μ-Coax Cable Neutron Radiation Exposure Plan

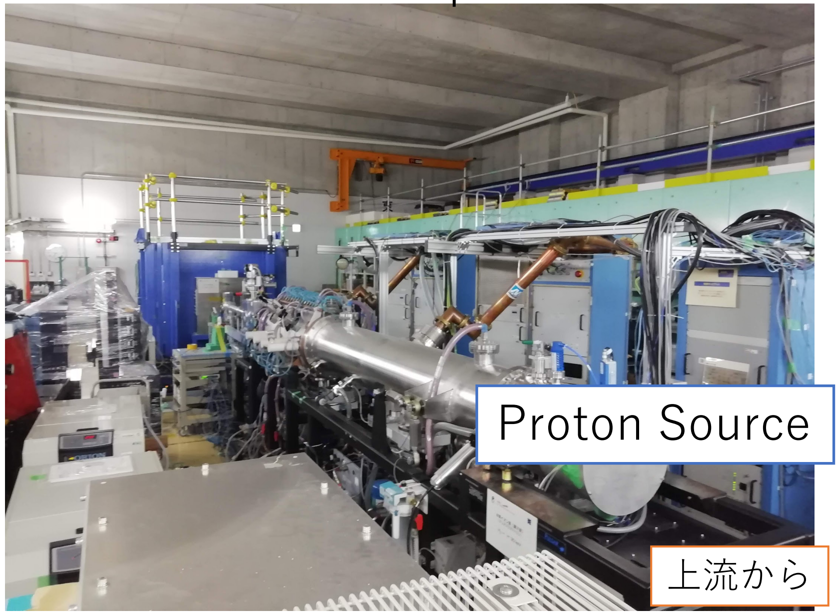
RIKEN/RBRC

Itaru Nakagawa

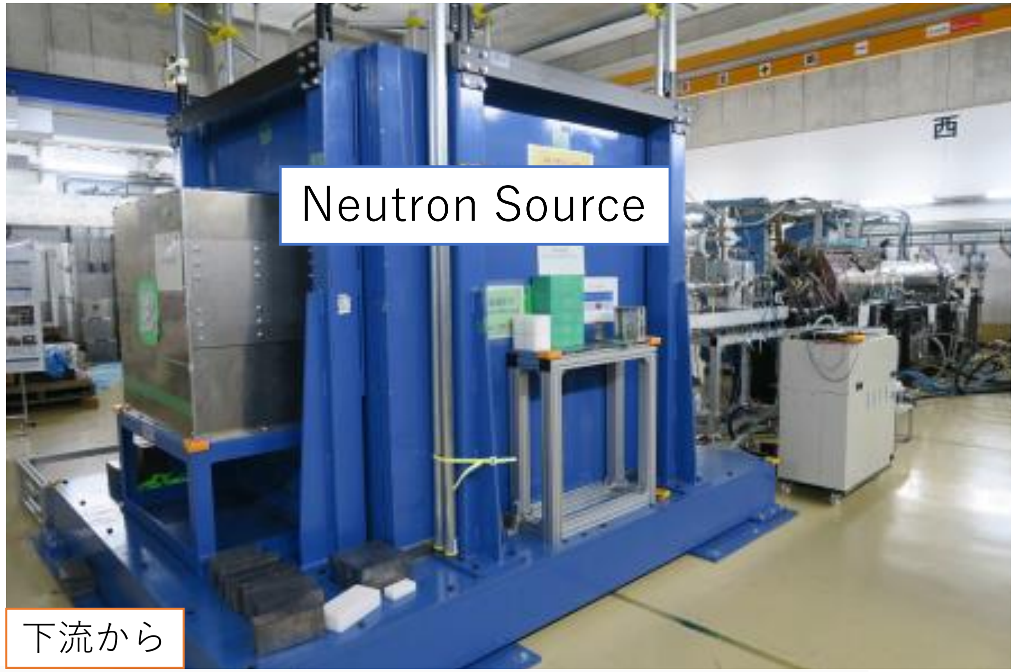
Any chance to expose μ-Coax in Radiation?

RIKEN Accelerator-driven compact Neutron Source: RANS

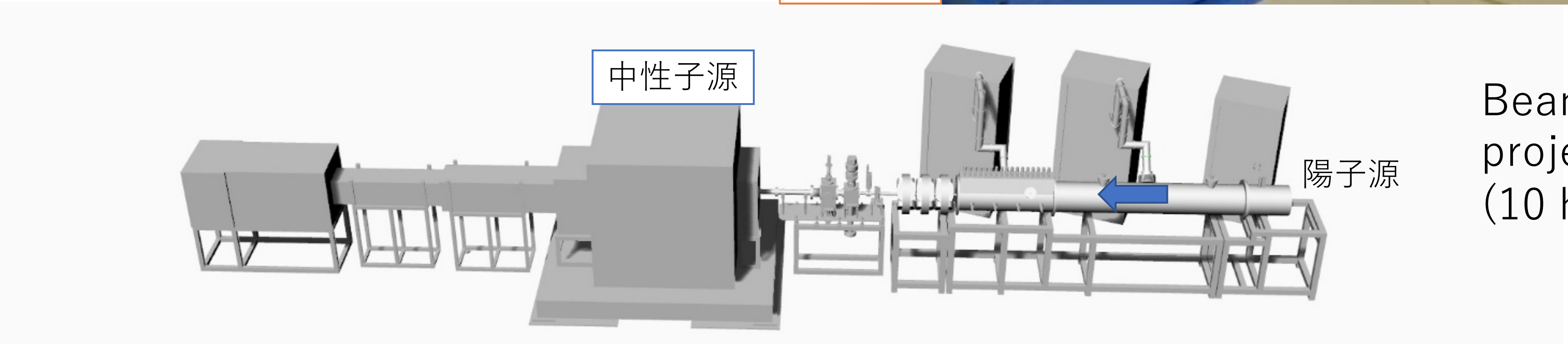
View from Upstream



View from Downstream



COMING UP



Beam Time for FoCAL@ALICE project in March 3-4, 2022. (10 hours)

2

RANS Neutron Source Characteristics

- Proton 7MeV, 100μA, 6 x 10^{13} proton/s
- Neutron 5MeV max, 10^{12} neutron/s from the target

	RANS	RANS-II
加速イオン	水素（陽子）	水素（陽子）
エネルギー	7MeV	2.49MeV
最大イオン電流	100μA	100μA
中性子発生核反応	^{9}Be（p,n）^{9}B	^{7}Li（p,n）^{7}Be
Maximum Neutron Energy	5MeV	0.7MeV
加速器方式	RFQ+DTL	RFQ
加速器本体重量	5t	2.5t
遮蔽体重量	20t	3t
装置長さ	15m	5m

