Minutes of EBIS Electron Collector Design Review
27 May 2005

1. Attending: L. Snydstrup, J. Tuozzolo, J. Alessi, E. Beebe, S. Pikin, S. Bellavia, J. Ritter, C. Pai, E. Haas (NSLS)

2. L. Snydstrup presented the steps and considerations for the design of the EBIS electron collector as follows:

- Basic Geometry, Specifications, and Operating Parameters
- Analysis Procedure and Steps: FE transient thermal, convective heat transfer, FE stress, fatigue strength
- Materials of Construction
- Manufacturing Methods

3. ~~The feeling of~~ All of those present ~~was~~ agreed that the electron collector design as presented would meet the requirements for the RHIC EBIS with a comfortable safety margin. The design is mature, and has been carefully studied with respect to thermal, stress, and fatigue issues. The design has benefited from the experience with the initial Test EBIS collector. There were some general comments, primarily related to the final use of the collector, that are given below. But the conclusion was that the collector was ready for fabrication.

4. Comments and items to be considered:

a) Cooling water velocity. SB suggested maximum of 3 m/s to avoid erosion in bends. Verify velocity and check bend design (e.g, consider fewer channels with larger bends as an option). Note from L. Snydstrup: After the meeting the flow velocity was found to be 4 m/s. A reference from the Facility Piping Systems Handbook (by M. Frankel, McGraw-Hill, 2nd Edition 2002) states that 4 m/s is the accepted limit where flow velocity is not a factor for erosion. Also it was noted that the AGS F10 septum runs at much higher velocity 11.5 m/s with similar small copper water passages for more than 20 years.

b) Verification of beryllium copper properties (SP). Obtain certification of material, and inquire about testing to verify properties of the actual material used during fabrication. (Action item for L. Snydstrup during fabrication).

c) Vacuum testing of the welds at intermediate point in manufacture (EB) . (Action item for L. Snydstrup during fabrication).

~~c).~~

d) Concern for asymmetrical distribution of electron beam and heat flux (SB). The analysis presented used an axisymmetric model for heat transfer and stress analysis.

e) Concern for loading other than thermal, such as bellows loading and pressure (CP). (Action item for L. Snystrup to do he hand calculations or computer analysis of this loading to determine if it significantly adds to the stresses on the collector. If it does than a more detailed analysis that includes the concerns from comment d. above can be done (either by L. Snydstrup or J. Tuozzolo will assign another engineer)).

f) Affect of annealing of BeCu in weld region (SB, SP). This ~~has not been~~is not a concern since welds were in an area of negligible stress.

g) Adequacy of solder/braze for operating and bakeout temperatures (EB). Consider location and interlocking of thermocouples on the collector. (Action item for L. Snydstrup to review and specify the braze material and braze flux on the fabrication drawng).

h) Boiling and critical heat flux. Continue to look into a method to detect excessive heat flux or a hazardous boiling condition to methods were suggested: Listen for noise/vibration from the onset of boiling (JA) and/or monitor temperatures at critical locations on the collector (EH). Installing klixons on each of the parallel water circuits should also be considered if the loading is asymmetrical on the inside of the collector. (Action item for L. Snydstrup to determine if a pressure transducer will pick up transients from nucleate boiling of the water or if thermocouples can be located on the collector that can monitor indirectly areas of concern on the inside surfaces of the collector.)

i)

~~i)~~Re-c~~C~~alculate collector temperature and stresses for different operating times and loads:~~at~~ 50 ms on-150 ms off; 100 ms on-100 ms off; and dc beam. By analysis come up with practical limits we can use as guidance when running the collector at various currents, pulse widths, etc. Safe water temp, boiling, etc. ~~Put clixons on the outlet channels to interlock?~~ (This is another action item for calculations using different time steps and loads for heating of the cavity. Action item for J. Alessi to come up with expected operation parameters).

5. Future Plan. Manufacturing drawings are 95% complete. Drawings will be given to design room to put into final format. R&D funding will soon be available for production of first EC. Quotation for manufacture has been received from Brush Wellman using Hycon 3, high conductivity grade of beryllium copper, C17510.