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## **Design and analysis of the internally cooled silicon mirrors and benders for wiggler sources at the Advanced Photon Source**

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When silicon single crystal mirrors are bent to cylindrical figures of typically 6 km bending radius, the moments needed are very small and easy to disturb by cooling attachments to the sides of the mirror. Hence, we decided to abandon the conventional concept of cooling plates attached to the sides of the mirrors and instead have chosen to use internal water channels.

We present here the design of mirrors with cooling channels near the neutral axis of the silicon beam which have a rather thick "hot wall". The results of this analytical work are non-intuitive regarding the stresses produced by wiggler heating. The design path chosen minimizes figure errors due to coolant pressure variations and residual stresses from machining and bonding of multiple layers of silicon. The geometry of the water channels avoids water-to-vacuum seals and uses the mirror bender as the coolant manifold. Engineering efforts which reduce the bending stresses at bender-to-silicon interface by a factor of five will be presented. The complete mirror bender and motion control mechanics will be shown.