Information for ATF3 discussion:

Current and possible upgrades and cost estimation for vacuum chambers (including magnets)

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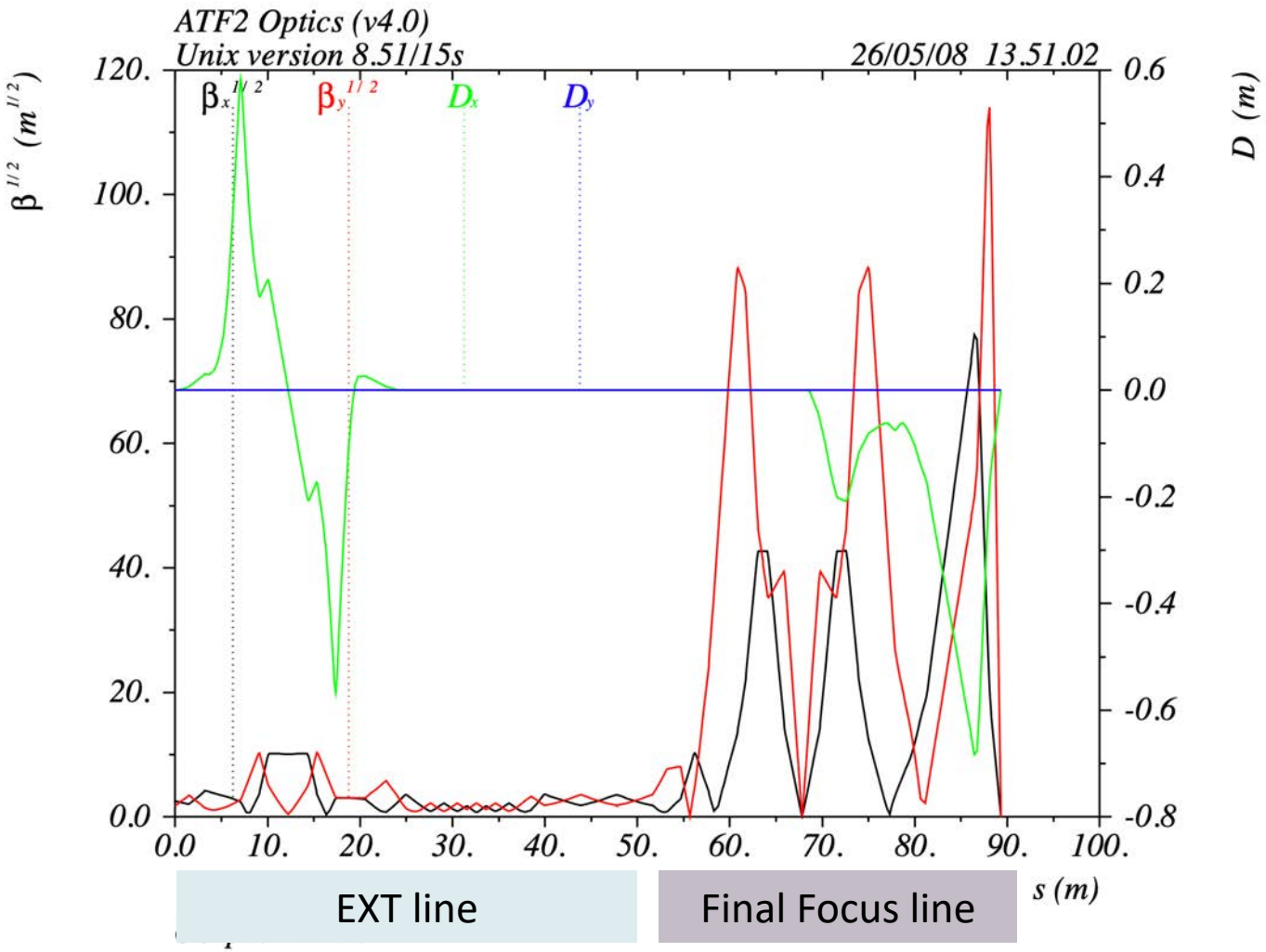
Backgrounds

- Most of the present EXT-FF vacuum chambers are **reused and duplicated from previous EXT beamline.**
- **The inner diameter of the beam pipe is 24 mm,** which is same as that of DR, and designed to fit DR magnets with a bore diameter of 32 mm. The magnets for the BT, EXT and FF beamlines are copies of the DR, then a vacuum chamber with an ID of 24 mm became the standard for ATF.
- Due to additional features, limited space and manufacturing difficulties, **the special sections use different cross sections.**
- The wakefield on the EXT line was not taken seriously as the beam passed once, while that on the DR was considered because of the multi-turn of 2 MHz.
- Under this background, we found the significant intensity dependency on the small beam size at ATF2 and conducted many wakefield studies

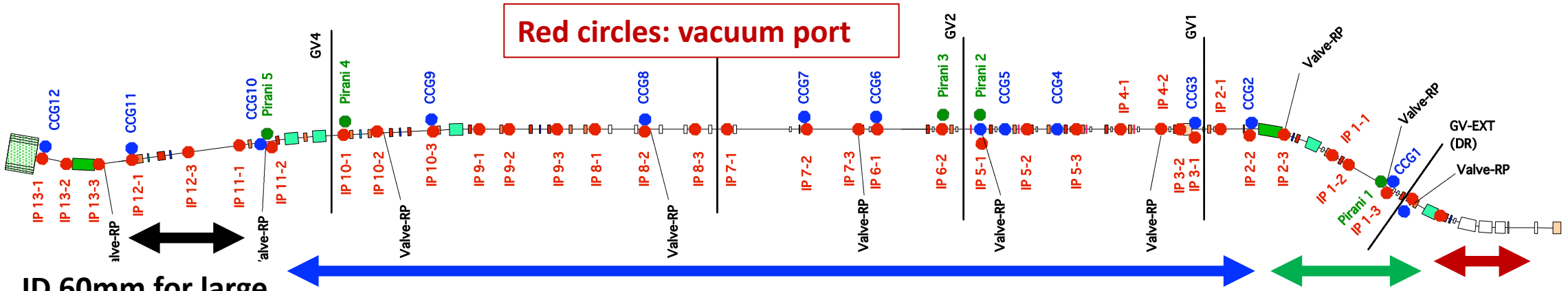
ATF2 beamline



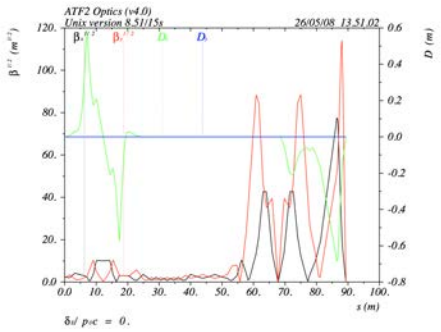
- Mitigation of the wakefield was conducted for the **Final Focus section (large beta section).**
- Replaced some of **CBPMs, bellows and flanges** to the straight pipes.
- **Shield contacts** were added to the bellows and flanges, to minimize the gaps and cross-section changes.
- They are not desired and effective way (?).
- **Need redesign for mitigation including the EXT line.**

ATF2 Beamline Vacuum Layout

2008/10/31 N.Terunuma



ID 60mm for large beam size at Final Doublet.



