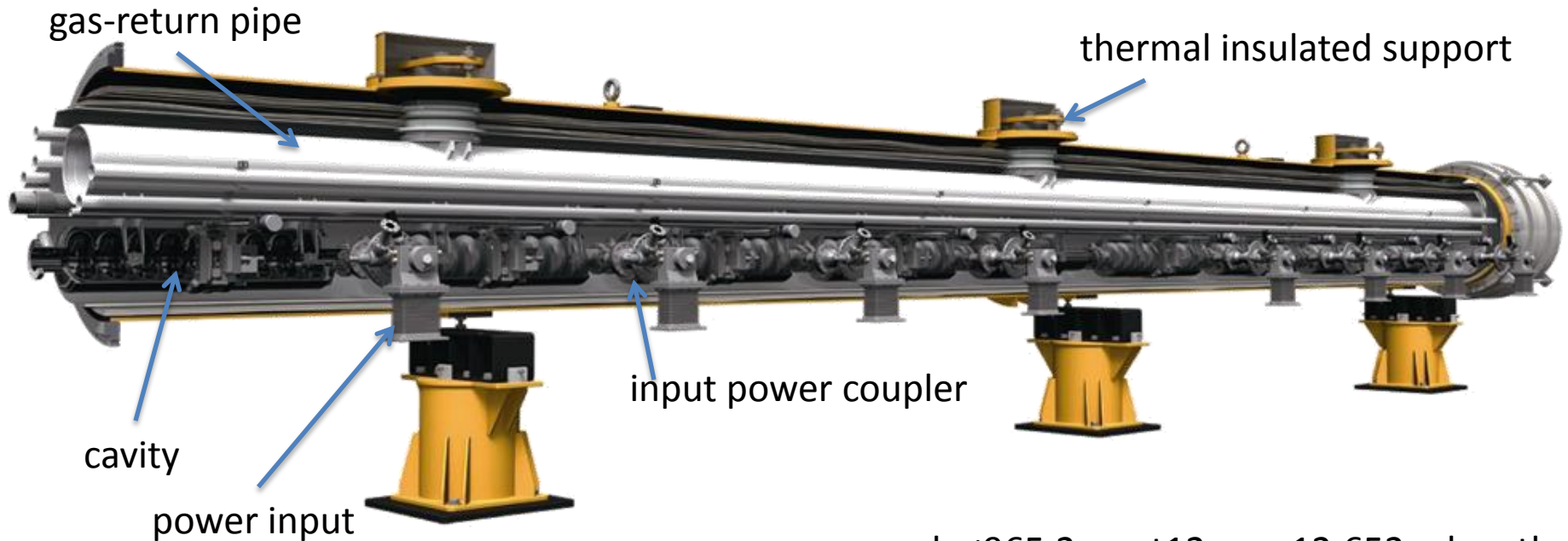


# Cryomodule requirements

for CFS consideration

Hitoshi Hayano, KEK 06012010

# What is cryomodule?



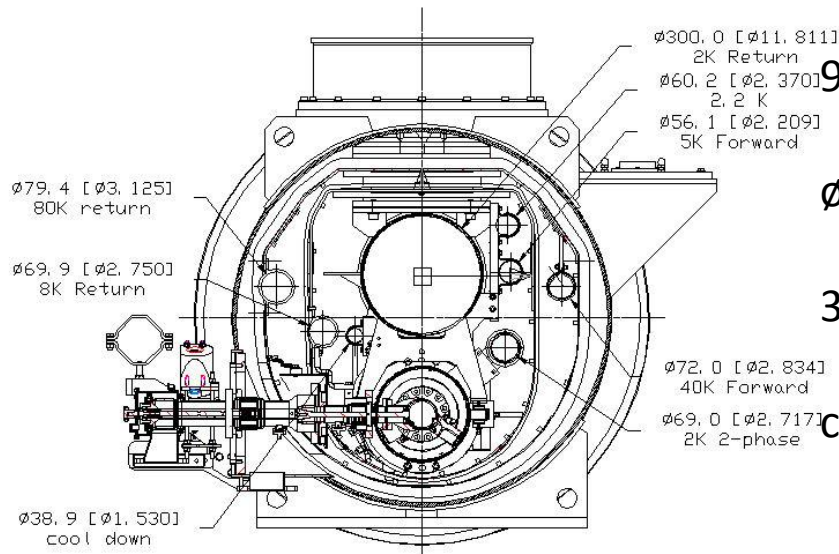
vacuum vessel:  $\varnothing 965.2\text{mm}$   $t 12\text{mm}$ , 12.652m length

9 cavities, or, 8 cavities + 1 quadrupole magnet

$\varnothing 300\text{mm}$  gas-return pipe, 7 He pipes, thermal shields

3 thermal insulated supports

cavity spacing:  $(5 + 3/4)\lambda$   $\lambda = 1.327\text{m}$



# Tunnel Installation Requirements

**(1) Keep cryomodule in horizontal, in any time.**

cavities are hung by sliding support,  
and fixed its longitudinal position to Invar-rod by an adapter.  
need to keep the cavity alignment.

