Cell preparation for high-field structure

Workshop on High Gradient RF

ANL

Oct. 7-9, 2003

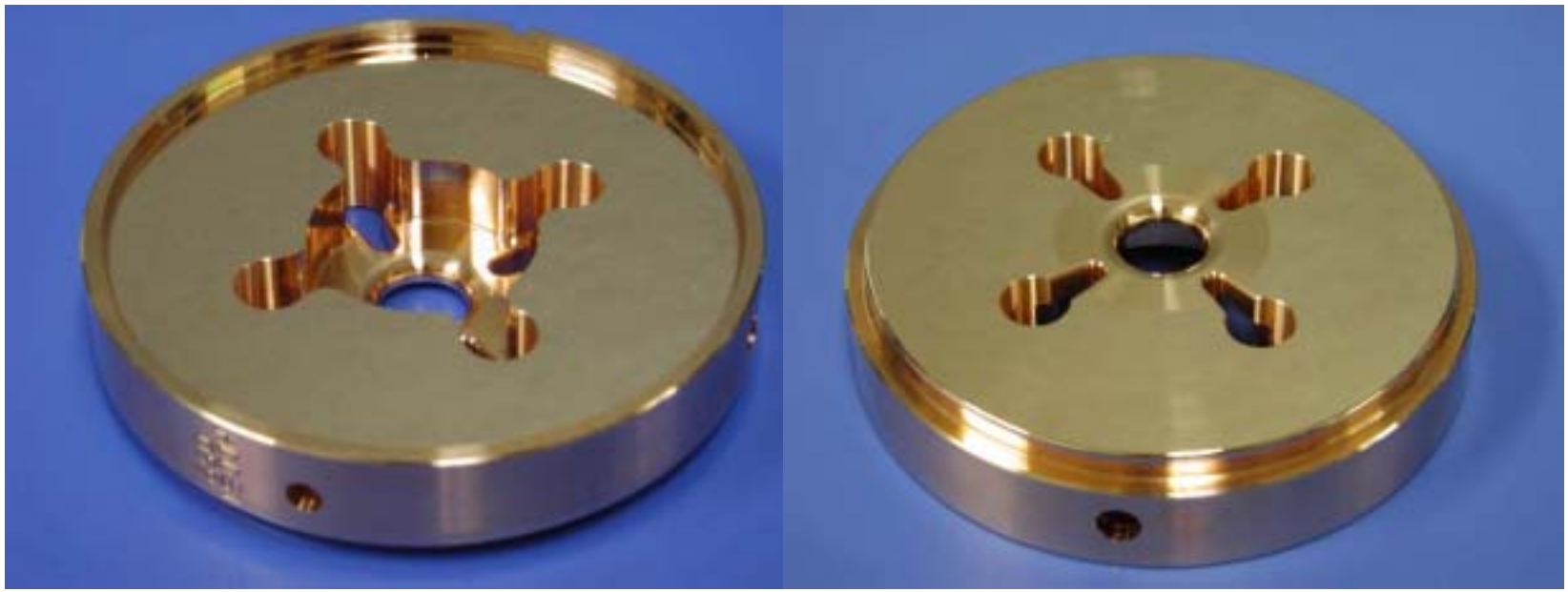
Toshiyasu Higo

KEK

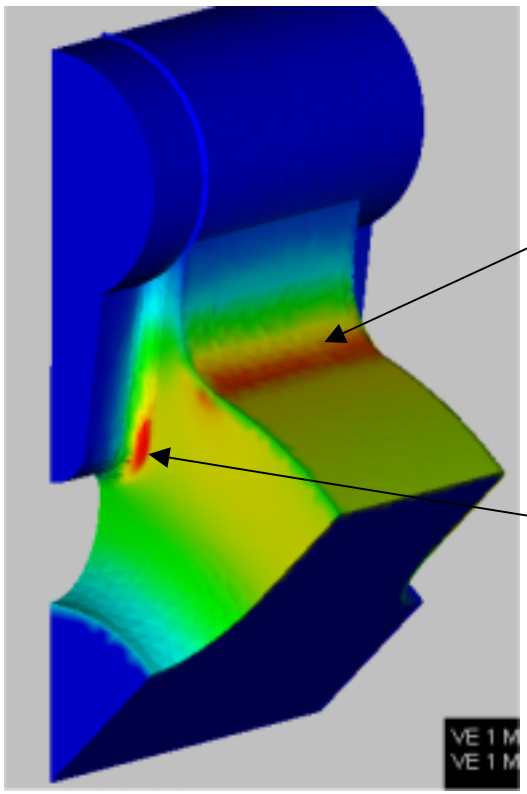
Items to be taken care of

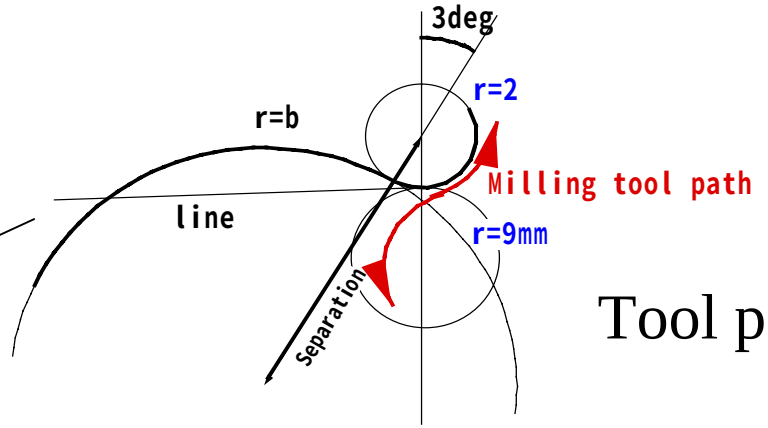
- Suppression of electro-magnetic field enhancement from geometrical point of view
- Improving surface quality by removing damaged layer due to machining
- Improving or deteriorating surface quality through high-temperature furnace cycle
- Change material to resist against erosion of surface material