- **ID 24mm for most of pipes, bellows and flanges.**
- **ID 20mm for CBPMs.**
- **Vacuum ports and gate valves.**
- **Multi-OTR, FONT kicker, Collimator,…**

Many IDs 24~60mm Reused chambers

ID 6mm in the Septum area

Wakefield Sources

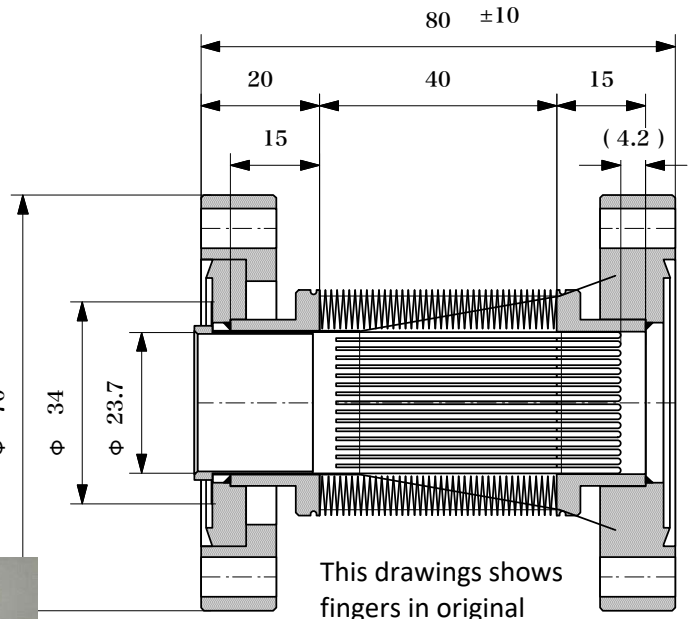
TABLE II. Summary of the peak and weighted average normalized wake potential calculated from a single offset of 1 mm for a bunch length of 7 mm. The quantities indicated are the approximate situation in spring 2013.

Component	$\lvert W_{n,\mathrm{peak}} \rvert$ V/pC/mm	$\lvert W_{n,\mathrm{avg}} \rvert$ V/pC/mm	Quantity
Bellows	0.1	0.06	~100
Vacuum flanges + step	0.06	0.04	~100
Vacuum flanges	0.03	0.02	~100
C-band position	0.11	0.06	~40
C-band reference	0.15	0.09	4
Vacuum ports	0.07	0.05	6

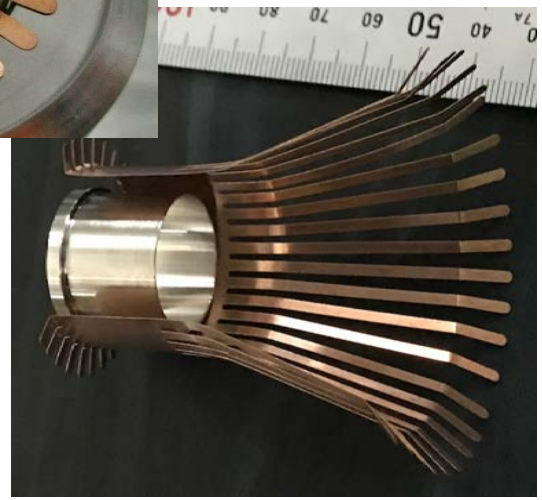
In EXT,

- Septum
- Bend chambers
- FONT kickers
- Stripline BPMs
- Many type of pipes

Bellows



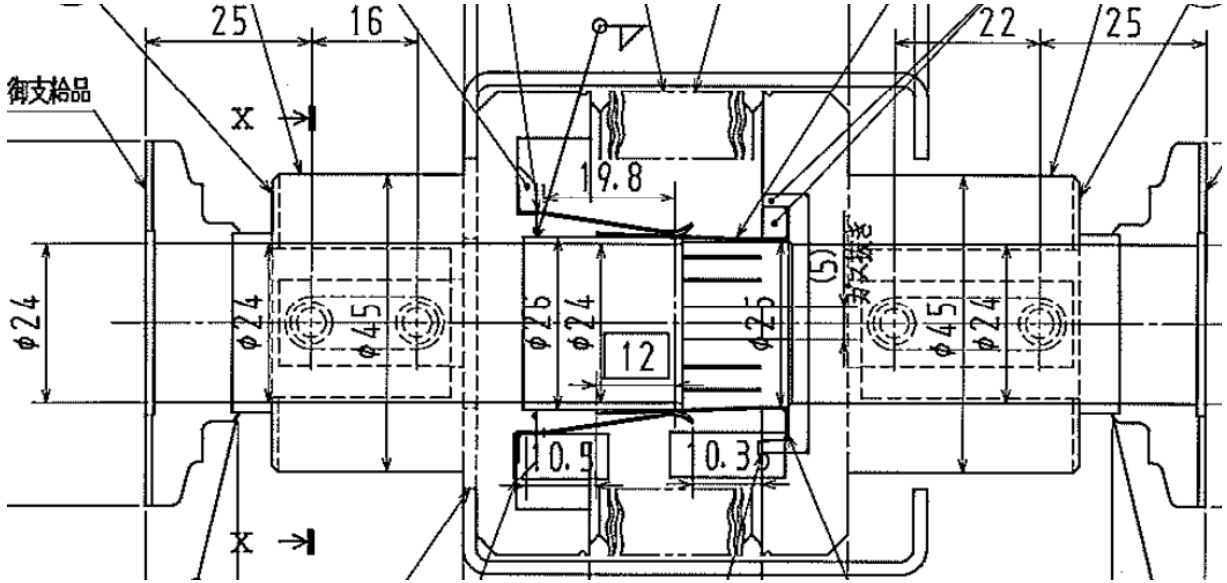
This drawings shows fingers in original shape.

