DESIGN AND FABRICATION CHALLENGES OF TRANSITION SECTION FOR THE CWA MODULE*

Transition Section

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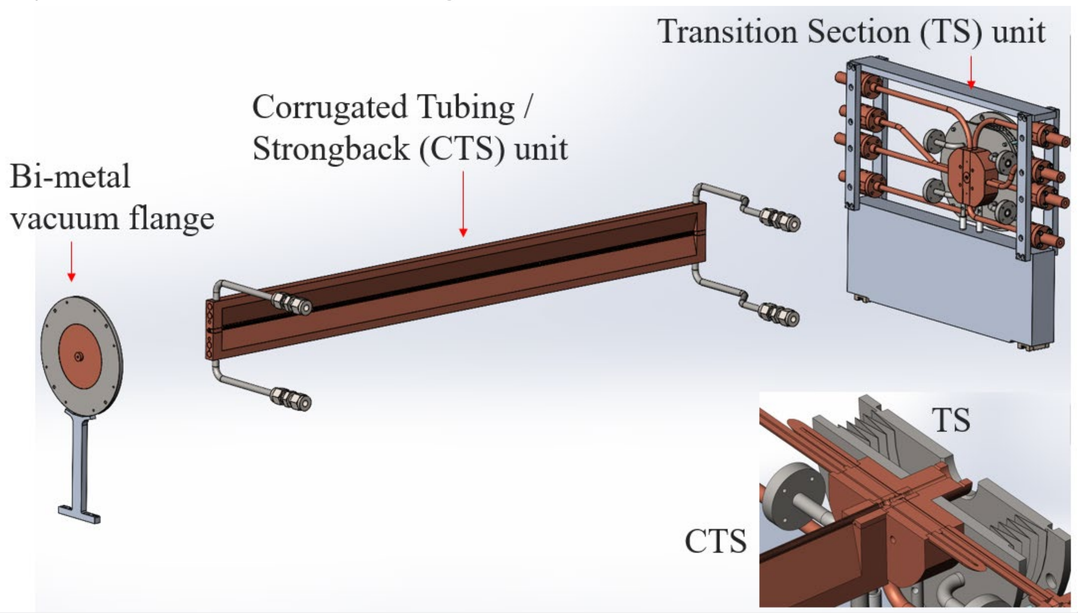
ABSTRACT

An effort to build Argonne's Sub-THz AcceleRator (A-STAR) for a future multiuser x-ray free-electron laser facility proposed in [1] is underway at Argonne National Laboratory. The A-STAR machine will utilize a compact collinear wakefield accelerator (CWA) assembled in modules. To extract the wakefield and monitor beam position downstream of each module, a 45-mm-long transition section (TS) has been proposed and designed. This paper will discuss the design and fabrication challenges for production of the TS.

[1] A. Zholents *et al.*, "A conceptual design of a Compact Wakefield Accelerator for a high repetition rate multi user X-ray Free-Electron Laser Facility," in *Proc. IPAC2018,* Vancouver, BC, Canada, 29 Apr.-May 2018, pp. 1266–1268.

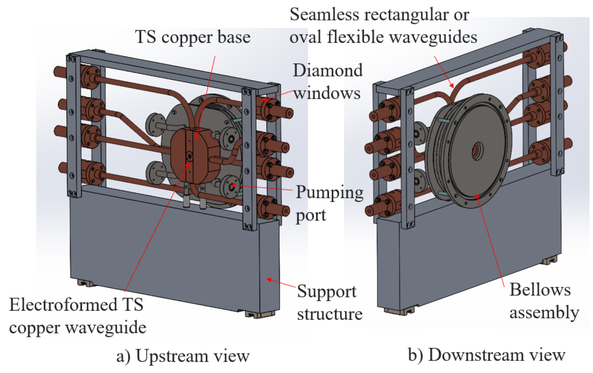
INTRODUCTION

The CWA vacuum chamber module is comprised of a corrugated tubing/strongback (CTS) unit, a bi-metal vacuum flange, and a TS unit with a bellows.



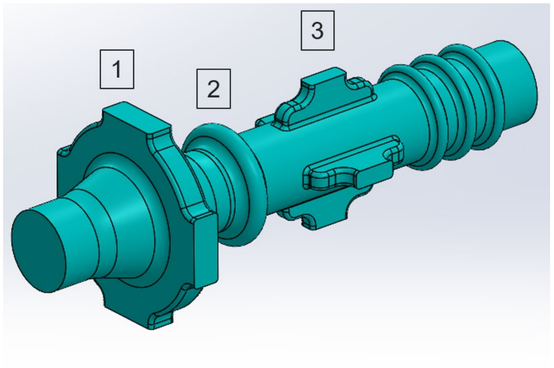
TRANSITION SECTION

- An electroformed copper core
- A machined copper base
- Eight seamless rectangular or flexible oval waveguides, diamond windows
- A stainless-steel bellows assembly with vacuum ports for pumping.