HDDS cell for LC X-band structure

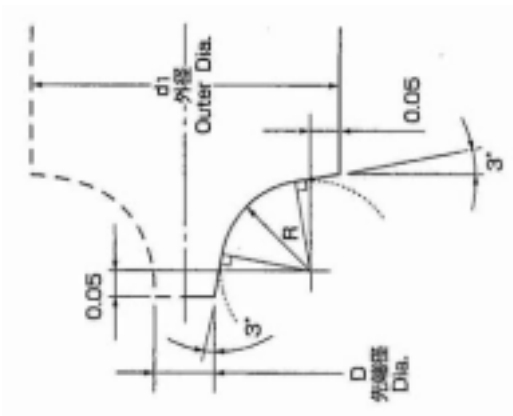


Ensure small but finite angle crossing





Tool path



Tool shape

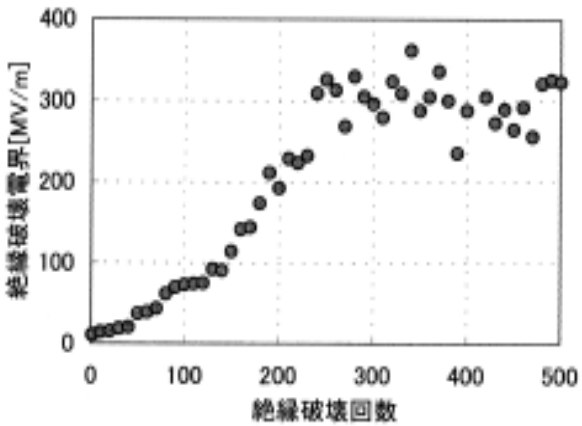
Possible improvements of copper surface

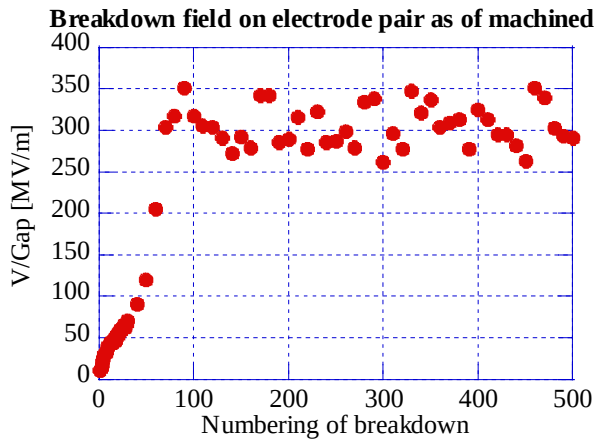
- Diamond turning without kerosene but with N_2
- Chemical etching following SLAC procedure
- Electro-polishing SCC process
- High temperature vacuum baking
