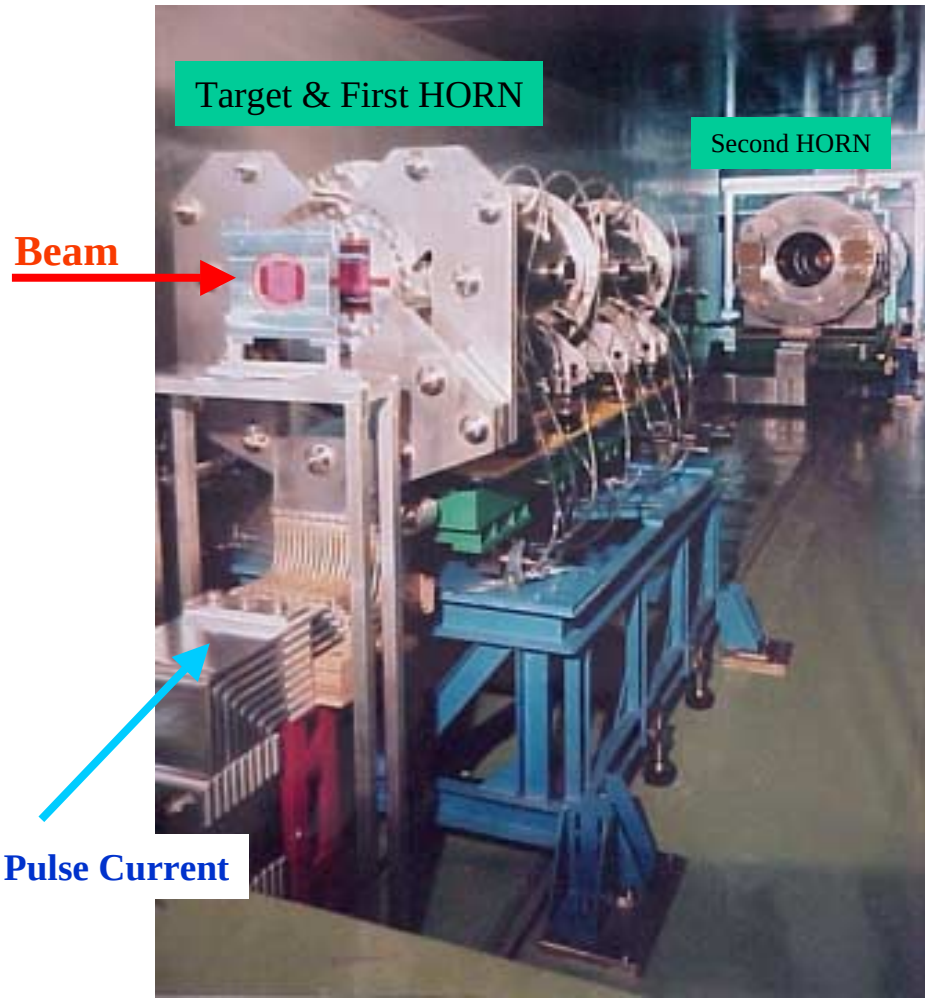
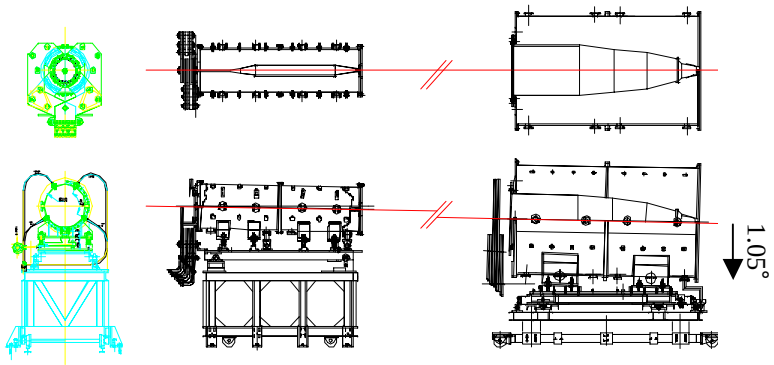
JHF Horn construction status and K2K horn experience

YAMANOI Yutaka (KEK)

- **K2K Horn system**
- **The operation result of K2K Horns**
  - **Trivial troubles (2002-2003)**
- **Status of JHF Horns**
- **Basic parameters**
  - **Mechanism and Merit of FSW**
  - **Concrete stuffing strip line**
  - **The pulse currents test by the power supply of K2K Horn**
- **Schedule**
- **Summary**

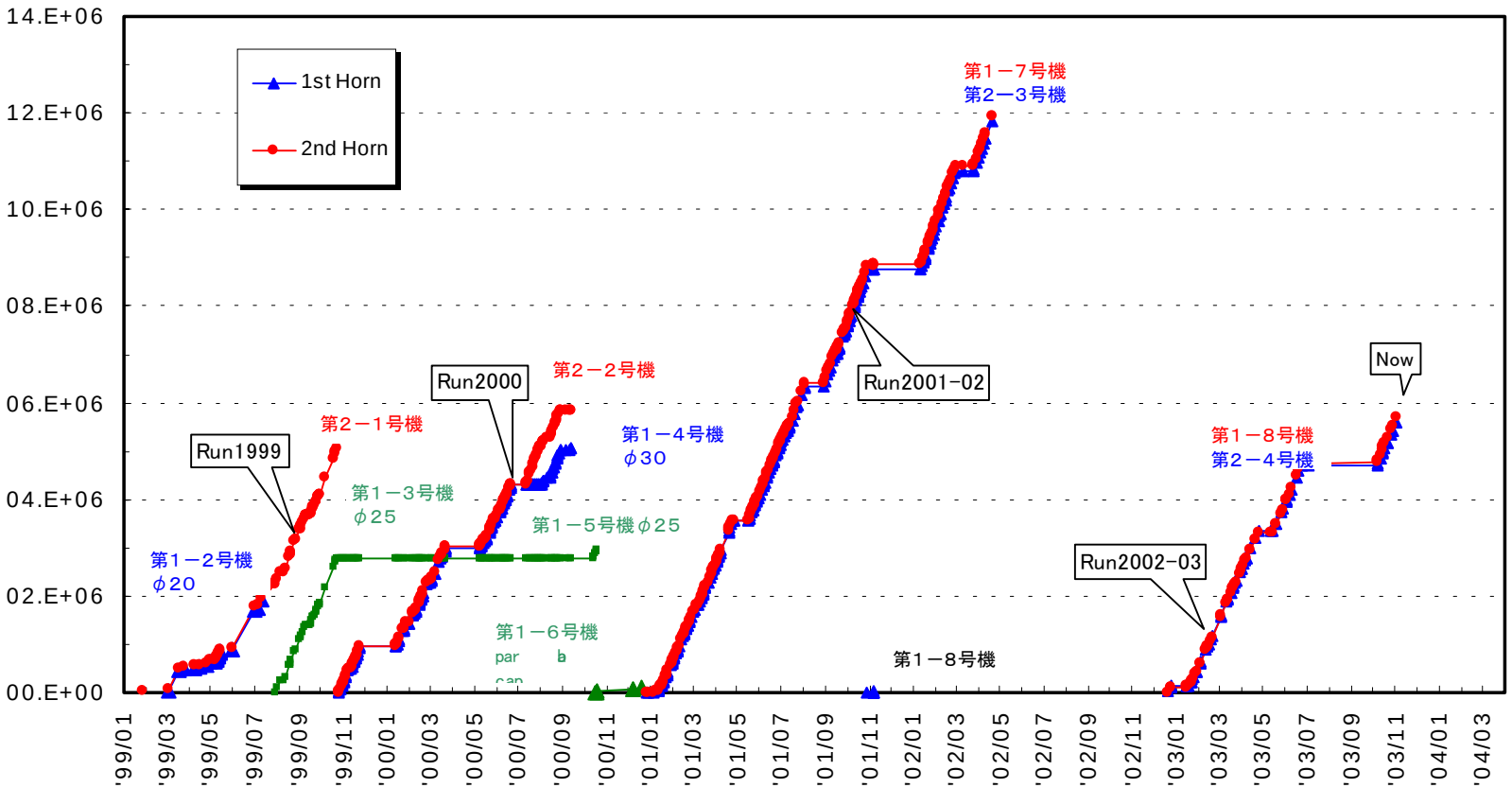
K2K Horn system





- Built-in production target (ϕ30mm)
- (Blue) Removable train:
  -A distance between horns is about 8.06 m.
- (Green) Adjustment table:
  -decline to Super-Kamiokande with 1.05˚
  -Accuracy is equal to about 0.04 mrad.
- Operation current 250k Amp at both horns
- High pulsed current 2.5ms width, 2.18s cycle
- Total Joule's heat=7740 kcal/h

The operation result of K2K Horns



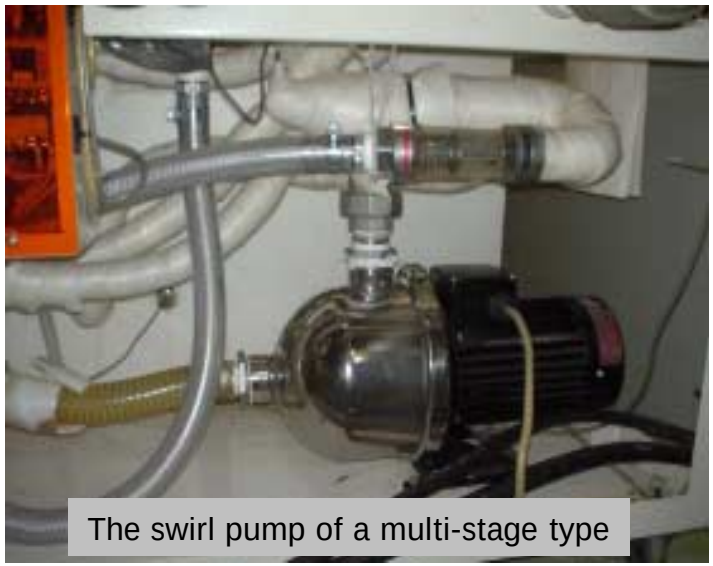
K2K Horns Logbook (1) Water level gauge

January 10, 2003
After underwater for 4 years
The water level gauge made from Teflon broke.

Eliminator unit

Reservoir, Pump unit

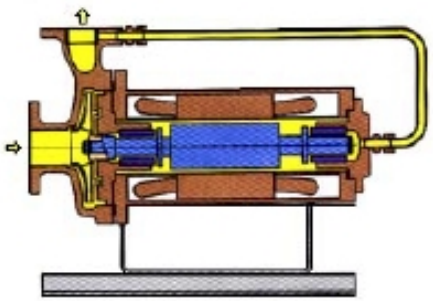
(2) Canned-Rotor Pump



The swirl pump of a multi-stage type

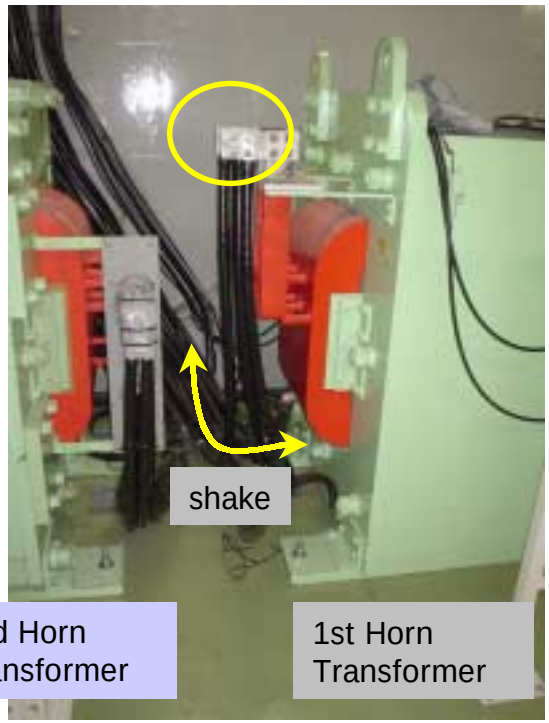
April 4, 2003
Water leaked from the mechanical seal of a swirl pump. The pump was changed into the canned-rotor pump.

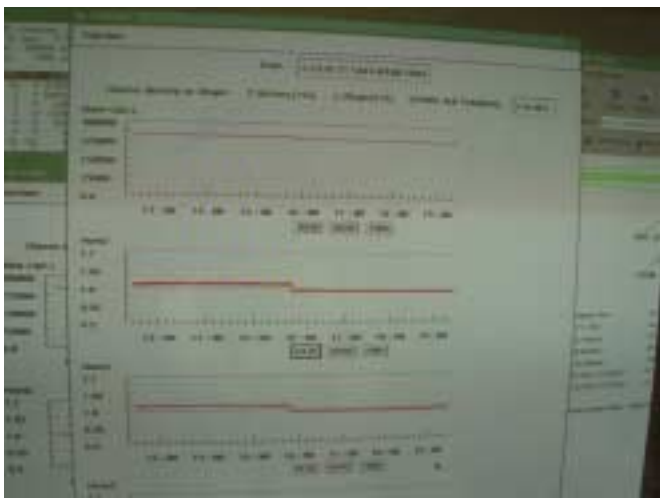
A canned-rotor pump is no liquid leak and low noise without a mechanical seal and a cooling fan.



(3) Harness of a sticking-by-pressure terminal

Jun 06, 2003
After 25.8 million operations
The harness of a cable shook and broke.



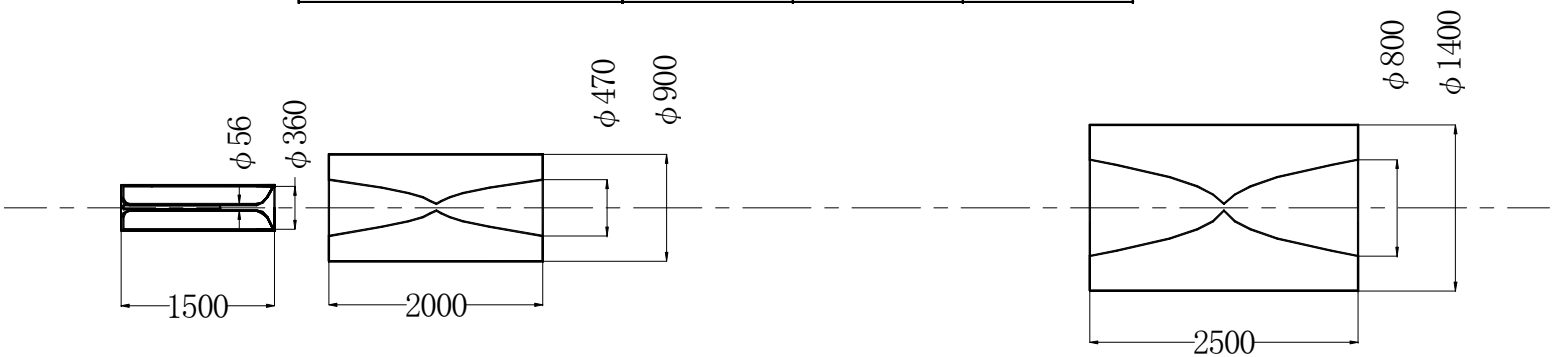


Status of JHF Horns

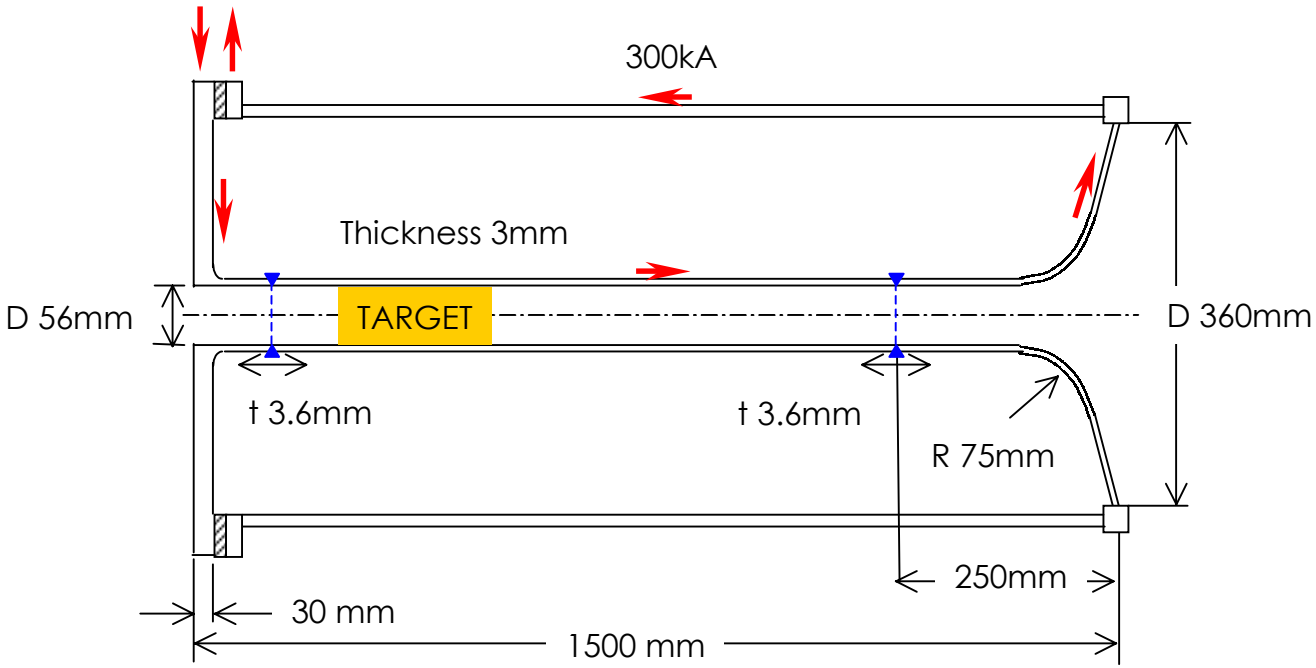
- Horn system optical design (Ichikawa)
- Target station design for Target and Horns (Yamada)
- Basic parameters (NBI03 version)
- High priority subjects
  - Consideration to recycle of K2K equipments
  - Welding technology for making a inner conductor
  - Design to installation to Target station with He-tight
  - Durability test by the power supply of K2K horn
- Construction Schedule

