ILC SCQ

Y. Arimoto, T. Yamada, A. Yamamoto
2025-05-20 SCQ-BPM meeting

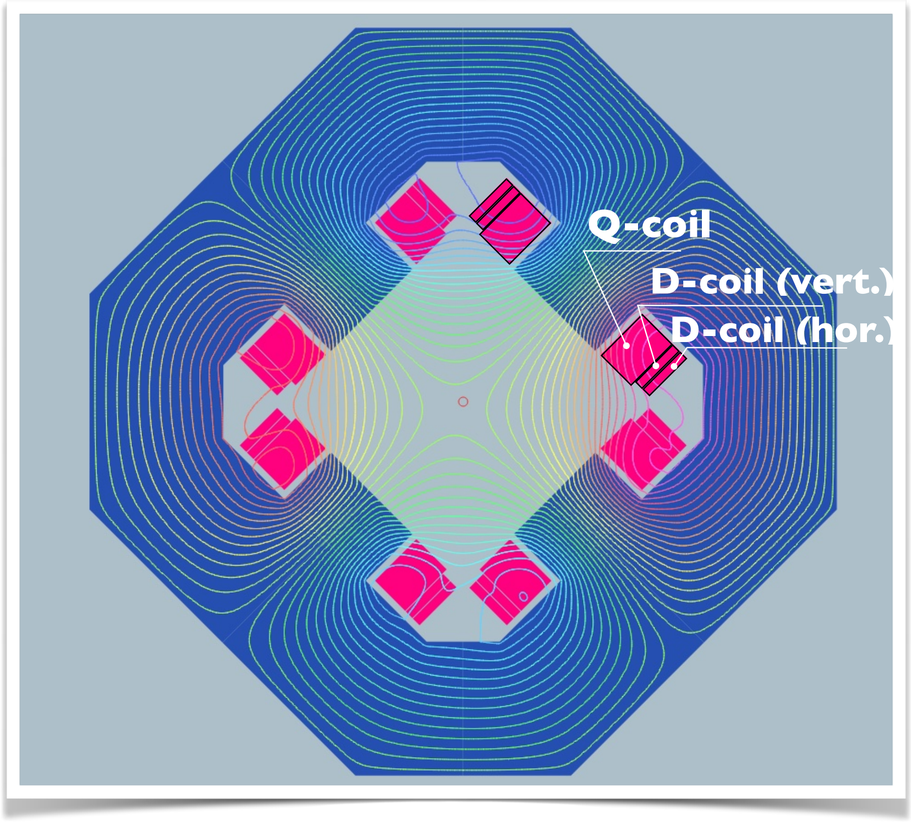
SCQ for ITN - Overview

The SCQ for ITN is a scaled-down version of the actual (HE-type) magnet to reduce costs.

- Axial length is shortened to 0.42 m from 1.0 m

However, its cross-sectional dimensions remain the same as the actual SCQ, resulting in the following parameters being identical:

- Energization currents
- Coil dimensions (number of turns, cross-section)
- Pole cross-section
- Magnetic field gradient



SCQ parameters

Low energy type

- Located at low energy section less than 25 GeV
- Physical length of magnet is 0.25 m
- Field gradient is 19 T/m

High energy type

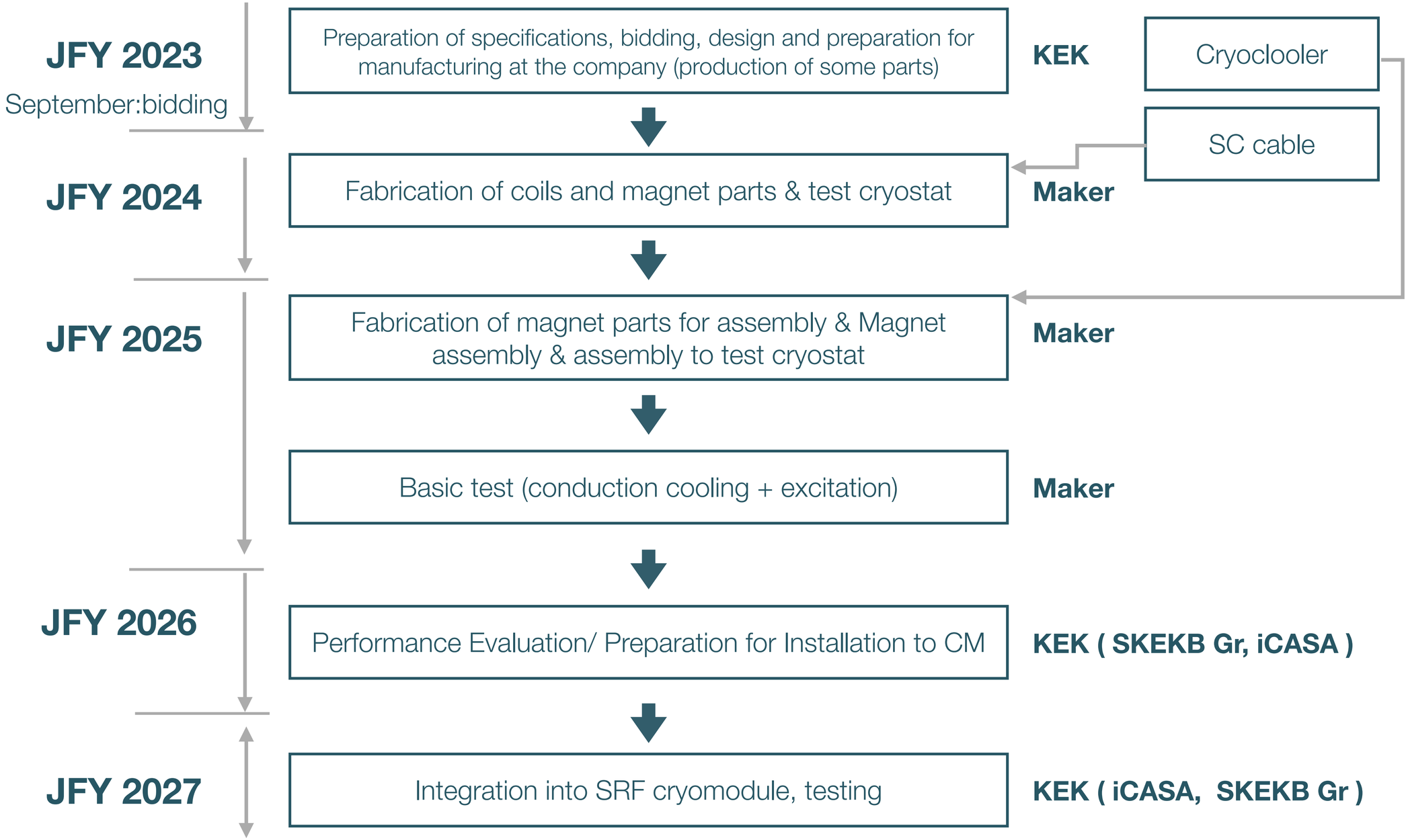
- Located at higher energy section more than 25 GeV
- Physical length of magnet is 1 m.
- Field gradient is 40 T/m

