

High-field test at KEK

CLIC Workshop
Oct. 16-18, CERN

T. Higo, KEK

Contributors

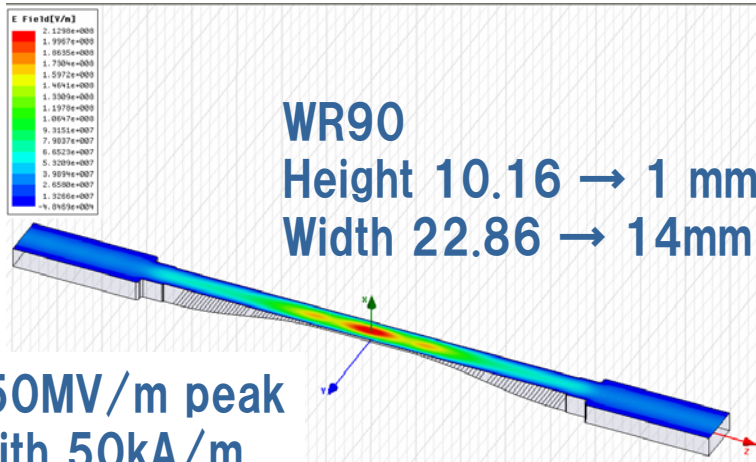
- Accelerator
 - S. Fukuda
 - S. Matsumoto
 - M. Akemoto
 - M. Yoshida
 - K. Yokoyama
 - N. Kudoh
 - T. Higo
- KEK MEC staff
 - K. Ueno
 - Y. Higashi
 - T. Takatomi
- Somewhat helped by KEKB injector team
- Operation will be supported by KEKB operators during its operation

Total FTE = 4~5

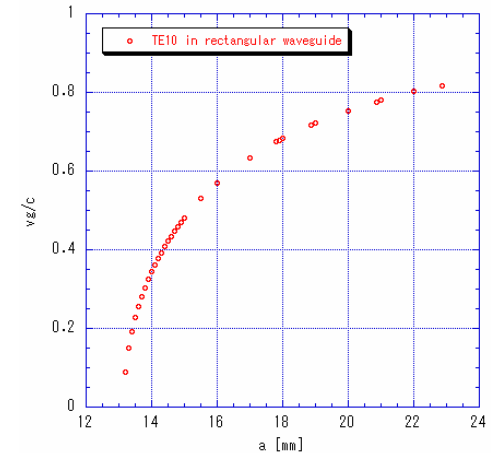
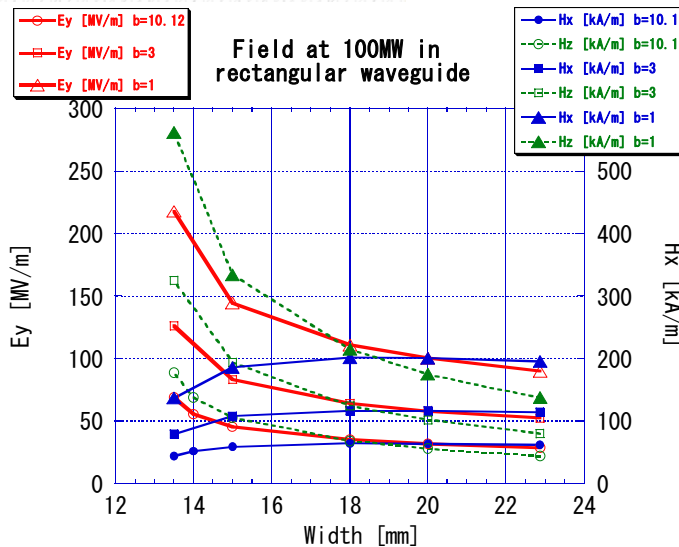
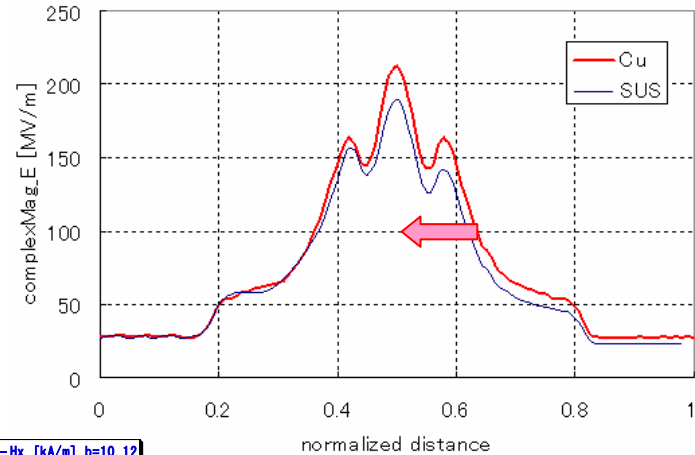
High-field test at KEK

- Klystron assembly hall
 - High field test is on-gong with narrow waveguide
 - Cupper and SUS models are tested
- Nextef
 - Start-up status
 - Combined power into shield room is foreseen in this month
 - Near future plan
 - System establish with old structure
 - Hope to test new CLIC-related structure early next year