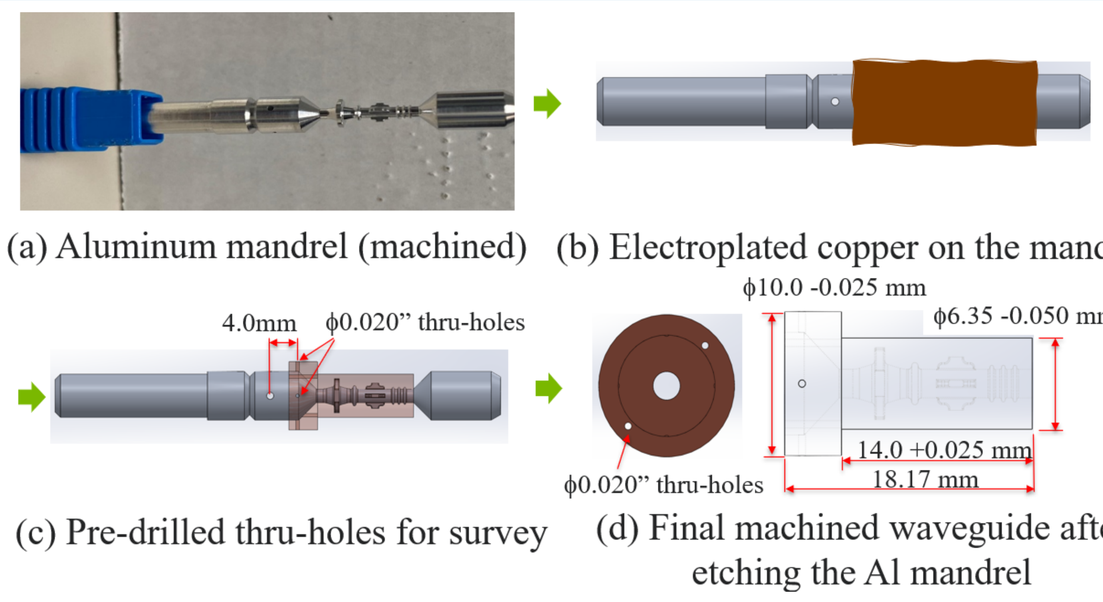


CORRUGATED MANDREL

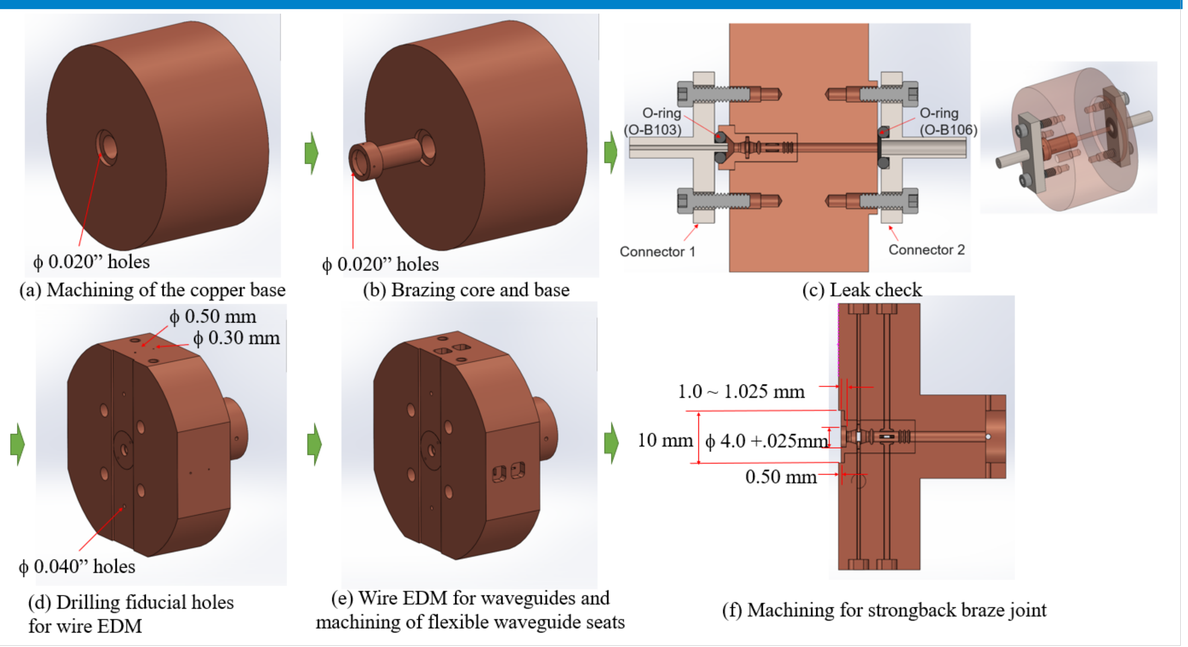
(1) TM01 output coupler: Extract unused TM01 accelerating mode from the corrugated waveguide
(2) Notch filter: Reflect TM01 mode
(3) Integrated offset monitor (IOM): For beam offset measurement