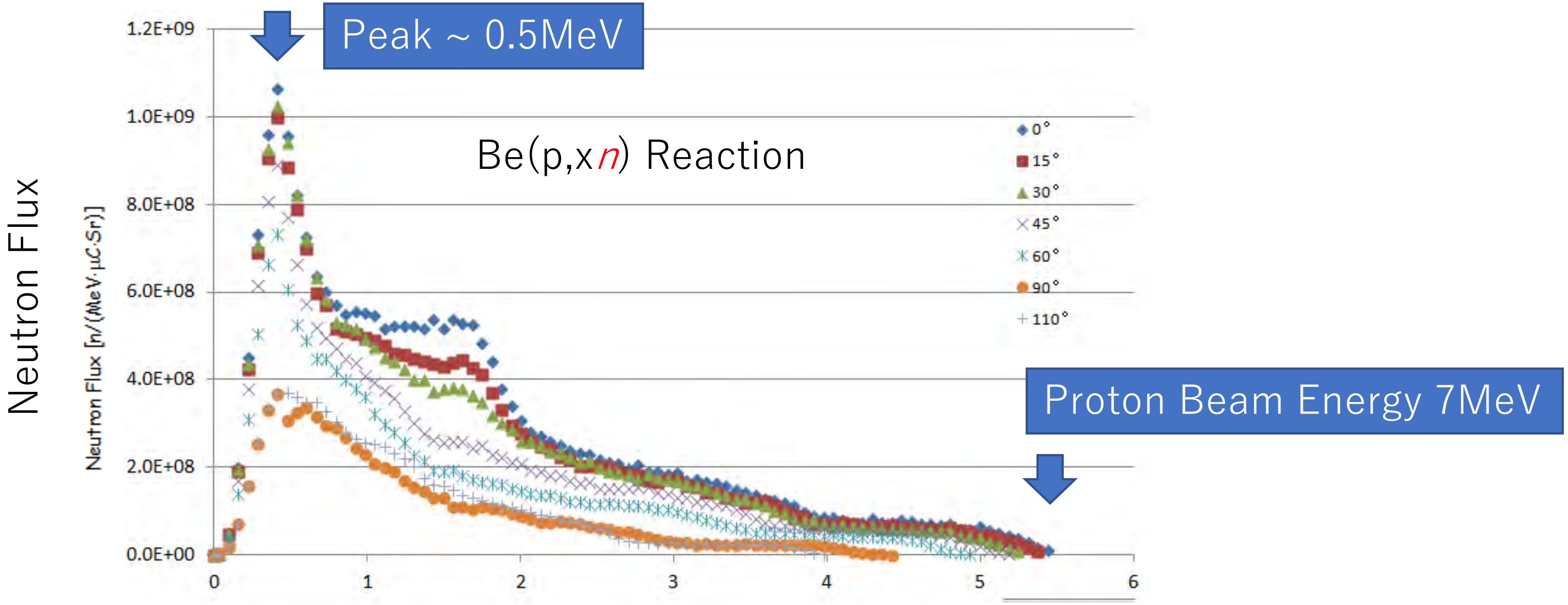
表1 RANSおよびRANS-IIのパラメータ比較

RANS-IIでは、陽子線のエネルギーを2.49MeVに絞り、標的をリチウム（Li）にしたことで、RANSと比べて加速器重量は1/2、遮蔽体重量は1/7程度にできた。装置全体の長さも1/3（5m）に短くなった。

Energy Profile of Neutron Beam

Neutron and Gamma Source Data

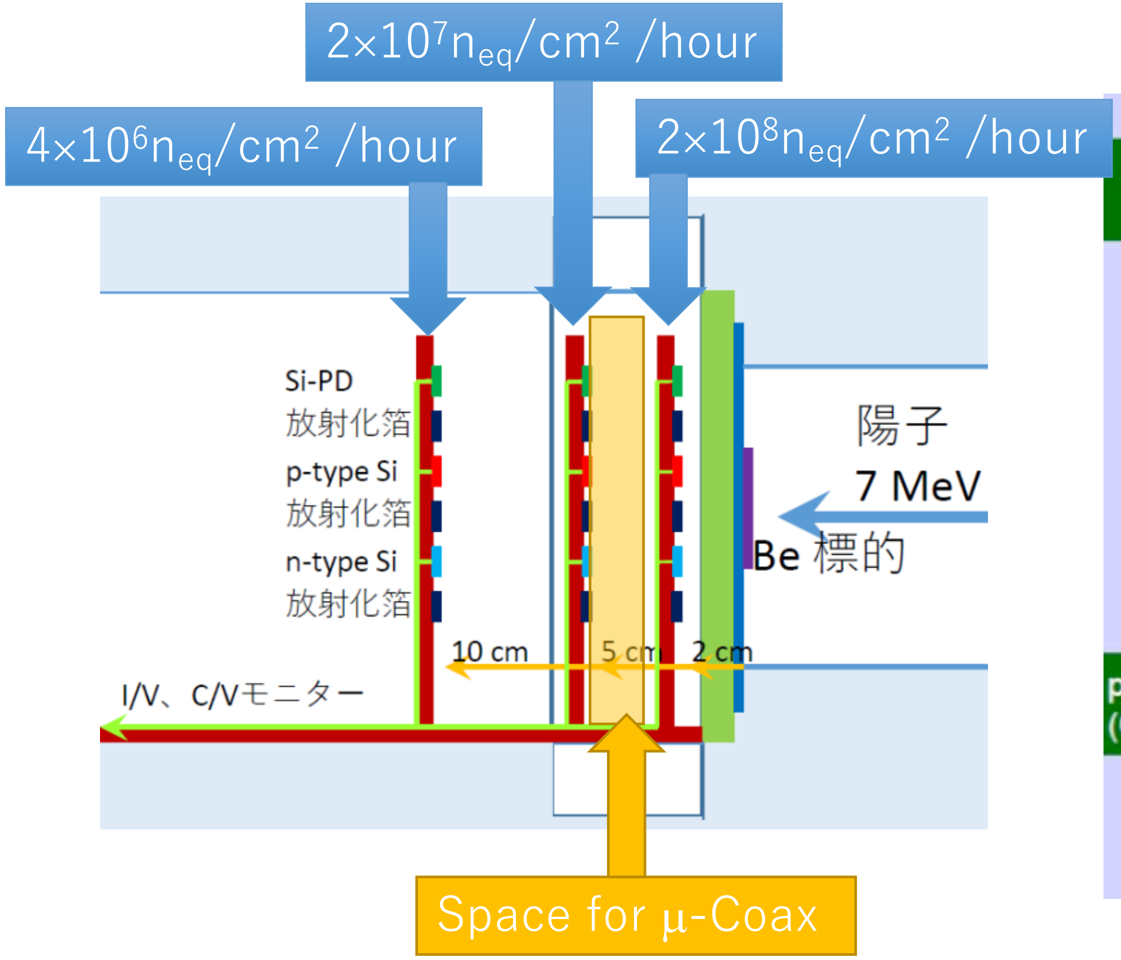
✓Neutron energy spectrum: Use TOHOKU Univ. data of 11 MeV* * for 7MeV by assuming linear relationship