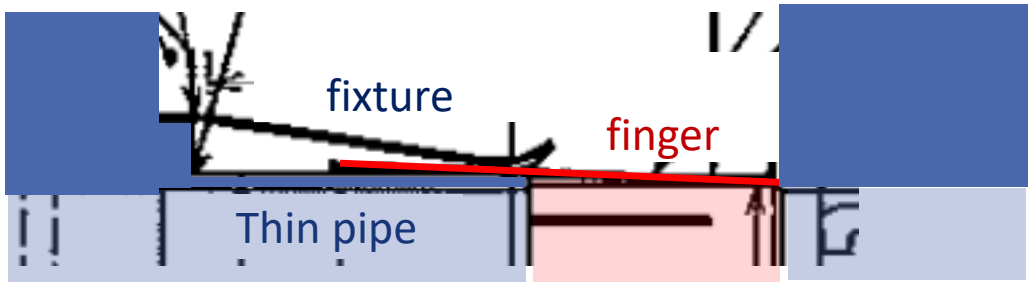


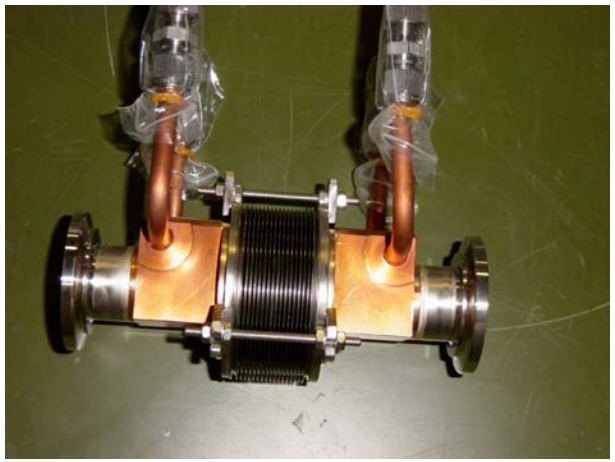
- We have many types of bellows in length and diameter. Typical ID clearance is 24mm.
- Some of them are too far from the edge of flange to allow the RF shield to be attached.
- **Only short bellows (standard in ATF2) units can have an RF shield inside.**

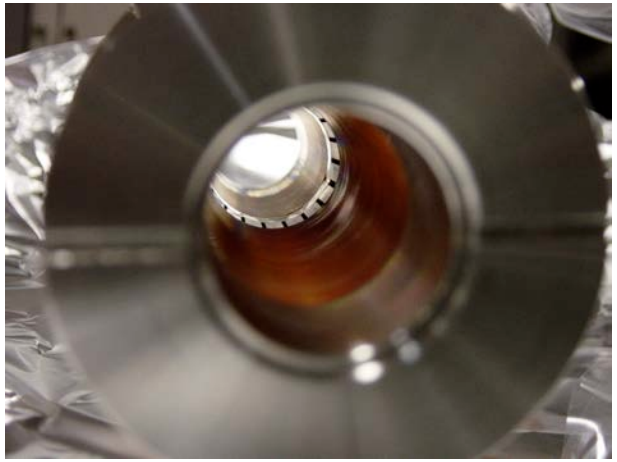
- Even if the bellows are deformed, the contact finger must still touch the pipe. That is, if there is an offset and angle between both flanges.
- The fingers are bent and not a straight.
- Not desired shapes.
- Need more space for shield structure → see DR bellows

Bellows for ATF DR





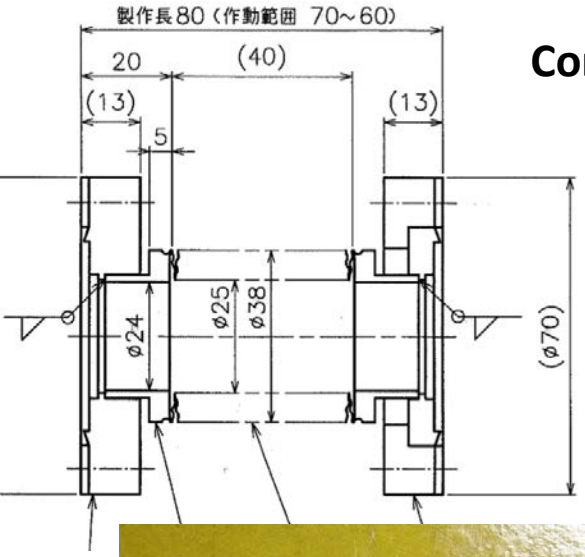




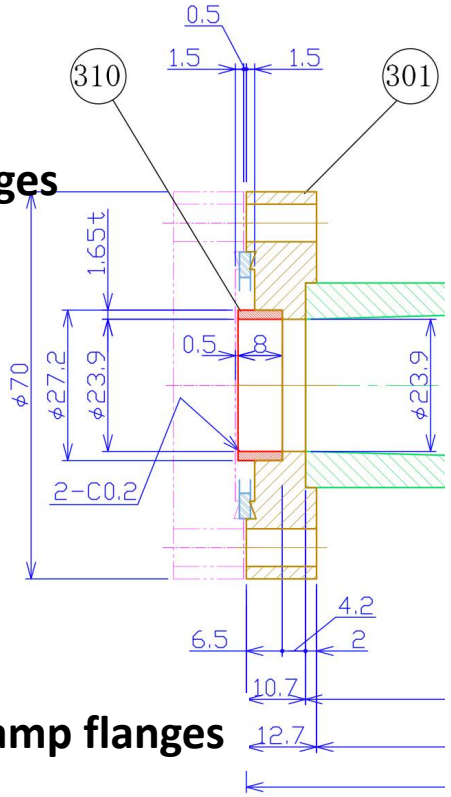
- Wider bellows
  → room for structure of shield fingers
- **Finger touches the thin pipe from outside**
- Fixtures push fingers to the pipe
- **No un-wanted structure inside the pipe**
- Complicated and **expensive** but better shielding
- **Can be applied for FF bellows**

(EXT-FF does not require the cooling pipes.)