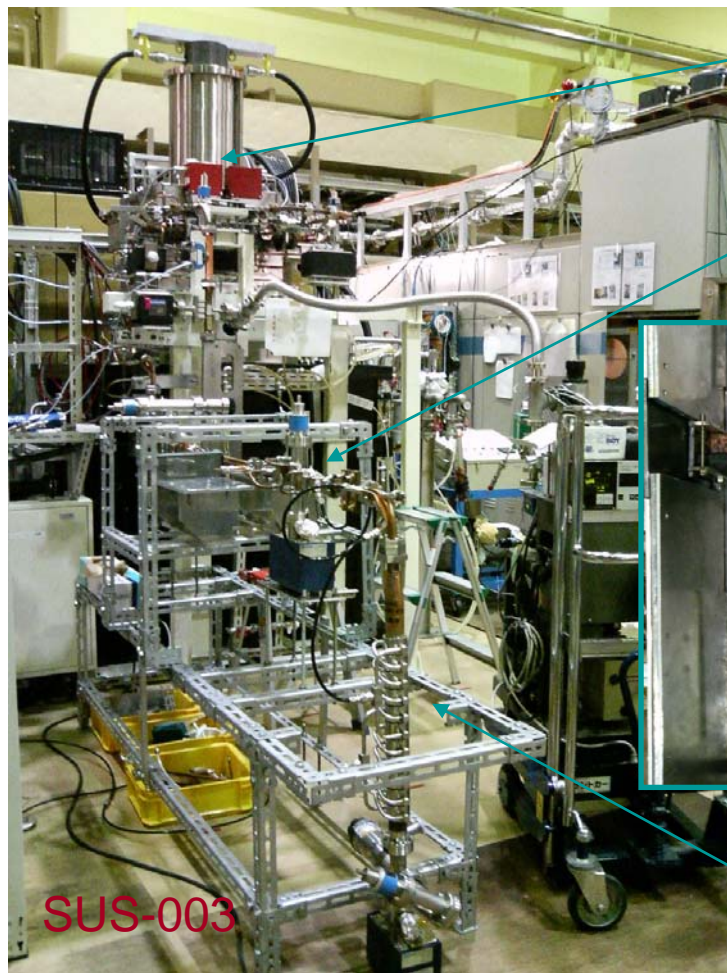
Narrow Waveguide Design



150MV/m peak
 with 50kA/m
 at 50MW
 (max with
 one klystron)



Setup for High-Power processing @ klystron assembly hall of Nextef



PPM Klystron

Narrow waveguide
in 5mm lead shield



Acoustic sensors

High power
Dummy Load

Our Plan

- Cu-002
tested at XTF and
used for startup of
new system (May)
- SUS-003
now under test
- Cu-004
to be tested (next)
- Other samples
to be tested (future)

Fabrication

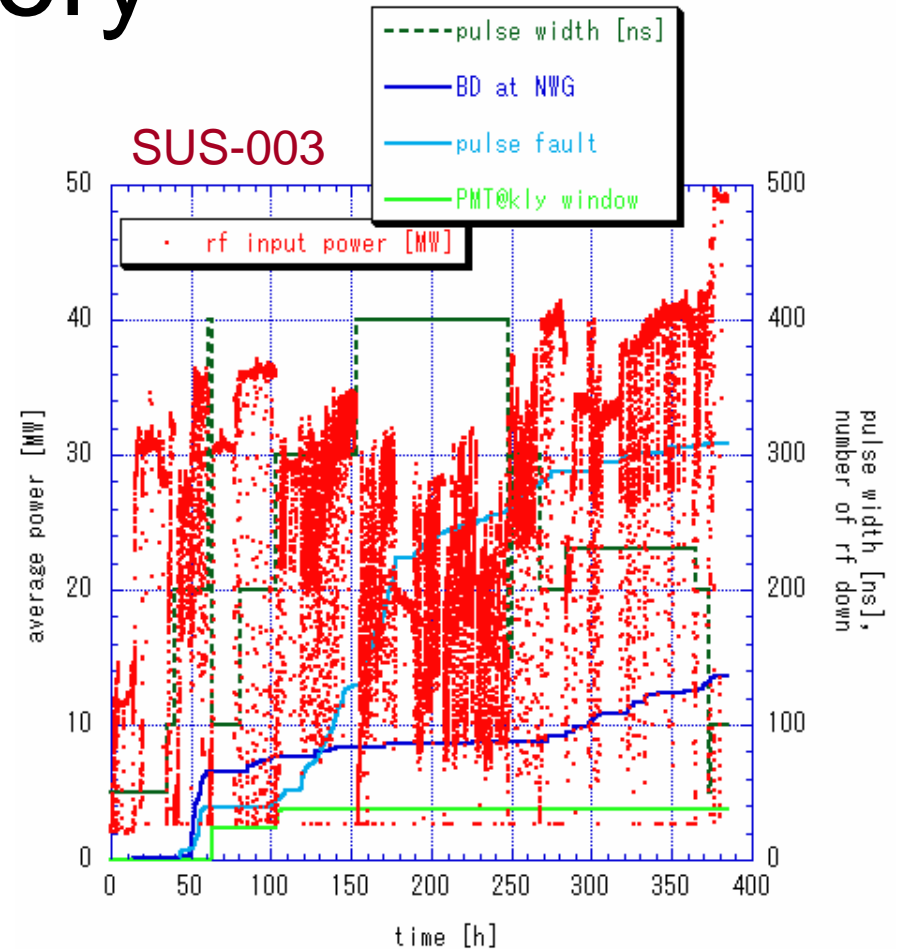
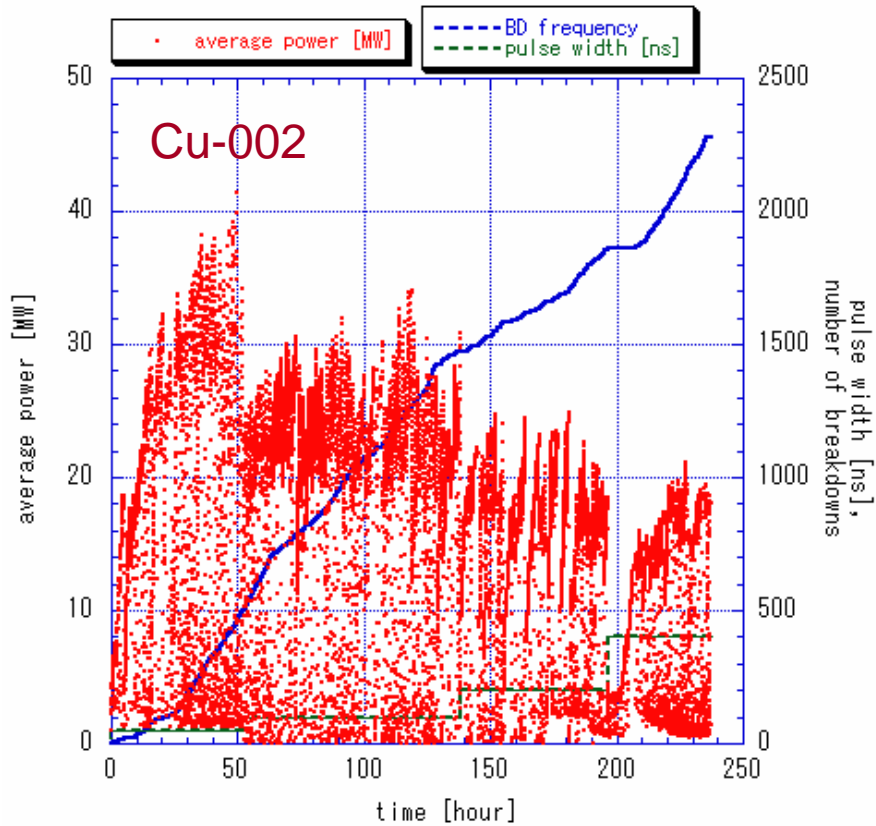


Narrow waveguide consists of 4 parts. These are joined by brazing.