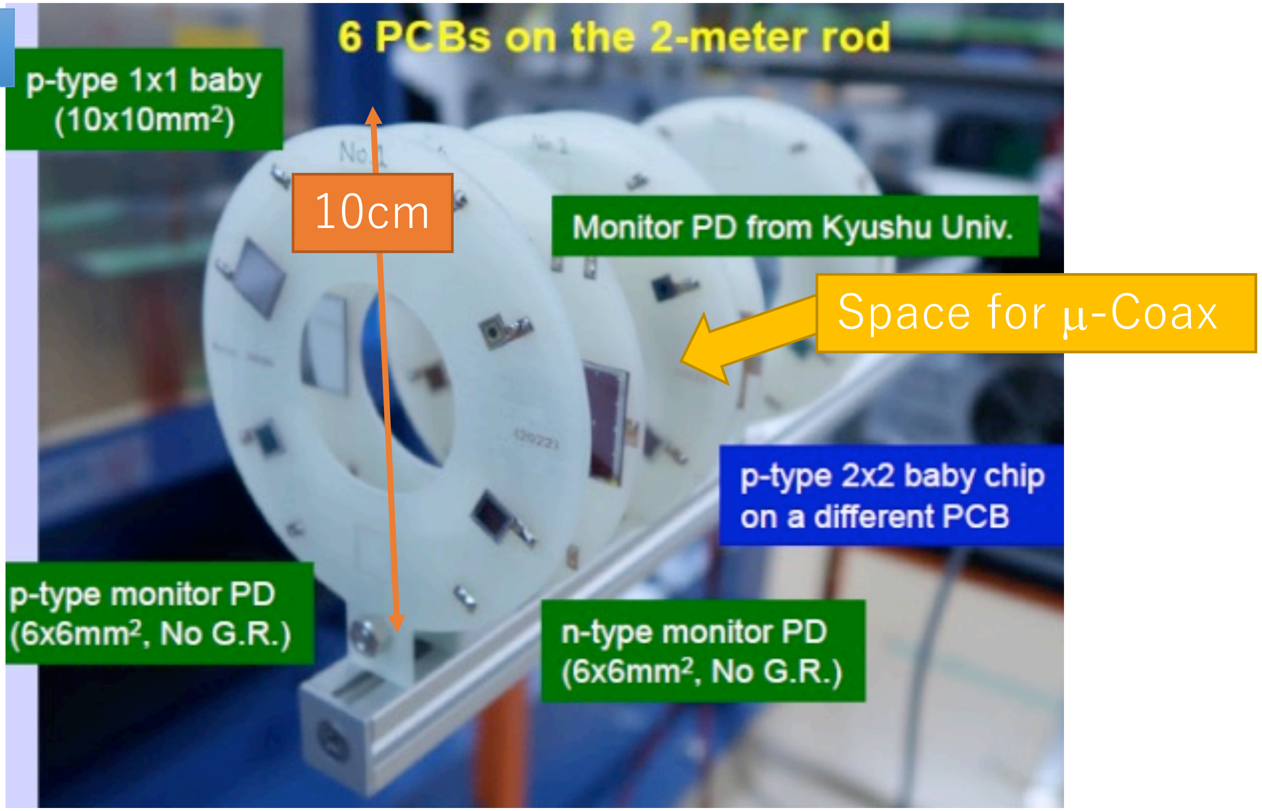
* * 東北大学　サイクロトロン・RIセンター 鎌田創 et al, 厚いターゲットからの生成中性子スペクトルの測定－11 MeV陽子による^{nat}Be(p,xn)反応－，2006年原子力学会春の年会

http://www.rri.kyoto-u.ac.jp/neutron/optics/workshop/20130118/20130118_06.pdf

Setup for the irradiation

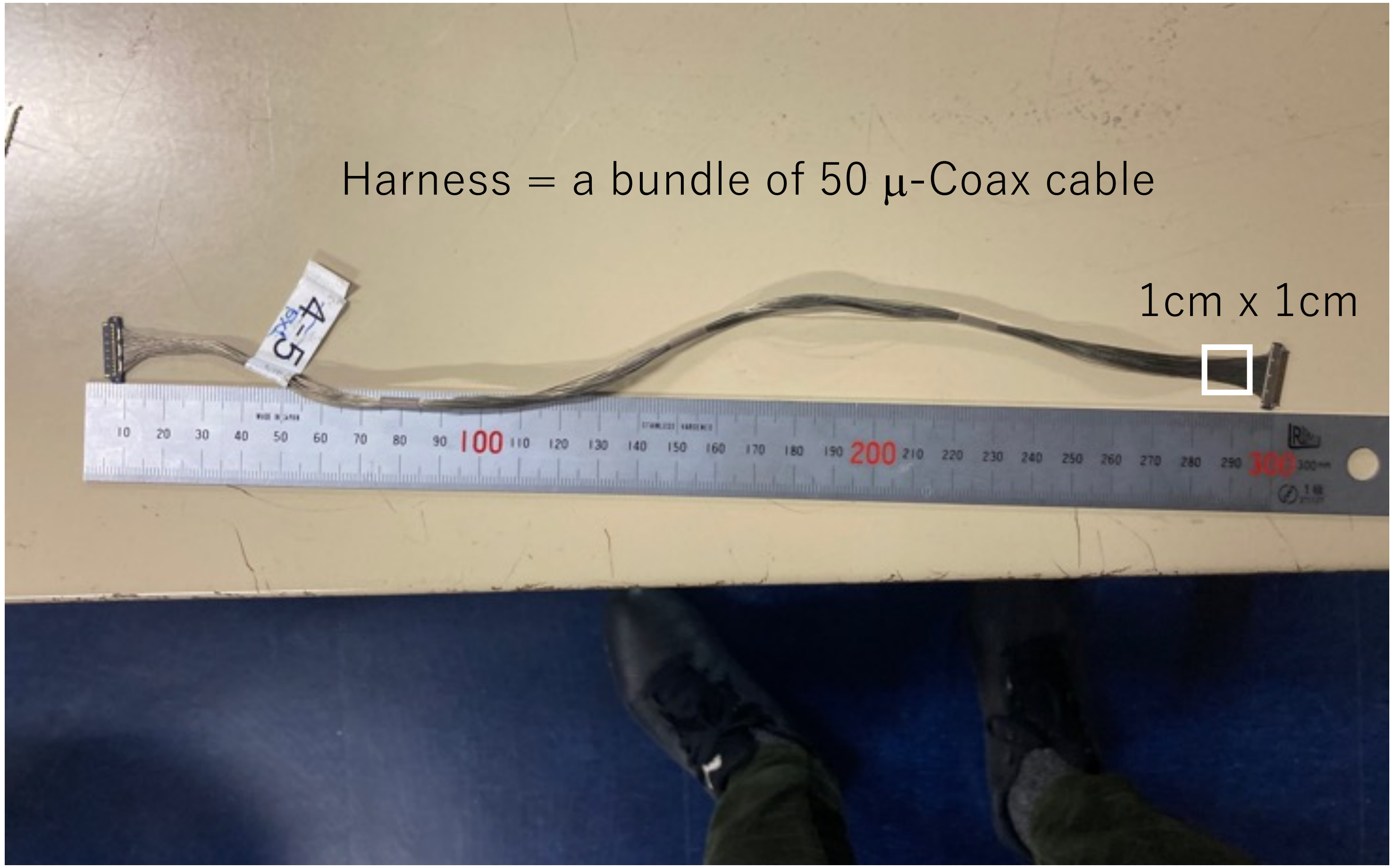


~ $5\times10^8 n_{eq}/cm^2$ /hour ?