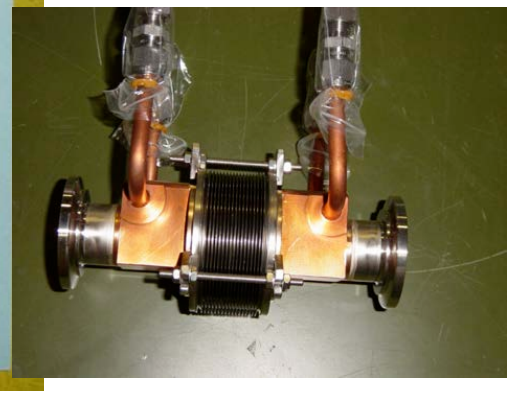
Flanges



Conflat flanges

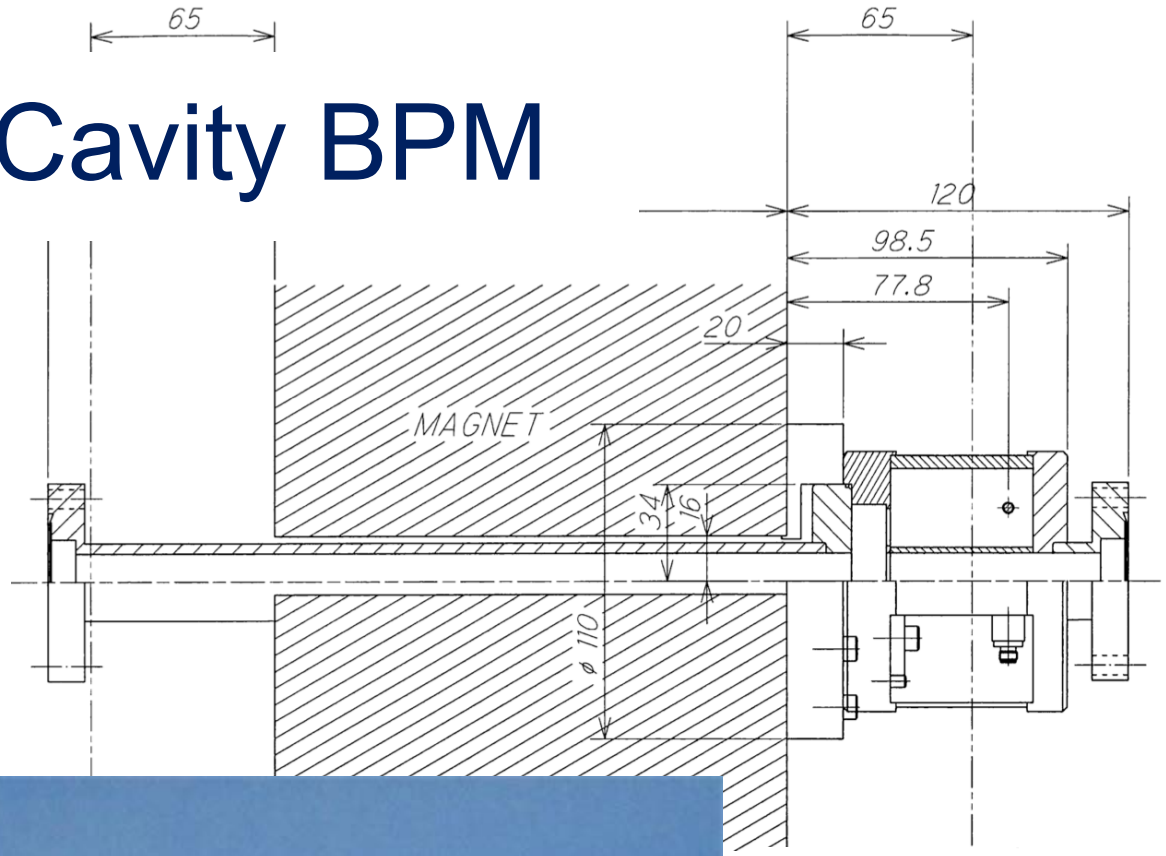


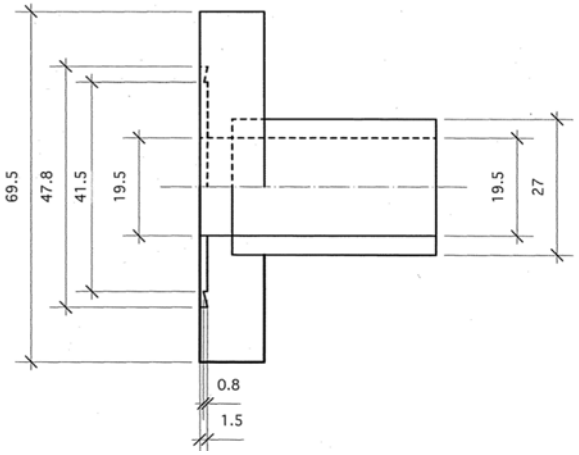
ATF-DR clamp flanges



- Conflat flanges are used for EXT and FF.
- Dimensions of flange are defined only for the knife-edge and fixtures, and not for others such as gap between two flanges, and joint for a pipe. It brings different gap by manufactures.
- As a result, it becomes hard to put good shield piece in each flange gaps. weak mechanical and electric contact.
- Shielding a gap of rotating flange becomes much harder.
- **ATF DR uses a clamp chain flanges customized by EVAC co. ltd., and no gap in connection.**
- It will be desired to use it for ATF3.