	Cu-002	SUS-003	Cu-004
material	OFC	SUS316L	OFC
annealing	500 °C	1020 °C	500 °C
processes	Milling & WC	milling	milling
cleaning	CP	SUSpika*	CP
bonding	Cu/Au/Ni, Brazing (H ₂)	Cu/Au, Brazing (H ₂)	Cu/Au Brazing (H ₂)
VSWR	1.4	1.12	1.02
Test status	finished	Under test	Next

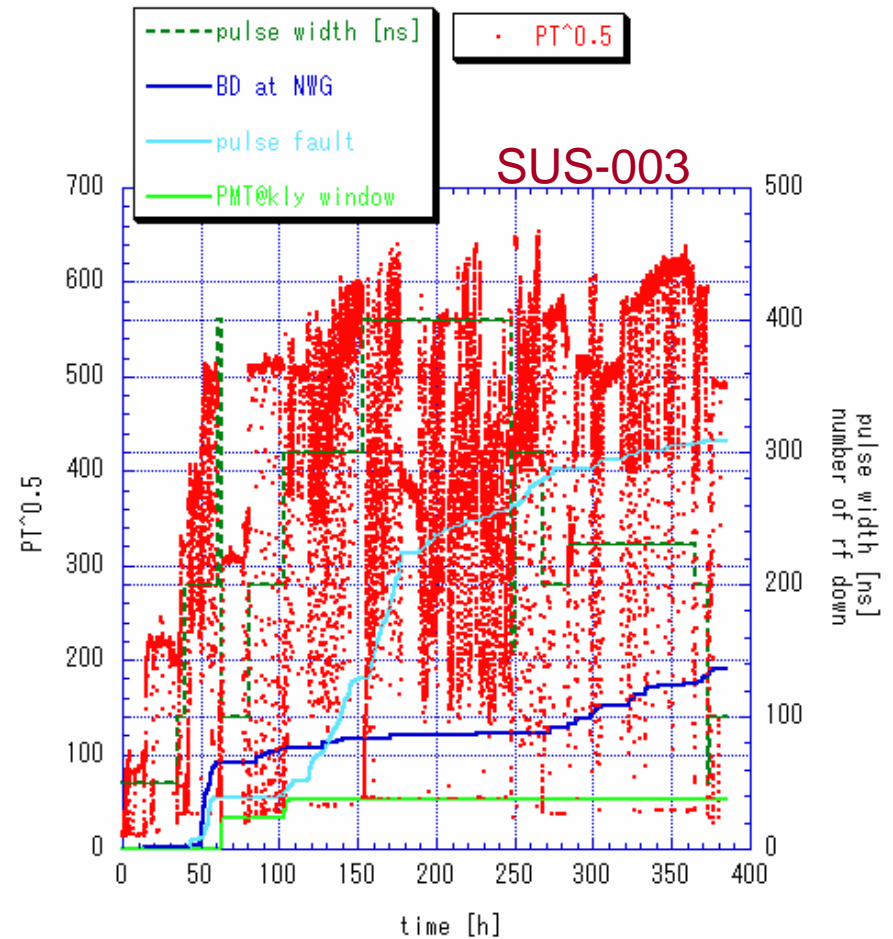
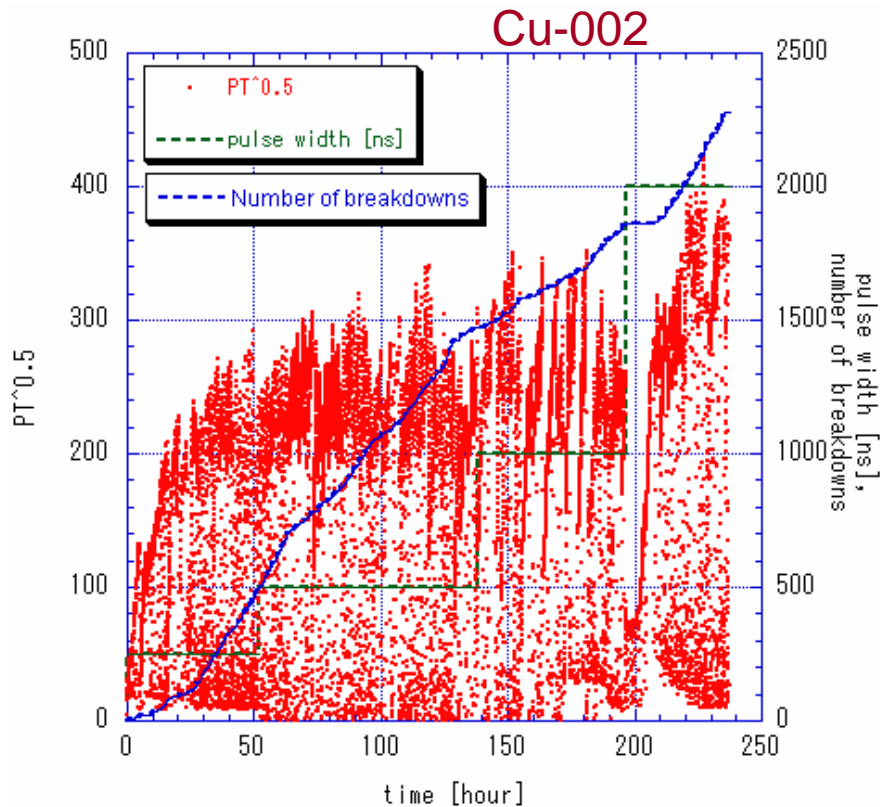
* San-ai plant co. Treatment good for vacuum.

Processing History



- The RF pulse went from 50 ns to 400 ns feeding up to about 40 MW during processing.

