INTT Sensor Capacitance

RIKEN/RBRC

Itaru Nakagawa

Strip Capacitance

FVTX NIM

The strip length increases with radius on the sensor, and goes from 3.4 mm at the inner radius to 11.5 mm at the outer radius, with a pitch of 75 μm in the radial direction. Each sensor covers 7.5° in ϕ, and since the strips are perpendicular to the radius, they make an angle of 86.25° with respect to the centerline, as can be seen in Fig. 4.

The data words are output over two LVDS serial lines at up to 200 MHz clock rate. The total power consumption of the FPHX is ~390 μW per channel. The noise, when the chip was wire bonded to a sensor with strips ~2–11 mm in length (~1–2.5 pF), was simulated and measured to be below the design specification of 500 electrons.

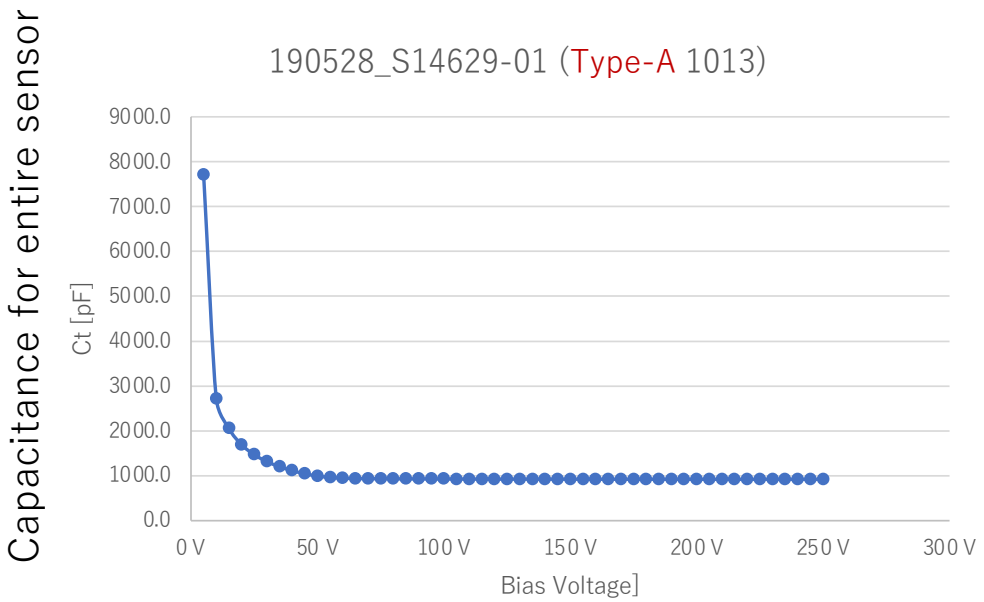
There are discrepancy between the actual measurement by Kaiyu, Hamamatsu, and expected value by simple scaling from FPHX by the length of the strip.

**later slide Hamamasu's measurement

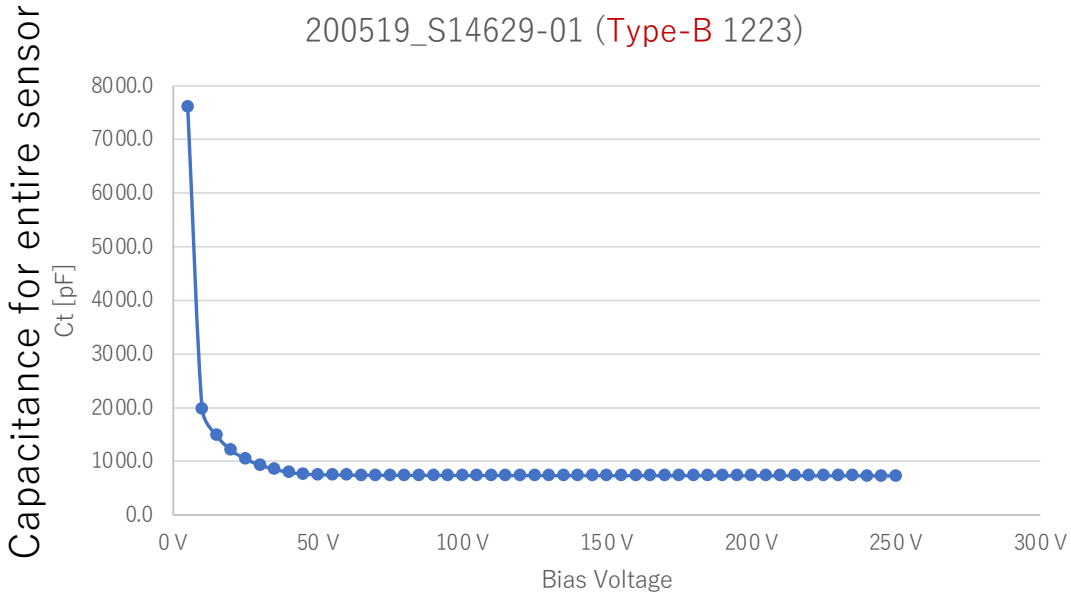
Strip	Thickness [μm]	Width [μm]	Length [mm]	Capacitance [pF]	Measurement (Kai-Yu)	Hamamatsu DC cap**
FVTX	320	78	2 ~ 11 mm	1 ~ 2.5		
INTT-Type-A			12mm	2.5*	~ 1 [pF]	0.45 [pF]
INTT-Type-B			18mm	3*		0.57 [pF]