ELECTRO-FORMING PROCESS OF THE TRANSITION SECTION CORE



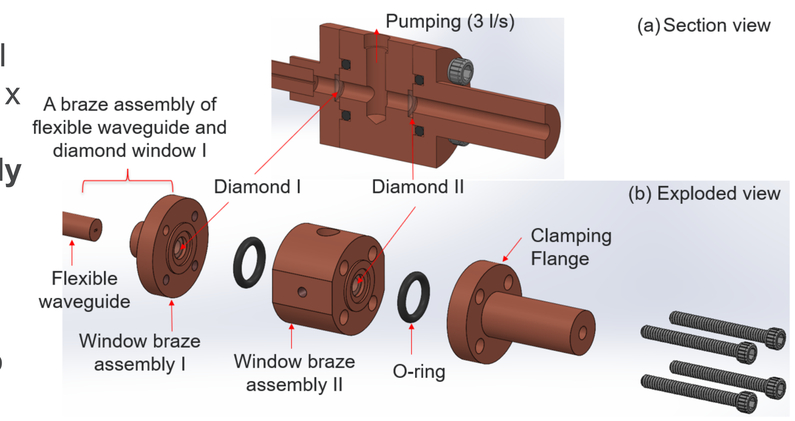
MANUFACTURING PROCESS OF THE TRANSITION SECTION CORE-BASE BRAZE ASSEMBLY



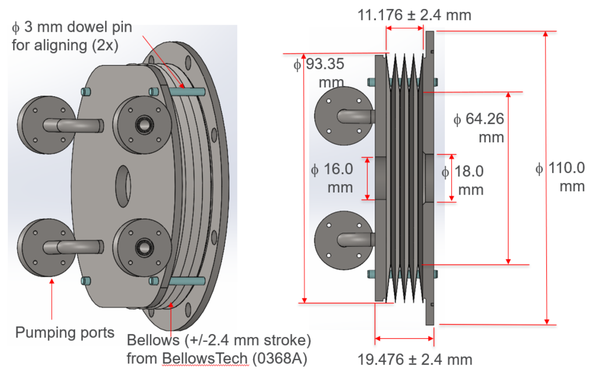
DESIGN OF TRANSITION SECTION ATTACHMENTS

Flexible waveguides
- Cold drawing with internal cross section of 1.78 mm x 0.723 mm

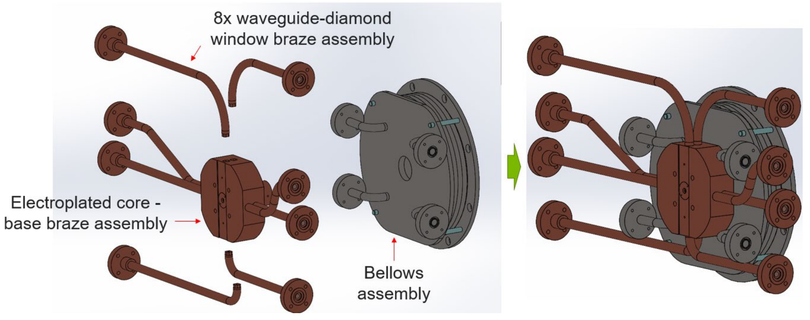
Diamond window assembly
- Double windows
- 1st: Brazed to flexible waveguides
- 2nd: Bolted to the 1st diamond window with two O-rings



Bellows Assembly
- To pump out the CWA vacuum chamber module
- To allow +/- 2.4-mm translational stroke for easy installation and maintenance
- Made of stainless-steel 304L or 316L, and TIG welded.



TS Unit
- All the components will be brazed together to produce the TS unit for the CWA vacuum chamber module.
- Mounted on its own support structure



TECHNICAL CHALLENGES

- Maintain the integrity of previously brazed joints in brazing: Select suitable brazing filler metals of successively lower temperatures
- Braze joint design for proper gap clearance: A clearance of 0.038~0.050 mm
- Surface conditioning of joining surfaces: Appropriate vacuum cleaning to remove oxide layers before brazing and post brazing
- Small holes with a high-aspect-ratio feature for threading thin wire rods: Must keep permissible tolerances of the wire-EDM process to avoid machine positioning, temperature instability, spark gaps, and electrode wear, etc.

CONCLUSIONS

- The transition section unit requires multi-step brazing of subsequent lower temperature, micro-drilling, and wire-EDM processes.
- Future work includes further optimization of the joint geometries, machining tolerances, and machining process through a step-by-step process evaluation in fabricating a transition section prototype

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