FOCal Radiation Exposure Setup

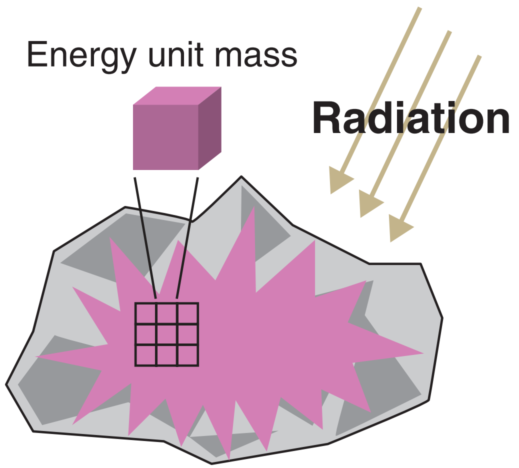
micro-Coax Radiation Exposure Sample



Assuming one spare m-Coax harness got from E16 group for free

Harness + Connectors = 1.00 g
Pair Connectors = 0.30g
Harness = 0.70 g Harness
Weight/1cm long : 0.70g/30cm = **23 mg**

Estimated Radiation Dose



Gray (Gy)

This unit represents how much energy was received by an object or person hit by radiation.
A dose of 1 gray corresponds to 1 joule of energy absorbed by 1 kilogram of matter.

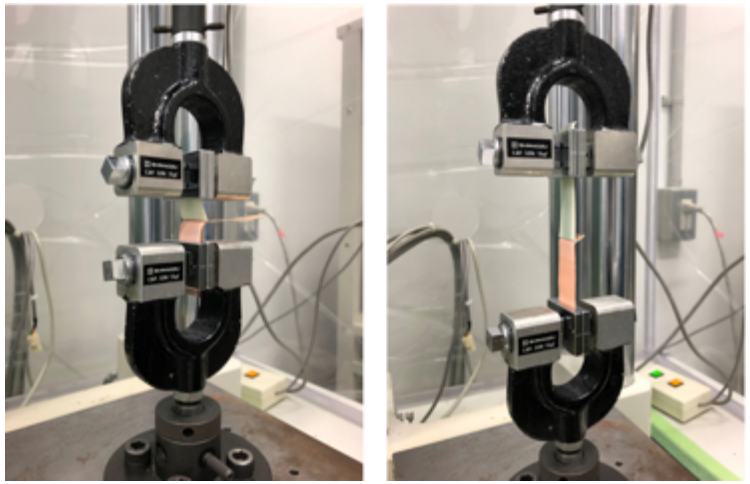
Weight of the Sample to be exposed [mg]	23
Neutron Flux [/cm^2/s]	5E+8
Energy loss per neutron [MeV]	0.5*
Energy loss per neutron [Jule]	8.0E-14
Absorbed dose per neutron [J/Kgm^2=Gy/cm^2]	2.86E-01
Total dose in 10 hours of exposure [kGy/cm^2]	60

*It is unlikely 0.5MeV neutron stops in the cable. Should consider as the upper limit.

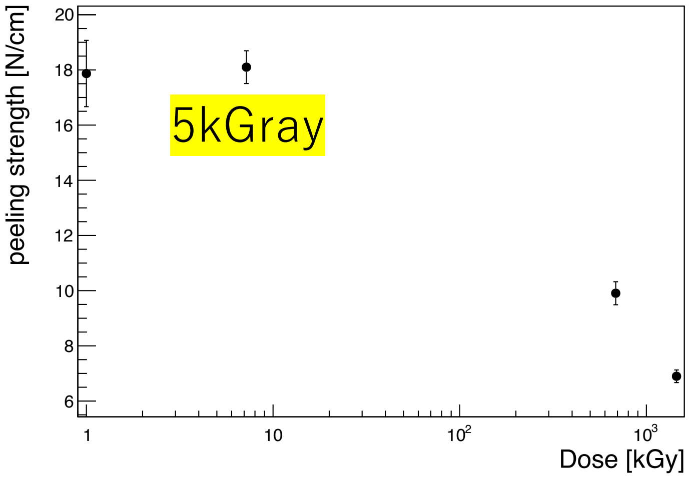
- The estimated radiation dose is not precise. Should be considered as the upper limit.
- Shall we have multiple samples with different dose?

Is 60kGray Sufficient?