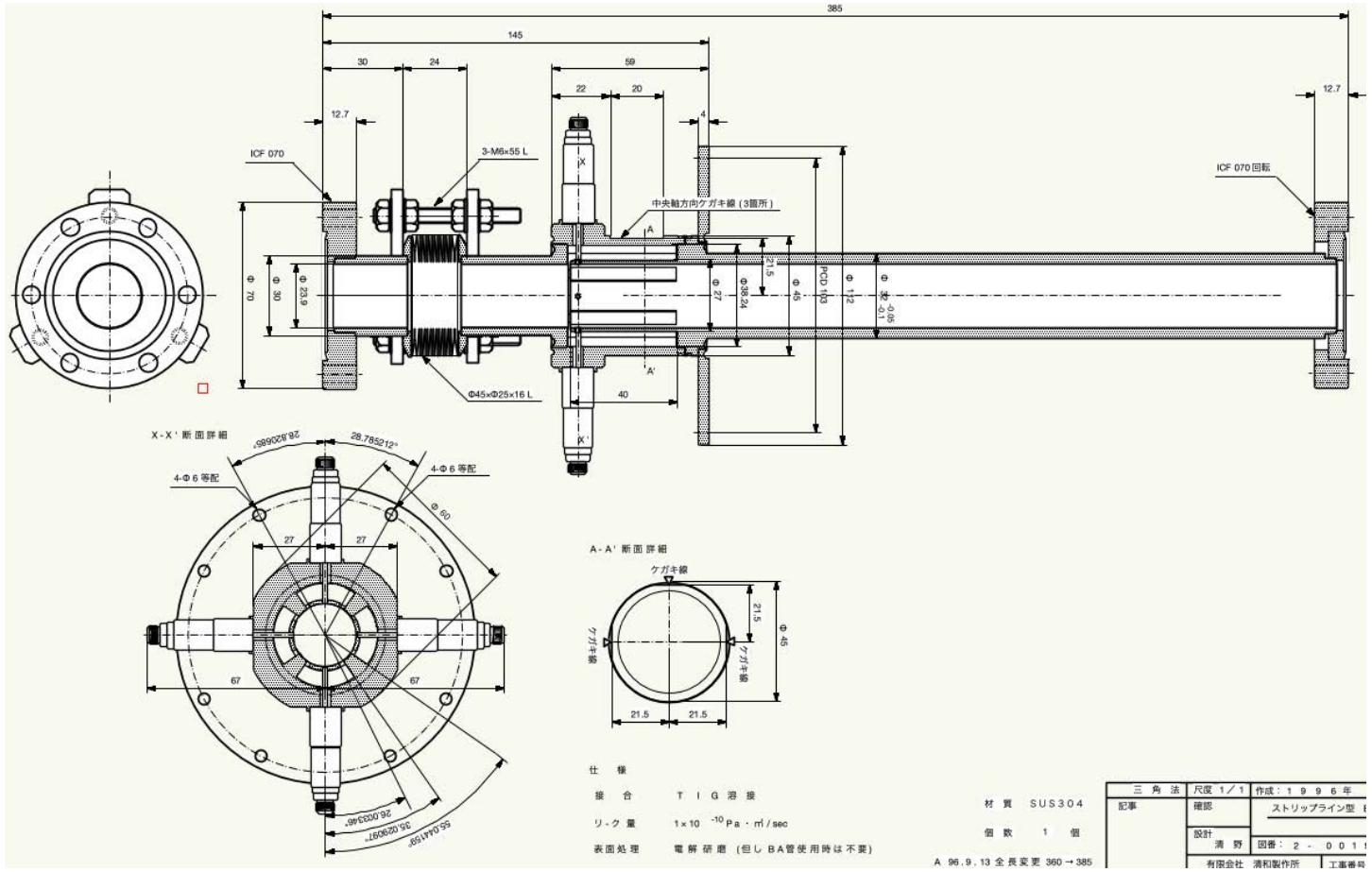
Cavity BPM





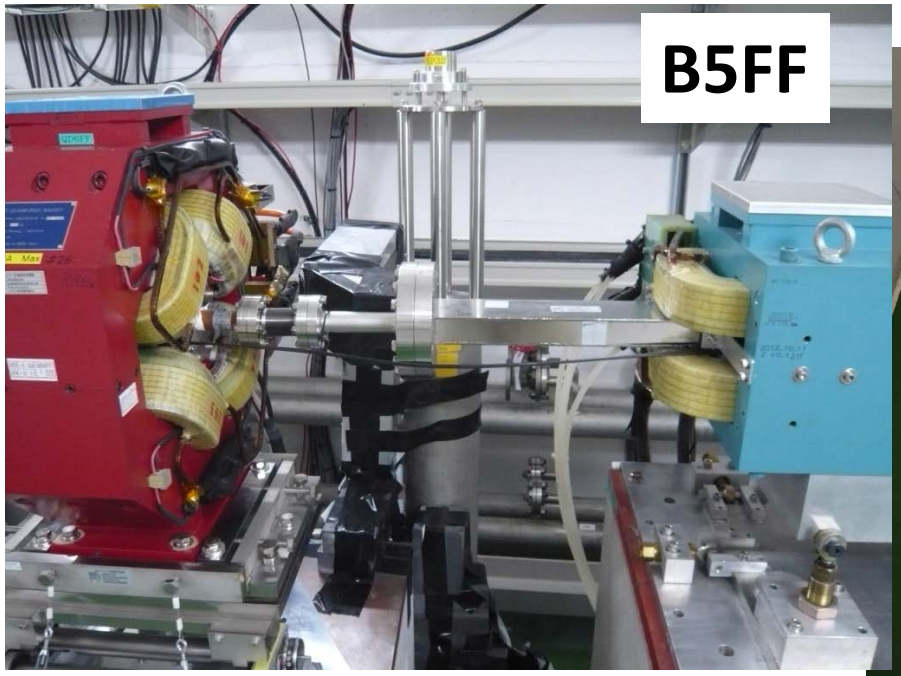
- We have no way to remove the cavity itself. Replacing flanges is also difficult. No welding and brazing again.
- Use CBPM as it is.
- **Each CBPM flange has 1.5mm gap. It brings 3mm gap when connected.**
- **In addition, pipe diameter is 20mm, not 24mm.**
- **We may need a taper for different diameter, and a peace to fill gaps.**

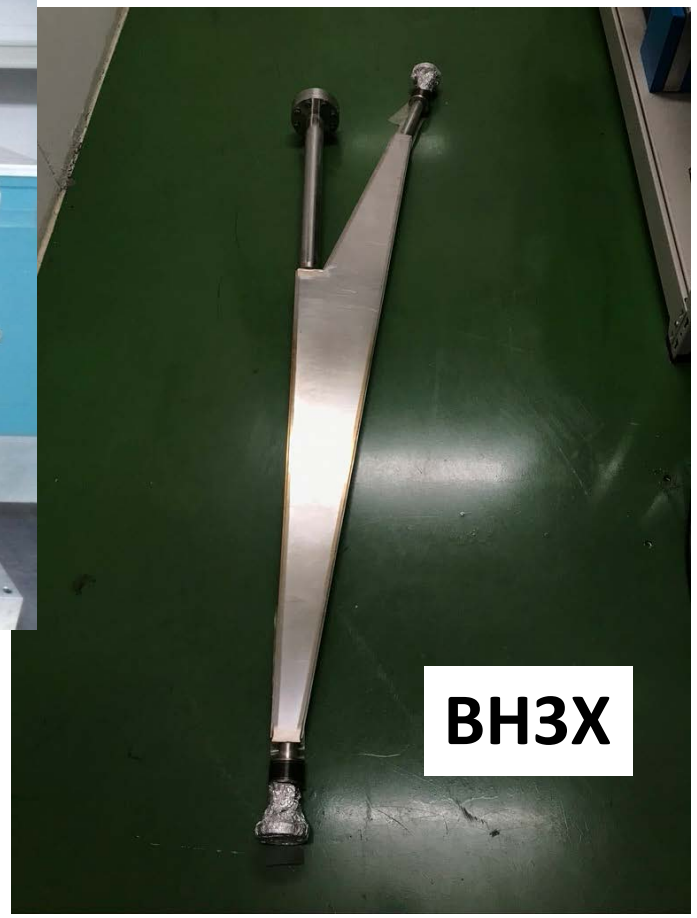
Stripline BPMs

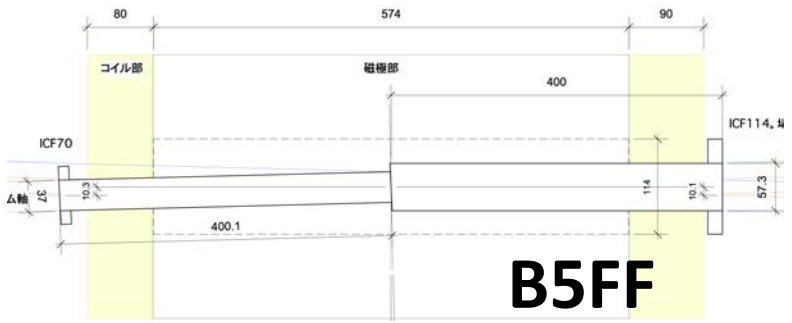


- There are many stripline BPMs with different length of electrodes, chamber length etc.
- Some stripline BPM has bellows where a shield can not be put.
- Think to use these BPMs as-is or prepare new BPMs.

Dipole chambers (box)

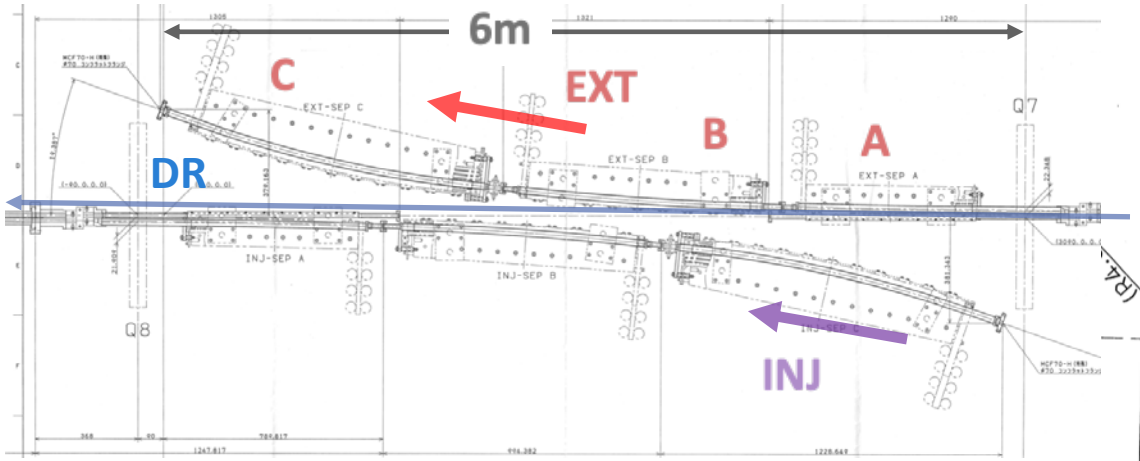


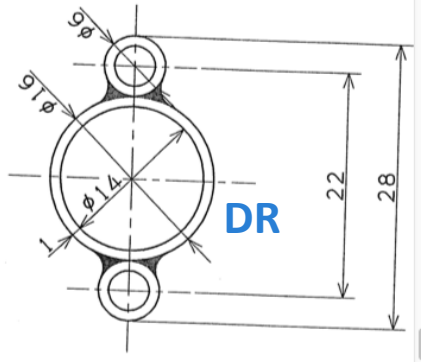


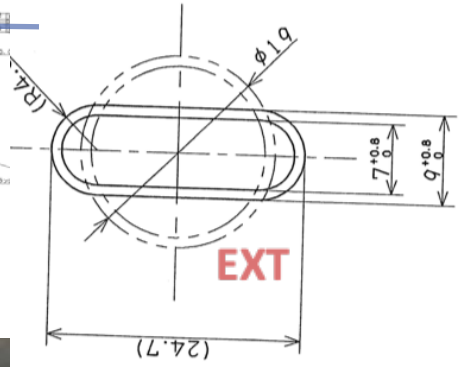


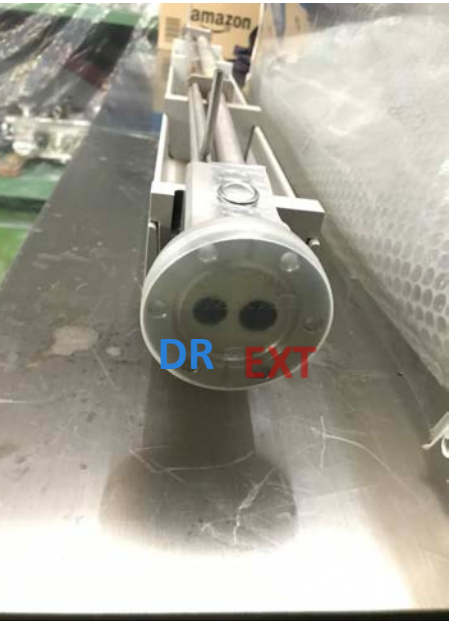
- Historically, some of dipole magnets were used to extract the Laser-Compton photons from the beamline.
- To have an electron line and photon line in the dipole, **a box chamber were prepared.**
- Now we do not need such photon port, then we can **replace box chamber by a simple pipe chamber.**

