WELDABLE COPPER CHROMIUM ZIRCONIUM MASK

An alternative approach to mask fabrication

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ABSTRACT

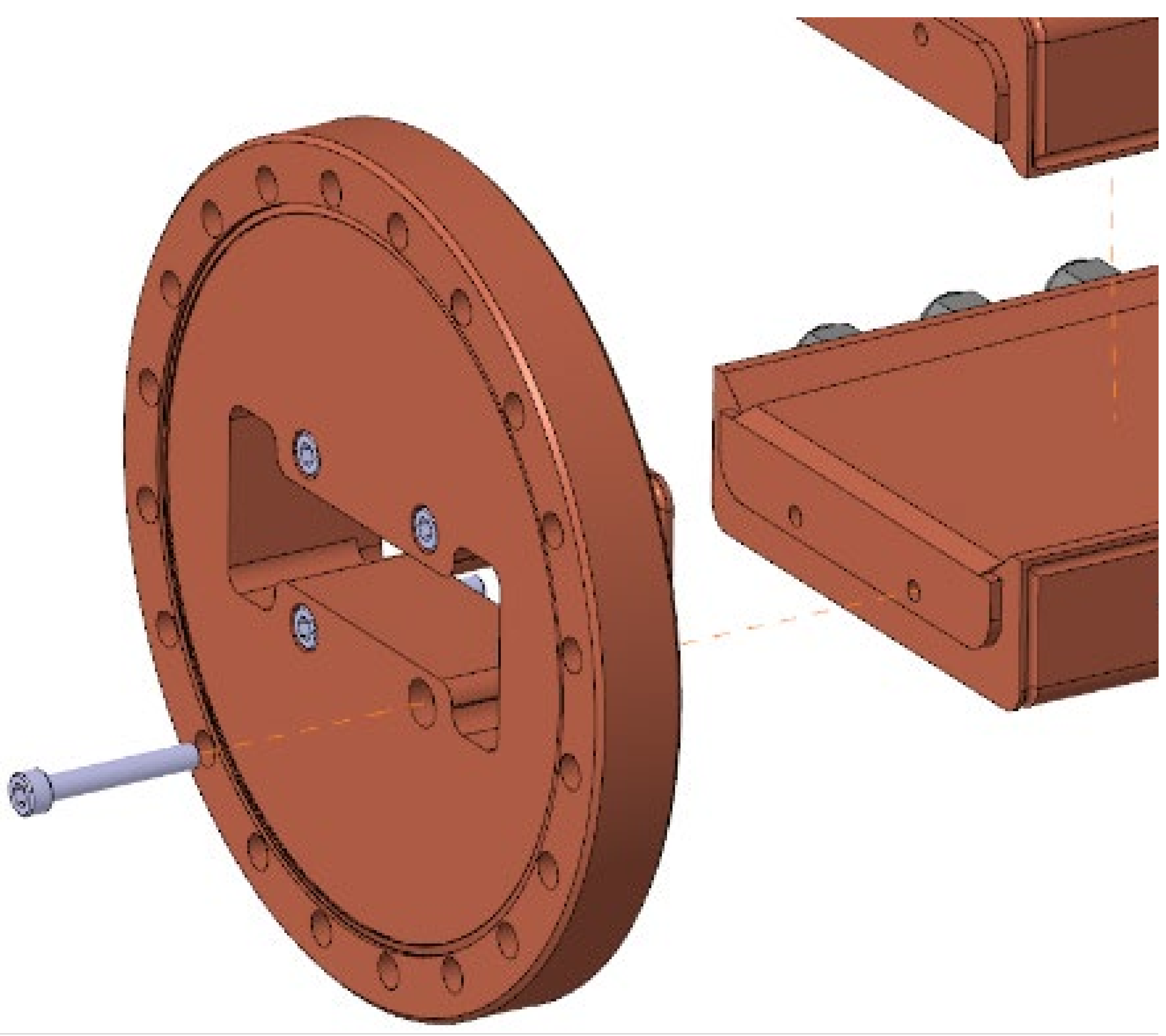
A novel design for a weldable copper chromium zirconium (CuCrZr) mask is being developed for use in the Advanced Photon Source Upgrade (APSU) beamlines at the Argonne National Laboratory (ANL). This alternative attempts to drastically reduce cost and lead time over traditional brazed Glidcop® mask designs. Thermal analysis simulations of the mask have predicted that it will meet mechanical and thermal requirements, even when subjected to the intense white beam of the new superconducting undulators (SCU) of the APSU. As of the writing of this paper, a prototype is being fabricated for testing and eventual installation on the 28-ID Coherent High Energy X-ray (CHEX) beamline.

MOTIVATION

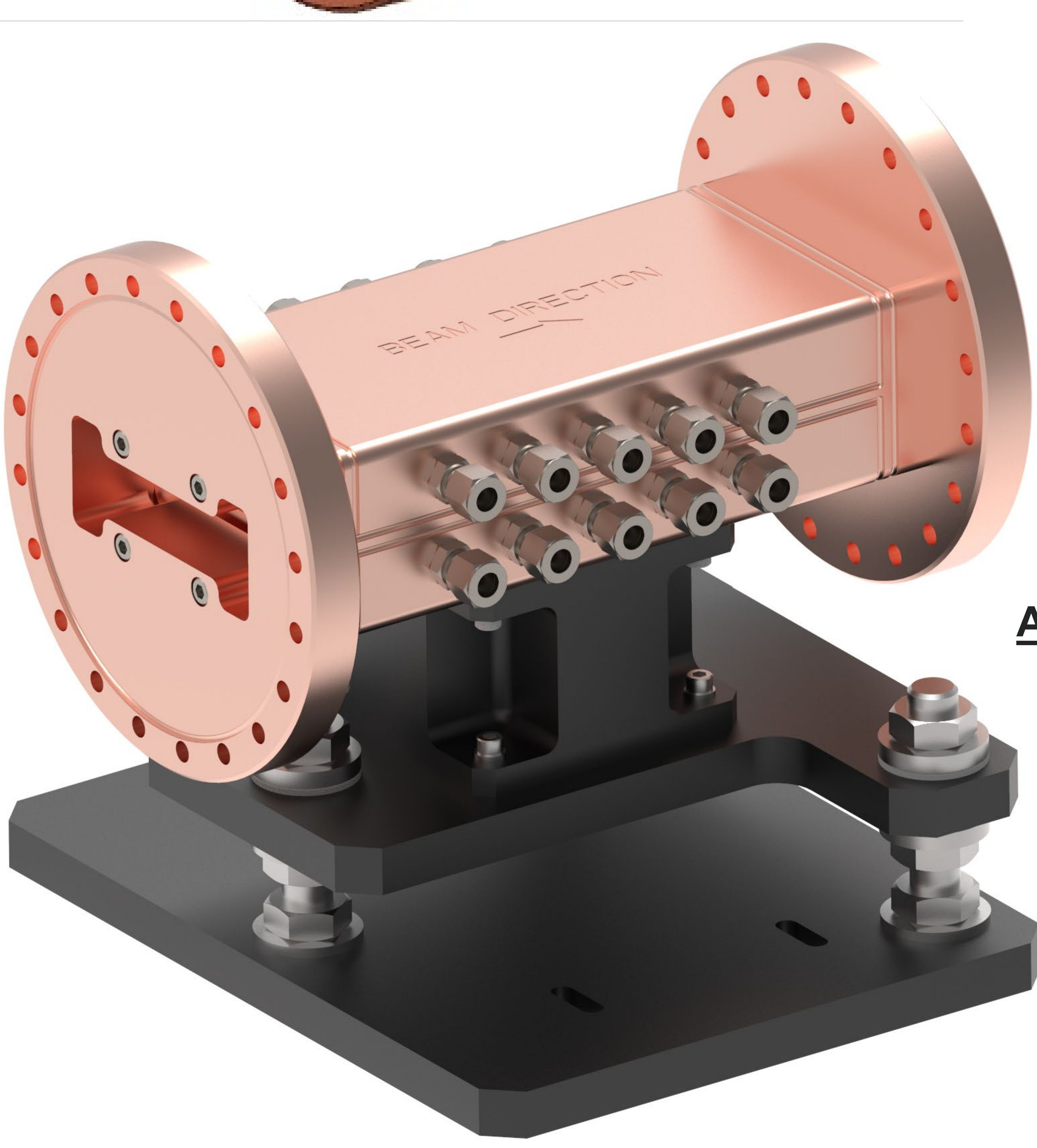
- Traditional photon masks are made of welded Glidcop® or brazed CuCrZr bodies, which are expensive and difficult to produce. Welded CuCrZr offers a significant reduction in cost and lead time.
- Welding avoids annealing, which is often what negates the usefulness of brazed masks.
- A compact photon mask that can withstand the intense white beam from canted superconducting undulators is required for the CHEX beamline.