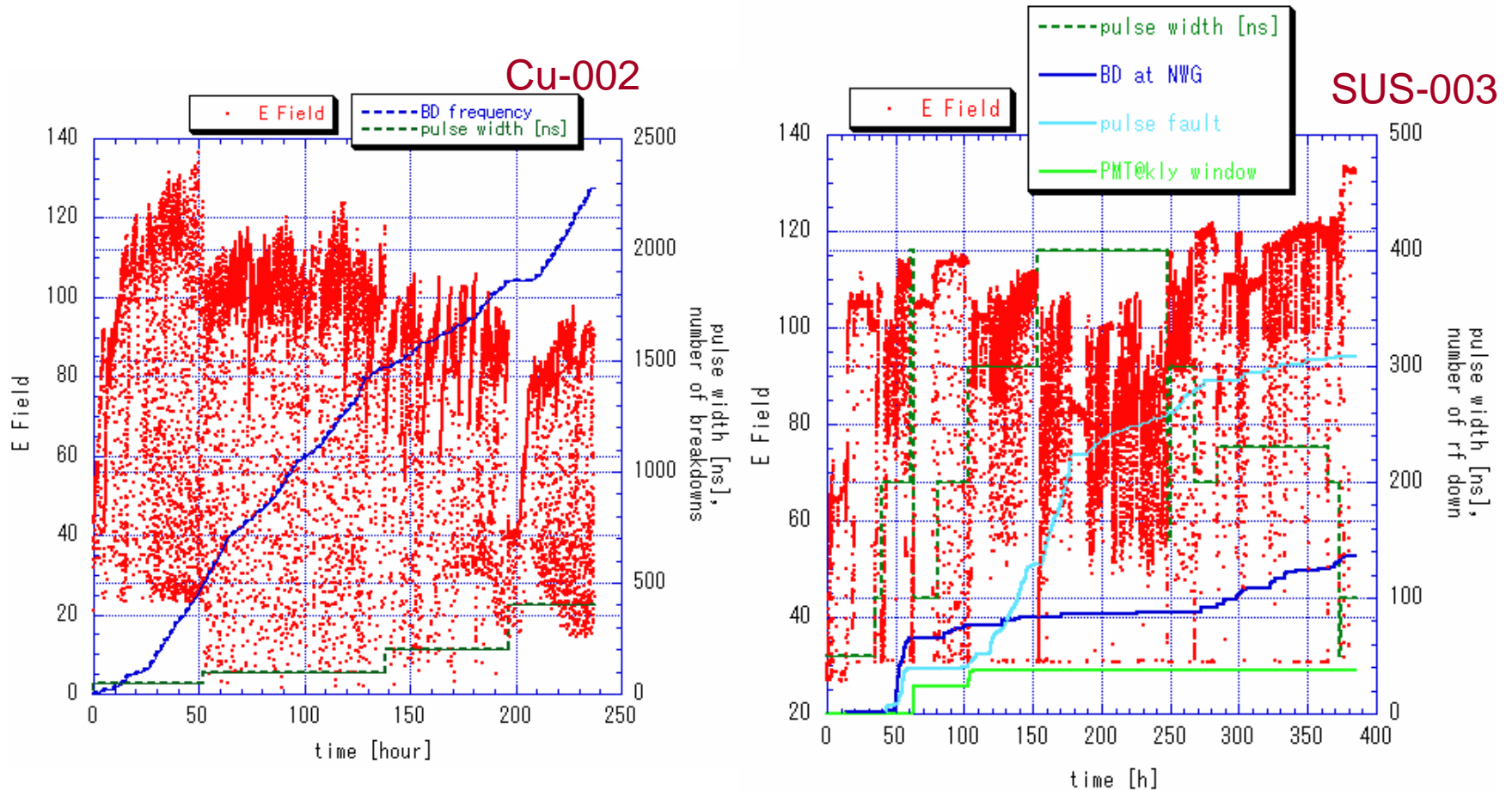
Processing History



$P \times T^{1/2}$ (present) \ll 2000 MW ns^{1/2} (Valery Waveguide or Structures)
Reason?