*Simple scaling from FVTX

Hamamatsu's Measurement

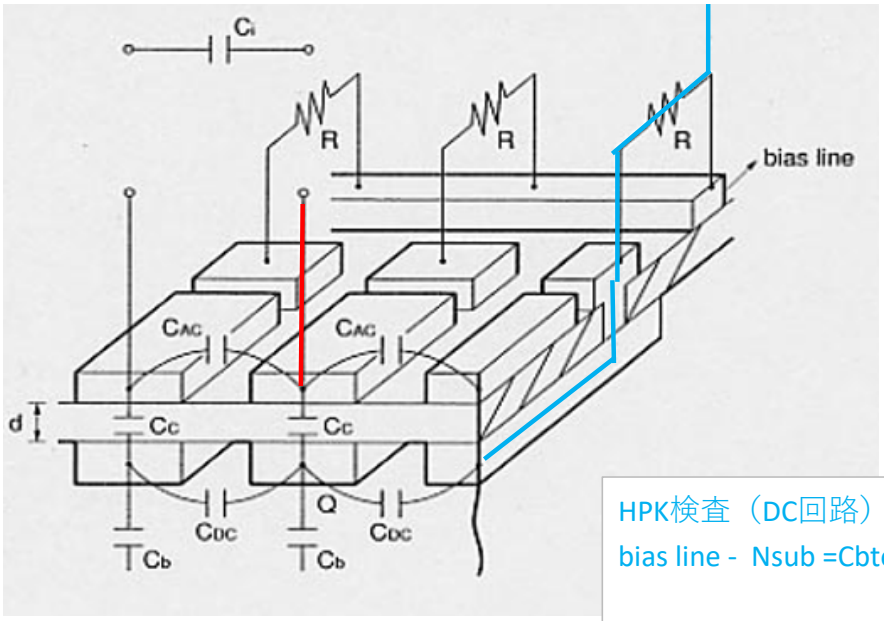


$$\frac{919\ [pF]total}{128\ [strip]\ 16\ [cell]} = 0.45\ [pF/strip]$$



$$\frac{730\ [pF]total}{128\ [strip]\ 10\ [cell]} = 0.57\ [pF/strip]$$

Hamamatsu's vs Kai-Yu's Measurement



CC : Coupling capacitance
Cb : Body capacitance
CDC : Capacitance between strip diffusions
CAC : Capacitance between AC electrodes
R : Bias resistance
Ci : Interstrip capacitance

HPK検査（DC回路）
bias line - Nsub =Cbtotal

論文の測定（AC回路）
CcやCiが加わる

On 2023/05/22 1:52, kaoshima@hq.hpk.co.jp wrote:

理化学研究所　中川様

お世話になっております。
浜松ホトニクス株式会社　青嶋です。

ご連絡ありがとうございます。

論文とは対象としている容量が異なると思います。

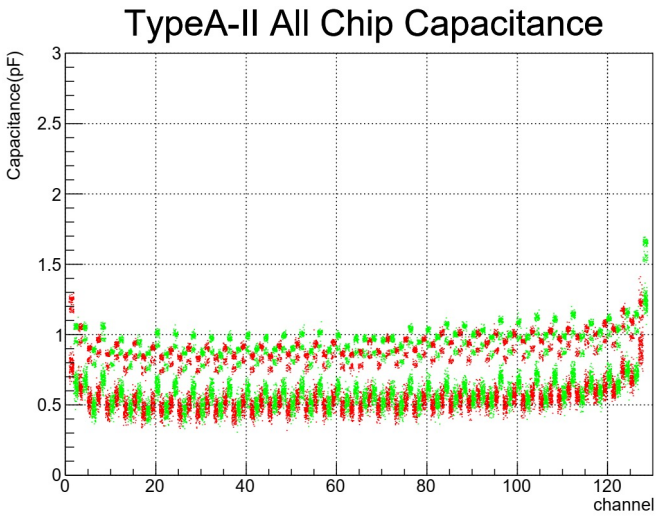
when the chip was wire bonded to a sensor with strips ~ 2–11 mm in length (~ 1–2.5 pF), was
simulated and measured to be below the design specification of 500 electrons.

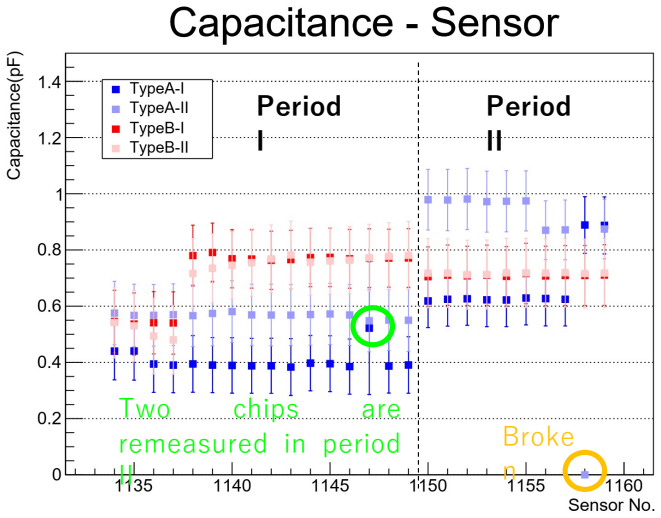
ですので、ACPADから見た際の容量(Load capacitance)になりますので、

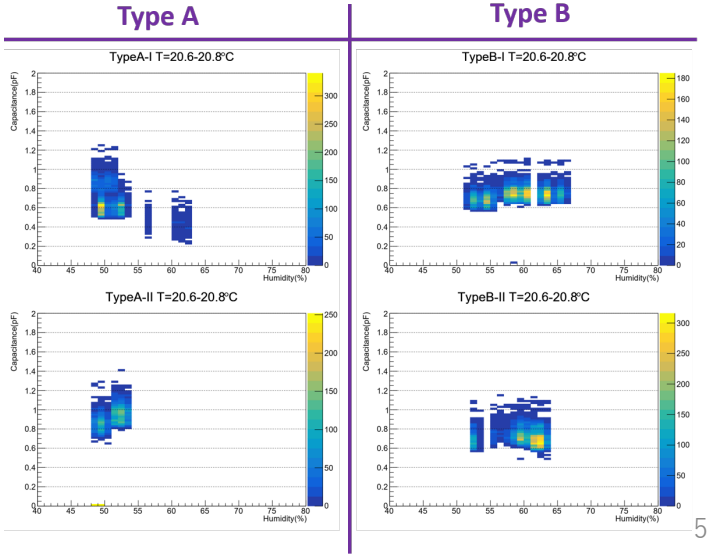
のモデル図になるかと思います。
HPKから提供しているデータは、Bias ring-Nsub間の総容量（Vfd算出のための測定データ）ですので、
このうちCbの全strip totalを測定しているものとなります。

The Measurement Result of INTT Sensor Testing

- Because the layout of sensor, each module is divided into four parts in the measurement. The left plot show one part result of sensor 1133-1159. All capacitance of channels are gaussian distribution, so we can identify the broken and functional channels from measurement. The left plot obviously show there are two different distributions. These differences could match to measuring period that be showed in middle plot.
- The capacitance of signal channel showed in left plots is about 0.5pF, so total capacitance is about 1000pF. Compared with total sensor from HAMAMATSU's inspection only has 7% difference. Therefore, this method could measure the capacitance of single channel.
- To check why capacitances are different in periods, we analyze the relation between environment and measurement. The right plots shows the variety of capacitance with humidity at same temperature. The result shows the measurement is not obviously affected by humidity, so maybe this effect come from the status of sensor or measure system.

