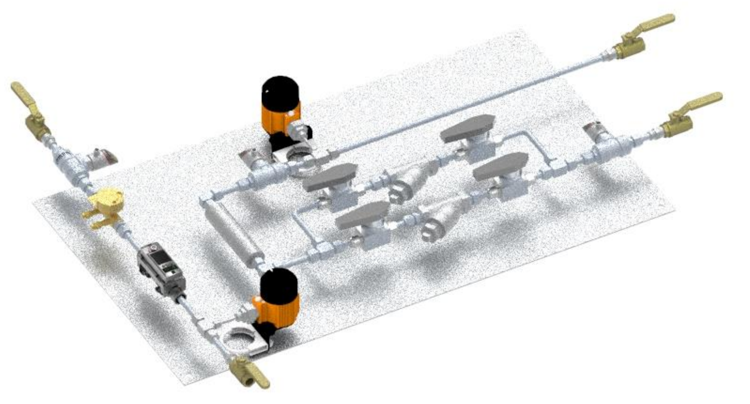
LCLS Internship Program

Active Cooling of Undulator Vacuum Chambers

Alexander Wiley[1] Xavi Permanyer[2] Scott Kaminski[2]

[1]SLAC – LCLS Internship Program [2]SLAC National Lab



Overview

Heat Load and Thermal Management

The increased heat load from LCLS-II-HE on SXR and HXR undulator vacuum chambers will require active cooling to maintain undulator thermal stability

The undulator vacuum chamber water cooling is designed to maintain a ±0.1 K temp stability

Cooling System

Water cooling channels in the vacuum chamber wall remove heat load due to chamber wall heating

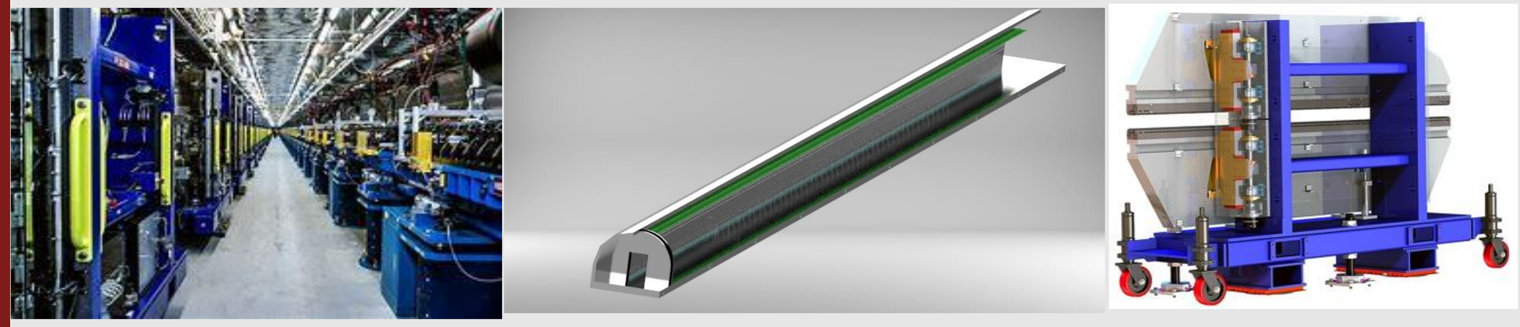


Figure 1: Undulator Hall and CAD Models

Analysis

Pressure Drop & Flow Equations

$$\Delta P = f_d * \frac{L}{D_H} * \frac{\rho * V^2}{2} \quad \text{Darcy-Weisback} \quad (1)$$

$$\Delta P = K_L * \rho * \frac{V^2}{2} \quad \text{Resistance Coefficient Method} \quad (2)$$

$$\Delta P = K_L * \rho * \left(\frac{Q}{C_v}\right)^2 * SG \quad \text{Valve Flow Method} \quad (3)$$