ITN type

- The physical length is 0.42 m
- Field gradient is 40 T/m

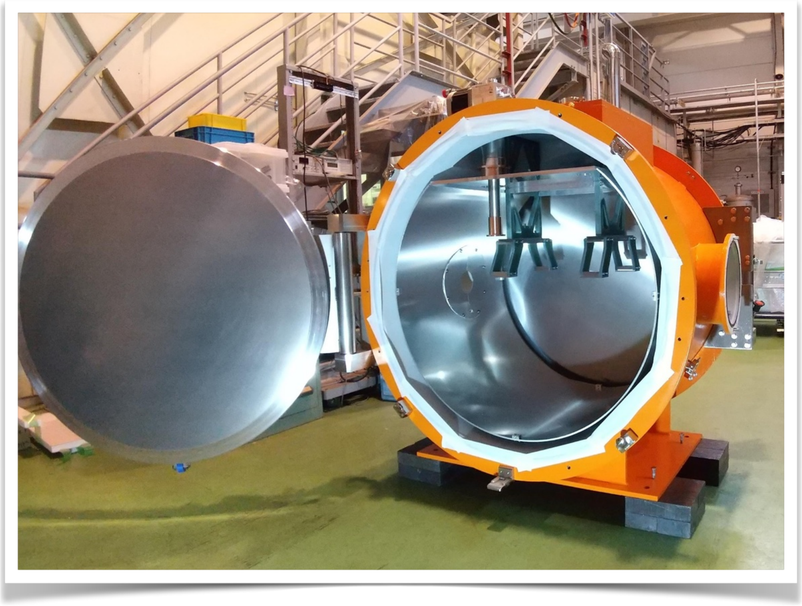
Parameters	Unit	Low Energy (5-25 GeV)	High Energy (25-250 GeV)	ITN
Dimensions:				
Physical length	m	0.25	1	0.42
Magnetic length	m	0.20	0.95	0.3
Iron-pole radius	m		0.045	
Quadrupole field:				
Field gradient (G)	T/m	19	40	40
G-Integral (required)	T	3.8	38	13
B_G at pole	T	0.86	1.8	1.8
Dipole field:				
B0	T	0.05	0.11	0.11
B-integral (required)	T · m	0.01	0.10	0.03
B max:				
in coil	T	~1.3	~2.6	~2.6
Operating temperature	K	2	2	2

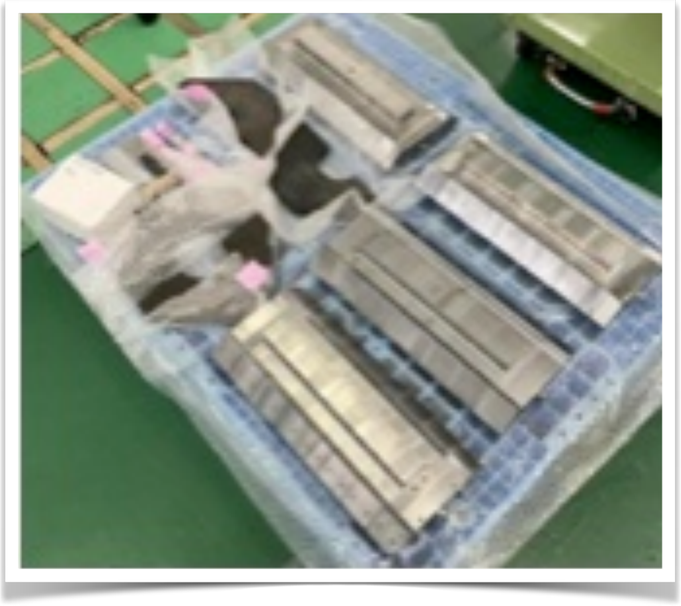
Overall Plan



Progress

- We produced yoke parts, coils, test cryostat.
- In this year, we will assemble them and test it with the test cryostat.





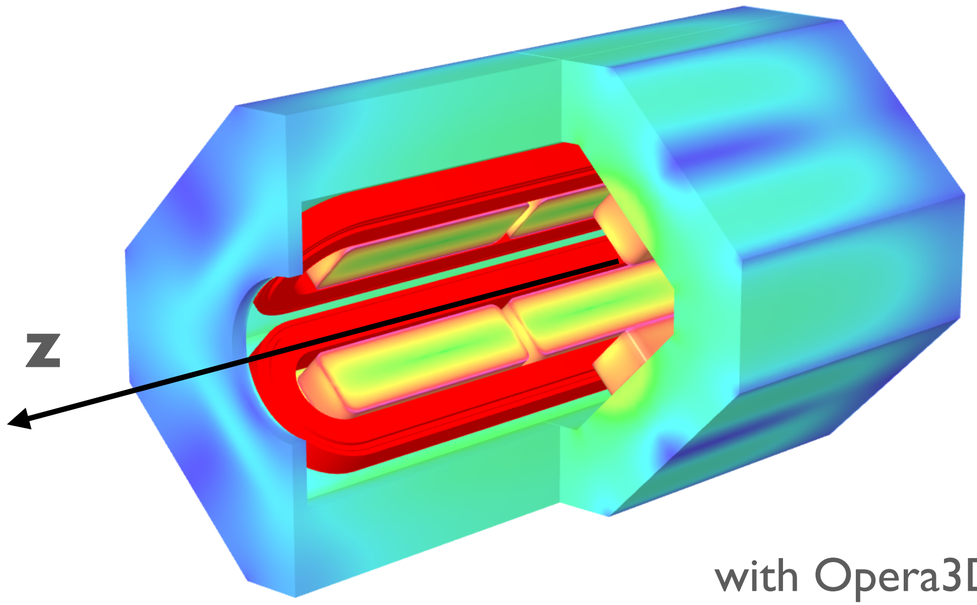
3D Field Calculation

Calculation conditions:

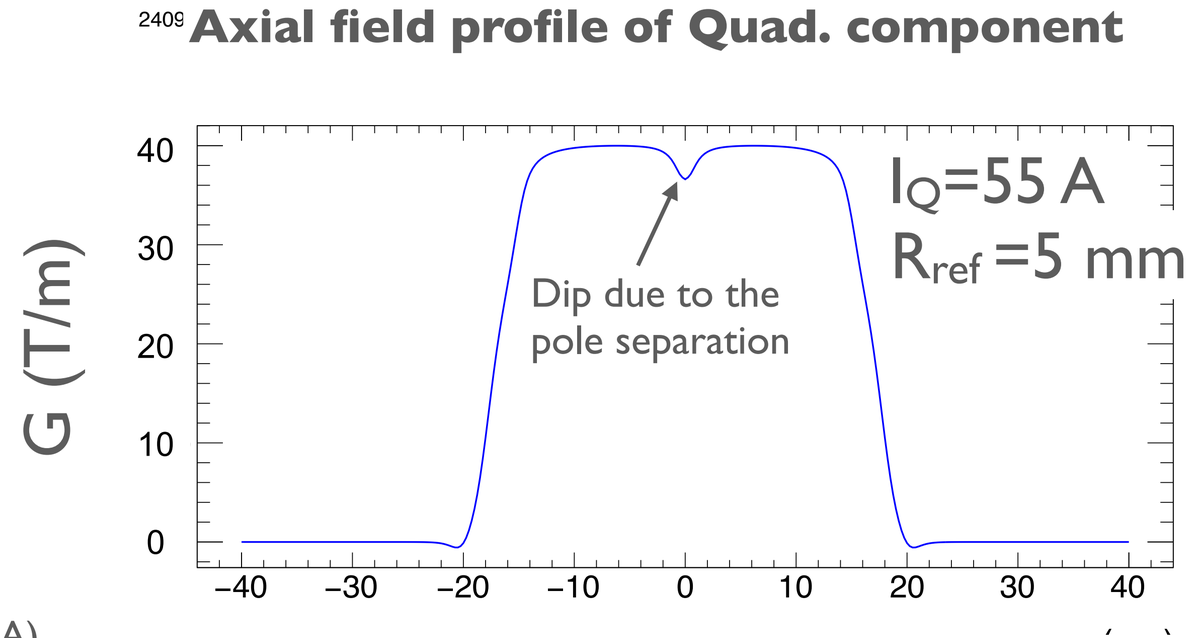
- Quadrupole coil current (I_Q)= 55 A
- Material : SS400 in JIS (structural iron steel)

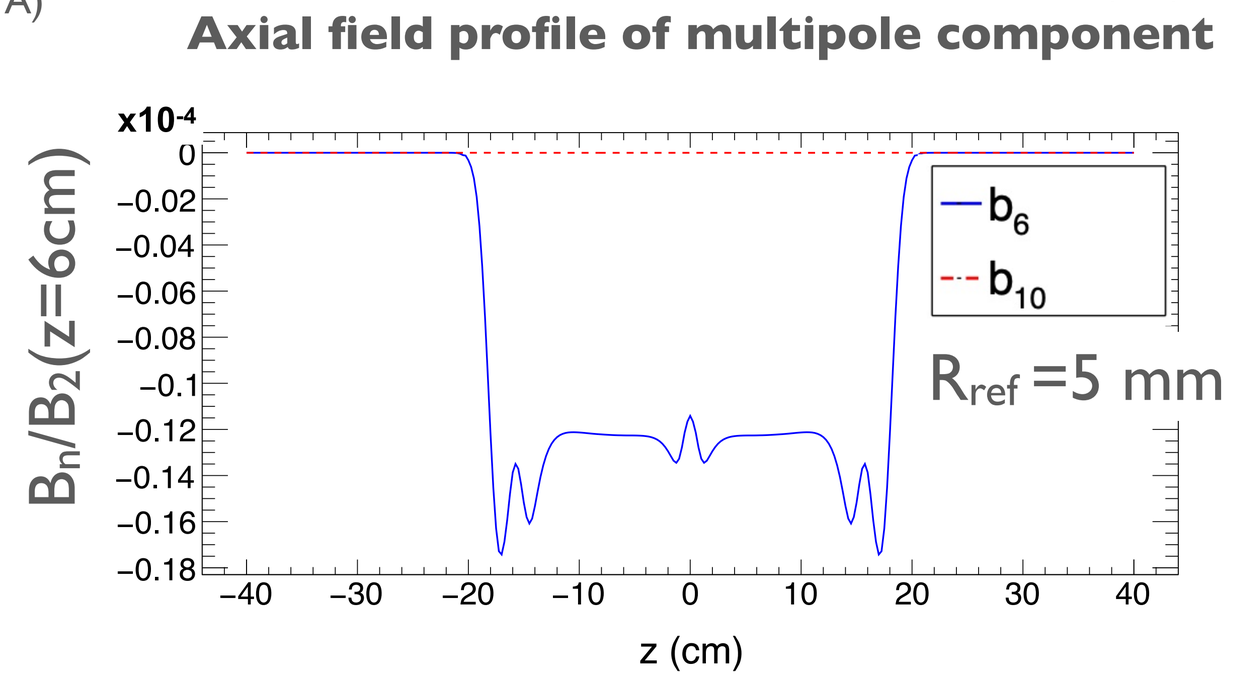
Calculated results:

- Field gradient (G): 40 T/m
- Integrated gradient (GL): 13.2 T
- Integrated multipole strength: -1.5×10^{-5} at R_{ref}=5 mm
- Maximum field in coil: 2.6 T (with both dipoles energized at 38 A)



with Opera3D

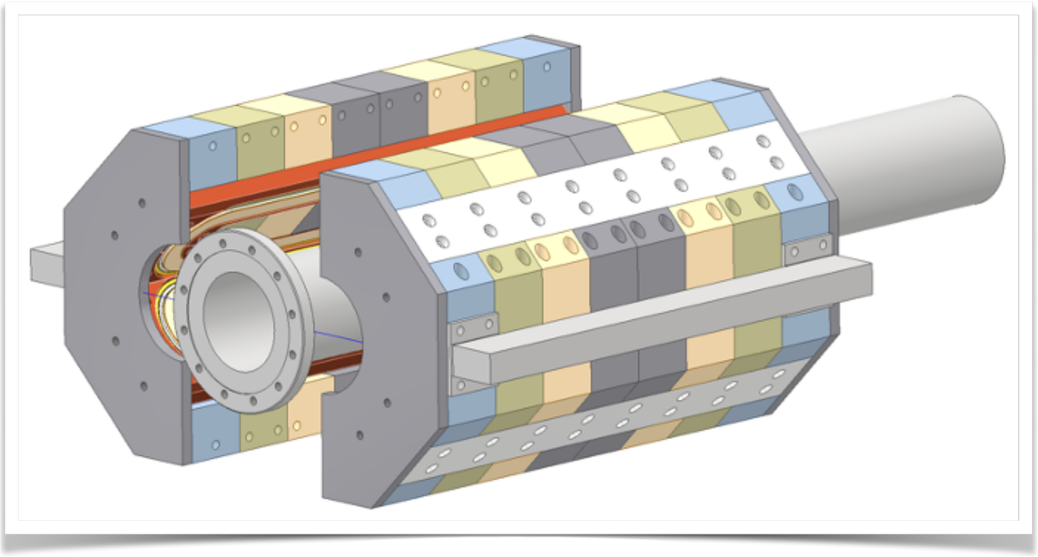




SCQ Structure and Cooling

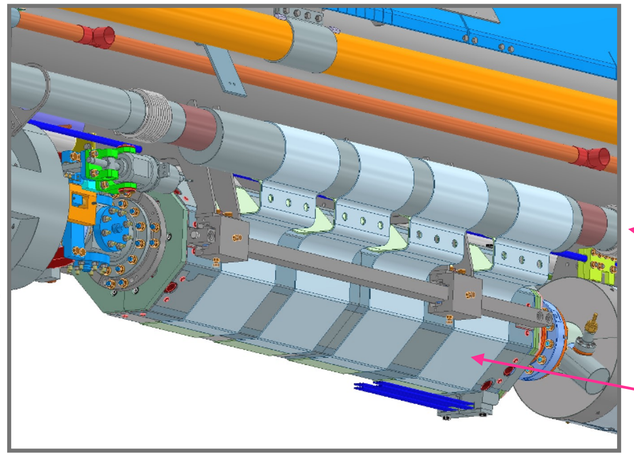
Structural Features

- Splitting into two halves horizontally, allowing installation after the superconducting cavity is placed inside the cryomodule.
- Eliminating the need to assemble the SCQ in a cleanroom due to this design.

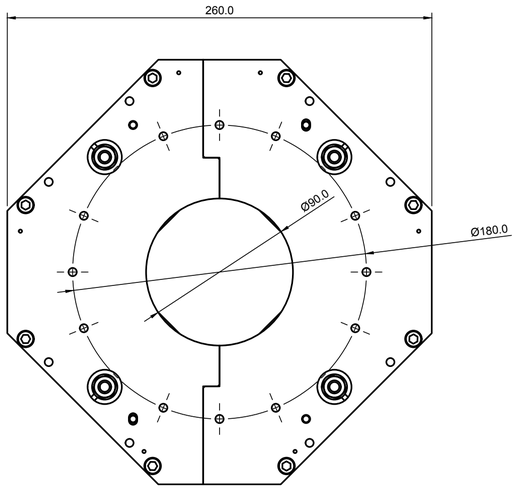


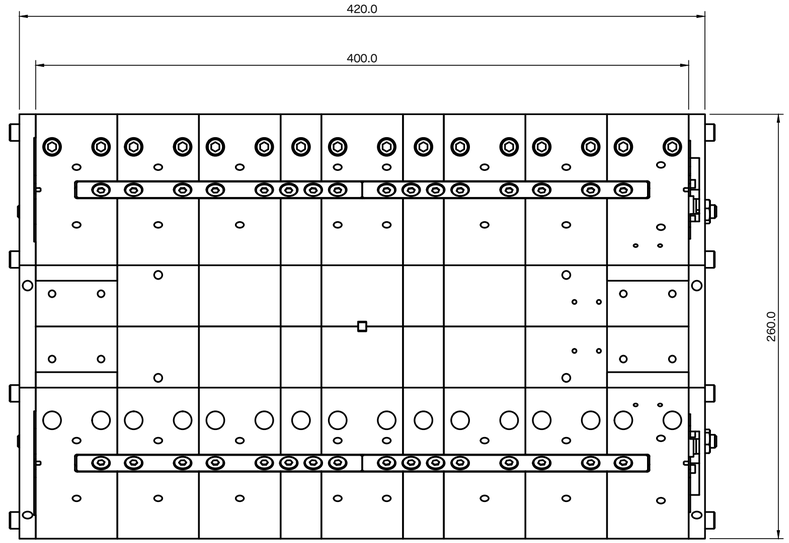
Cooling Mechanism

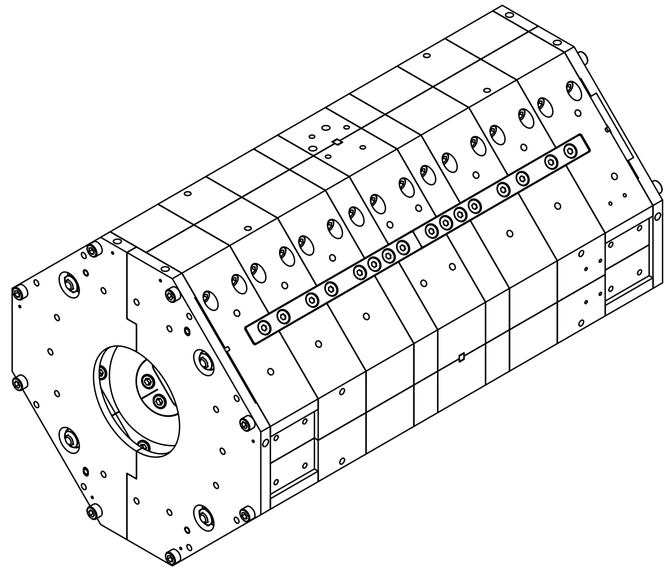
- Cooling by conduction from the 2K two-phase helium pipe in the cryomodule.