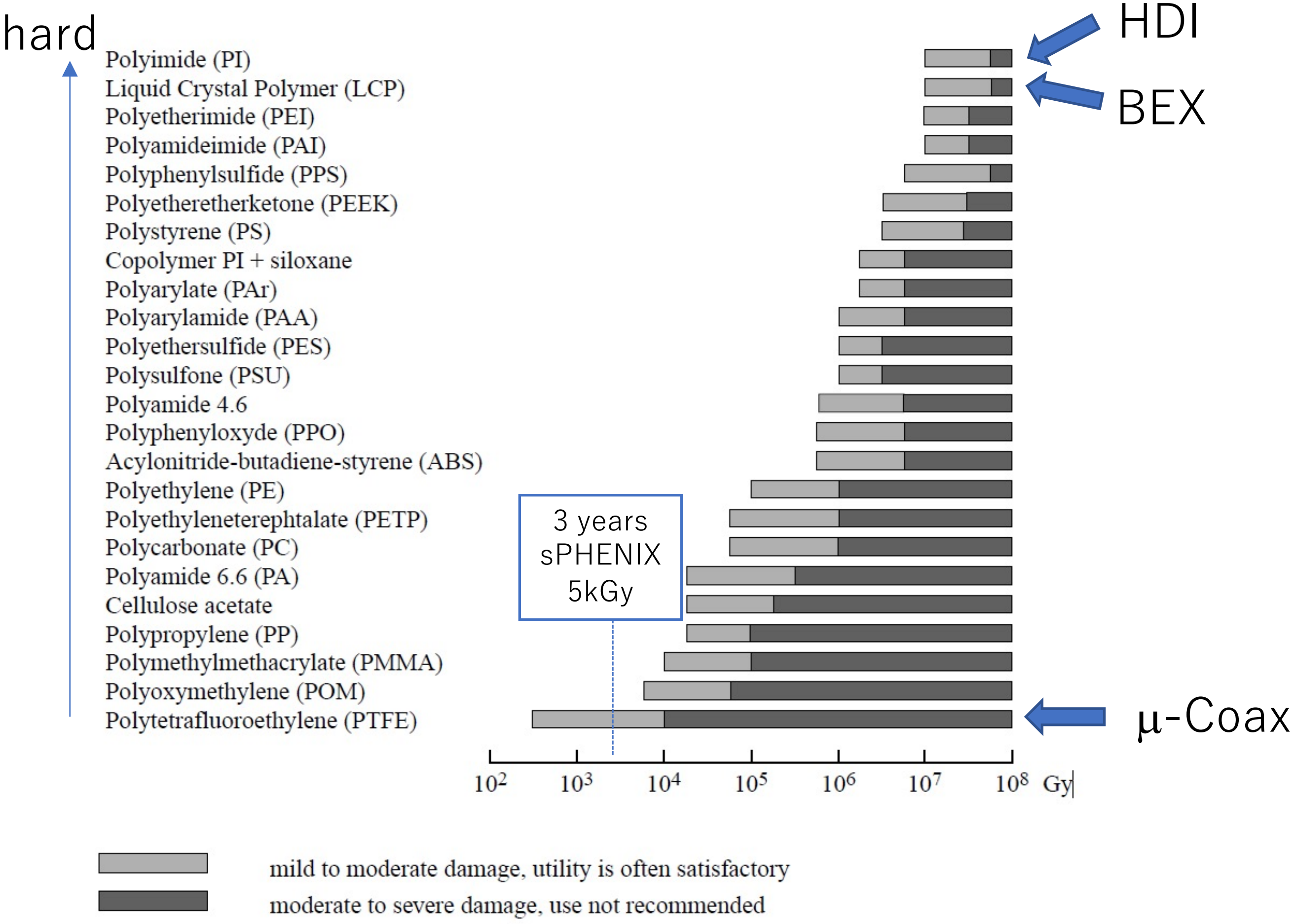
Hikaru Imai, Deploma Thesis (2021)



Peel Strength Test

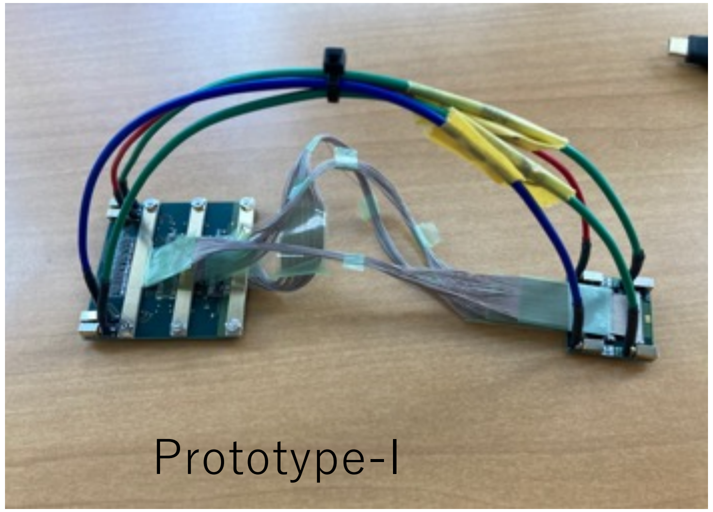


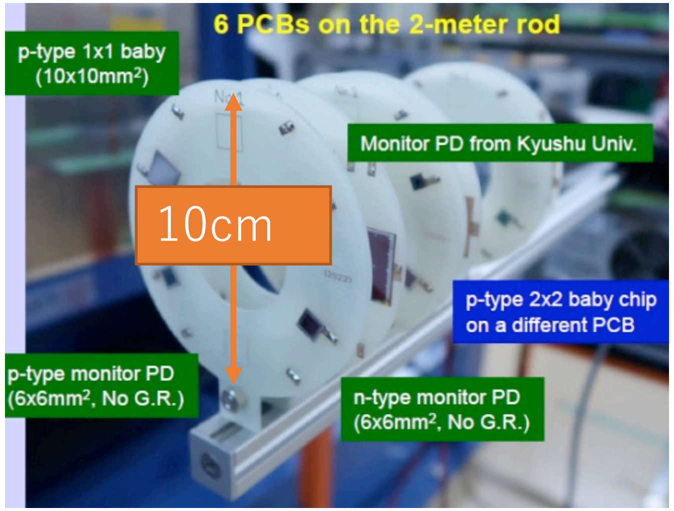
Bus Extender Radiation Hardness Study



Given the distance of the conversion cable from IP, 60kGray seems sufficient.

Which one to be irradiated?

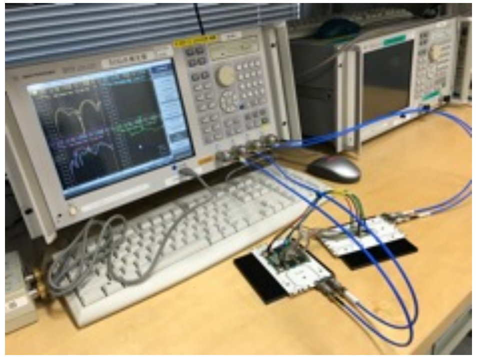




😰 Need to make dedicated board for TDR/sParameter measurement.
😃 Not big deal if it is damaged.

😃 No need to make new board to readout. Also, we already have TDR/sParameter measurement.
😰 Risk to give up further test if it is damaged.

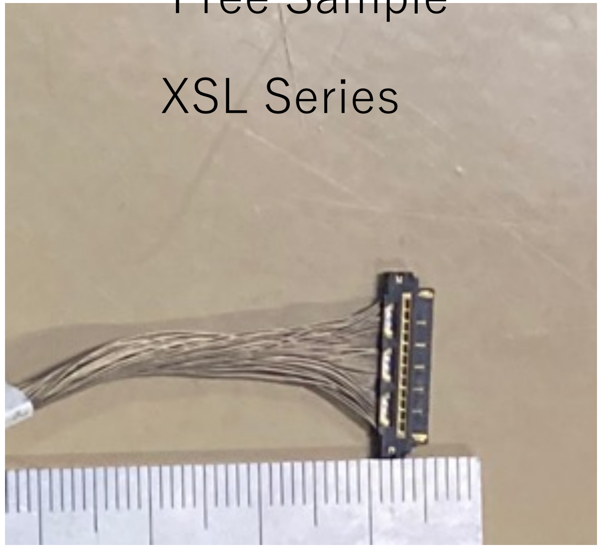
The prototype-I can still fit within the space.