**(2) Input coupler and waveguides are installed at the surface.**

need care during transportation, because of ceramics windows and  
inner conductor flexibility by bellows structure.

**(3) Pipe welding work for the cryomodule connection is required in the tunnel.**

**(4) Local clean room environment is required during cavity connection.**

beam pipe installation between cryomodule cavity gate valves,  
pumping it, open gate valves, then close the vacuum vessel.

From K. Kubo's GDE meeting 2010@Beijing presentation,  
we can see the alignment of cavities relative to cryomodule

## Errors Equivalent to “Standard”

	Vertical	Horizontal
Quad Offset ( $\mu\text{m}$ )	360	1080
Quad Roll ( $\mu\text{rad}$ )	300	
Cavity Offset ( $\mu\text{m}$ )	640	1920
Cavity Pitch and Yaw ( $\mu\text{rad}$ )	300 (pitch)	900 (yaw)
BPM Offset ( $\mu\text{m}$ )	360	1080
BPM Roll ( $\mu\text{rad}$ )	0	
BPM resolution ( $\mu\text{m}$ )	1	1
BPM scale error	0	0

All errors are random and independent.

This is almost (not exactly) equivalent to the “standard” in the previous slide.





pipe welding work at tunnel



closing the vessel



example of local clean room



local clean room work

From K. Kubo's GDE meeting 2010@Beijing presentation,  
we can see allowable movement of quad & cavities

## Fast errors (jitters) -2

	0.14 $\sigma$ RMS orbit change	6.3% emittance growth
Quad position	12 nm	200 nm
Cavity position	22 $\mu$ m	130 $\mu$ m
Cavity tilt	0.5 $\mu$ rad	2.5 $\mu$ rad
Magnet strength	2.5E-5	1E-3

[Wang Dou, This workshop, old results by K.Kubo]

- 0.14 sigma orbit change will cause ~3% luminosity reduction without orbit feedback downstream.
- 6.3% emittance growth cause ~3% luminosity reduction in head on collision



# Cryomodule associated device

**(1) Vacuum vessel pumping, coupler pumping.**

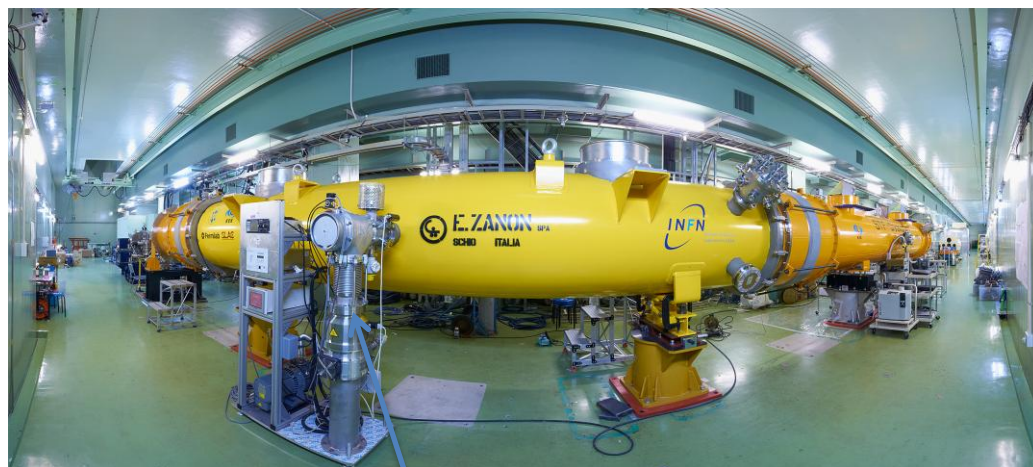
**(2) Cryomodule alignment cat's-eye holders**