Basic parameters

	Horn #1	Horn #2	Horn #3
Proton beam energy	50 GeV		
Beam Intensity	$3x10^{14}$ppp		
Ring cycle	3.6s		
Pulse length	5 μs		
Horn current peak	300 kA		
Inductance	0.55 μH	0.46μH	0.48μH
Resistance	118μΩ	100μΩ	90μΩ
Transformer ratio	5		
Peak risetime	0.31ms		
Joule heating	1.1kW		
Radiation Heating	10kW		
Capacitance	1.0mF		
Charging voltage	5400V		

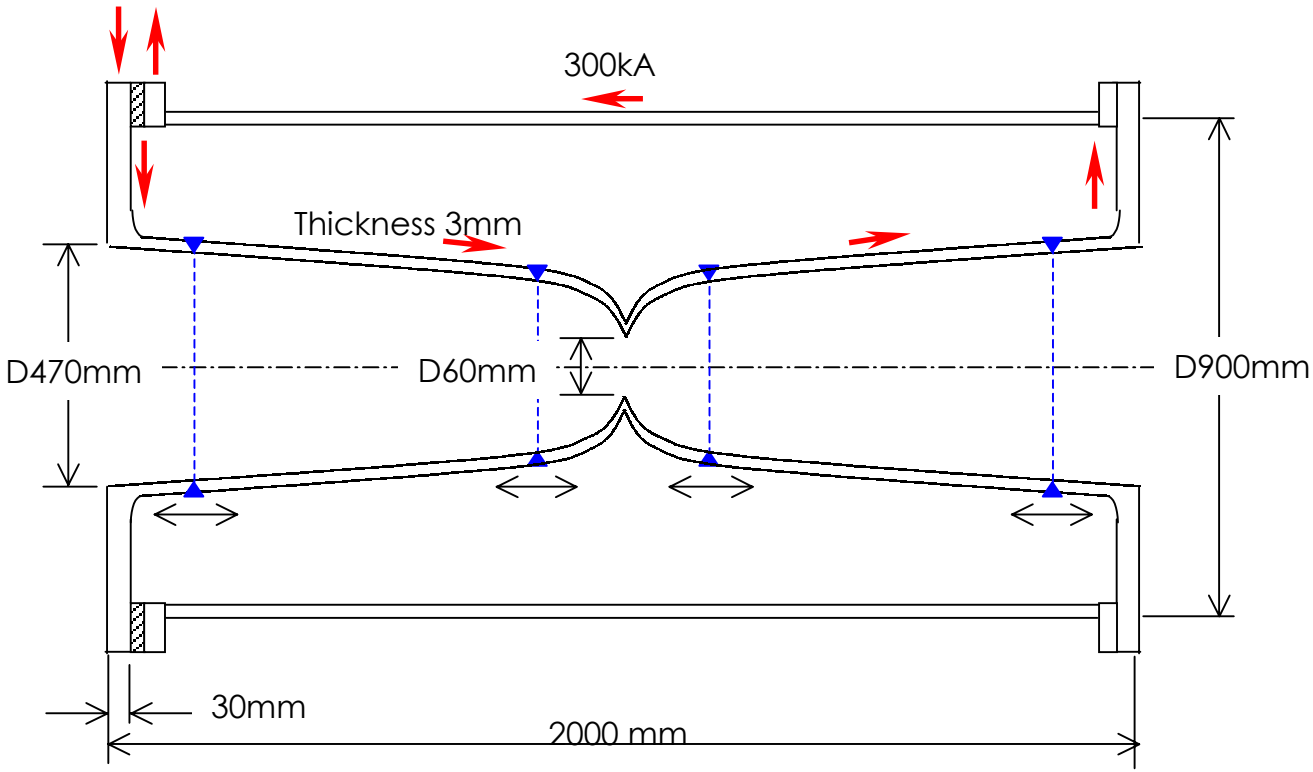


1st Horn

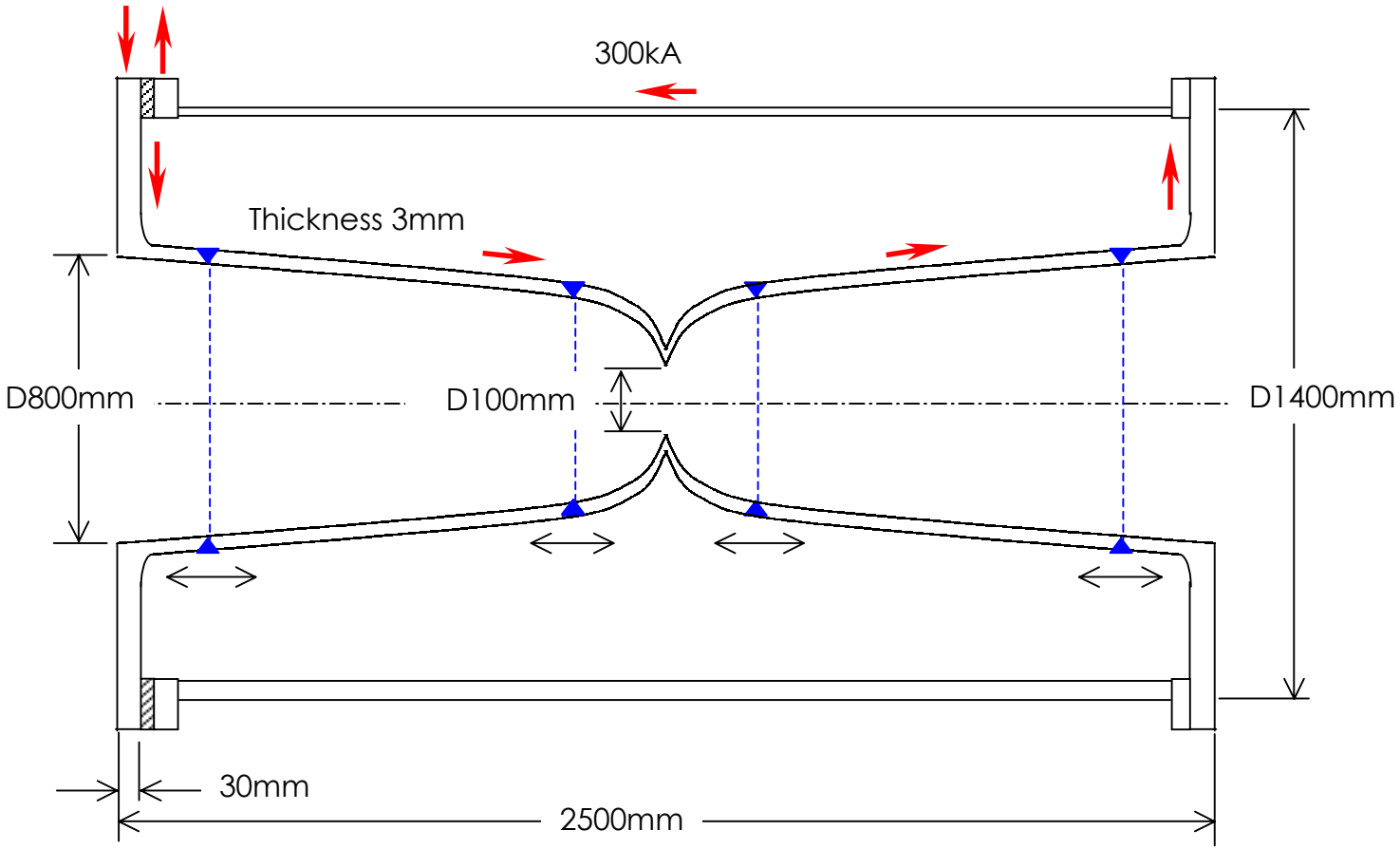


A6061、or (A2219, A7003, A5083)

2nd Horn



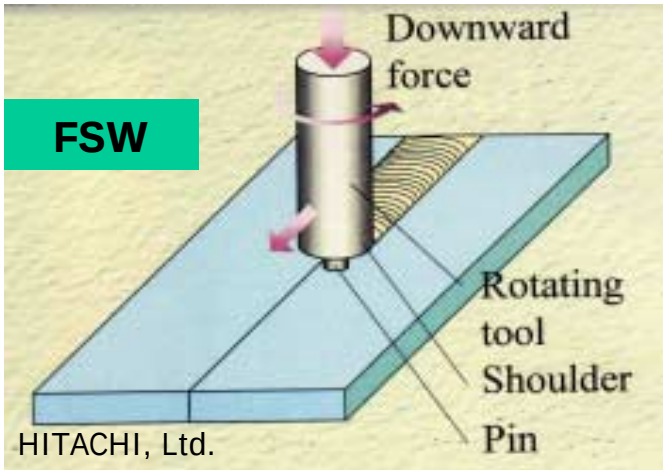
3rd Horn

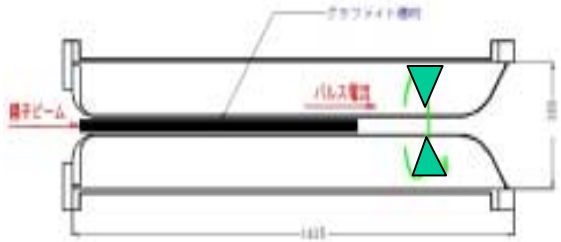


Comparison with the welding method

	Proof stress (A6061)	Heat distortion	Workability	Cost	Merit/Demerit
Laser Beam Welding	○ ～85%	◎	○	△	A welding pretreatment is required. The large equipment is required. Triming is needed after welding.
Electron Beam Welding	○ ～85%	◎	○	△	The vacuum chamber containing a horn is needed. Triming is needed after welding.
Friction Stir Welding	○ ～80%	◎	◎	○	New technology. No-Trimming after welding. Easy to adjust the length. ～0.3mm
MIG (metel inert gas) Welding	△ ～60%	△	○	◎	Welding distortion is large. There is variation in the quality by skill.
TIG (tungsten inert gas) Welding	△ ～60%	△	○	◎	Welding distortion is large. There is variation in the quality by skill.

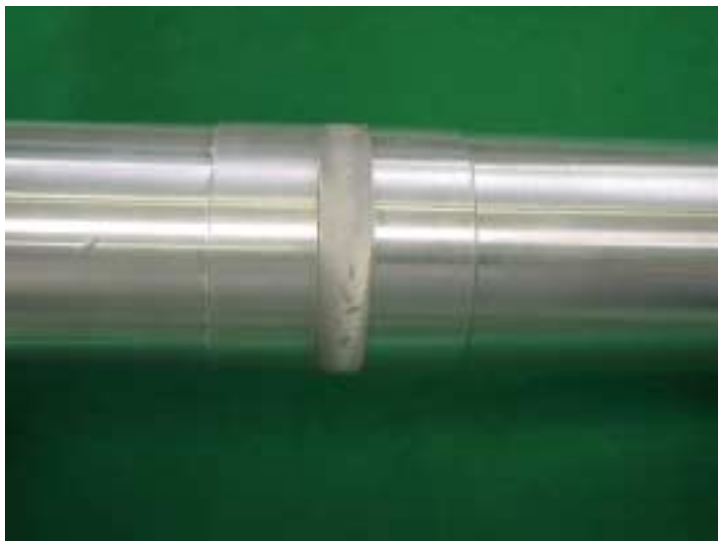
Mechanism and Merit of FSW (Friction Stir Welding)



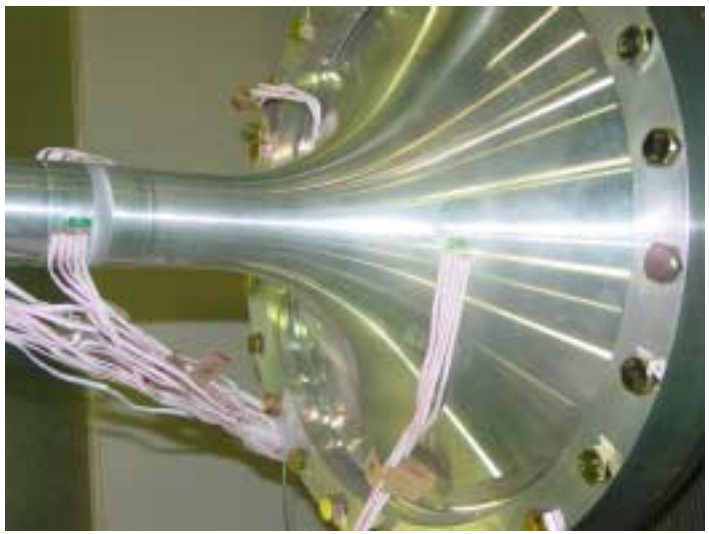


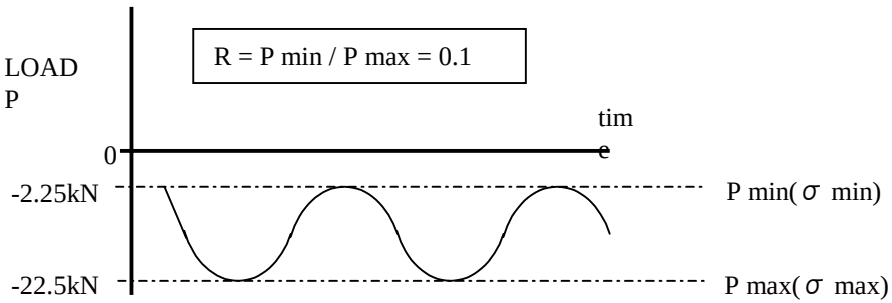
- Invented at TWI(1991)
- Applied to space rocket, train body

- Very low distortion
  -Good dimensional stability and repeatability
- Fully mechanical process
  -No fume, porosity or spatter
- Excellent mechanical/metallurgical properties
- Very cost effective