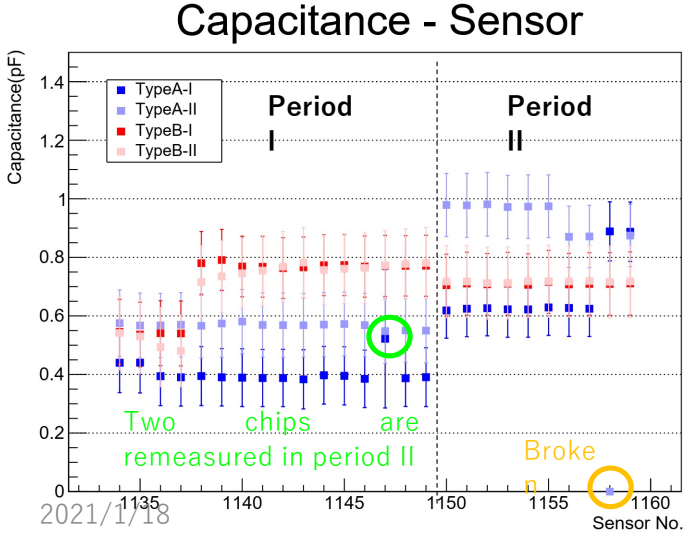


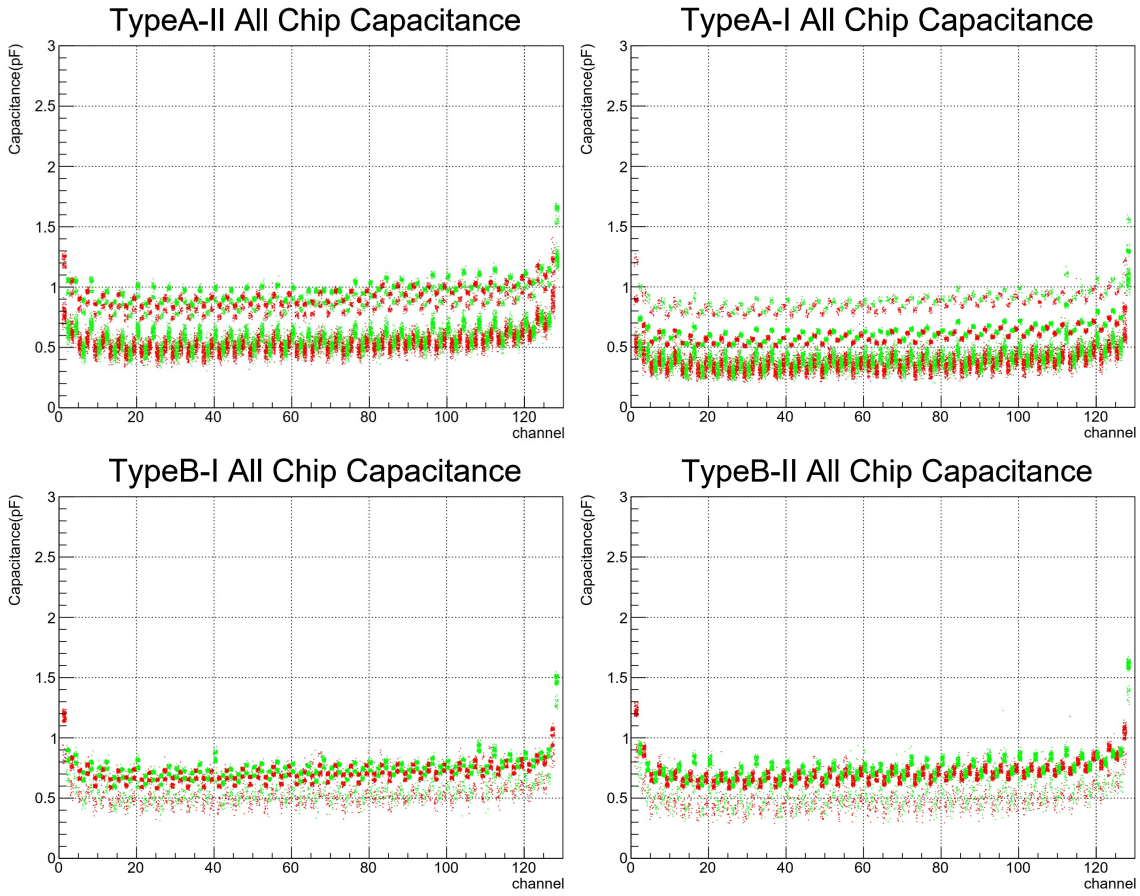




The Measurement Result of INTT Sensor Testing

- One set of sensor need use four probe cards to measure all chips. All sensor data shows in right four plots. These plots obviously show there are few different capacitance distributions. These differences could match to measuring period.
- The measurement was paused in the middle, so whole testing could be divided into two period. The bottom plot shows the values are different in these two periods.