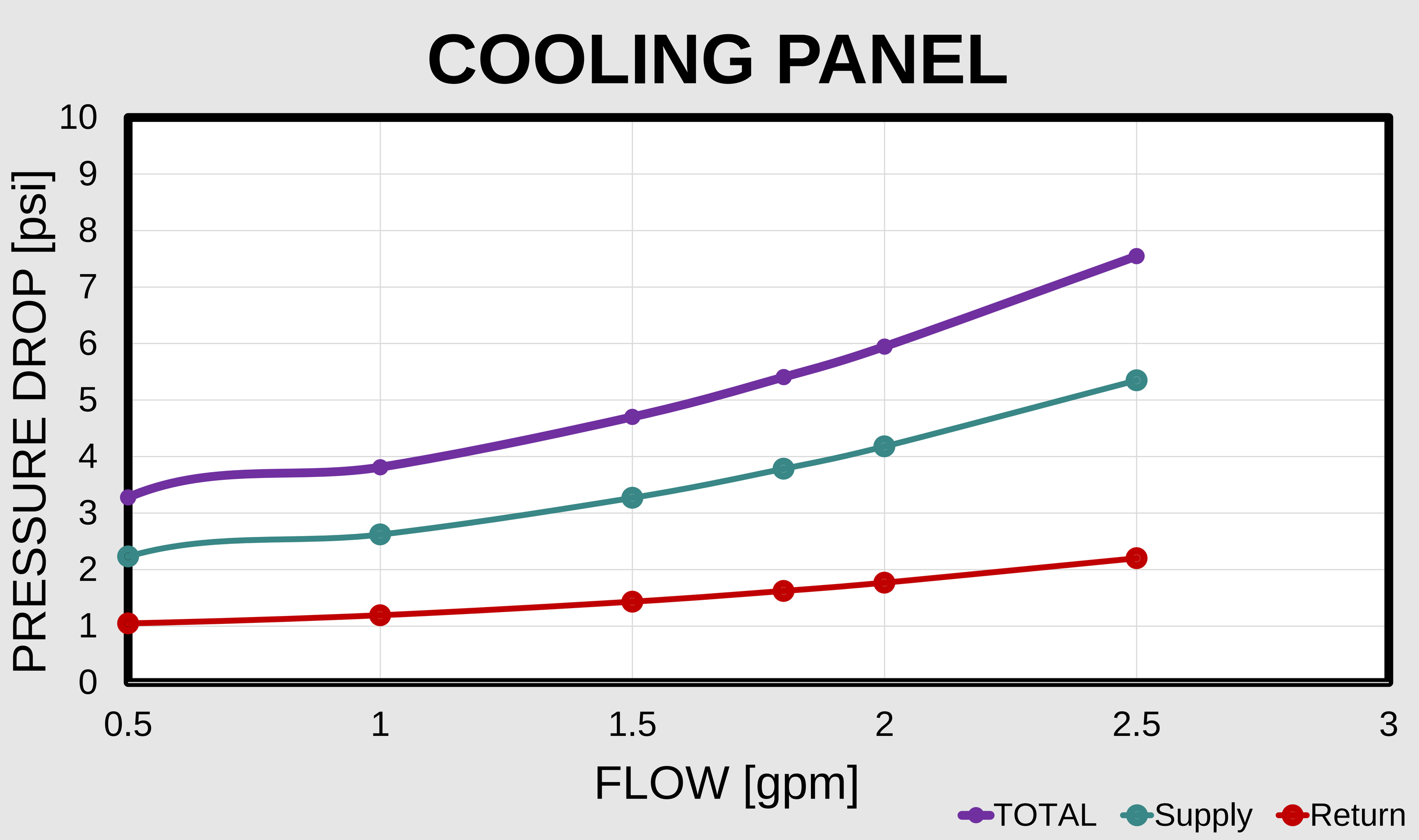


Figure 2: Cooling Pane Pressure drop as a function of flow.

Cooling System Design

The cooling panel design will be identical for the HXR and SXR undulator systems. The integration of the cooling panel into the two system is illustrated in Figure 3.