Mechanical structure of SCQ for ITN



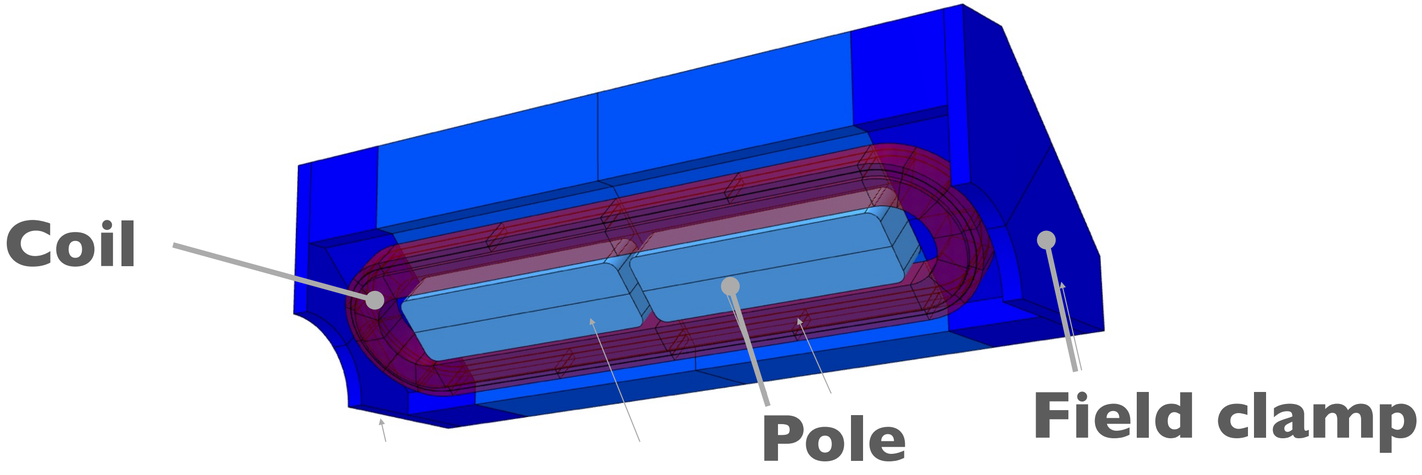




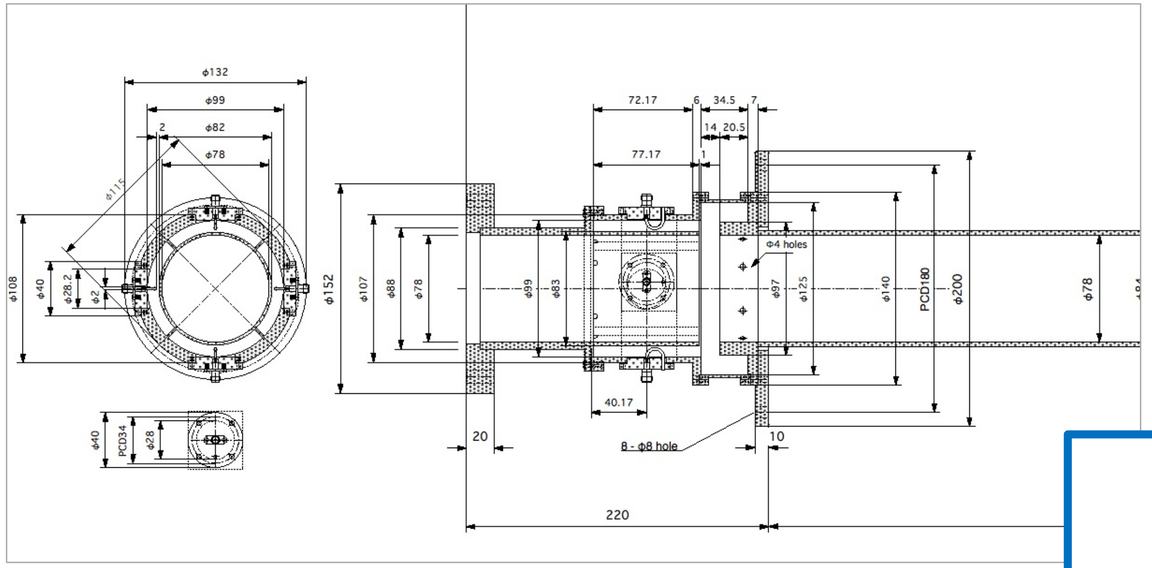
The yoke consists of nine plates to reduce the eddy current

Field clamps are implemented to reduce the leakage field at the SC cavity.

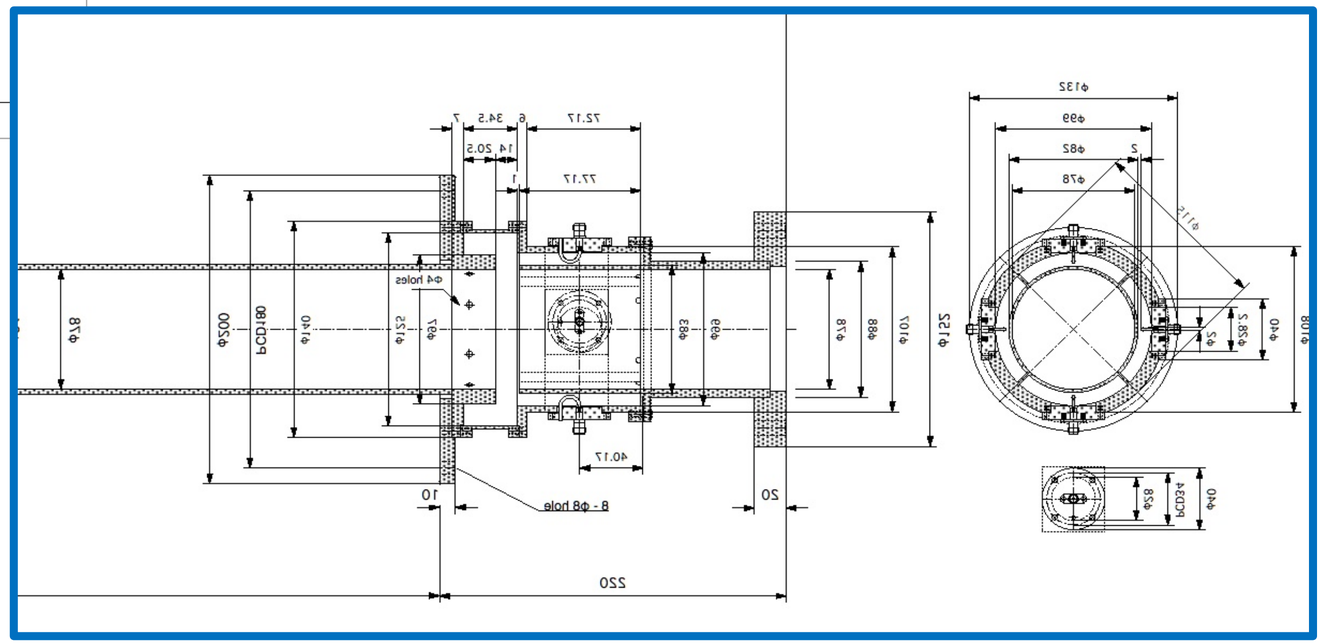
For cost reduction, the yoke material is structural steel (SS400 in JIS) instead of electrical soft iron.



ILC-ML Beam Position Monitor



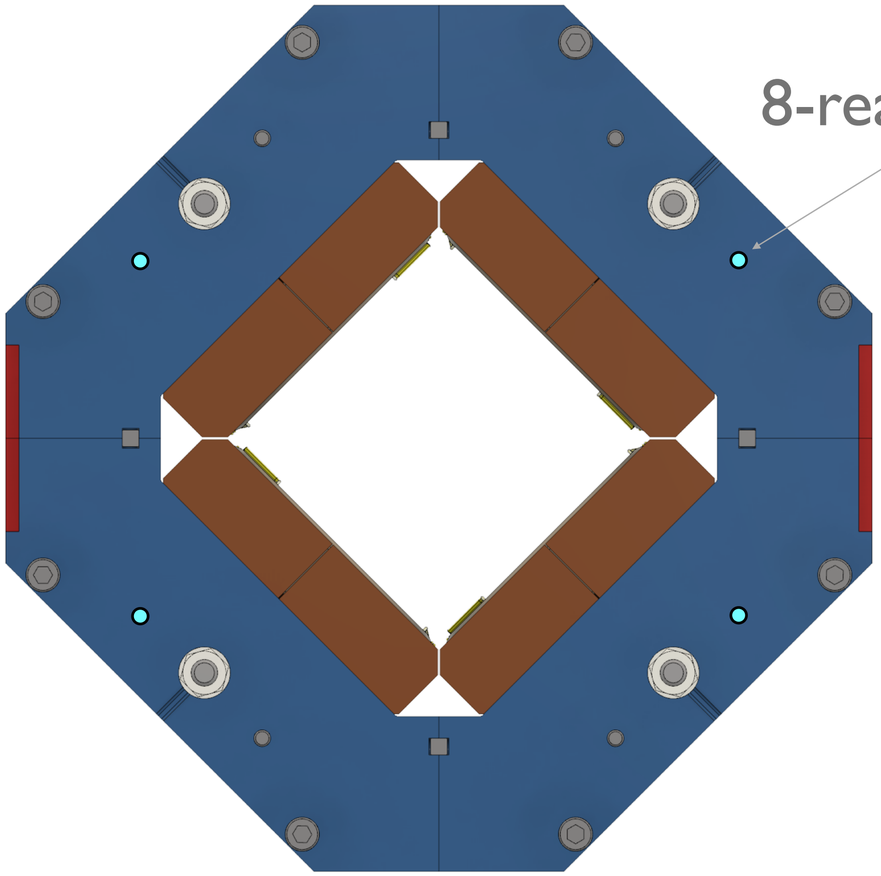
An update:
BPM tp be placed at
SCQ downstream end