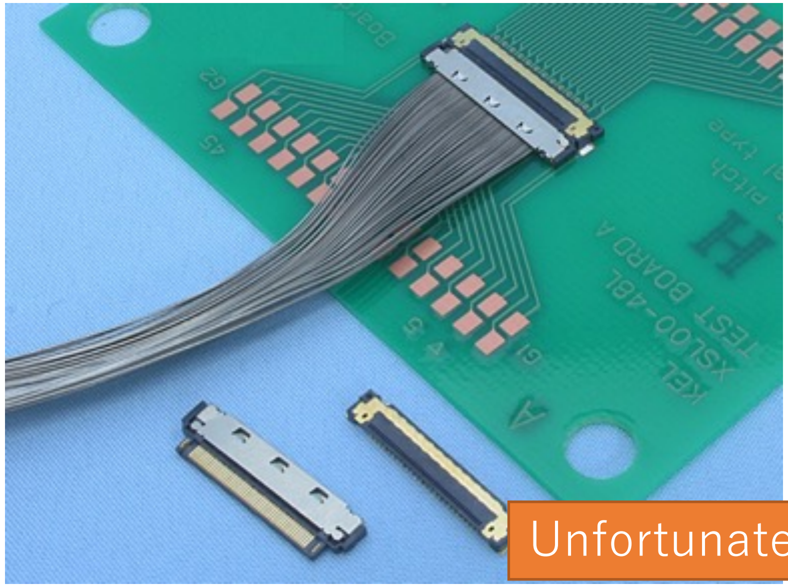


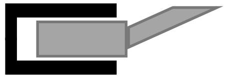
Intermediate monitoring of the damage. Stop irradiation once damage becomes visible.