MECHANICAL DESIGN

- Flanges are also made from CuCrZr and are bolted to the absorbing body before being welded in place. Four center-vented silver-plated M6 socket head cap bolts hold the flanges in place.
- Weld reliefs 1/8 inch diameter are milled along the weld seams on each body component. They allow formation of a continuous weld bead needed to provide strength, prevent virtual leaks, and ensure successful fusion of the halves.



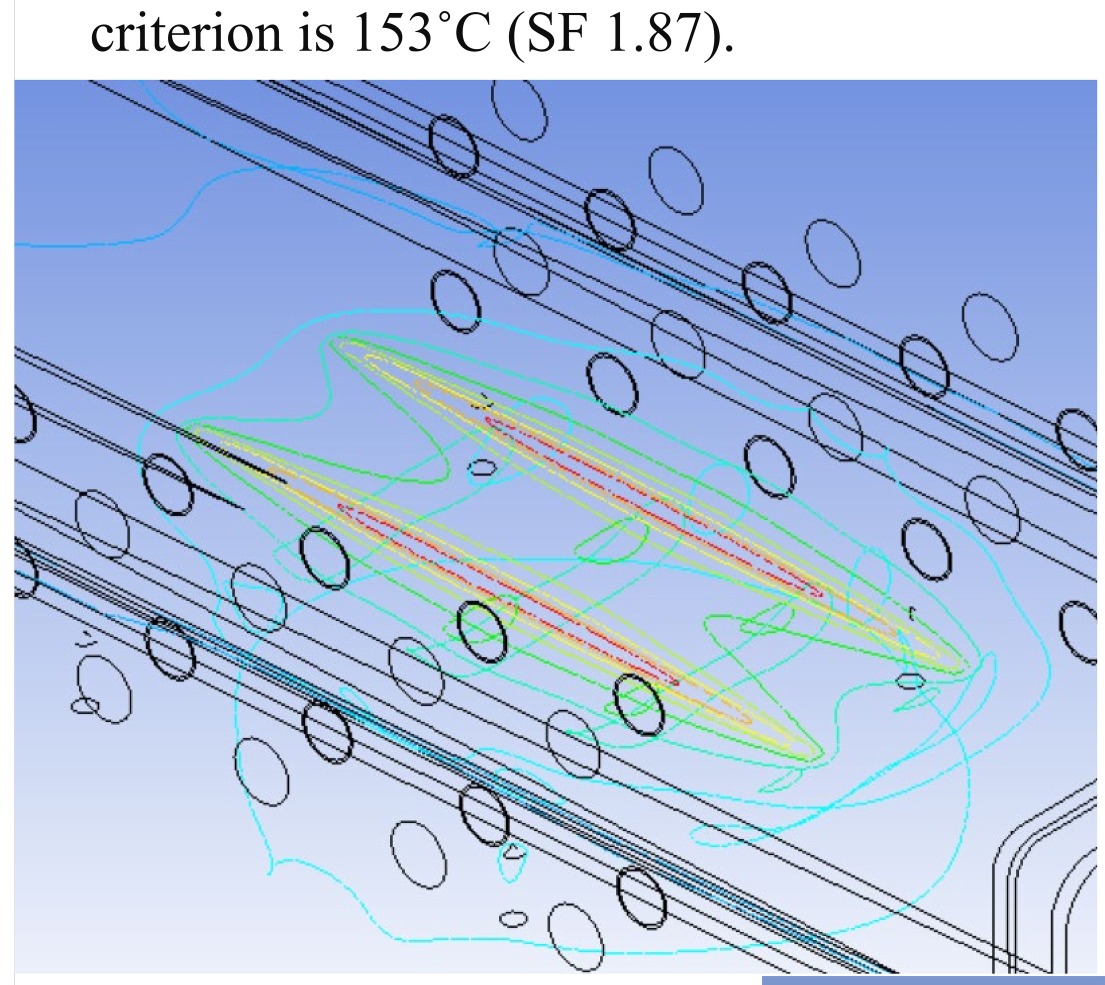
FABRICATION SCHEME



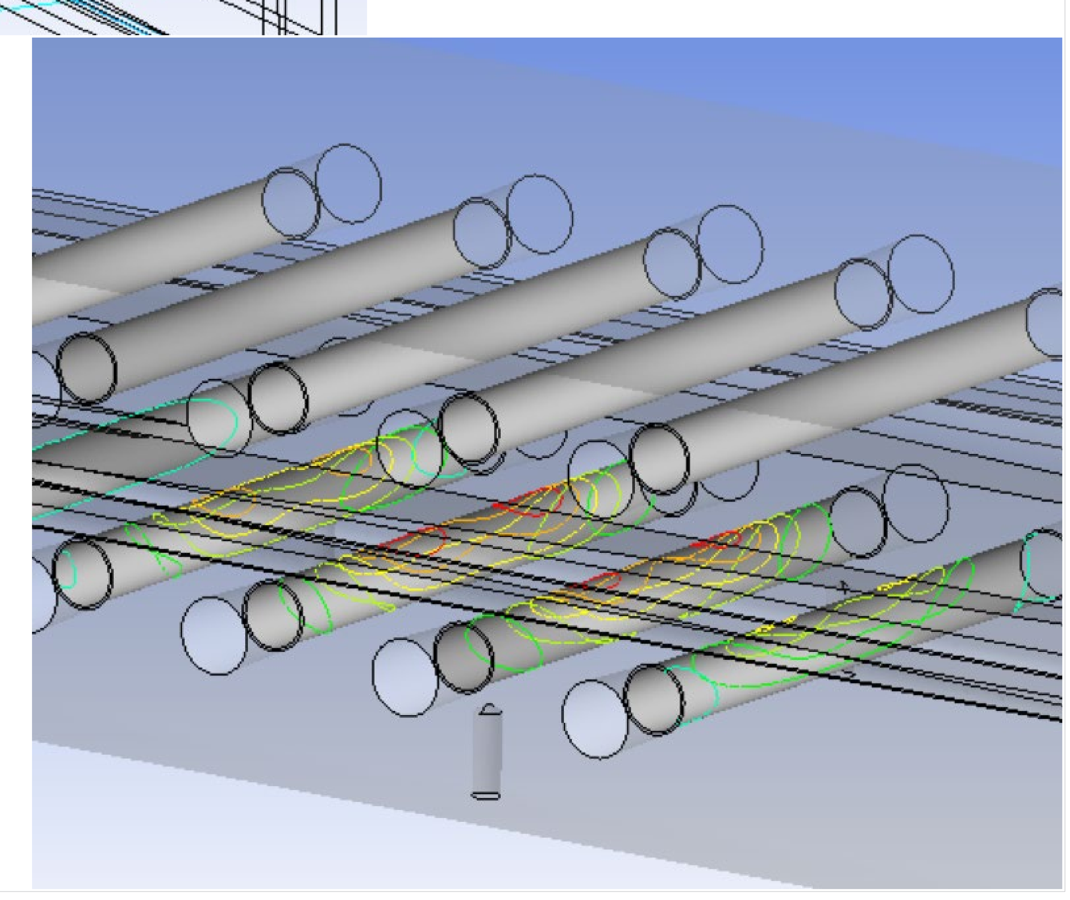
MASK ASSEMBLY

THERMAL FEA

- Steady-state thermal analysis was used to predict performance of the mask when subjected to full white beam from dual canted 1.85 cm period, 4.8 m length SCUs corresponding to a total power of 1402.7 W.
- A Gaussian distribution of the peak power density was calculated and applied to the incident surface and convection in the cooling channels was given a worst case of 10,000 W/m^{2}K.
- Results predict a maximum temperature at the incident surface of 53.1˚C, when the failure criterion for CuCrZr is 250˚C (SF 4.71). They also predict a maximum water temperature of 81.7˚C, when the failure criterion is 153˚C (SF 1.87).



CANTED HEAT FLUX ON INCIDENT SURFACE



COOLING CHANNEL CONVECTION

CONCLUSIONS

- Based on the positive results obtained from the thermal analysis, procurement and fabrication of the mask will commence and a prototype will be fabricated and tested.
- Assuming fabrication is successful, its installation would introduce a new method for producing photon masks in an easier and more economical fashion when compared to traditional mask designs.

REFERENCES

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[2] S. Sharma *et al.*, "A Novel Design of High Power Masks and Slits", in *Proc. MEDSI'14*, Melbourne, Australia, October 2014, https://medsi.lbl.gov/SysIncludes/retrieve.php?url=https://medsi.lbl.gov/files/page_156/Presentations/A_Novel_Design_of_High_Power_Masks_and_Slits_ Sushil_Sharma.pdf

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