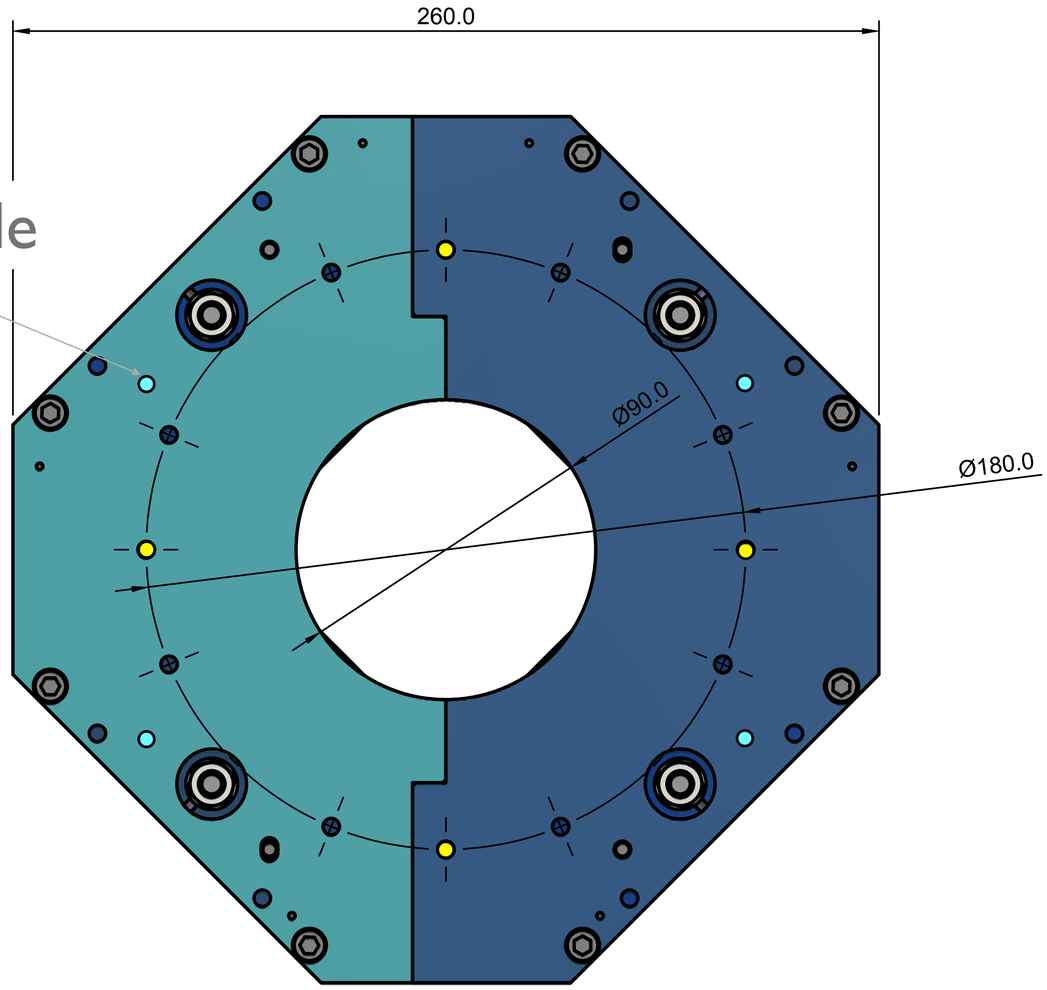
A. Yamamoto

Yoke and field clamp

Field clamp position wrt the magnet yoke is defined by the reamer hole on the yoke end



8-reamer hole

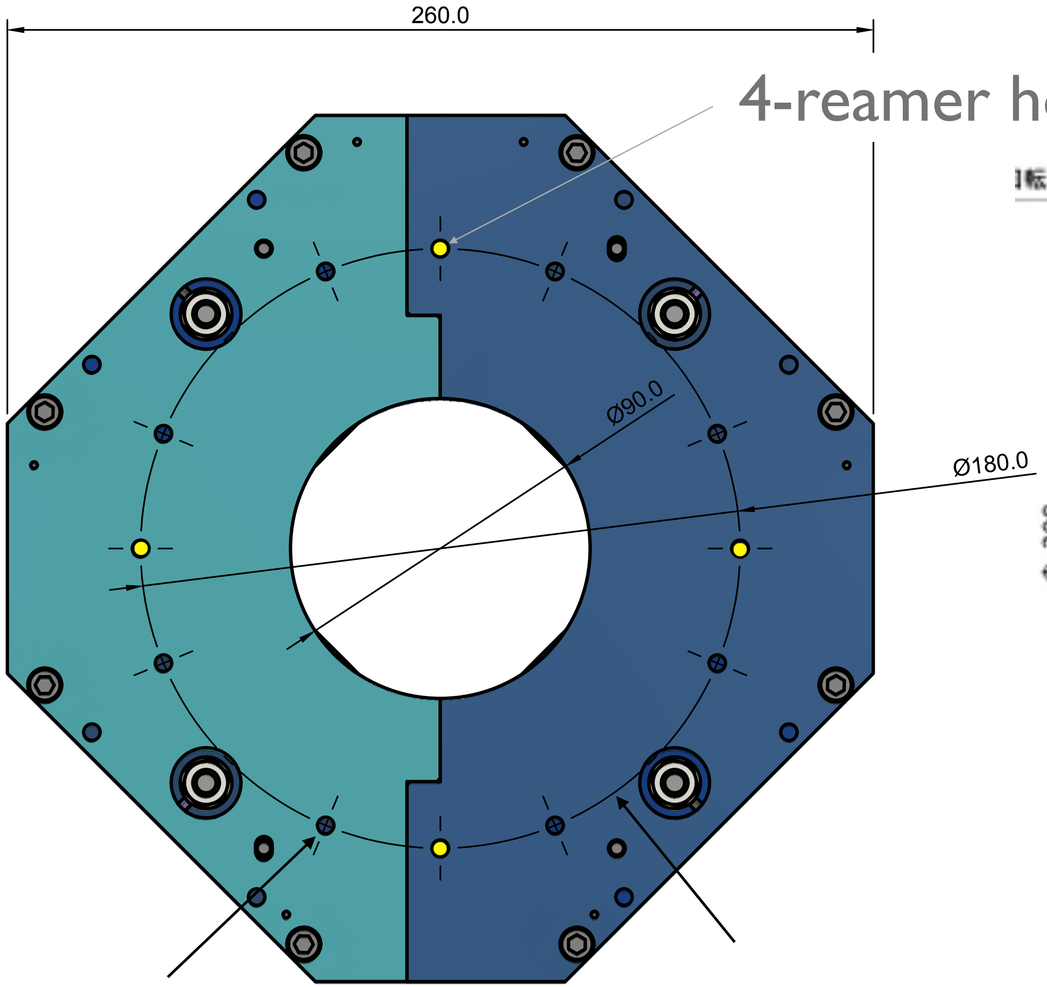


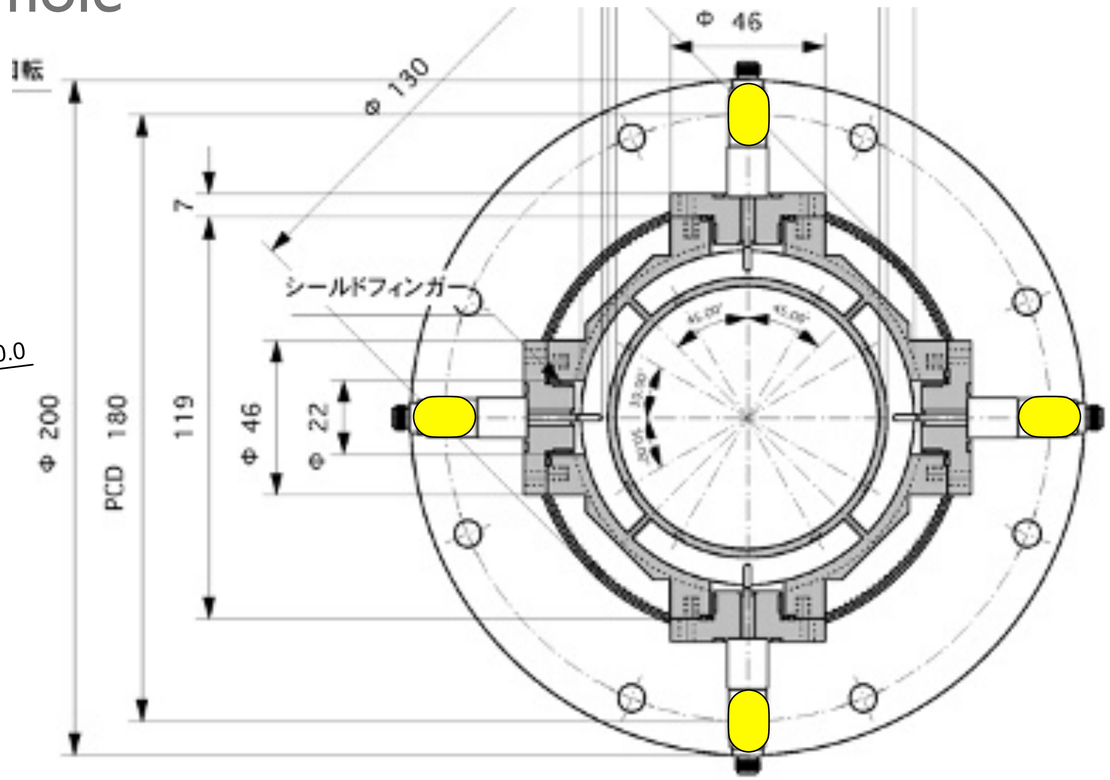
Yoke

Field clamp

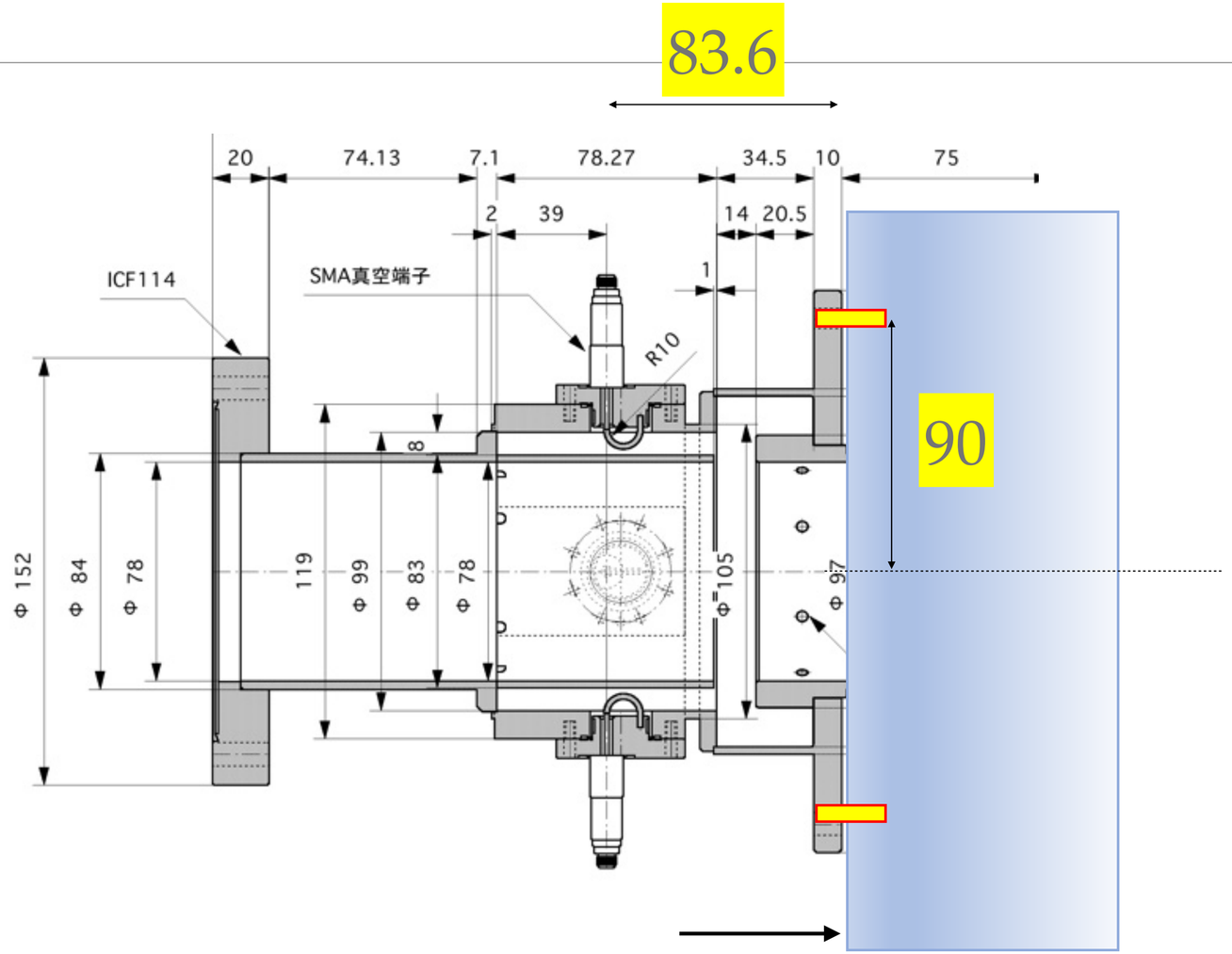
Field clamp and BPM

BPM position wrt the field clamp is defined the reamer holes on the clamp



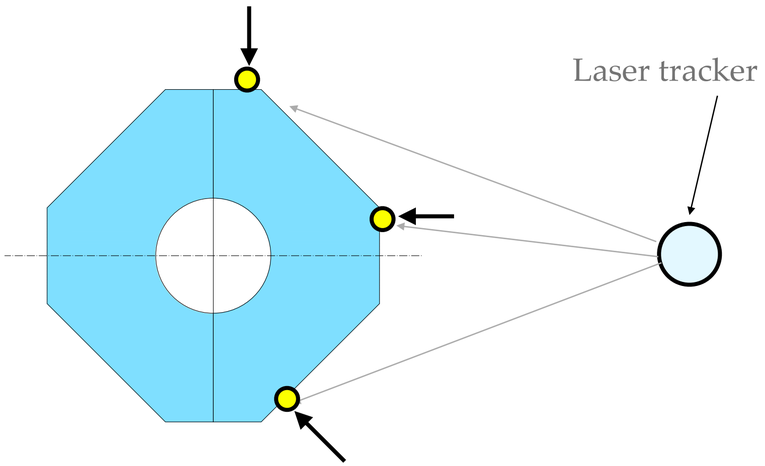


Top view



A. Yamamoto, “ILC-ML-BPM: Interface to SCQ”, Jan 2024

Target postions for laser tracker



Target positions