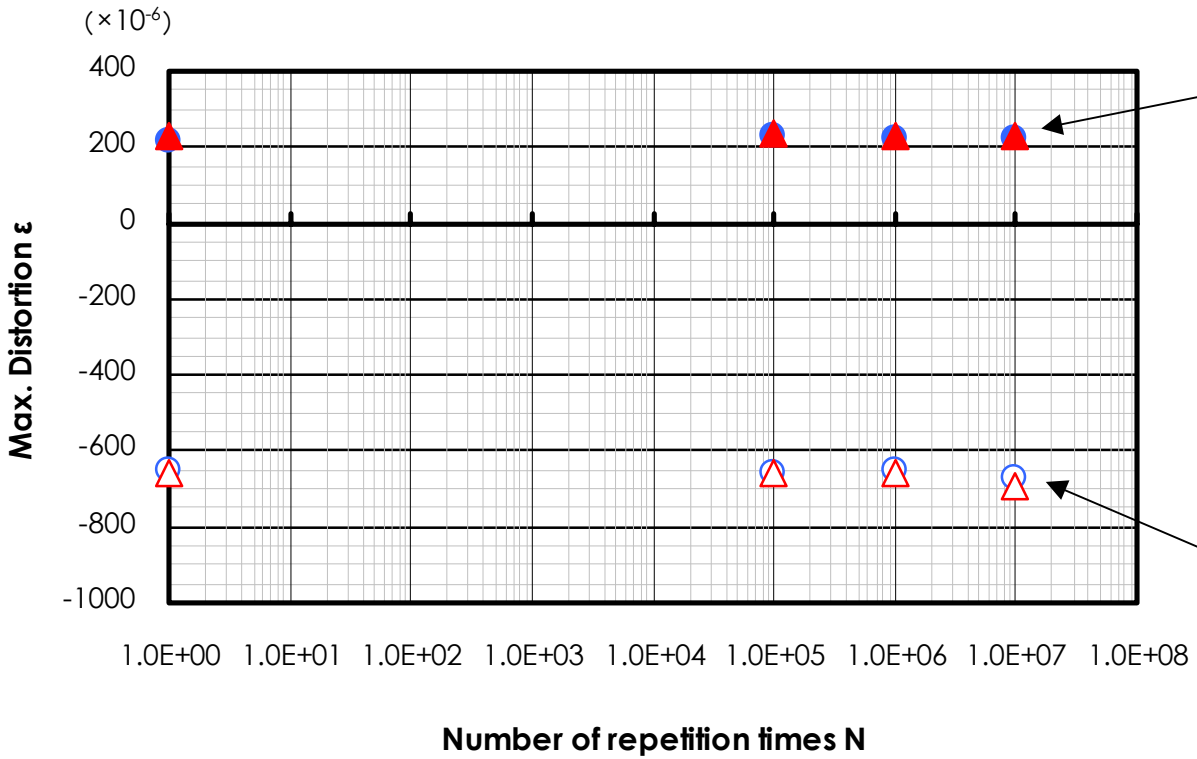


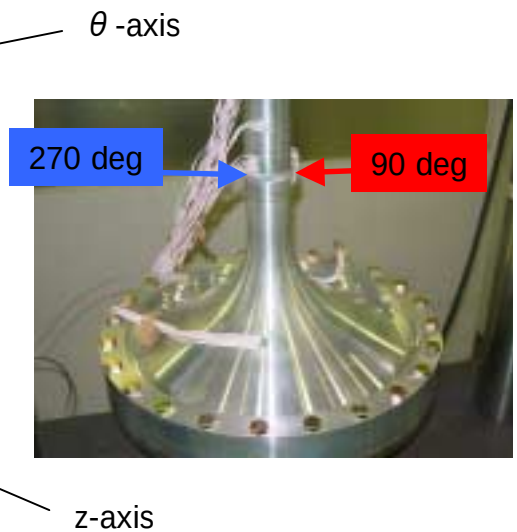

グラファイト標的
陽子ビーム
パルス電流




R = P min / P max = 0.1
LOAD
P
tim
e
0
-2.25kN
-22.5kN
P min(σ min)
P max(σ max)

Result

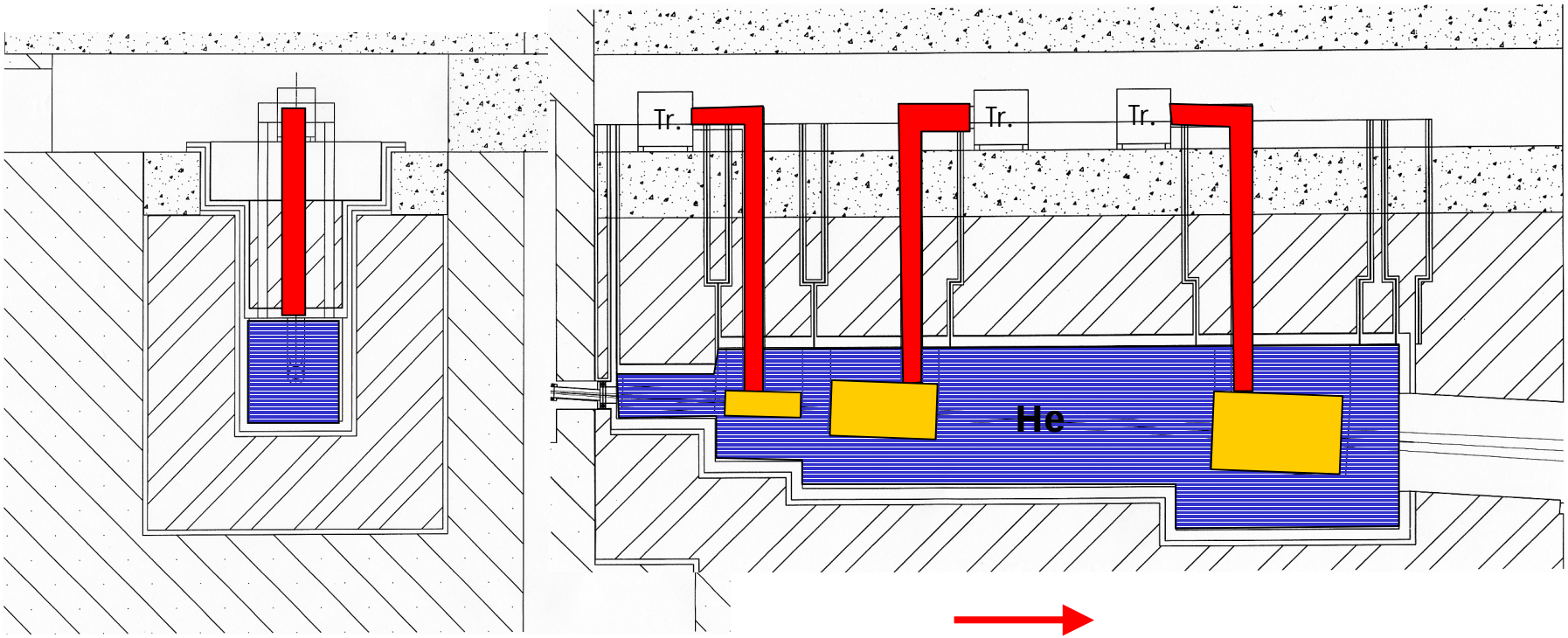




It carried out 1.09x10^7 times by the maximum load 22.5kN.
The damage by repetition fatigue was not found.

Target Station (Y.YAMADA)

To reduce NOx and Tritium in the target station
> The He gas is filled in TS.