- High temperature hydrogen furnace cycle
- Rinsing with pure-water jet irradiation

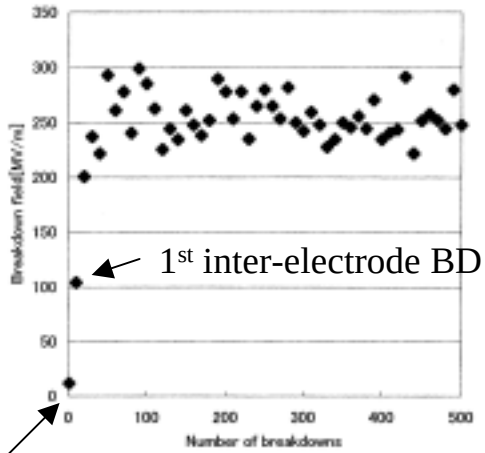
Tasted to some extent To be studied

Pulsed DC-HV breakdown experiment

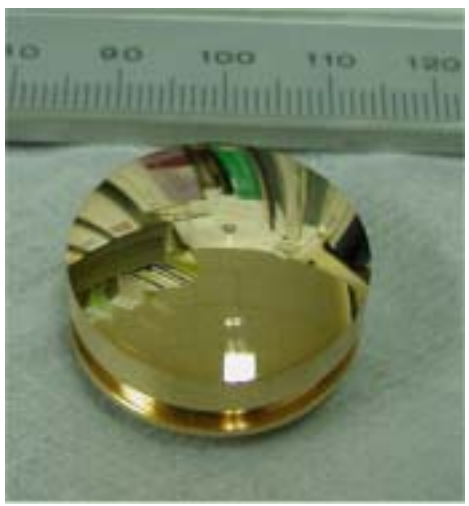
As diamond turned → + In-situ He sputtering → + Hydrogen brazing process







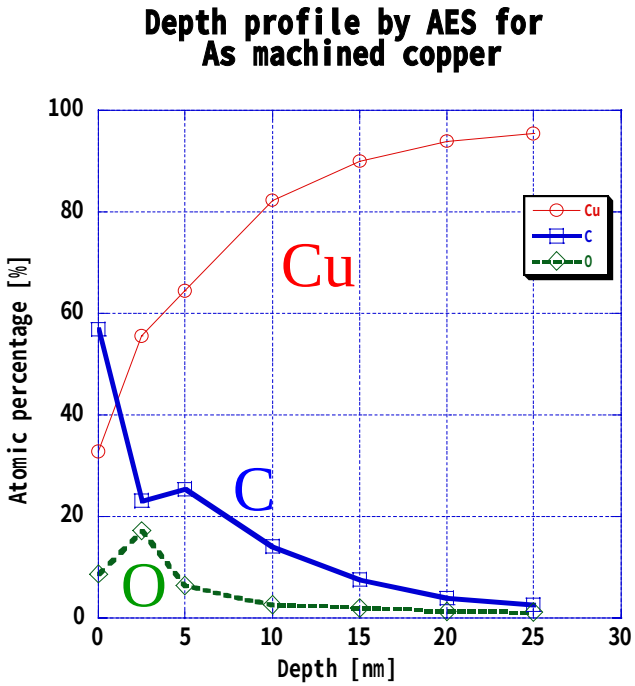
Side BD



Importance of carbon on surface?

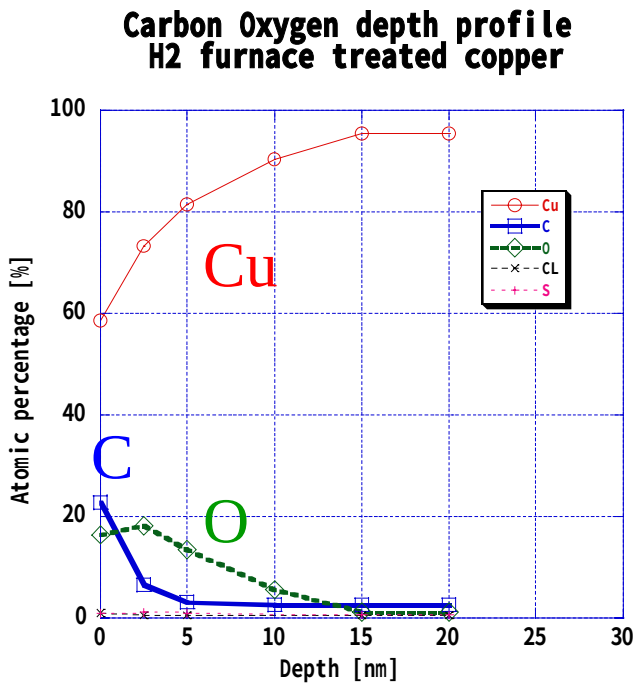
Or just high-temperature treatment?

Carbon and oxygen depth profile by AES



As diamond turned

with Kerosene



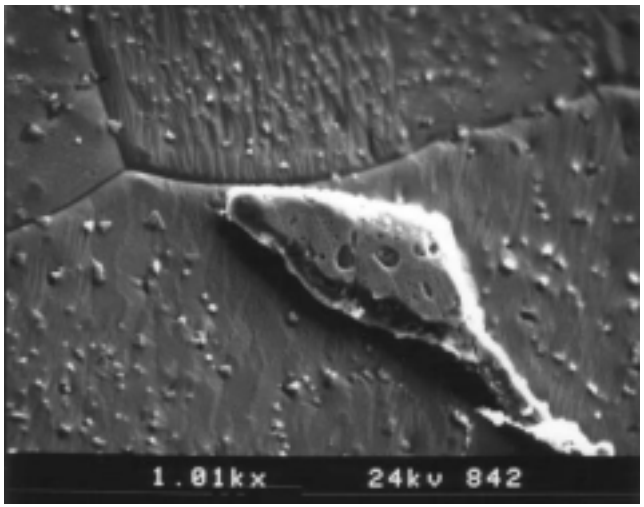
After H_2 furnace

1040C, 5min

Carbon decreases through high-temperature process.

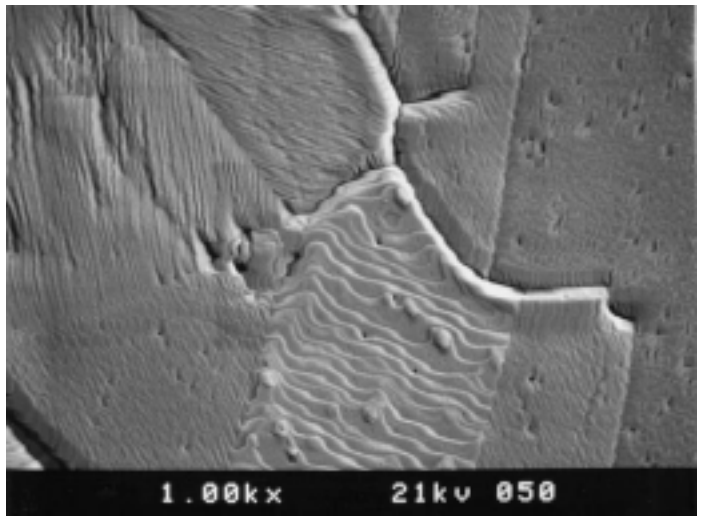
Surface change due to

actual industrial VAC furnace used for structure assembly



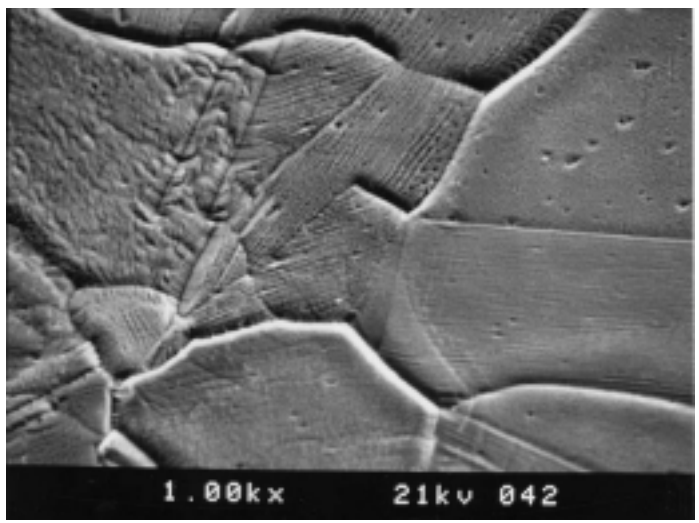
Surface open to furnace
In a bad VAC

- Couplers and those cells open to furnace are subject to the same condition
- IH1 1.3m structure behaved badly in 10MV/m range



Surface open to furnace in an improved VAC

Sublimation at 900C

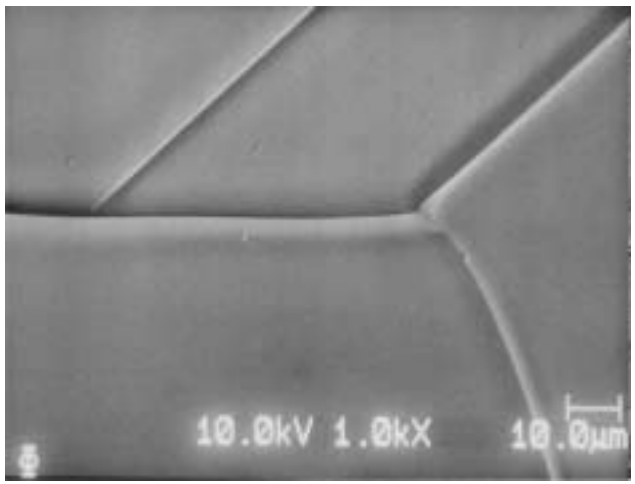


Surface with Cu cap to hide from furnace

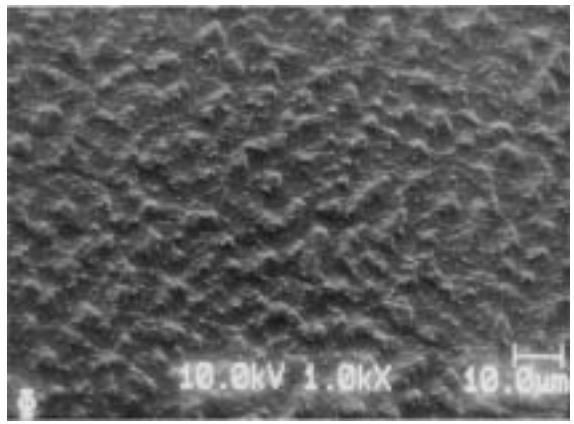
Smoother surface
Prevent from attack from bad furnace

SEM view of copper surface exposed to hydrogen or VAC furnace

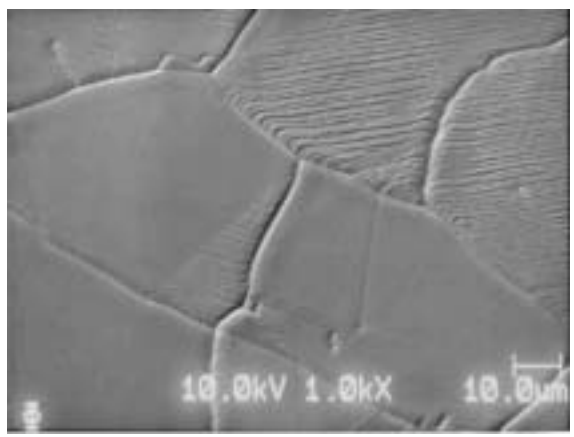
at 900—1000C for actual production of structures



H2 furnace
Gas makes smoother surface



Open to
VAC furnace



VAC furnace
with Cu cap

- **Gas helps smoothing**
- **Cu shield prevent attack from bad material in furnace**

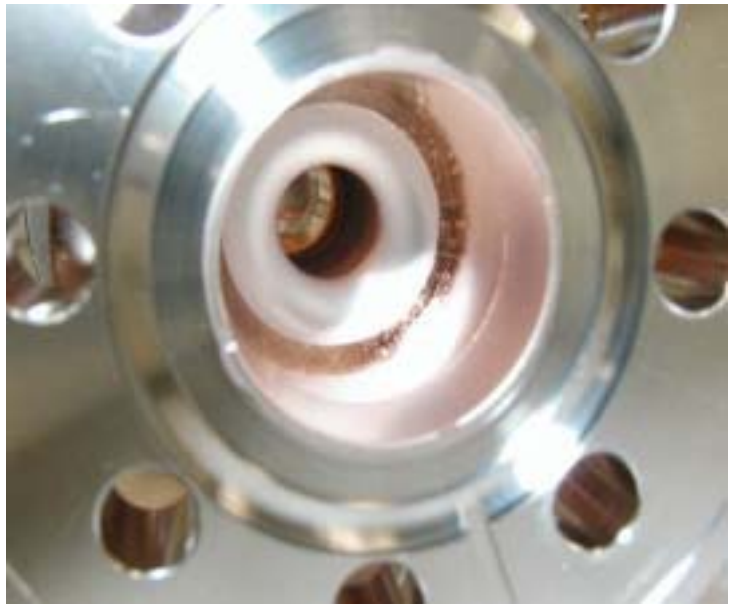
Surface other than copper

- Search materials strong against erosion by breakdowns
- Started with moly-coated, moly-cladded, moly-only in addition to Cu-only to compare
  - Mo-coated diamond-turned copper surface keeps well through thermal cycle at 1000C
  - Cladded Mo-Cu subject to large thermal stress, but will be compensated by original offset in frequency
- Should try stainless?, tungsten?, ….
- Collaborate with SLAC single-cell study and then think to study at KEK and also study pulsed DC HV study at Saitama U.

Examples: Cu only / Cu/Mo clad

Cu: OFC Class1

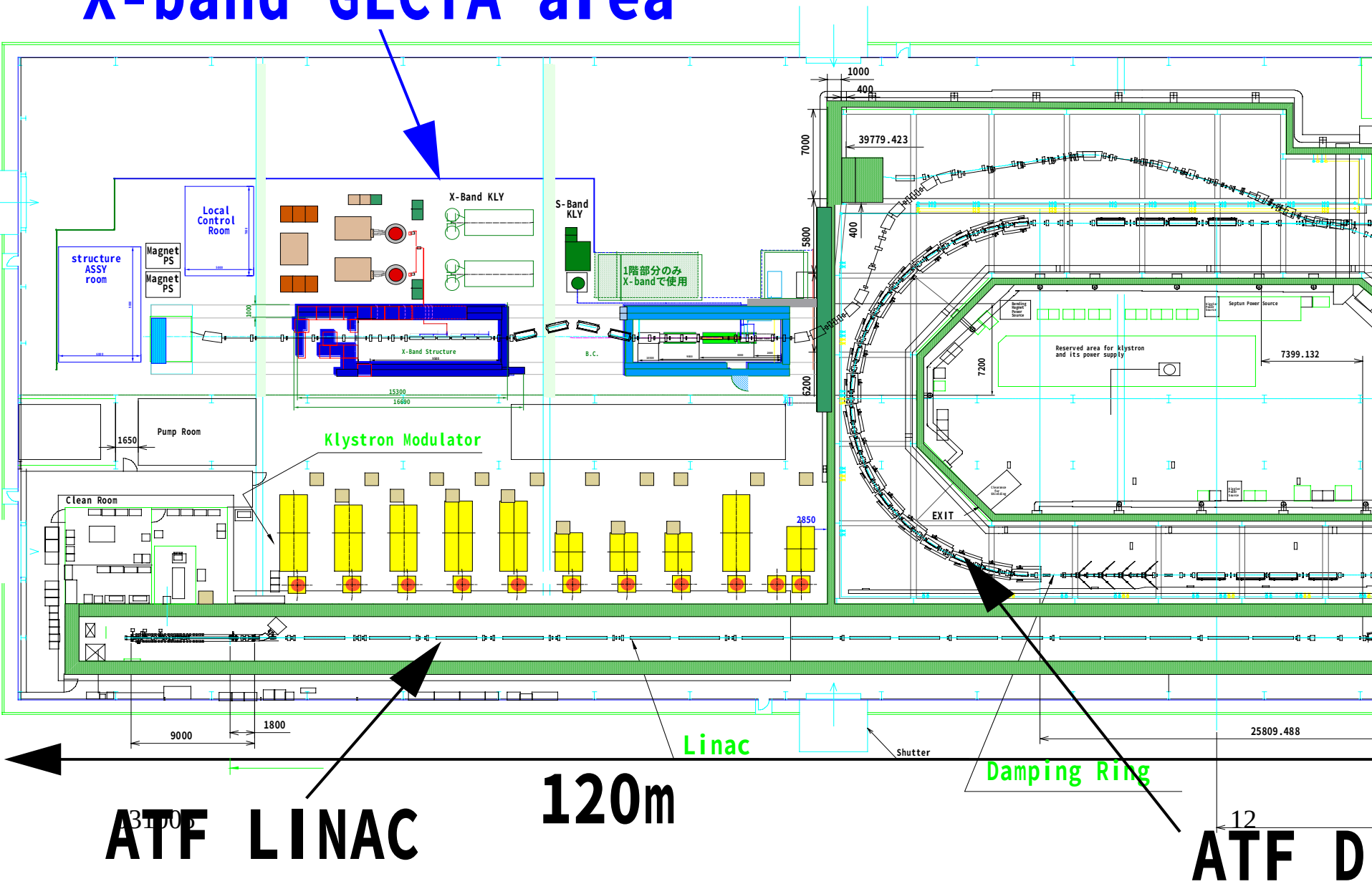
Cu:
Rough cut
500C anneal
Final diam. cut
Chemical etching
Diff. Bond
Brazing



Cu/Mo: Mo: 99.95%
HIP
Rough cut
500C anneal
Final diam. cut
500C pre-stress release
Chem. etching
Diff. Bond
Brazing

GLCTA & ATF

X-band GLCTA area



Conclusion

- Study copper practical limit with exploring surface treatments and fabrication/installation procedures in realistic structures
  - Geometrical effect keeping in mind
  - Develop better furnace conditions
  - Explore treatments such as water rinsing, etching, hydrogen, high-temperature vac baking, ….. and handling in clean environments
- Study pulsed-DC, pulsed-RF and FE characteristics on surfaces made through the same processes
- Explore different materials following DC experience as the next step
  - Mo, SUS, … coating, clad, etc.

- We are thinking how to commission these studies in parallel to LC studies in realistic confirmation phase