XSL vs XSLS Model Connectors

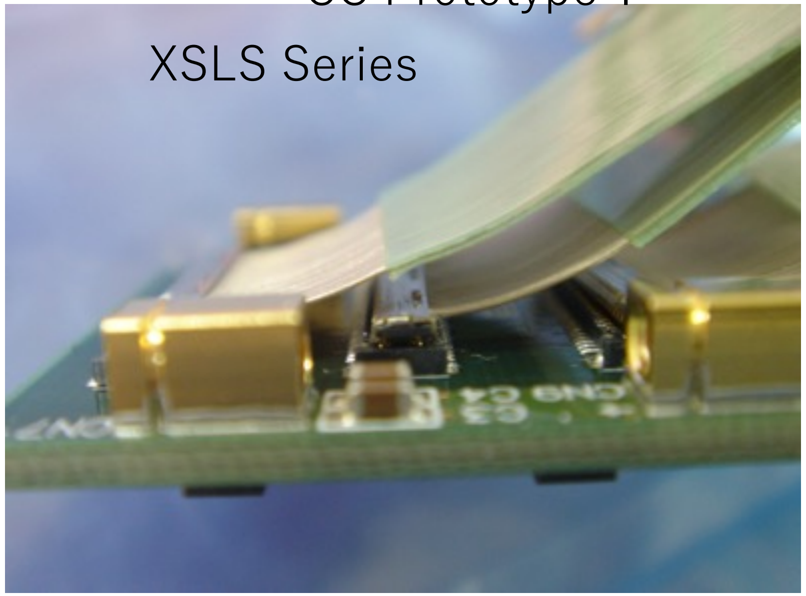
Free Sample

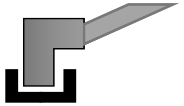






CC Prototype-I

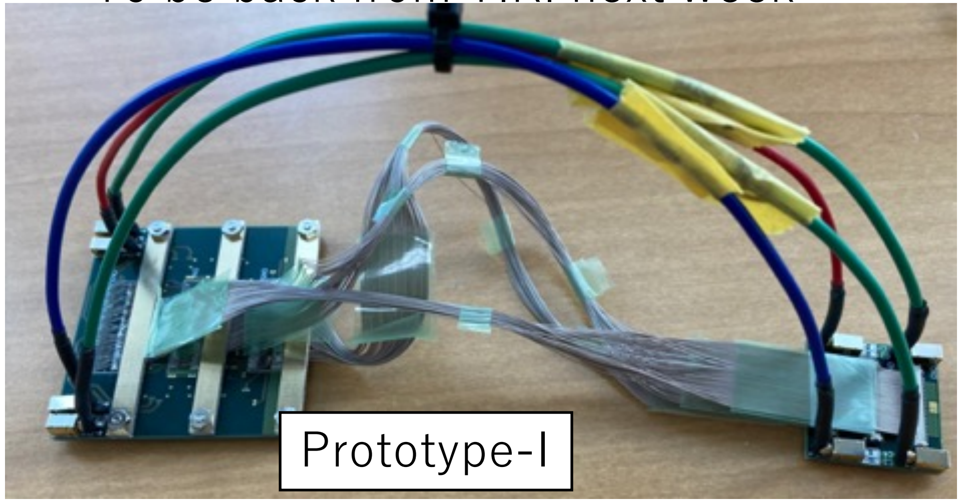




Unfortunately XSL and XSLS are incompatible

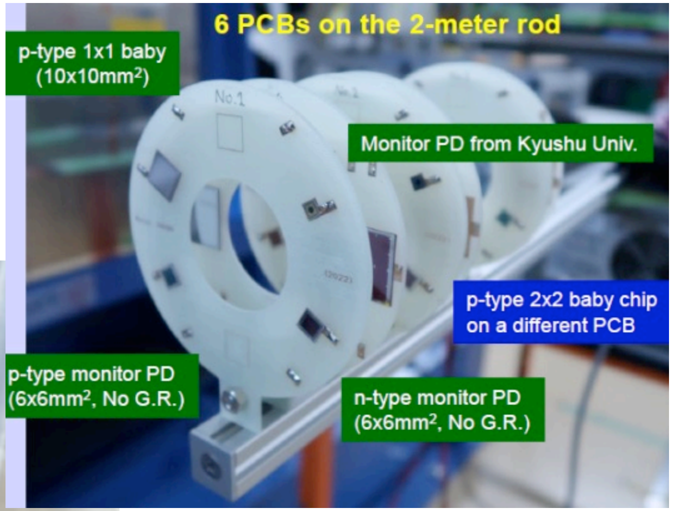
μ-Coax irradiation proposal

To be back from TIRI next week

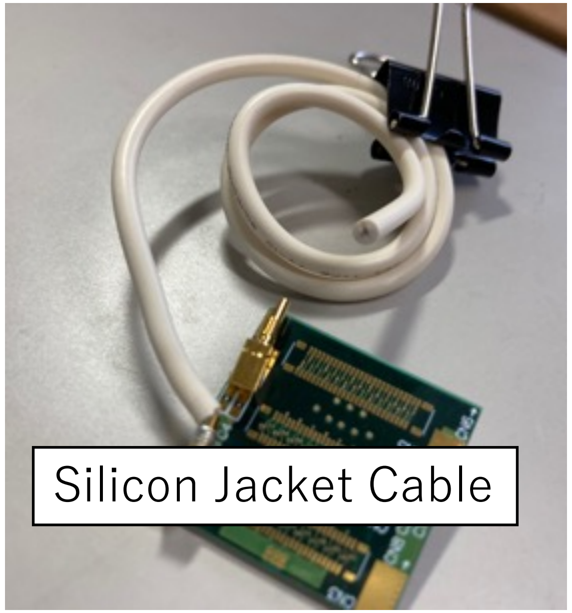


Prototype-I

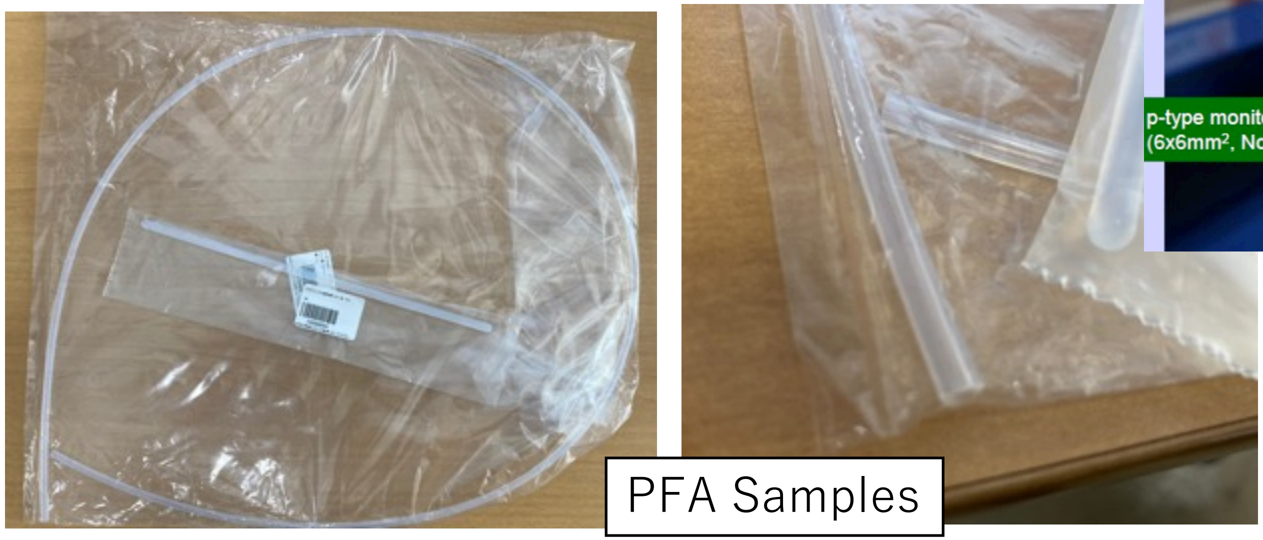
- Prototype-I Cable with one silicon jacket GND cable.
- Some PFA samples.
- Implement passive radiation dose measurement.
- Installation to the irradiation fixture next week.
- TDR/sParameter measurements after the irradiation at TIRI.



FoCAL irradiation fixture



Silicon Jacket Cable



PFA Samples

Backup

位置	1 時間	2 時間	3 時間	4 時間	5 時間
2cm	0.36	0.72	1.08	1.44	1.80
5cm	0.06	0.12	0.17	0.23	0.29
10cm	0.01	0.03	0.04	0.06	0.07

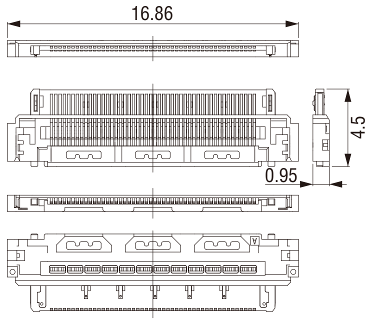
Table 1: 1 日の運転で得られる照射量の見積もり（$\times 10^{12} n_{eq}/cm^2$）。

- Proton 7MeV, 100 μ A, 6 x 10^{13} proton/s
- Maximum current stable produced about 40 μ A
- 5MeV max, 10^{12} neutron/s from the target
- 2 cm from the target: 10^{8} neutron/cm2/s
- After the Be target, several x 10 μ m silver wax, 5mm vanadium, 5mm water, and 5mm titanium