Concrete stuffing strip line

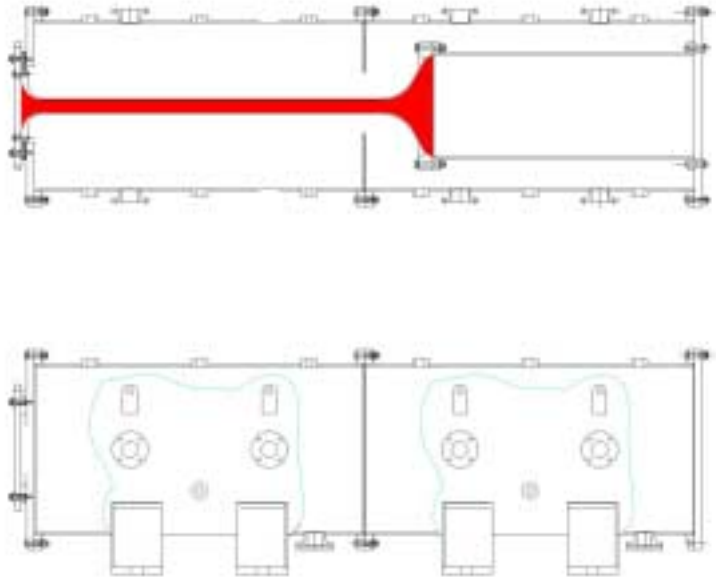
Surface treatment (t 25 μ m hard anodic oxide coating + sealing)

Withstand voltage	2.8kV-2x10^{10}ohm
Heat resistance	300 degrees C-4hr
Corrosion resistance	Salt spray test OK (ASTM-B-117)

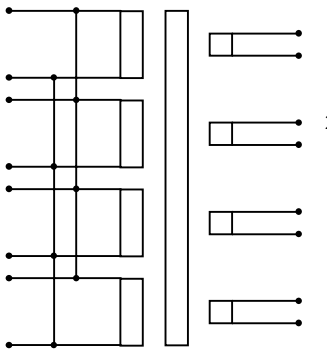
The pulse currents test by the power supply of K2K Horn

Power supply of K2K Horn

Transformer



Primary
circuit
20 turns

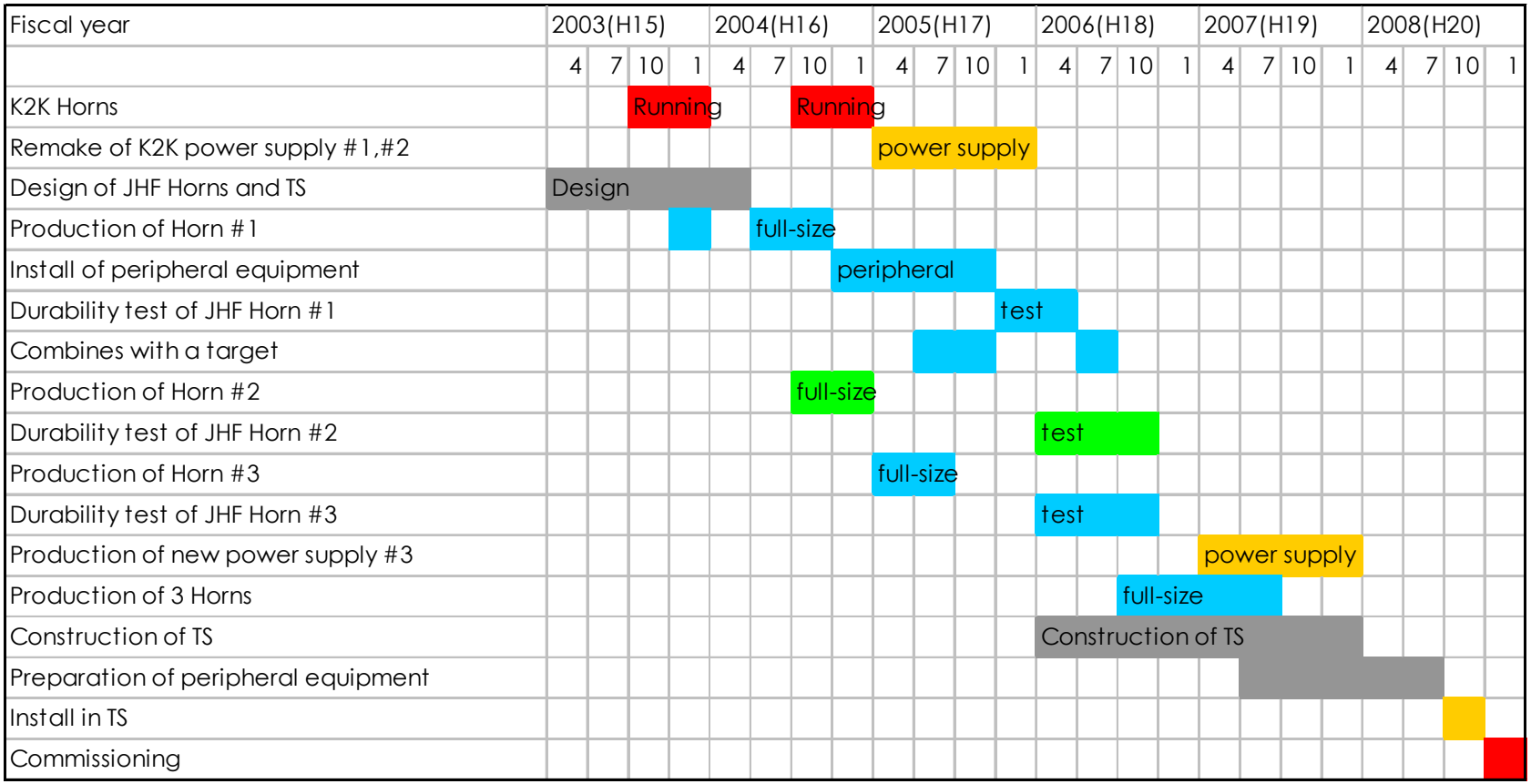


Secondary
circuit
2 turns
x 4 circuits

- JHF Inner conductor
  + K2K Outer conductor
- Transformer ratio: 10 -> 5
  250kA -> 300kA(Max.500kA)

The pulse test will be begun
in spring of 2004.

Horns Construction Schedule



Summary

- Now our K2K horns are very stable.
- We should pay attention more and more to peripherals.
- Now we design JHF Horns and Target station.
- I want to excitation tests about full size horn and all peripherals in the real situation as soon as possible.