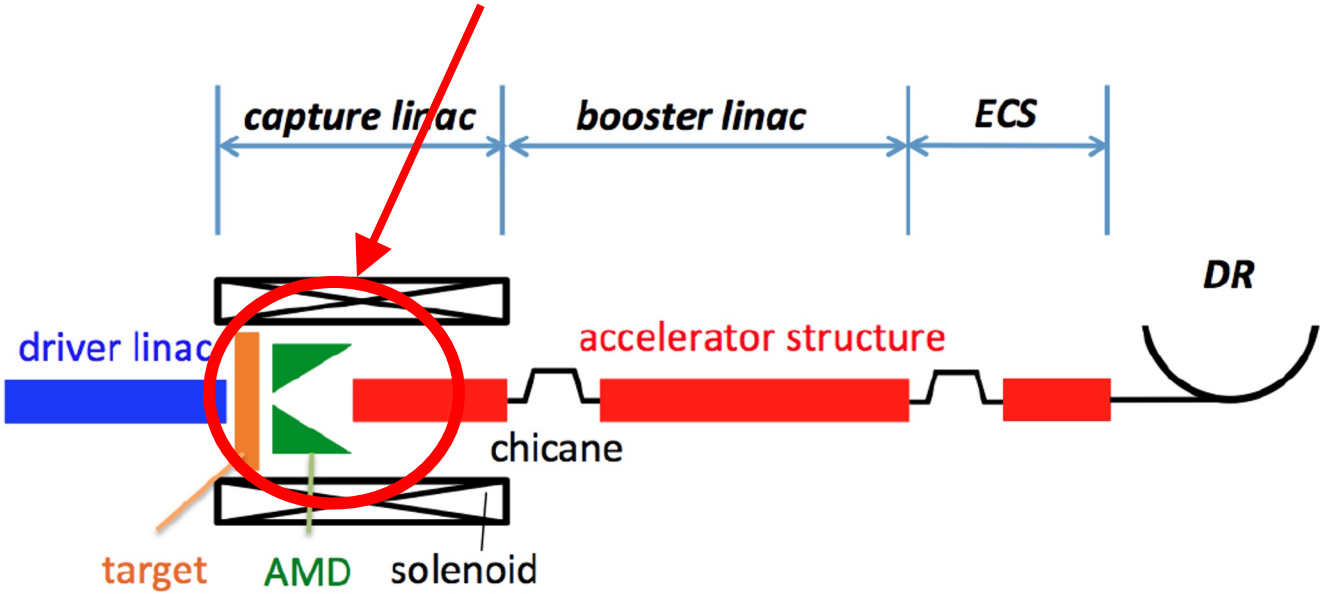
ILC E-Driven e+ Source

R/D plan for 2023-2026

the plan is just for kick-off discussions, not conclusive

Hardware: target and immediate downstream devices (civil not included)



6-Feb-2023
IDT Source Group Meeting@ Remote
T. Omori (KEK)