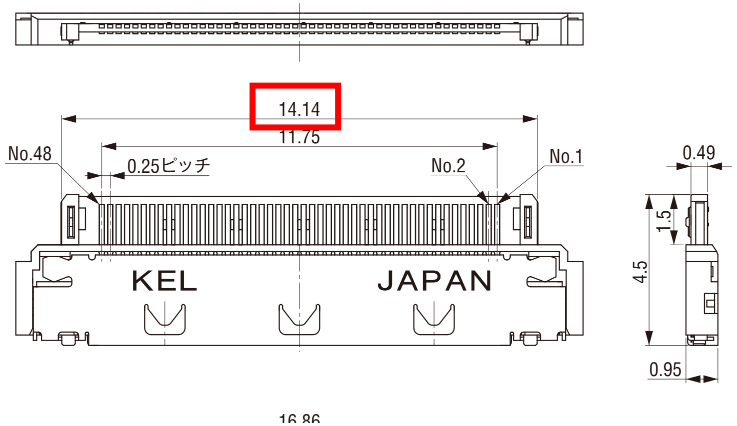
XSL20-48S（プラグ・ケーブル側コネクタ）

単位：mm

XSL20-48Sベース



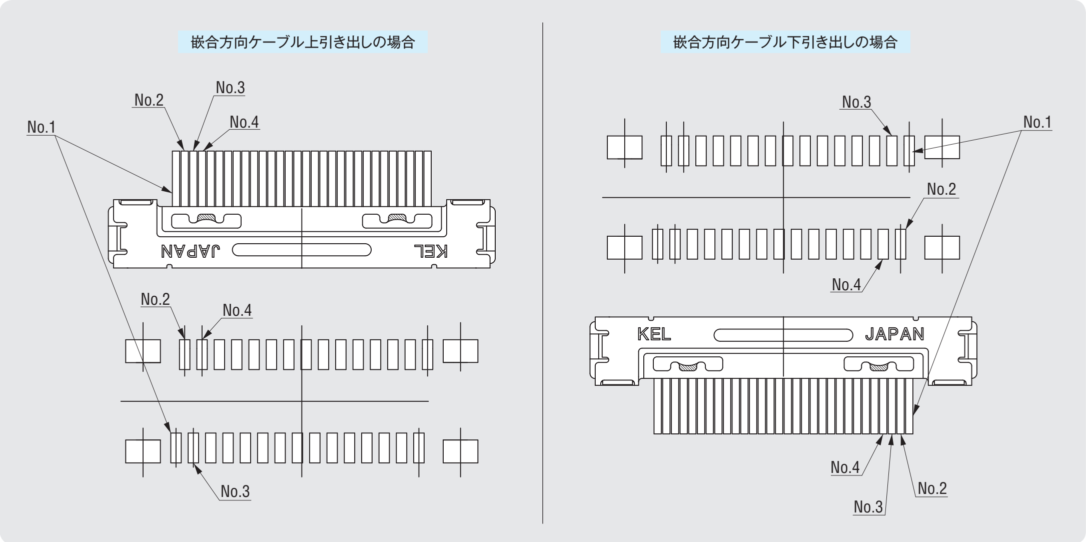
梱包単位
1,000

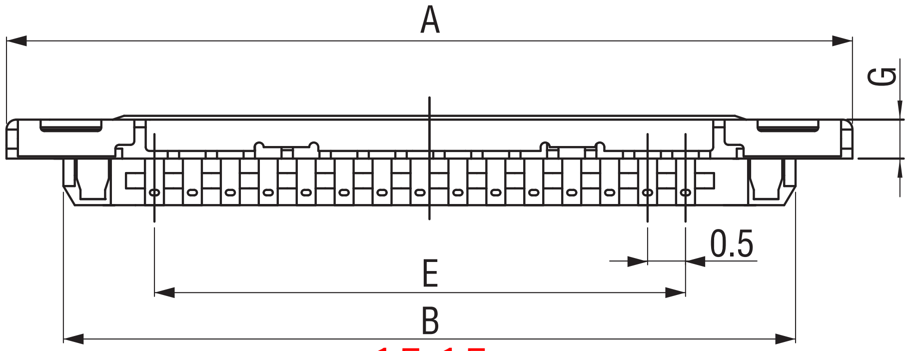


XLS and XLSL are not compatible

参考基板配列

本コネクタは回転対称形状であり実装、嵌合の方向性がありません。ピン配列、およびプラグコネクタ挿入時の嵌合方向に注意をお願いします。
プラグコネクタ挿入方向によるピン配列（コネクタ搭載面）は下図を参照してください。



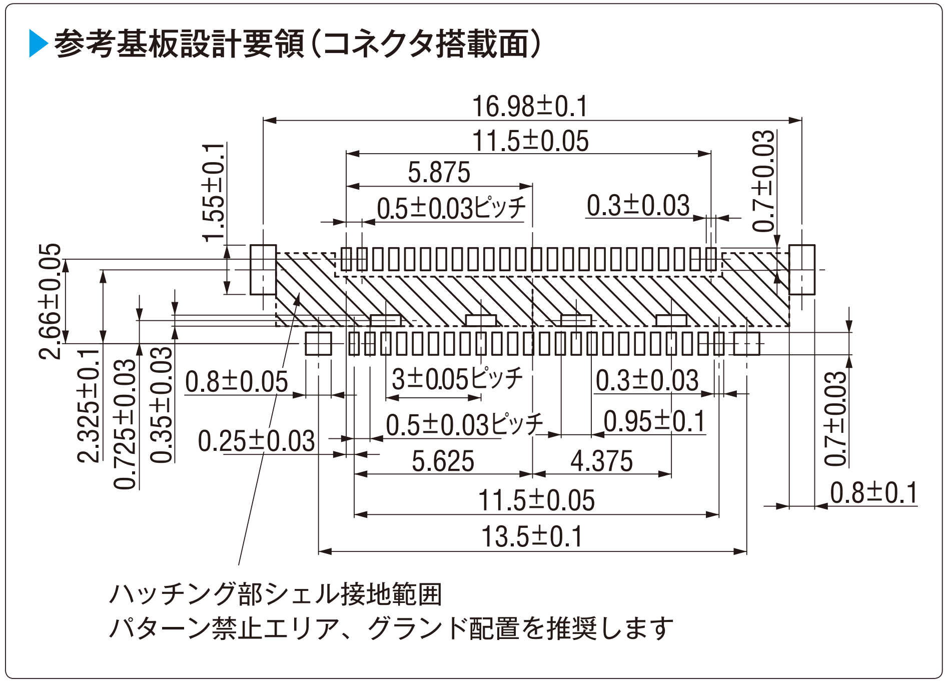


15.15

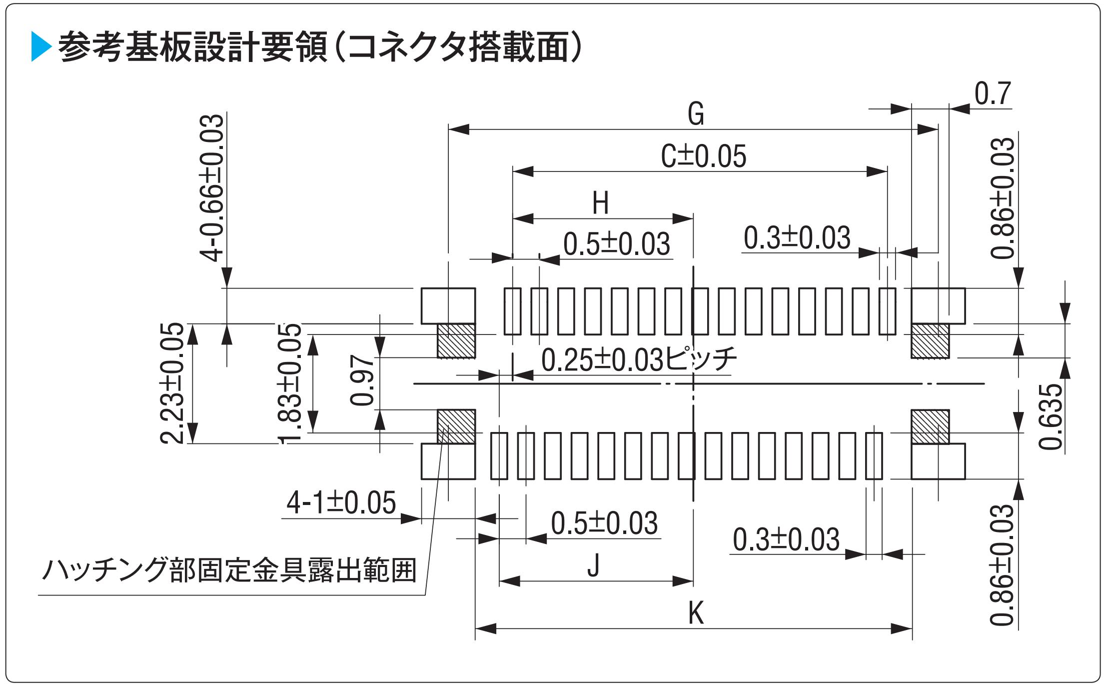
極数	品　名	A	B	C	D	E	F	G	H	J
30	XSLS20-30	11.15	9.65	8.09	7.25	7.0	10.85	0.51	1.97	2.29
40	XSLS20-40-□	13.65	12.15	10.59	9.75	9.5	13.35	0.56	1.99	2.40
52	XSLS20-52-B	16.65	15.15	13.59	12.75	12.5	16.35	0.56	1.99	2.40

Soldering Pattern

XSL Series



XSLS Series



Unfortunately, incompatible. We cannot replace XSLS receptacles by XSL one on the ROC side board.