**(3) Current lead into quadrupole inside.**

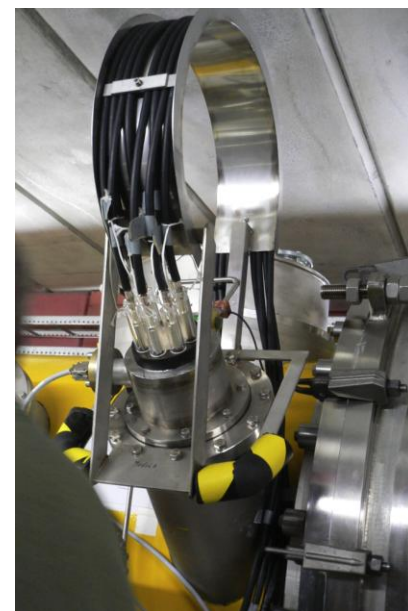
**(4) RF cable feed-through & tuners feed-through.**



cat's-eye holder

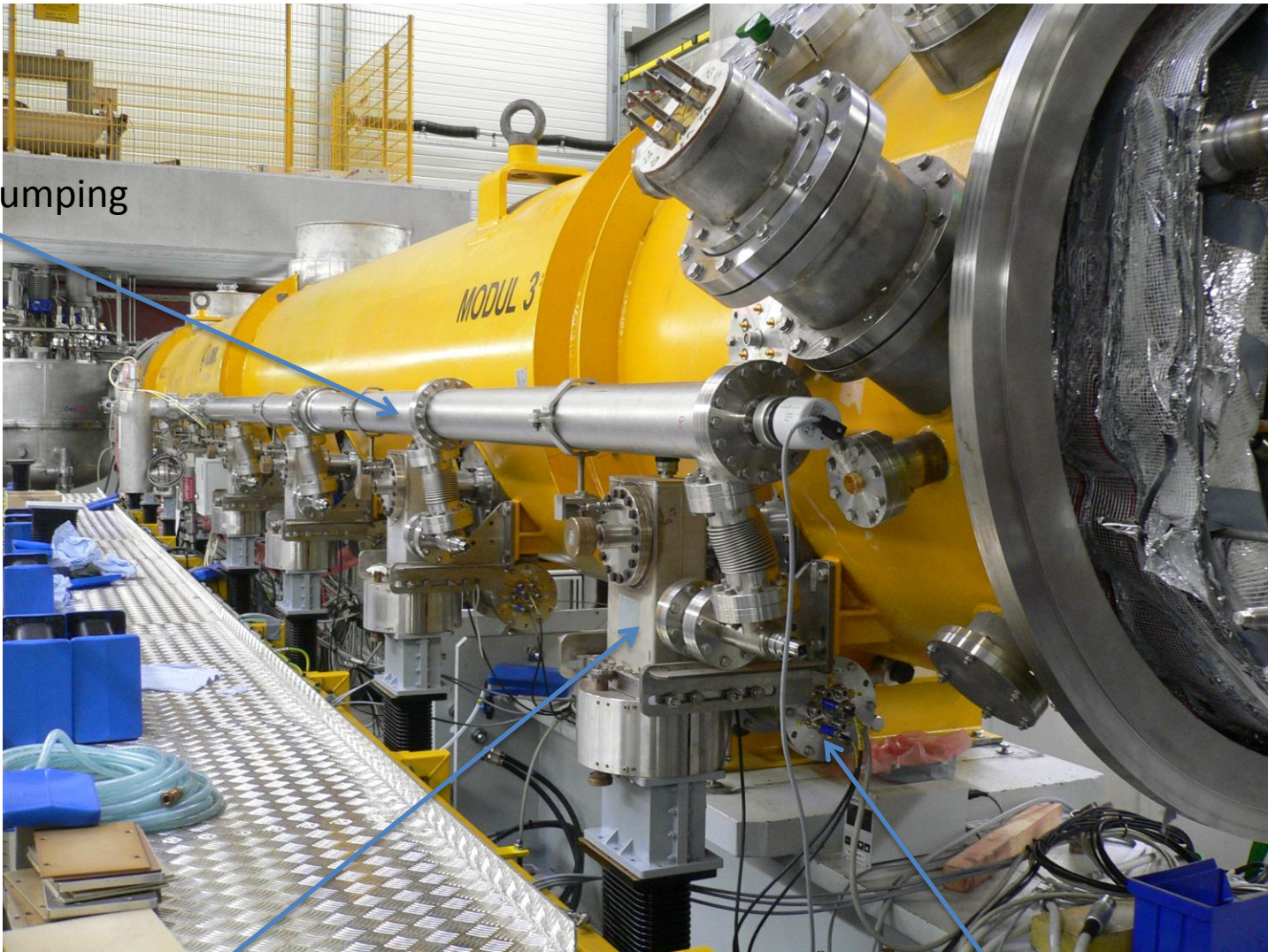


vessel pumping



quad current lead

coupler pumping