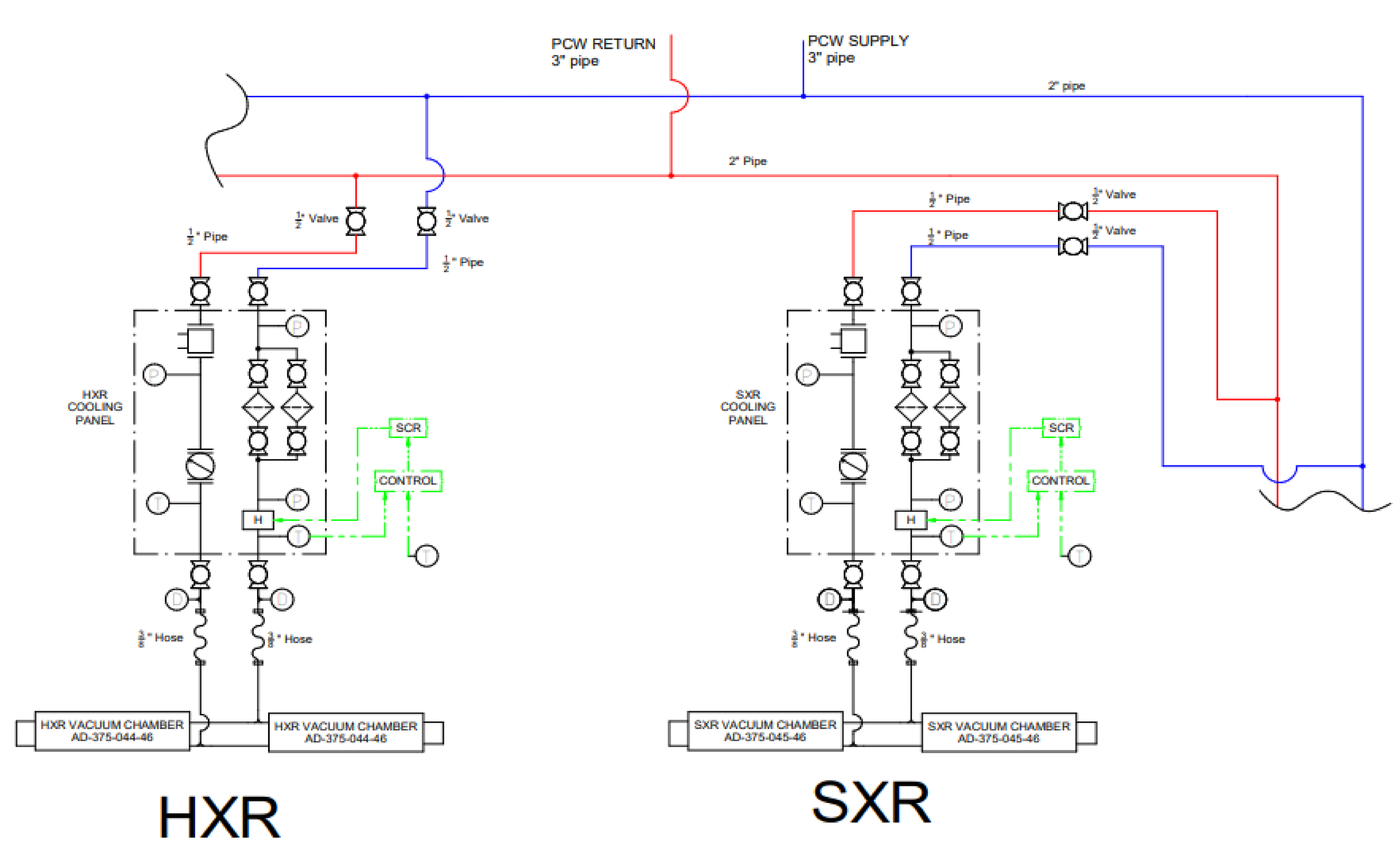


Figure 3: Schematic Drawing of Cooling System

Design Requirements

Supply

- Heater
- Two Y-Strainer - Ball Valve Series

Return

- Circuit Setter-Pressure Management
- Flow Meter

Both sides require Gauges for Temperature and Pressure.

a total nominal flow of 1.8 gpm (0.9 gpm on each line)