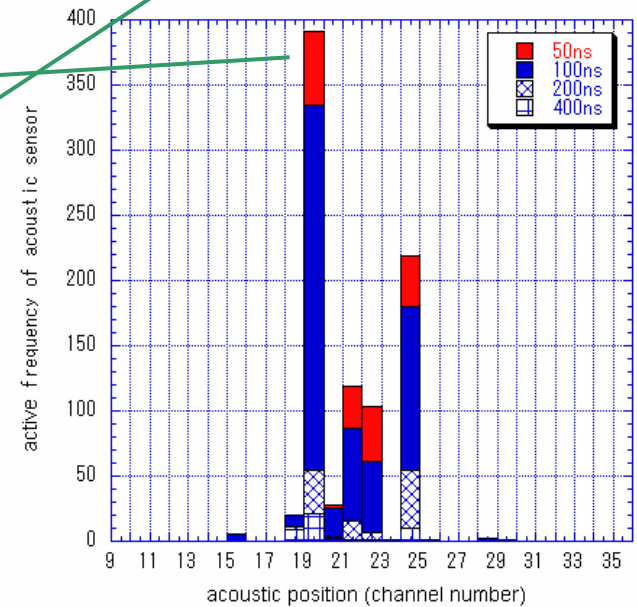
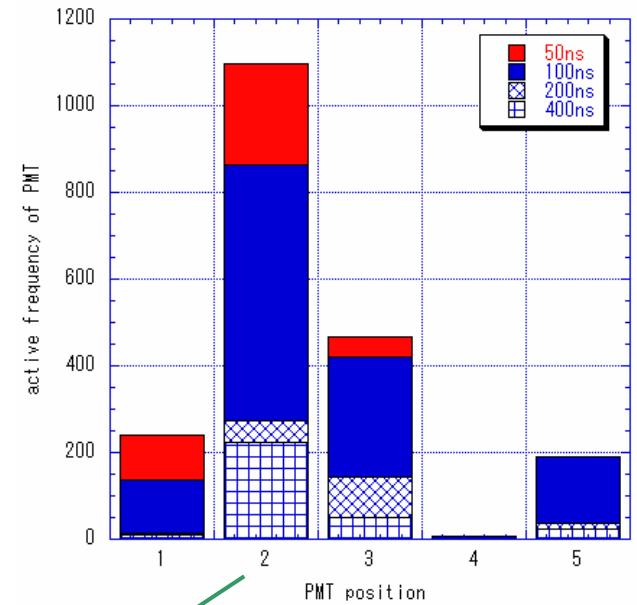
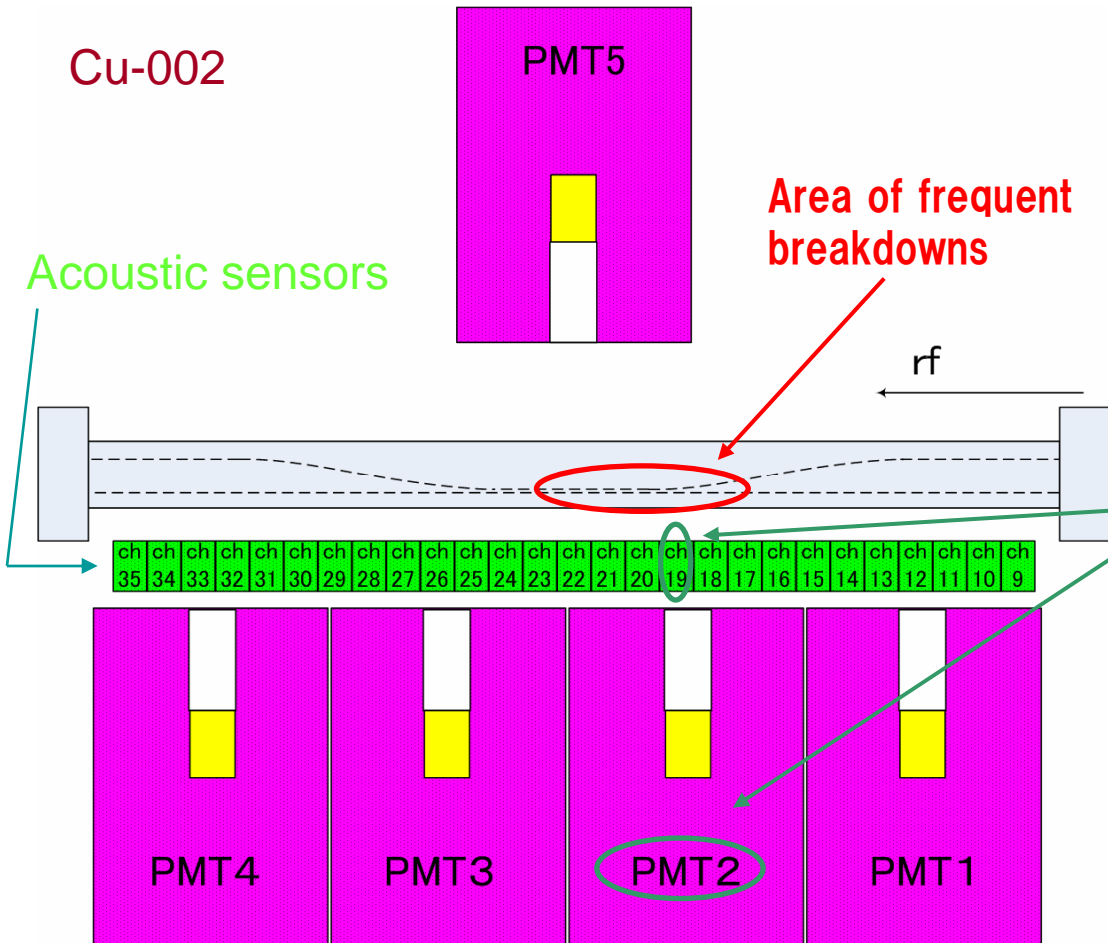
Less-aggressive processing? Less-number of BD?? Surface treatment?