coupler waveguides

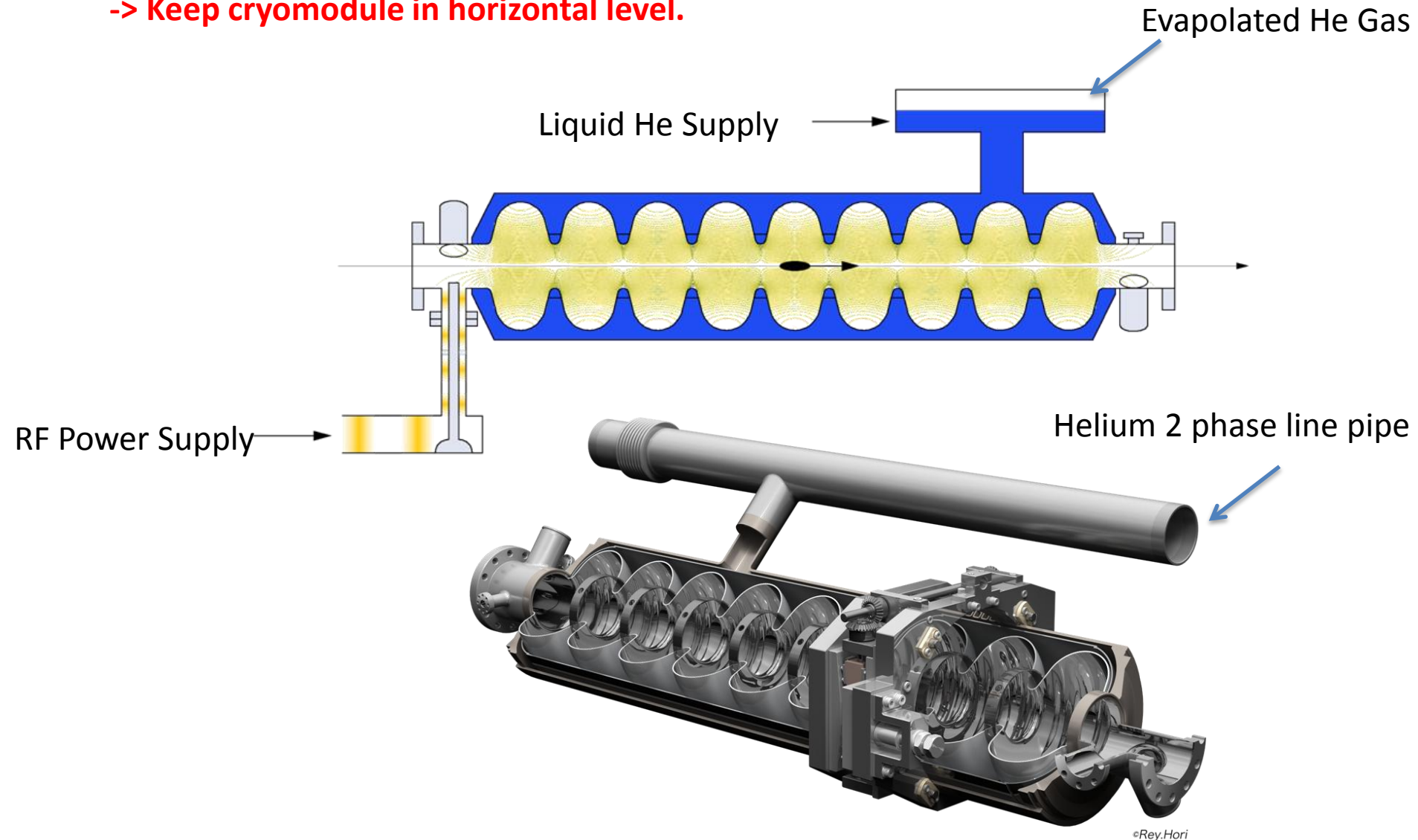
RF cables feed-through, tuners feed-through



# Liquid Helium Filling into Cavity Jacket

**Liquid Helium Surface must be kept inside of 2 phase line pipe.**

**-> Keep cryomodule in horizontal level.**



END of Slide