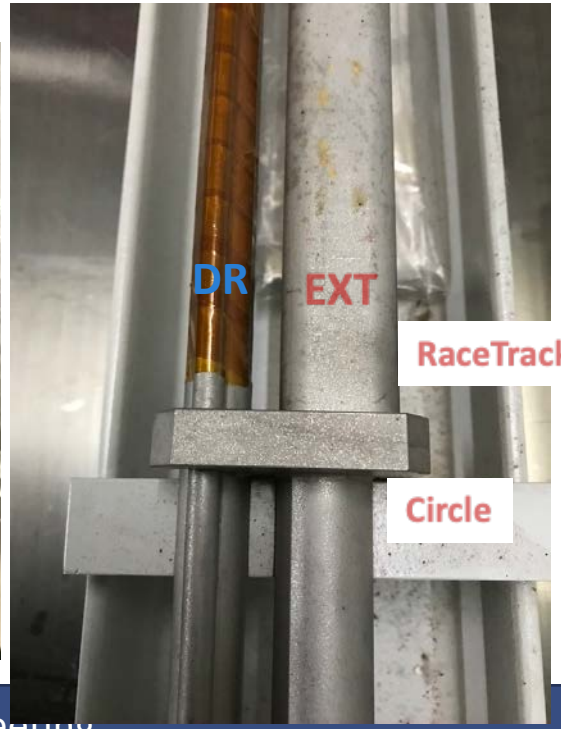
Septum chambers

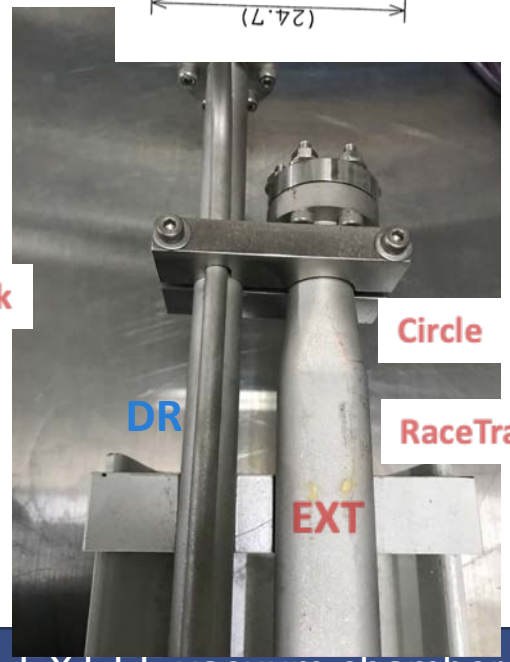






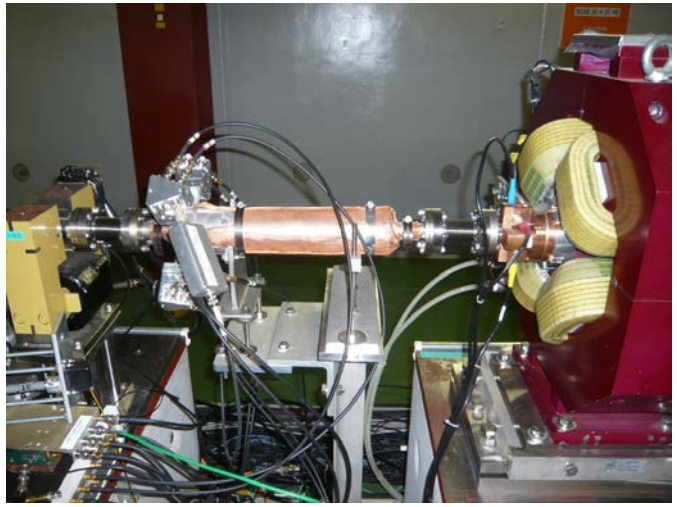


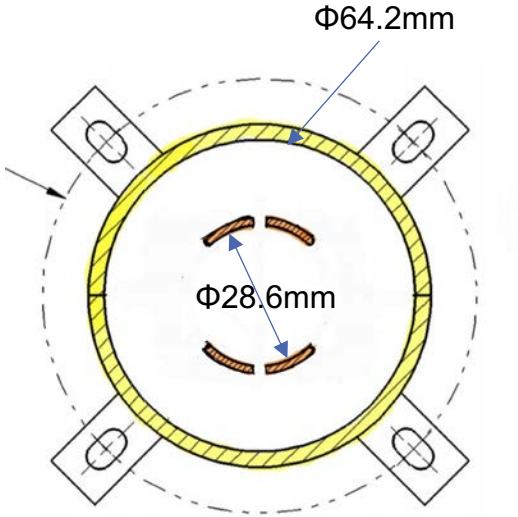




- There are 3 septum magnets (A,B,C) for EXT.
- Space available in the Septum magnet is very limited.
- Beam pipe is about **7mm high and 23mm wide over 6m** of the beamline, **including small bellows**.
- Since it is difficult to manufacture a small-diameter chamber, the septum chamber is realized by pushing and deforming the pipe.
- Pipes with different cross sections are welded to small blocks, and there are **steps in cross-section**.
- Septum C has a possibility to be replaced by standard dipole magnet → get large aperture.