Processing History

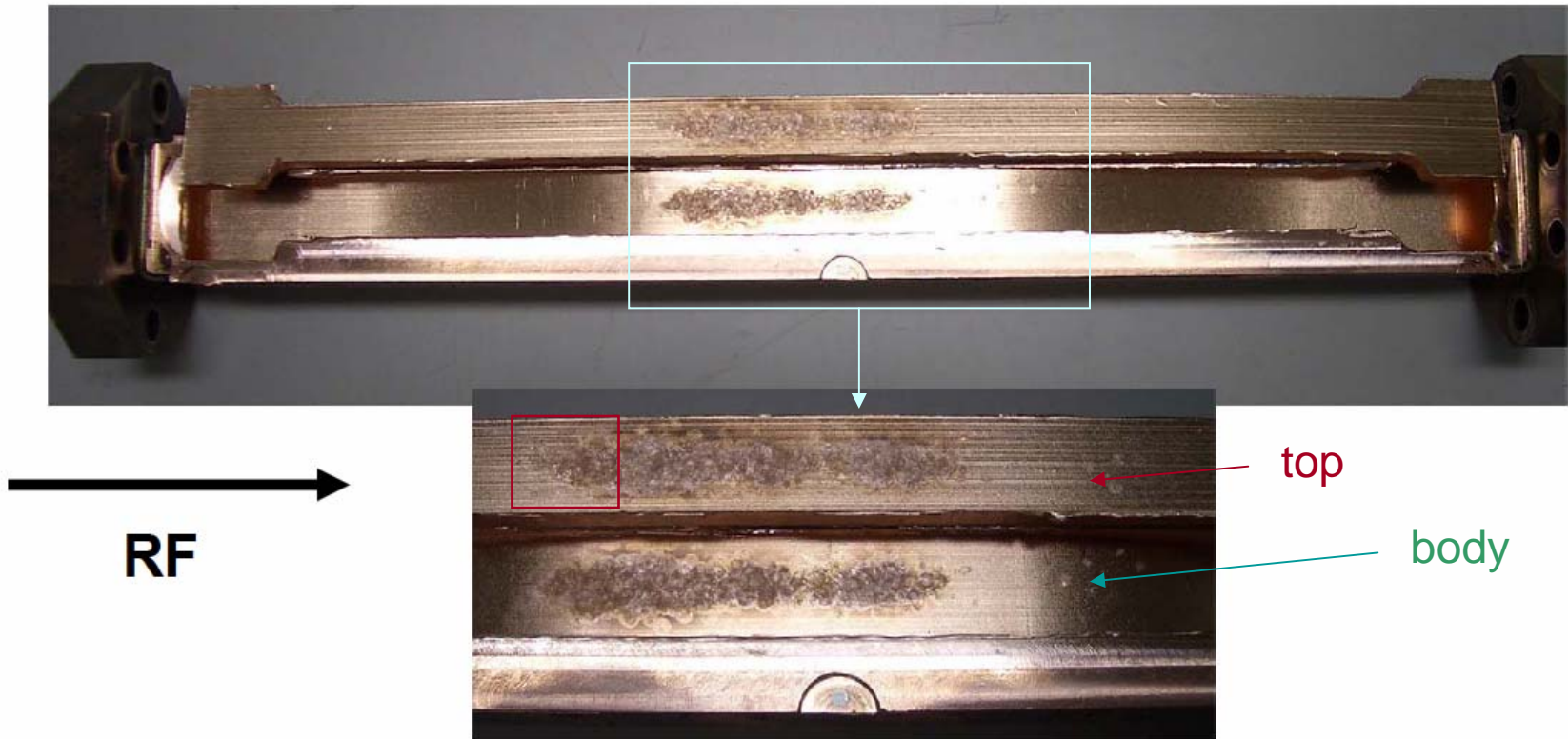


- E Field at the center of narrow waveguide.

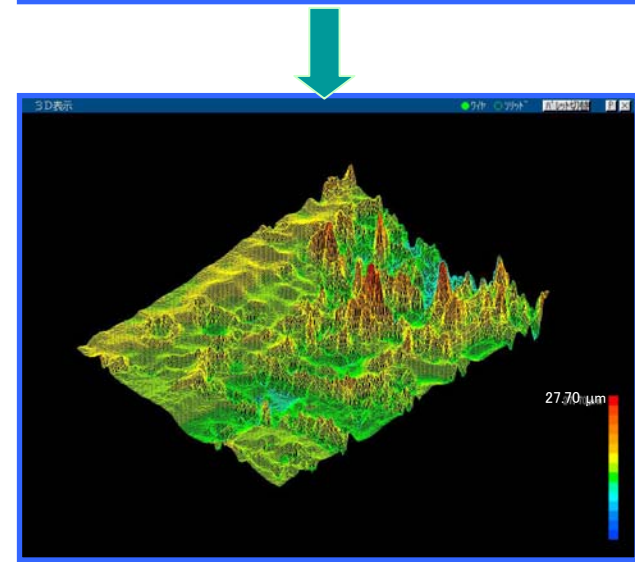
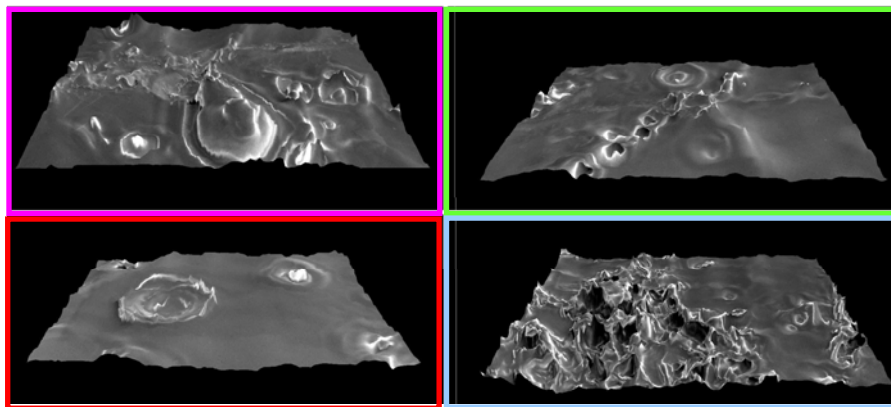
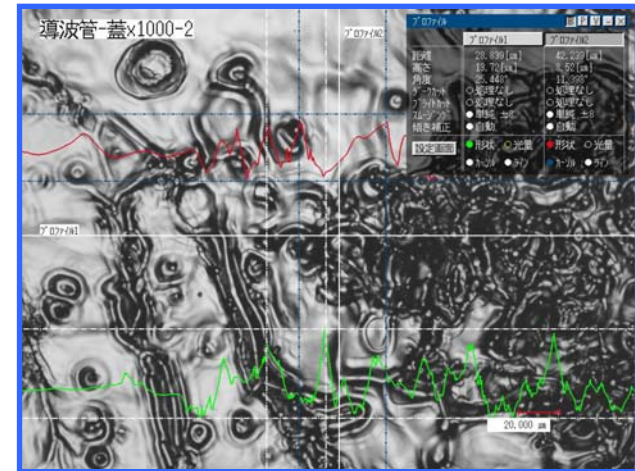
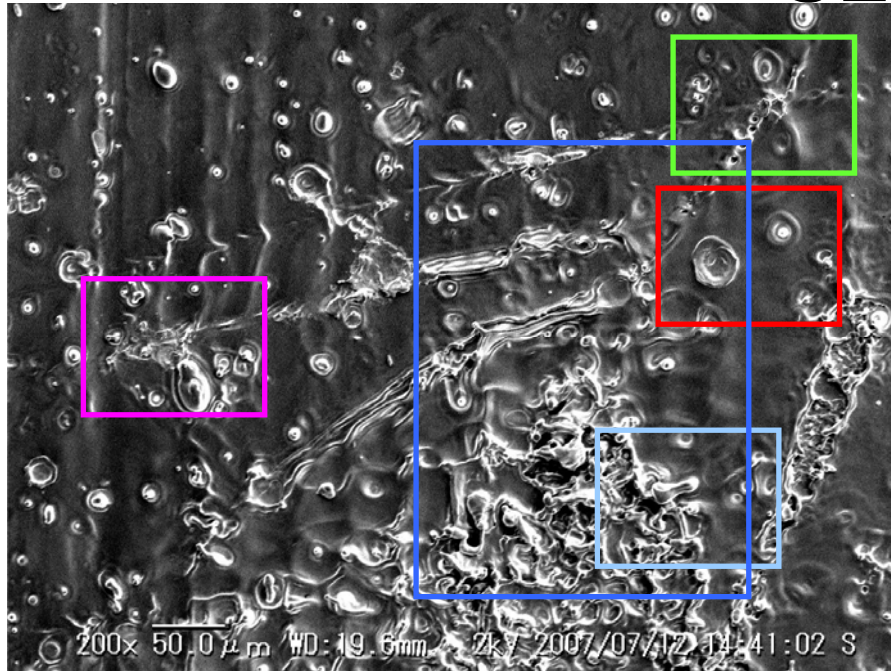
Breakdown location