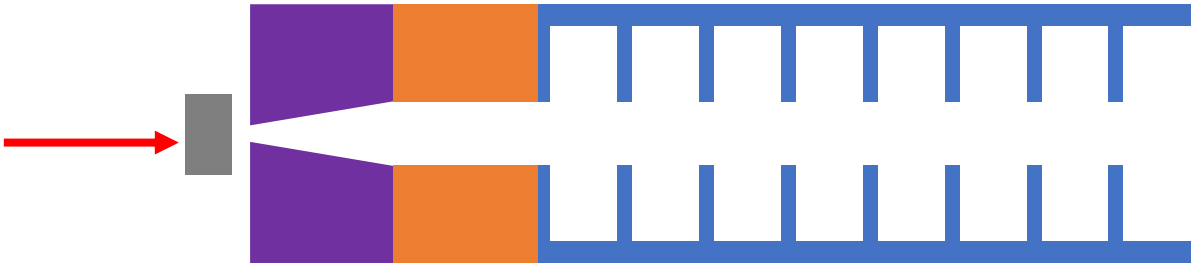
Introduction

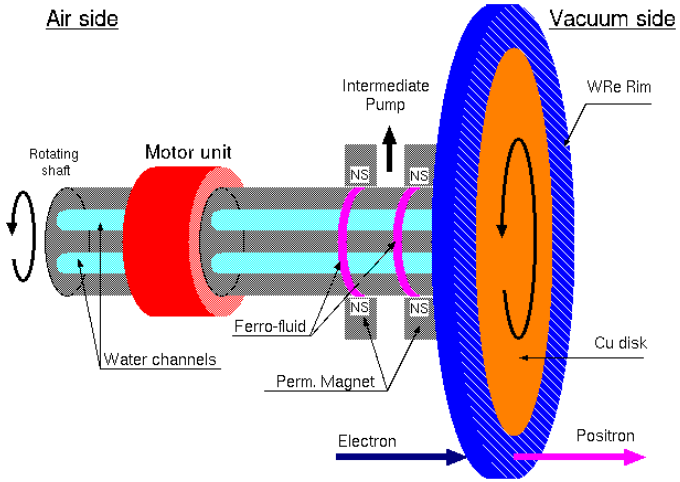
- **Our task in Pre-lab (+Time Critical WP) era.**

The Pre-lab Proposal states;
- Much technical work has already been completed.
- From technical design to engineering design.

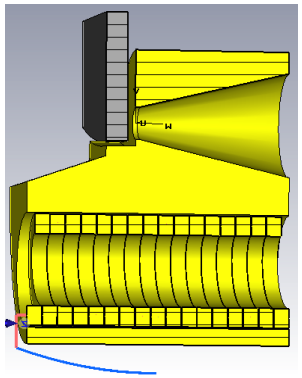
Now we have Time Critical WP period, so there is some delay.
However NO difference in principal directive.
- To be ready for ILC construction, with minimal delay.

For the e-Driven Positron Source

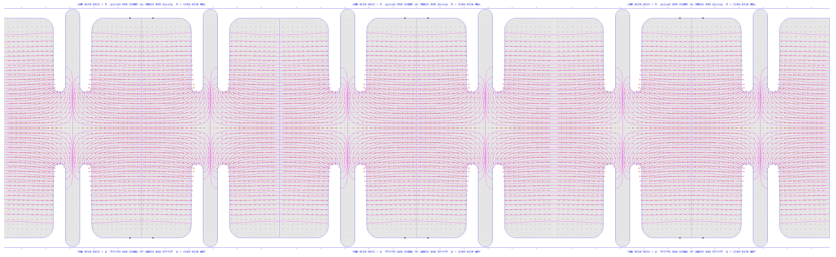




Rotation Target with Ferrofluid Vacuum Seal



Tow Conductor FC (à la VLEPP)



APS Cavity (water channels in iris)

The developments of the three items have progressed smoothly so far.
Next step: Go further to make detailed engineering design.

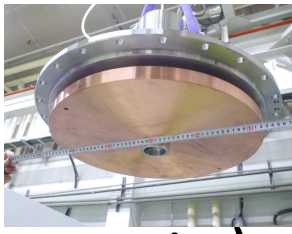
*** Hardware R/D items in 2023 – 2026:**

Target, FC, 1st Acc. tube: Go to engineering design.

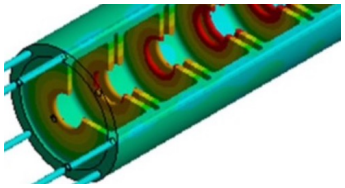
Target, FC, 1st Acc. tube: Integration Test

Achievements so far

- **Rotation target**
  - Development started in 2014. (Rigaku, KEK, Hirosima U., Waseda U.)
  - Rotation target with ferrofluid vacuum seal.
  - Radiation test completed (dose compatible with 2600 bunch/pulse, 3-year operation)
  - Prototype (ver.2) with a real size dummy disk exists.
  - Long term vacuum test with rotation shows good results (2-year operation).

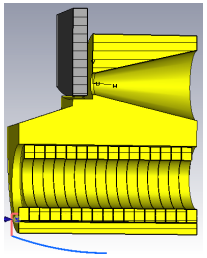


- **The 1st acceleration tube**
  - Production of a cavity for cold test is on going with Tohoku industrial-academic collaboration.
  - Preparation of the detuning test is ongoing at Iwate Industry Promotion Center.