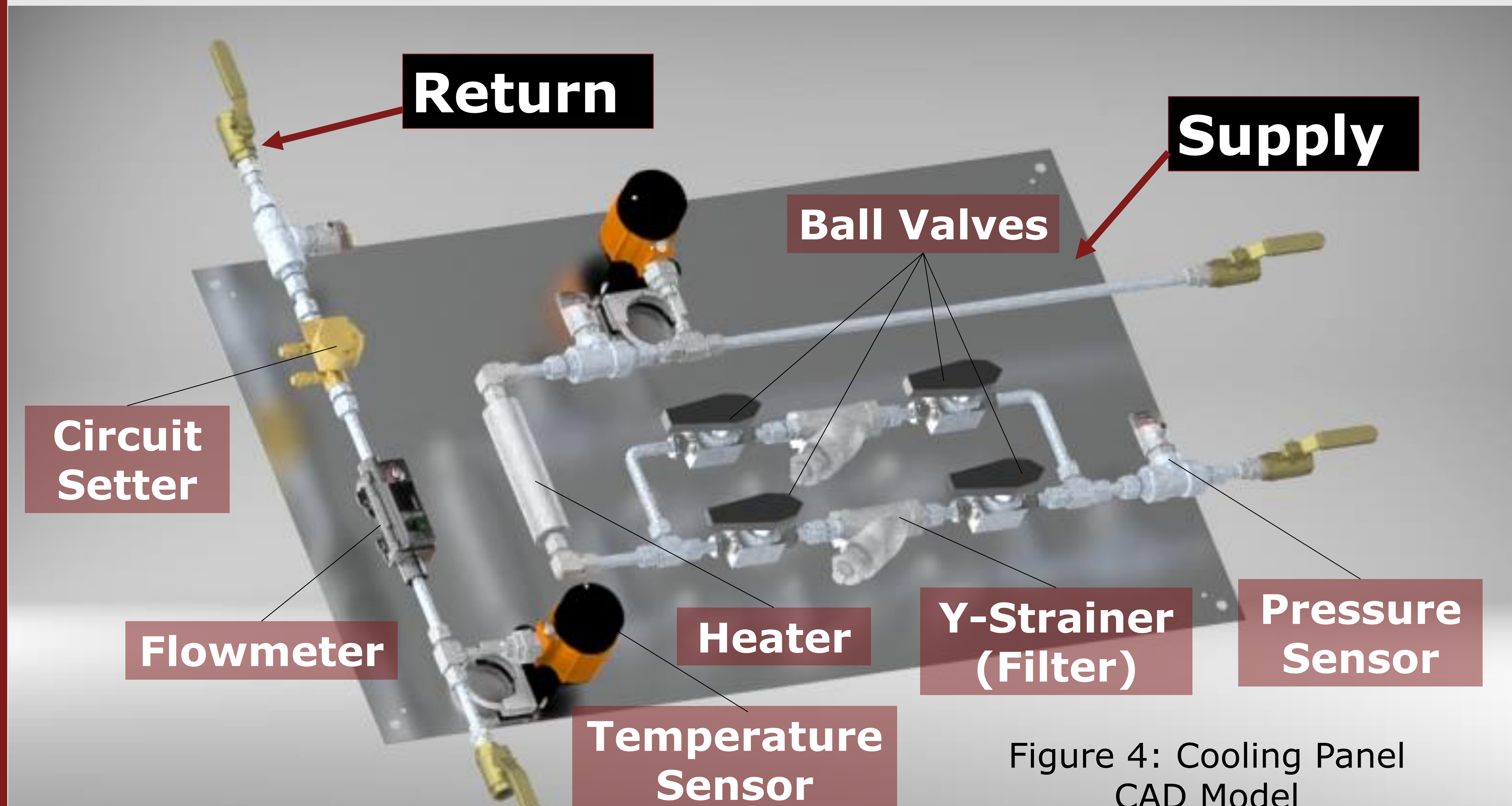


Figure 4: Cooling Panel CAD Model

Installation Design

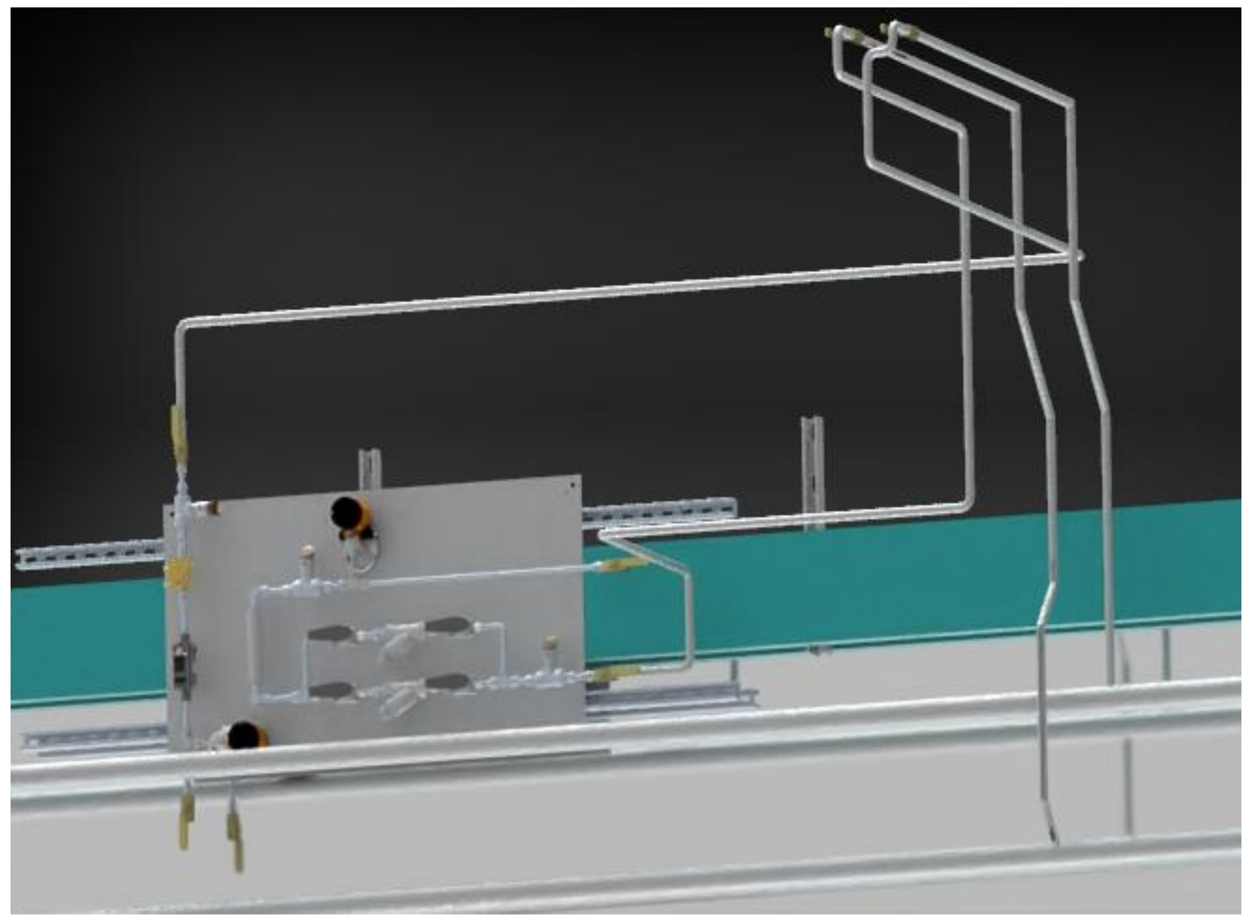


Figure 5: Cooling Panel undulator hall installation CAD model

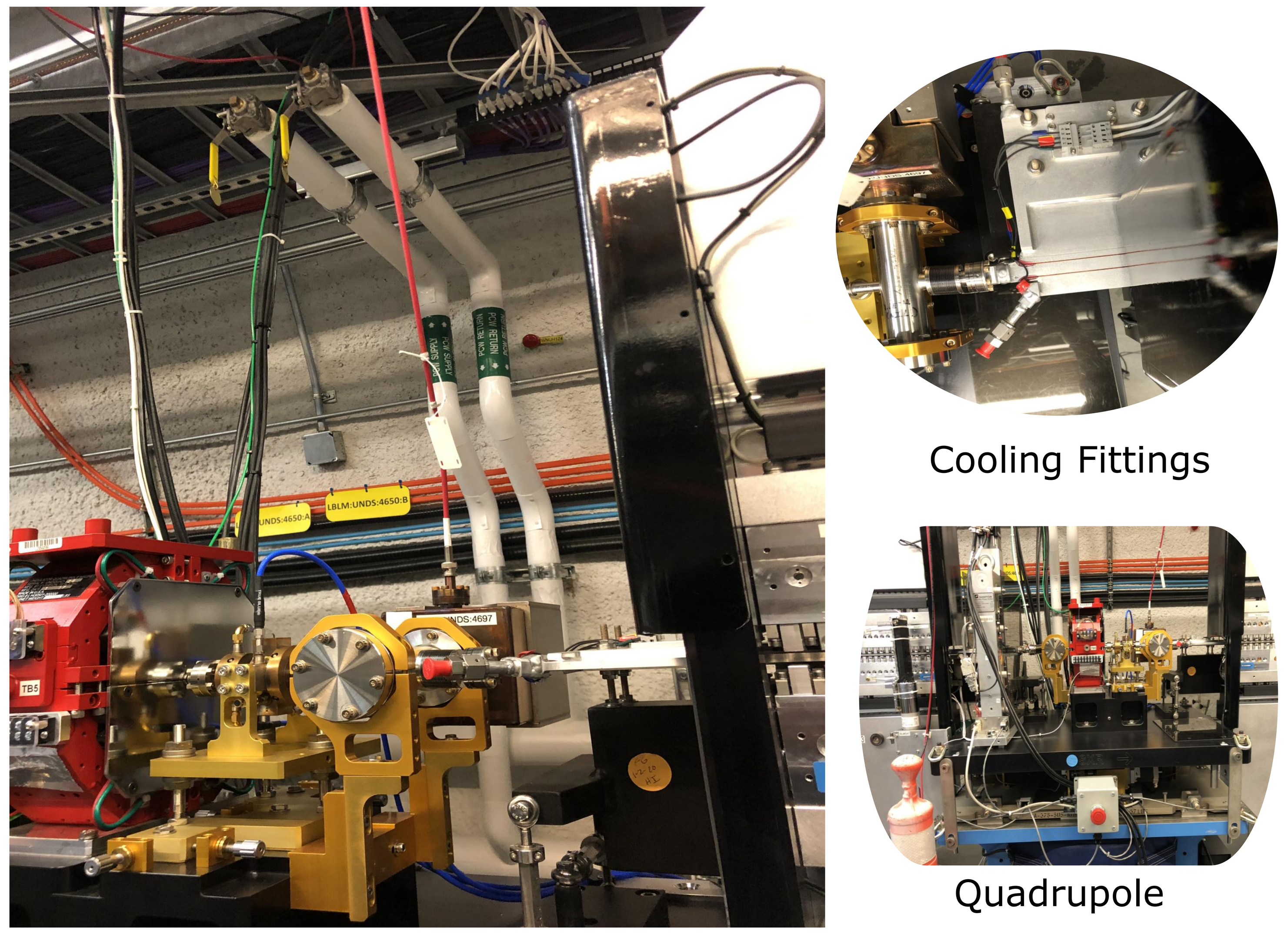


Figure 6: Water Cooled Undulator Chamber Installation Region

Further Work

Prototype will be assembled and installed for testing process. Deployment of around 34 panels are planned for 66 stations once finished.

References

[1] Curry, S. (2016). LCLS II. Retrieved from https://engineering.lbl.gov/lcls-ii/

[2] LCLS-II. (2022). Retrieved from https://lcls.slac.stanford.edu/lcls-ii

[3] Permanyer, Xavi. (2023, February 27). LCLS-II-HE Analysis of a Cooling Panel for the Vacuum Chambers in the Undulator Hall. Menlo Park, Ca: SLAC National Laboratory.

[4] SLAC NATIONAL LABORATORY. (2015, November 22). LCLS II Final Design Report. MENLO PARK, CA: SLAC NATIONAL LABORATORY