Cu-002 After high-power processing



Observation of breakdown surface (top) by SEM



Results

Cu-002 → SUS-003 → Cu-004 →

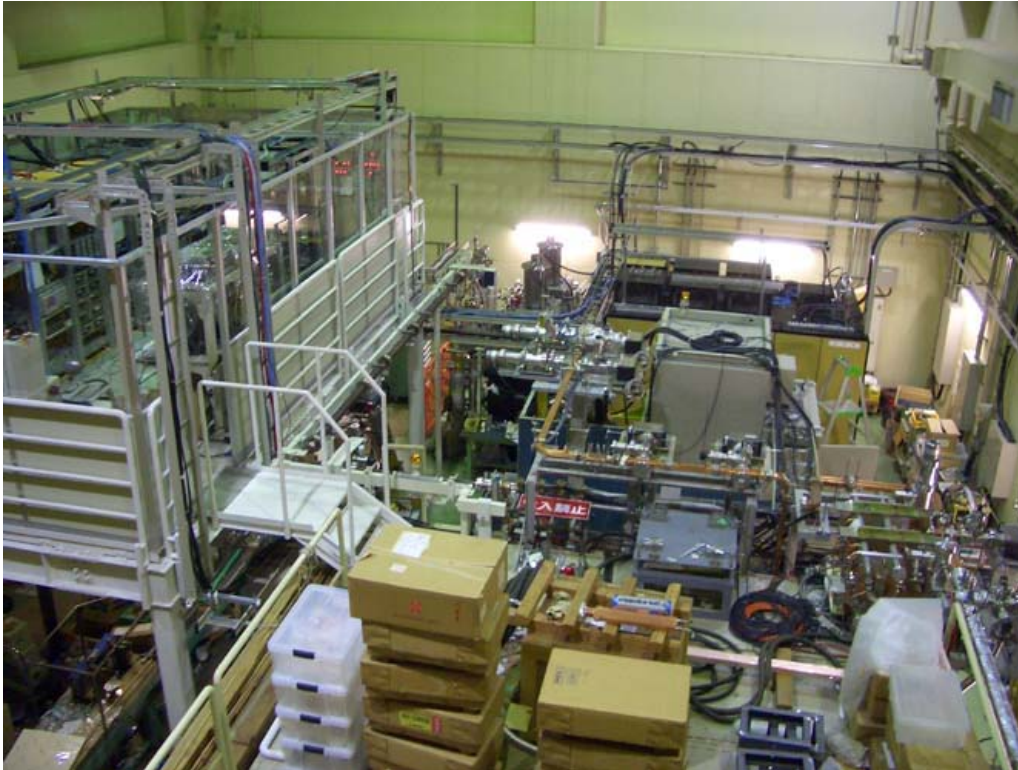
- SUS reached higher $PT^{1/2}$ with smaller number of breakdowns than Cu (tested at GLCTA).
- SUS is limited by guard window. Restarted with TE01 window.
- SUS will be tested in Nextef feeding with two klystrons.
- We will test copper in the present setup again to carefully compare with Cu case.
- Coppers prepared and treated differently will be tested.

Trial to get good surface for high field

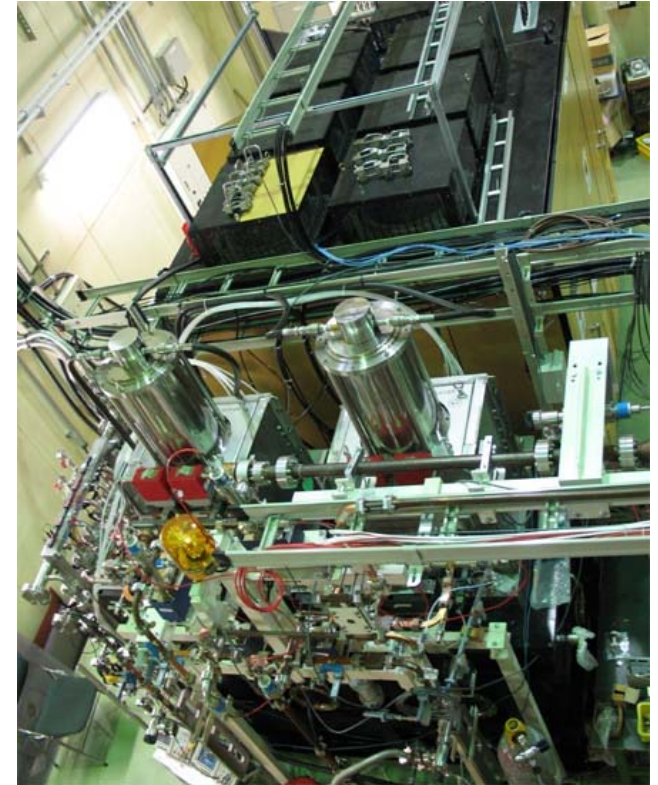
- Y. Higashi has been pursuing various trials
 - Bakeout and installed without exposure to gas
 - Apply SCC technologies such as
 - High-pressure pure-water rinsing
 - Megasonic rinsing
 - Steal various technologies for Si wafer cleaning
- We want to continue and extend these activities
 - With SLAC high gradient test, SW with a few cells
 - With utilizing KEK facility
 - Narrow waveguide or MC+ small-number of cells

Nextef

Nextef



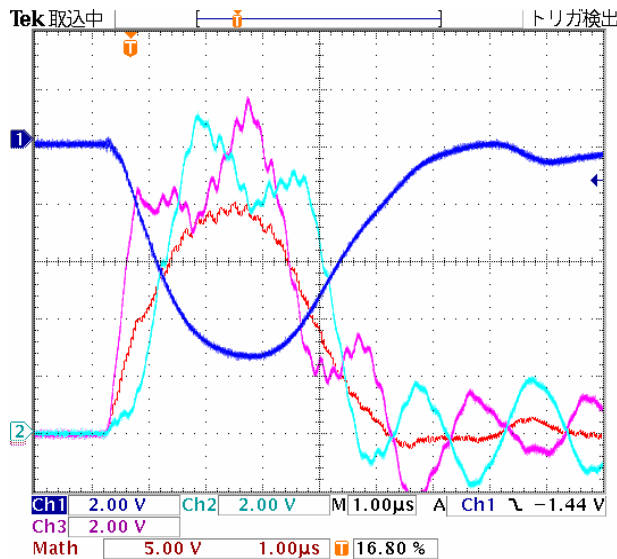
Modulator, klystrons, power transfer line, shield room, control room