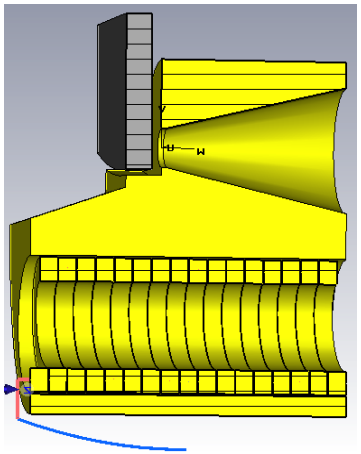


note: Joint study with Tohoku industrial-academic collaboration started in late 2020.
2021-2022 : Collimator prototype
2022-2023 : Prototype of the 1st acceleration tube (cold model)

- **FC**
  - Basic design exists (two-conductor type à la VLEPP), collaboration w Pavel-san (BINP).



FC



- Basic design exists (two-conductor type à la VLEPP)
- Next step: FC prototype
- FC cooling test with electric heater (can we skip this?)
- FC excitation test by using pulsed power supply

  Step-by-step?

  Comparison of pulsed power supplies

  - ILC FC PS (expensive) : I_{peak} = 25 kA, T_w = 25 us, Rep. rate = 300 Hz (av 100Hz)
  - SuperKEKB FC PS* : I_{peak} = 12 kA, T_w = 5 us, Rep. rate = 50 Hz
  - Sband-klystron PS* : I_{peak} = 4.8 kA, T_w = 5 us, Rep. rate = 50 Hz

* In SuperKEKB FC development, step-by-step apploach was taken, by using the klystron PS for KEKB.

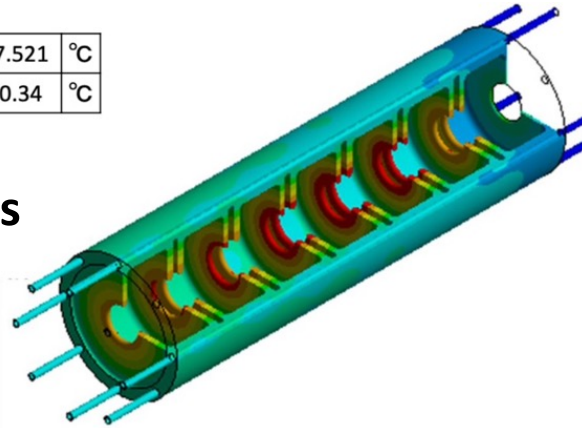
* Proceedings of the 10th Annual Meeting of Particle Accelerator Society of Japan (August 3-5, 2013, Nagoya, Japan)
  Mitsuo Akemoto, Takuya Kamitani, Tetsuo Shidara, Hiromitsu Nakajima, Shigeki Fukuda, Hiroyuki Honma, and Shinichiro Michizono (KEK)

- Target and FC combined test (we will discuss later)

1st Acceleration Tube

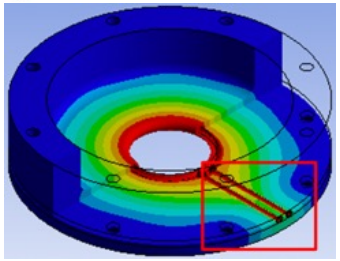
Detuning Experiment
by using Cold Model in air

最大温度	67.521	℃
平均温度	40.34	℃



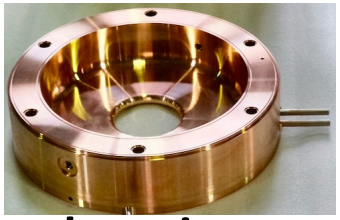
- **Cooling Design of the Acc. Tube**

  The iris section got very big heat by the electromagnetic shower in creation of positrons. The acceleration tube has two types of water channels. It has channels in the iris section in addition to the cylinder section, to cope with the heat generated by the electromagnetic shower.

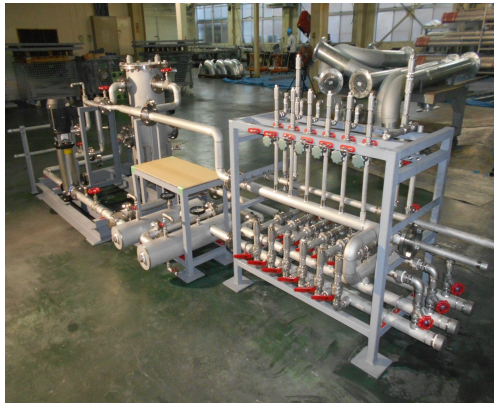


- **Detuning Experiment**

  The cold model has two types of water channels.
  We can emulate the situation of the acc. tube under EM shower environment, by running,
  - Cooling water in channels at cylinder,
  - Hot water in channels at iris.



  We put antenna inside the cavity and measure detuning.



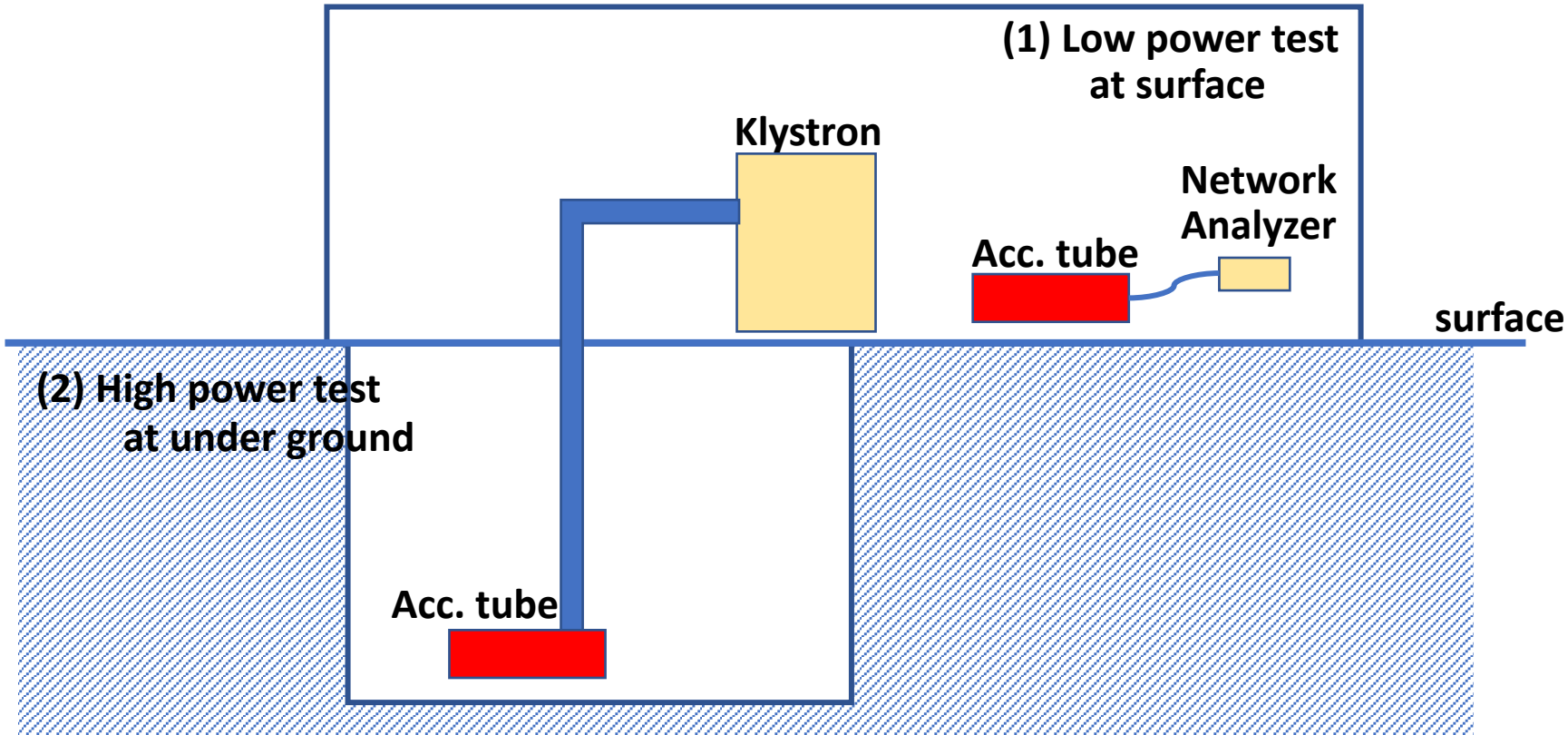
  We will take data Feburaly - July 2023

  We expect good results, good data, then we will publish a good paper.