FONT kickers





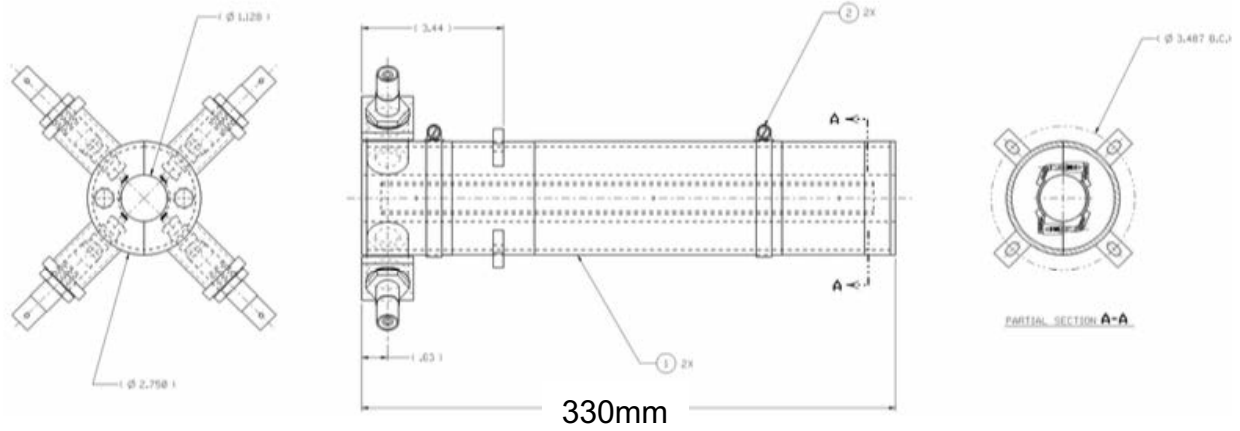
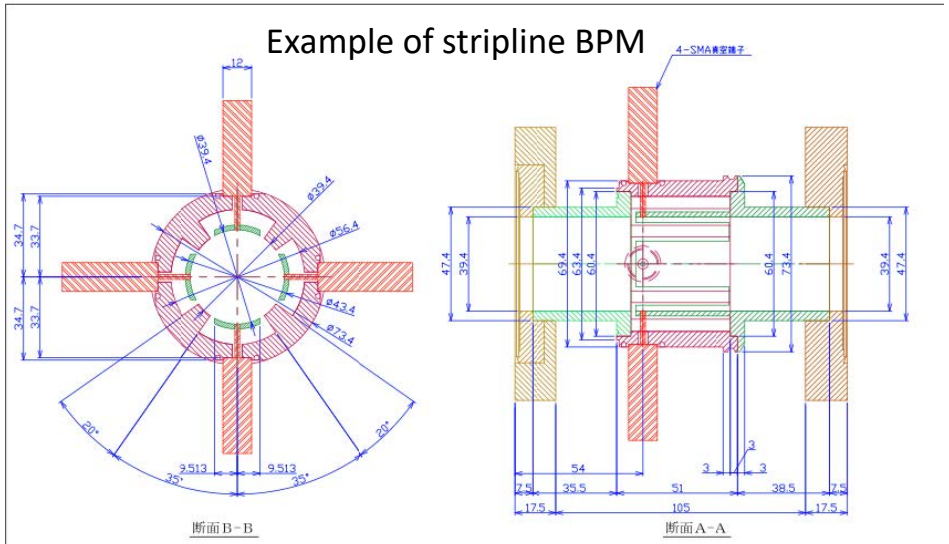
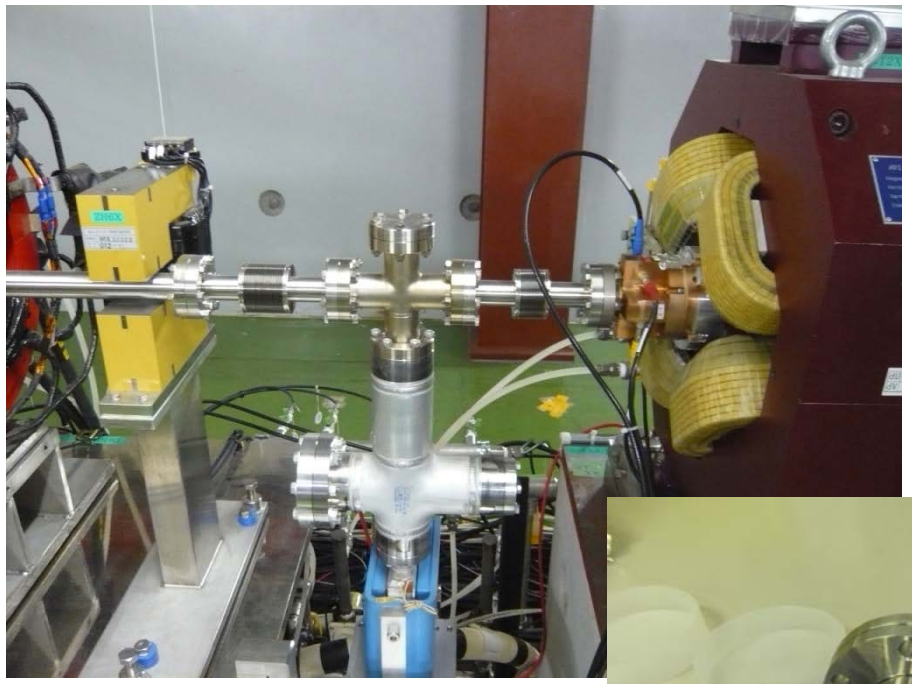


Figure 5.17: A Schematic diagram of the SLC Scavenger Post Kicker. The kicker plates are approximately 30 cm in length; measurements are in inches. Figure adapted from [112].

- **FONT kicker is located in the EXT line where the beta function is relatively low.**
- Gap around the electrodes are bigger so the minimization can be considered.
- **Stripline kicker which gap is filled, can be designed for ATF3.**



Pumping ports



- Commercially available Cross-chamber is used for pumping port. Its ID is bigger than other pipes.
- **Insert a pipe unit which diameter is 24mm and has pumping slots.**
- Slots are horizontally aligned in the beamline to minimize the vertical effect of wakefield.
- Gap by flanges is not shielded at present.

Cost estimation of vacuum chambers

In the case of replacement of **all chambers of EXT and FF asumming clamp flanges** except for cavity and stripline BPMs.

Type		Unit Cost k Yen	units	Total k Yen
Shielded Bellows		300	100	30,000
Taper chamber	For CBPM; ID 20mm	60	40	2,400
Bend chamber - Large	BH3X	500	1	500
Bend chamber - Small	BH1X, 2X, B1, B2 and B5	100	5	500
Straight chambers		100	30	3,000
Pump port chambers	For ID 24mm	200	30	6,000
FONT kicker	Stripline kicker	500	2	1,000
Septum C	→ standard dipole	100	1	100
Others	Attachment for the gap of CBPM conflat flange, …			1,000
TOTAL				**44,500**

Cost of clamp flange unit is included in each chambers.
(30k Yen/connection)

1 Yen ~ 0.009 CHF
1 K Yen ~ 9 CHF
Then
~ 400 kCHF

Rough cost estimation of magnets

Type		Unit Cost k Yen	units	Total k Yen
Final Doublet	QD0, QF1	3,000	2	6,000
Final Doublet (Sext)	SD0, SF1	1,500	2	3,000
Skew Sextupole	Poor assembling	1,500	4	6,000
Movers	For Skew Sextupole	2,000	4	8,000
	Renewal of motor drivers/controllers			(10,000)
Septum A, B		-	-	-
Septum C	→ Standard Dipole + PS	5,000	1	(5,000)
TOTAL				**23,000 (38,000)**

1 Yen ~ 0.009 CHF
1 K Yen ~ 9 CHF
Then
~ 210 kCHF
(~ 340 kCHF)