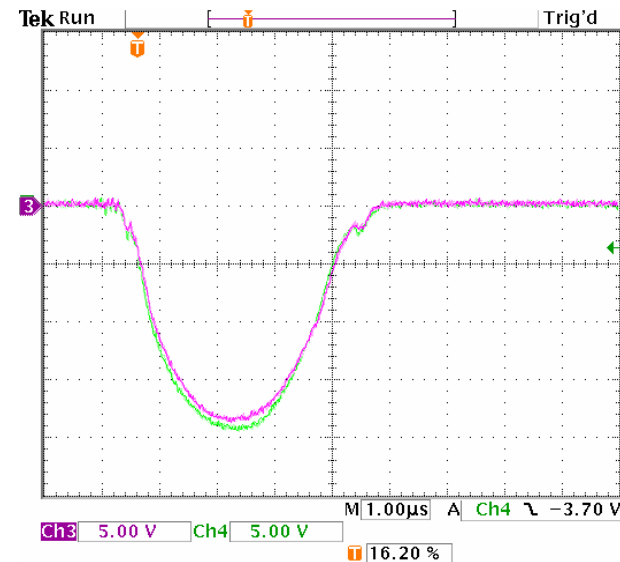
Modulator and two klystrons

2-kly operation in high voltage

V_k , I_{k1} , I_{k2} , I_{K1+2}



I_{coll_1} , I_{coll_2}



407KV, 12.5pps

Two klystrons are driven with a single pulse transformer: Our first experience. It functions well but we suffer from troubles of inverter power supply and thyatron power supply, etc.

Preparation inside shield room



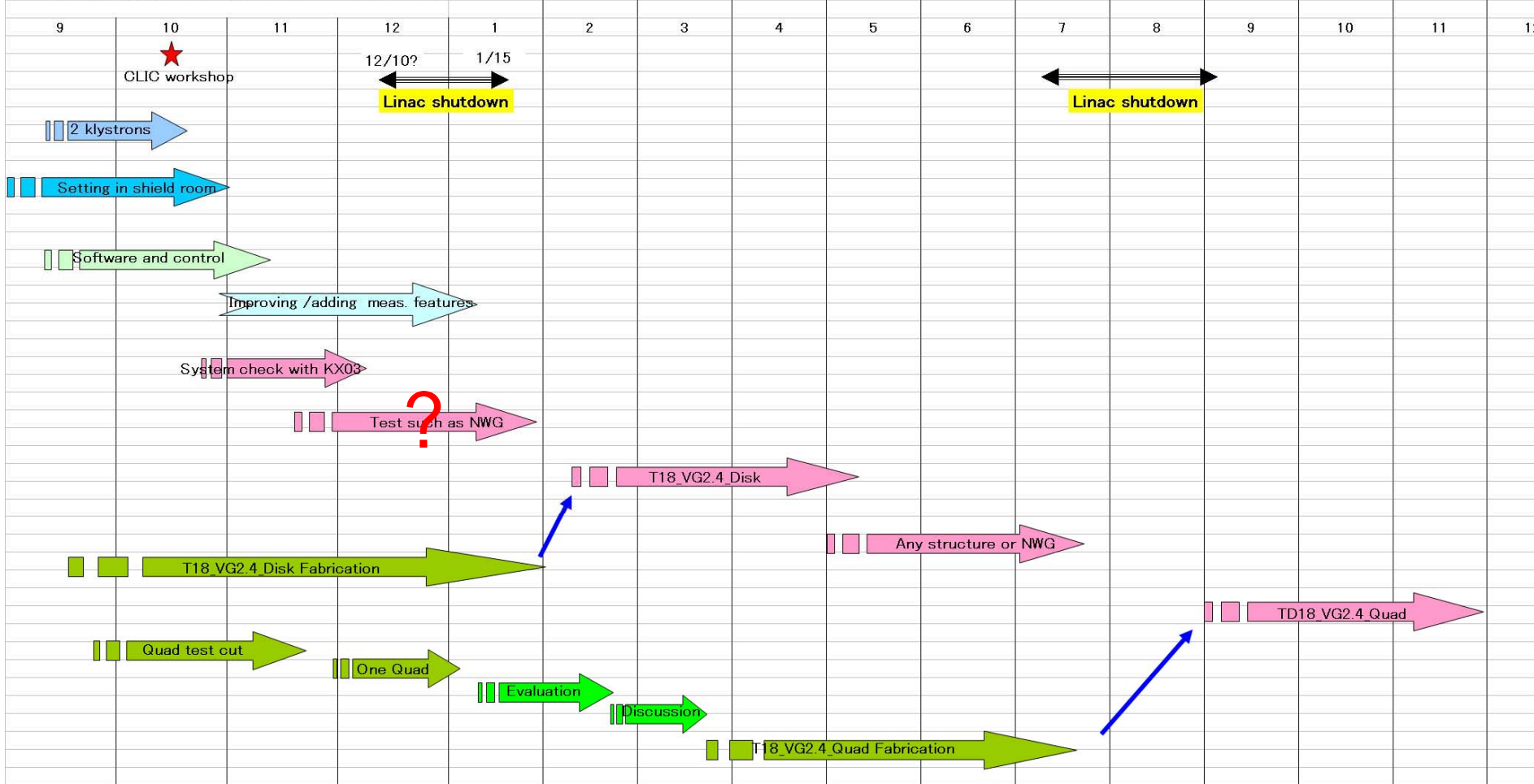
Girder for structure and beam-line components



Waveguide and guard window

Nextef planning

Nextef program drawn as of Oct. 12, 2007



Conclusion

- We continue narrow waveguide high-field study for a moment with varying material or surface treatment.
- Nextef will be system checked in November. A series of tests of CLIC-directed structures will be from early next year.
- We are sure that many stages from material and fabrication to installation and processing should be re-examined and refined to realize such high field as CLIC design. We want to proceed the road with you all.