1st Acceleration Tube

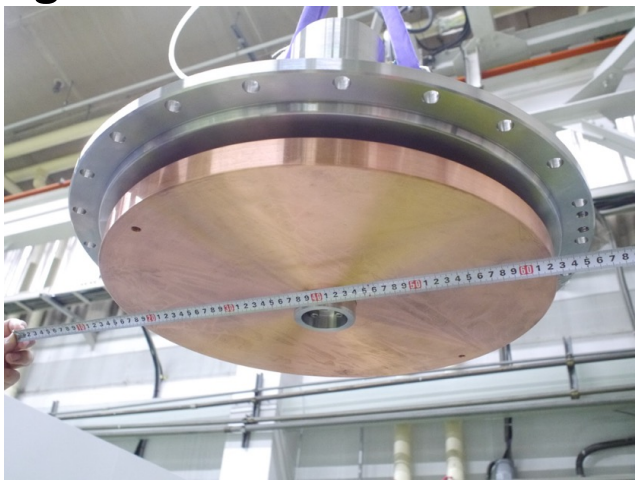
RF Test by using Prototype of vacuum and RF power compatible

- The place for the experiment has been prepared at STF building.
  (by Enomoto-san, Hayano-san,,,)
- Accelerator tube Prototype (expensive)
  - Vacuum compatible
  - RF power compatible
- Klystron for high power test
  - Expensive, but we have it at STF building.



Rotation Target

- Prototype (ver.2) with a real size dummy disk (Cu) exists.
- Long term vacuum test with rotation shows good results (2-year operation).
- What are remaining things to do for engineering design?
- Development of Cu-WRe target disk is necessary.



Cu-WRe bonding by step-by-step

- Test piece
- Small size disk
- Heating test
- Real size disk

bonding success -> apply to the prototype-2, then Target-FC combined test

- Material choice : Cu-WRe

WRe：high tensile strength, high yield strength, and proven results by high energy beam : Operation at SLC (1), and test at SLAC linac(2)

(1) SLC trolling target (Cu-WRe) was used in 6 years. During the 6 years, high luminosity was achieved in the one year called "the last run (1997-1998)". After the use of 1 year high intensity operation, SLAC people opened the vacuum chamber then they fund many cracks at back side of the WRe ring of the target, but still NOT collapsed.

(2) SLAC-CN-128

Cu-WRe is appropriate

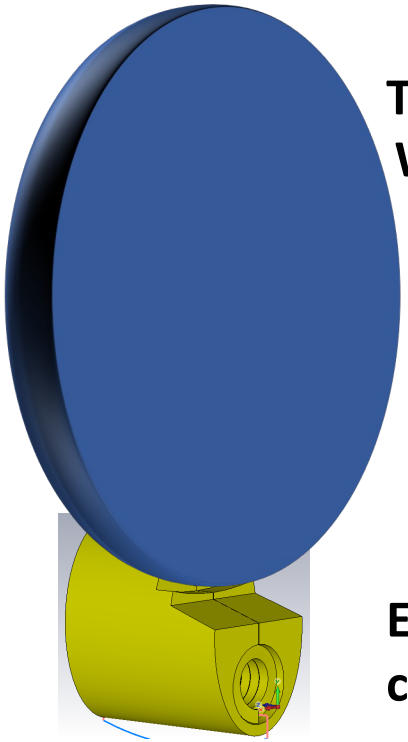
Combined test: Target and FC

- **Combined test of rotation target and FC**

  Rotation + Pulse B-field by FC + Maintain vacuum (effect of pulse B-field on target)

  - Rotation target : Use target prototype 2
  Replace Cu dummy disk with Cu-WRe disk (if we can make it timely)

  - Rotation target : Use target prototype 2
  Make experiment with Cu disk. (if don't have Cu-WRe disk in time)

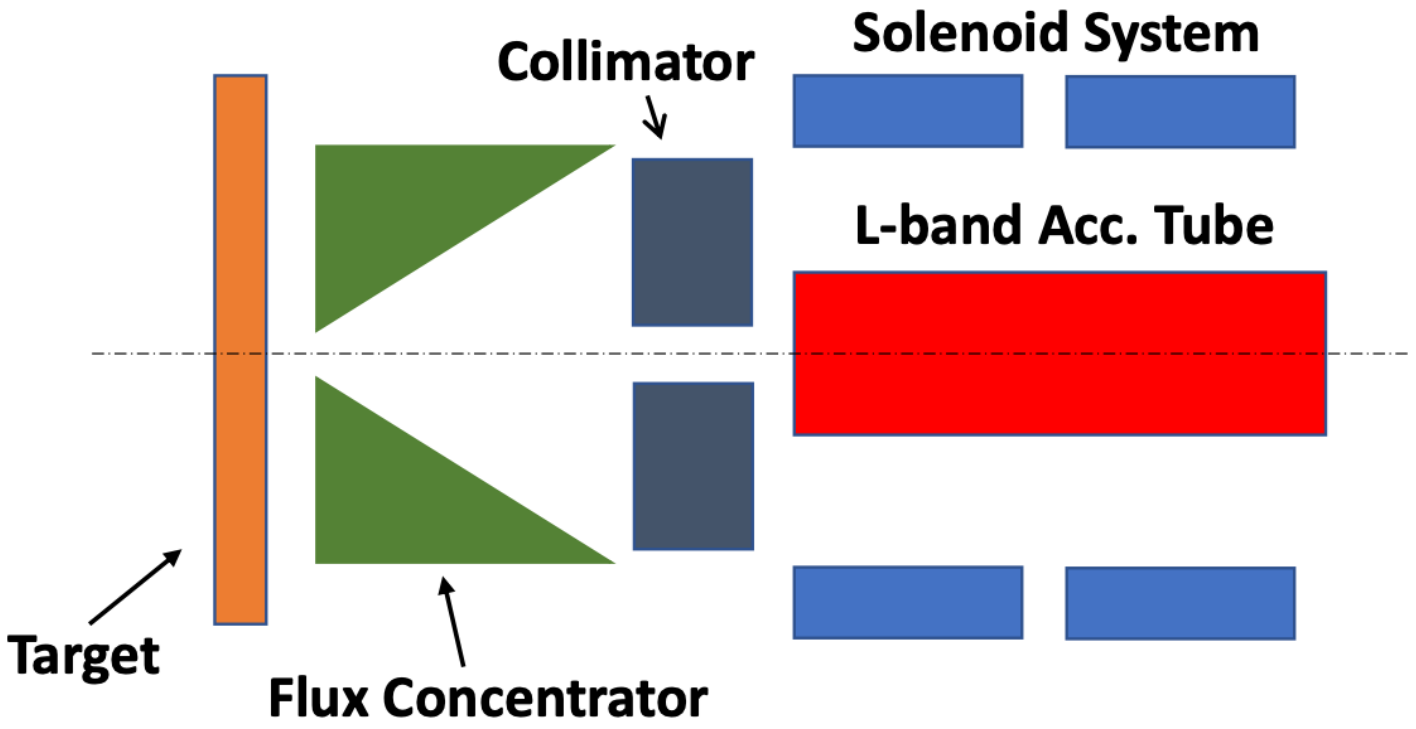


Target prototype 2 with real size dummy disk exits.
We will use it.

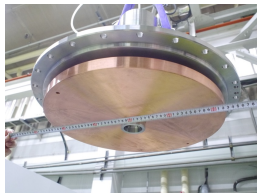
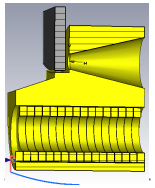
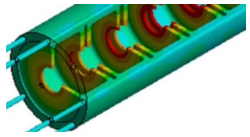
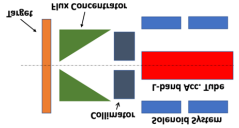
Eddy current by pulse magnetic field of FC possibly can make effect of vacuum of rotation target

Mockup of target and capture assembly

- Target + FC+ collimator + 1st Acc. tube + Solenoid
- Use for study of maintenance scheme (remote handling)
- Real size ?, 1/5 model ?, need consideration
- Made by wood ?



Summary

	2014 - 2022	2023	2024	2025 - 2026
Rotation Target : 	Basic study Off-the-shelf target Radiation hardness Residual gas analysis high field test	Cu-WRe bonding test piece	Cu-WRe bonding disk (small, real size)	Target Prototype 2 + Cu-WRe Real Size Disk + FC Prototype Rotation + Vacuum + Pulse B
	Target prototype 1	under preparation		
	Target prototype 2			
	Target prototype 2 w. Cu real size disk			
FC : 	Basic design	FC prototype Heat test	pulse test	
Acc. Tube 	Design comparison chose: APS	Cold model under production	Acc. Tube Prototype vacuum and RF power model Low power test	High power test detuning experiment
Others				Mockup of target and capture assembly T + FC + Collimator + Acc.-tube + Solenoid