Strip Capacitance

Thickness:320 [μm]

Strip	Length [mm]	Pitch [mm]	p+ width [mm]	Al Width [mm]	Meas. [pF] (Kai-Yu)	HPK model [pF]	FVTX NIM
FVTX	2	75	18	28	N/A	0.32	1
FVTX	11				N/A	1.74	2.5
INTT-Type-A	12	78	10	20	0.5 ~ 1.5	1.57	
INTT-Type-B	18				0.4 ~ 1.5	2.35	

- Hamamatsu's a model calculation is consistent with given dimensions.
- The capacitance value found in FVTX NIM is larger than Hamamatsu's calc by factor of 2 to 3.
- Kaiyu's measurement is smaller than Hamamatsu's calc by > 1/3 or so.
- Problem what to be stated in the INTT paper.

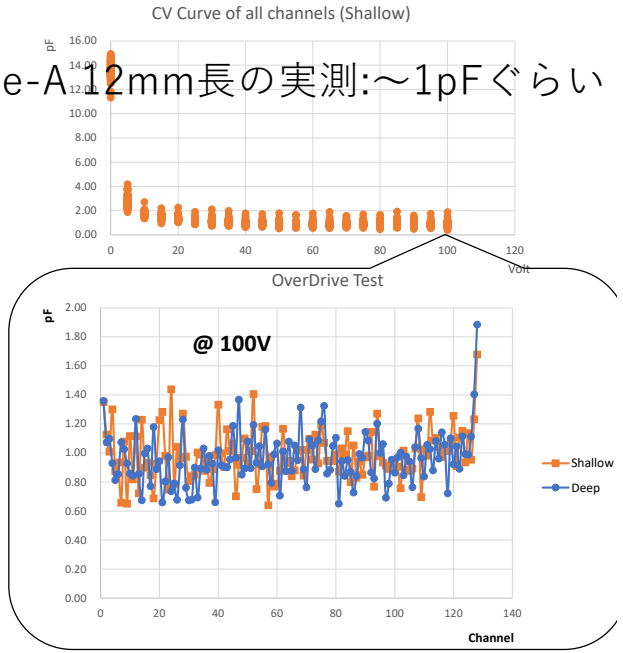
Backup

Stripの電気容量

*FVTXの長さでスケールした予測値

Strip	Thickness [μm]	Width [μm]	Length [mm]	Capacitance [pF]	実測値	Hamamatsu DC cap**
FVTX	320	78	2 ~ 11 mm	1 ~ 2.5		
INTT-Type-A			12mm	2.5*	~ 1 [pF]	0.45 [pF]
INTT-Type-B			18mm	3*		0.57 [pF]

Type-A 12mm長の実測:~1pFぐらい



FVTX： pitch 75um
P+ width 18um
AL width 28um

strip length 2mm 0.32pF/strip
11mm 1.74pF/strip

S14629-01： pitch 78um
P+ width 10um
AL width 20um

strip length 12mm 1.57pF/strip
18mm 2.35pF/strip

- On 2023/05/24 21:03, kaoshima@hq.hpk.co.jp wrote:

- 理化学研究所　中川様

  お世話になっております。
  浜松ホトニクス株式会社　青嶋です。

  ご連絡ありがとうございます。

  理由については、よくわからないです。
  そのため、こちらの持っている試算モデルで、ジオメトリーからの理論値を出してみました。
  論文の容量値のほうは少し大きく出ている気がします。

  FVTX：　pitch 75um
  　　P+ width 18um
  　　AL width 28um

  strip length 2mm 0.32pF/strip
  　　11mm 1.74pF/strip

  S14629-01：　pitch 78um
  　　P+ width 10um
  　　AL width 20um

  strip length 12mm 1.57pF/strip
  　　18mm 2.35pF/strip

  よろしくお願いします。

＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊
浜松ホトニクス株式会社 営業本部
国内統括部 東京営業所
青嶋 克海
〒100-0004 東京都千代田区大手町2-6-4
常盤橋タワー11階
T.03-6757-4994 F.03-6757-4997
携帯.080-1607-2123
E-mail kaoshima@hq.hpk.co.jp
＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊＊