9μm
ボンディングシート:25μm
ベース:ポリイミド 25μm
L7電解銅箔+銅めっき:9+15μm
接着層:25μm
L7カバーレイ:ポリイミド 12.5μm
接着剤:熱硬化性接着剤 40μm
L7補強板:FR-4 1000μm

ASIC Layout as example

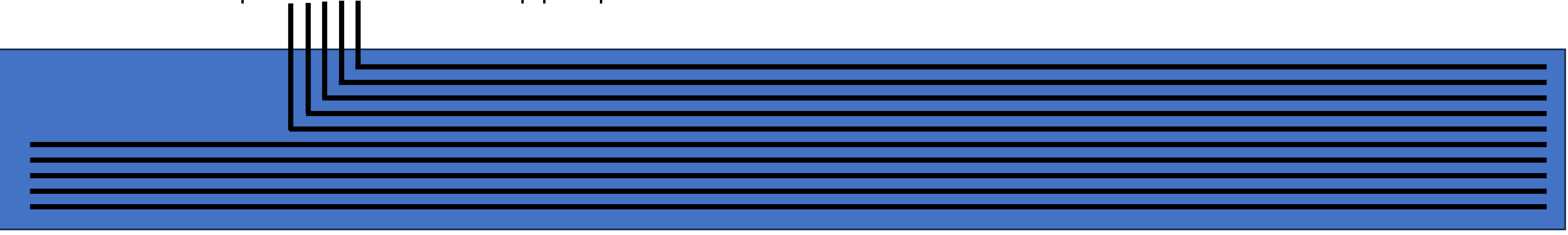
ASIC vertical placement



ASIC horizontal placement



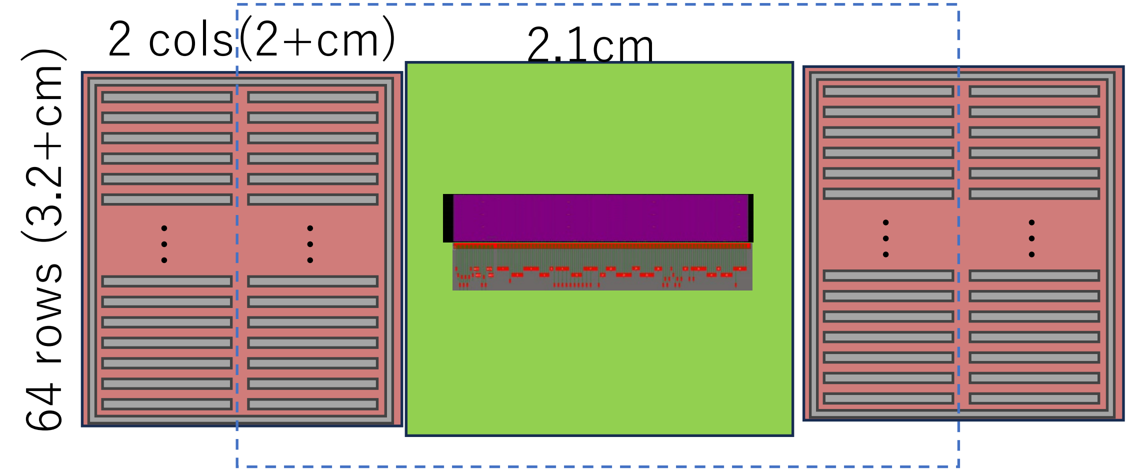
- Signal lines are placed horizontally in FPC
  - Which placement are appropriate for us?



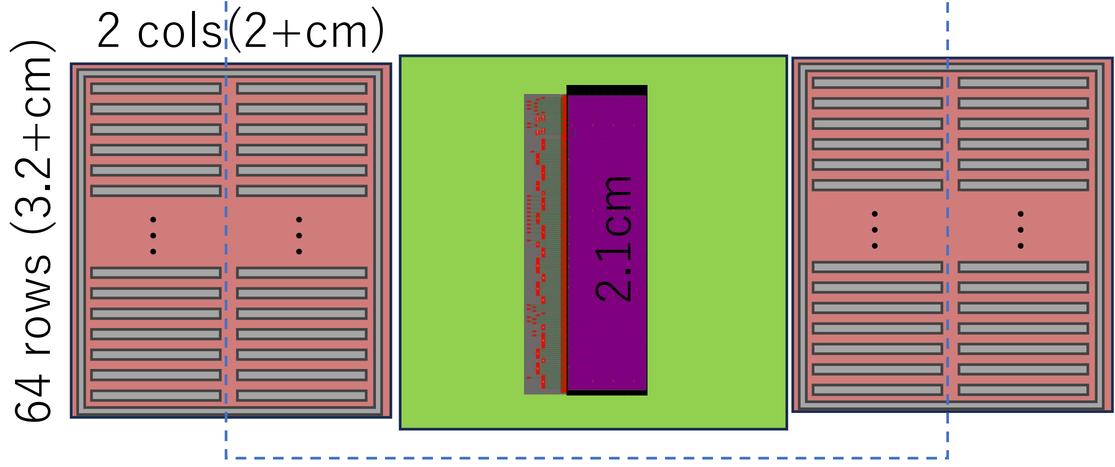
FPCの配線としては、左側の配置が良さそう

ASIC Layout as example 2

ASIC vertical placement

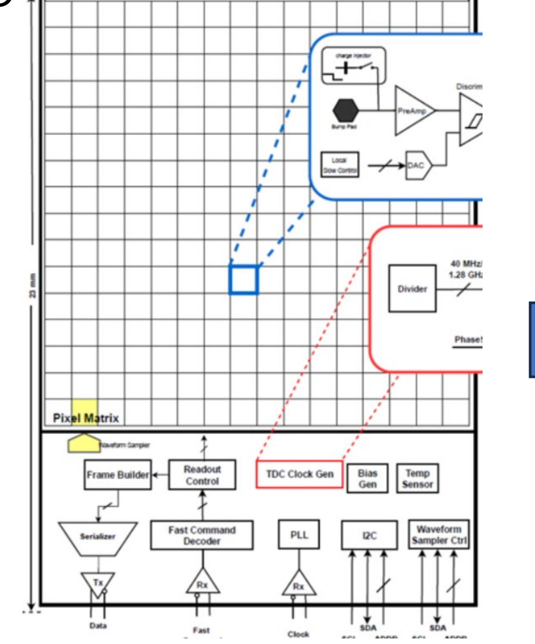


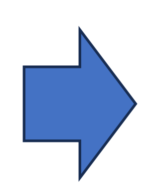
ASIC horizontal placement

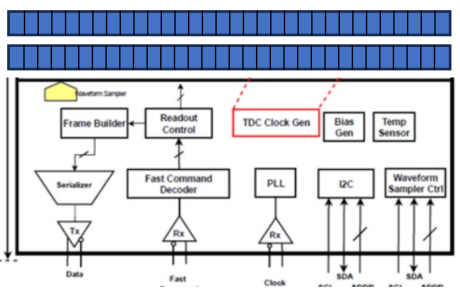


- Signal lines are placed horizontally in FPC
  - Which placement are appropriate for us?
- ASIC size might get shorter

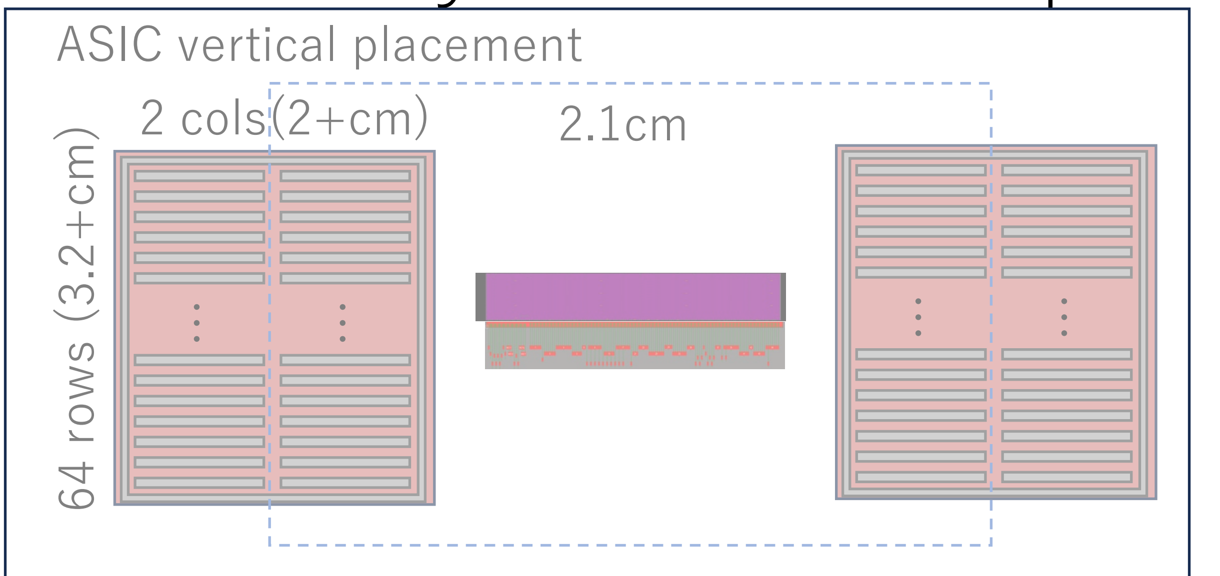
- ASICのデザインは進んでいない
- Interposerのデザインは進んでいない

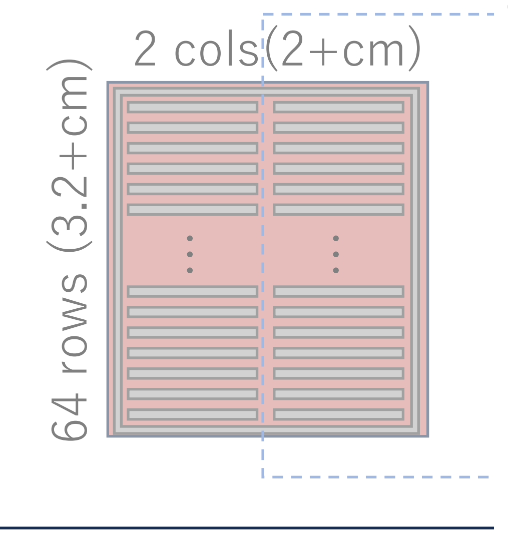






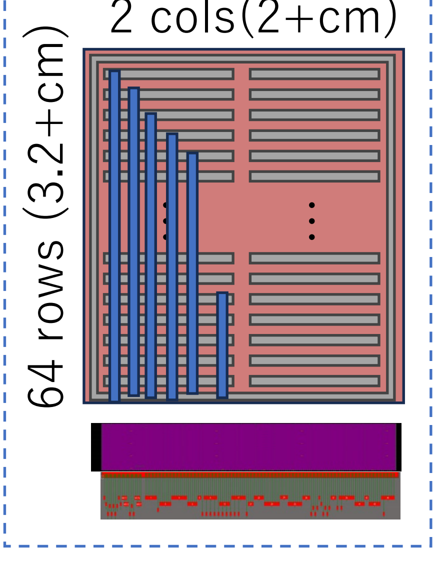
ASIC Layout as example 3

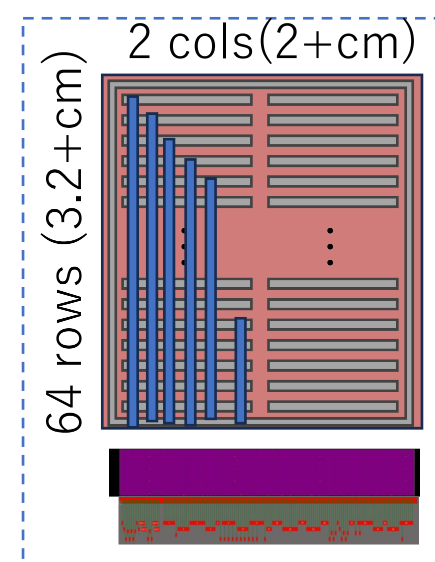




N shaped electrodes by double metal on INTT sensor

ASIC bottom placement



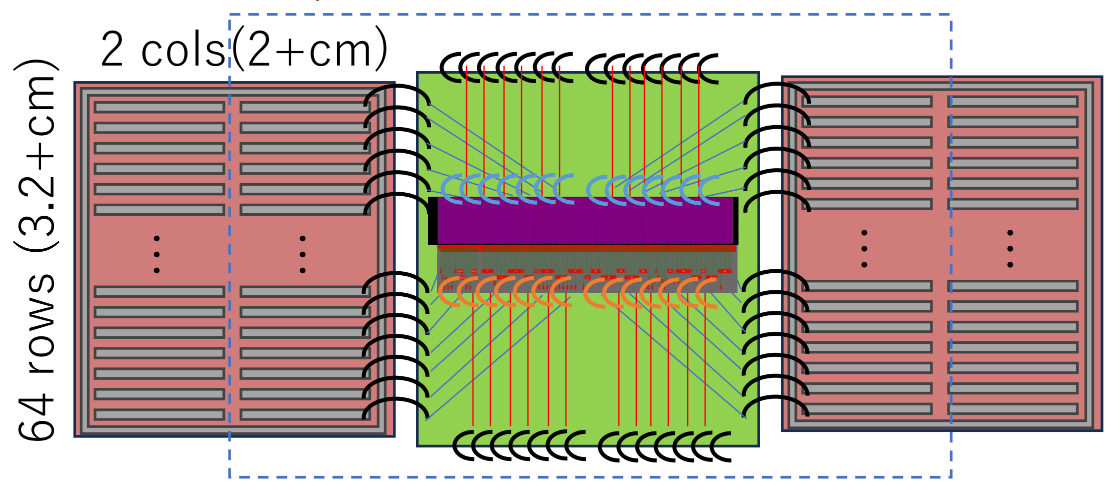


- Bottom placement
  - Double metal technology
    - Standard for nominal Si (INTT used)
  - Easy to make an unit module

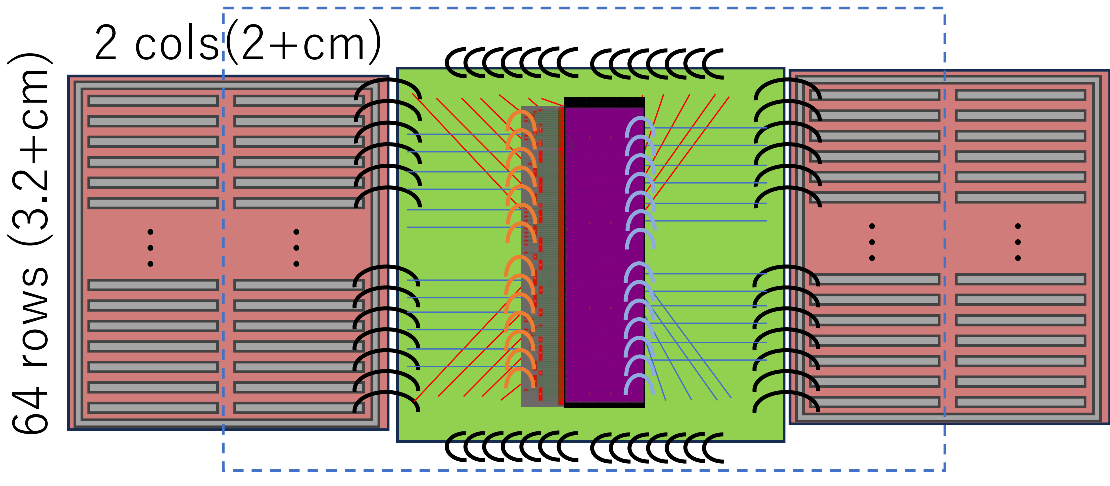
- ミーティング時のコメント
  - ダブルメタルはCh毎に配線長が異なり、時間分解能が悪くなる。
  - 蜂谷コメ：　配線長はインターポーザとチップのデザインによる部分も大きい。　配線長による分解能の悪化度合いはStudyが必要

ASIC Layout as example 2

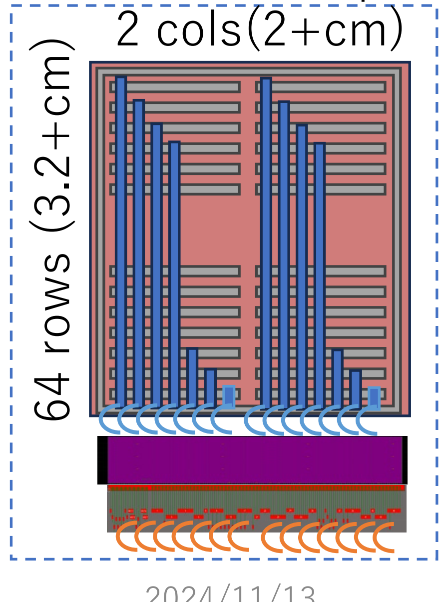
ASIC vertical placement



ASIC horizontal placement



ASIC bottom placement



- インターポーザがある場合
  - 多層基板が必要
  - 内部の配線長はCh毎に異なる。
  - FPCかRigidか、まだ決まっていない。
- インターポーザが無い場合、
  - WireBondingは単純になる。
    - その分FPCが複雑化？　要検討

Summary

- ETROC2 has many connections (124) including signals, power, and GND

- Questions for design
  - Which lines are in parallel ?
  - What size (dimension) of ASIC (ETROC2) for us?
  - How does ASIC is placed?
  - Furthermore
    - How signal lines are placed in FPC ?
    - Complicated routing of the signal lines are not good for the long FPC.
    - Connecting some short FPC to make long FPC is possible option (as shown by Simone last week)

Simone's slide last week