

## Measurements of Energetic Electron Bremsstrahlung during Lower Hybrid Current Drive in HL-2A Tokamak

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Energetic electrons existing widely in magnetic confinement fusion plasma emit hard X-rays via bremsstrahlung. Hence, hard X-ray diagnostics plays an important role in the behavior research of energetic electrons in magnetic confinement fusion plasma. Thus, a hard X-ray camera introduced from CEA has been used to study the behavior of energetic electrons in HL-2A plasma.<sup>[1-3]</sup> Because the hard X-ray camera is mainly focused on hard X-rays emitted from plasma center region, a new hard X-ray camera, which faces the plasma peripheral region, has been designed, manufactured and installed in HL-2A tokamak.

Figure 1 shows the schematic drawing of the newly developed hard X-ray camera on HL-2A tokamak. The new hard X-ray camera was mainly developed to measure the hard X-ray (HXR) with energy from 20 to 200 keV in HL-2A tokamak during lower hybrid (LH) current drive experiments. It mainly consists of 10 CdTe detectors, Pb shielding box and electronic system. It should be noted that the new hard X-ray camera is installed on the inside side of a flange to face the plasma. In order to eliminate the soft X-ray signals in detectors, a Al-plate with a thickness of 1 mm has been put just before the detectors.

Since the hard X-ray camera was designed to face the plasma peripheral region (see figure 2), it can get the distribution information of energetic electrons during MHD. The newly developed hard X-ray camera on the HL-2A tokamak has been used to study the behavior of energetic electrons in the 2021 experimental campaign. The presentation focuses on the applications of the new hard X-ray camera on the HL-2A tokamak as well as its experiment results in the 2021 experimental campaign.

### References

- [1] Y. P. Zhang, D. Mazon, J. Zhang, et al., A Hard X-Ray Pinhole Camera System for Fast Electron Bremsstrahlung Measurements in the HL-2A Tokamak, *Fusion Science and Technology*, 2021, 77(1): 1-8.
- [2] J. Zhang, Y. Zhang, Y. Li, et al., Application of the Abel-inversion method for the hard X-ray camera on the HL-2A tokamak, *Journal of Instrumentation*, 2021, 16:P03034.
- [3] Y. P. Zhang, D. Mazon, Y. Peysson, et al., Measurements of the fast electron bremsstrahlung during lower hybrid current drive in the HL-2A tokamak, *AIP Advances*, 2019, 9:085019.

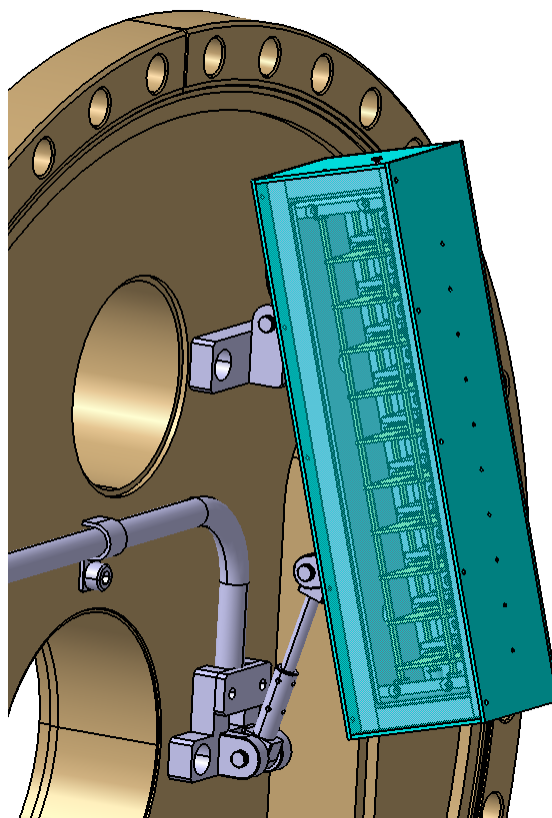


Figure 1. Schematic drawing of the newly developed hard X-ray camera on HL-2A tokamak. It is installed on the inside side of a flange to face the plasma.

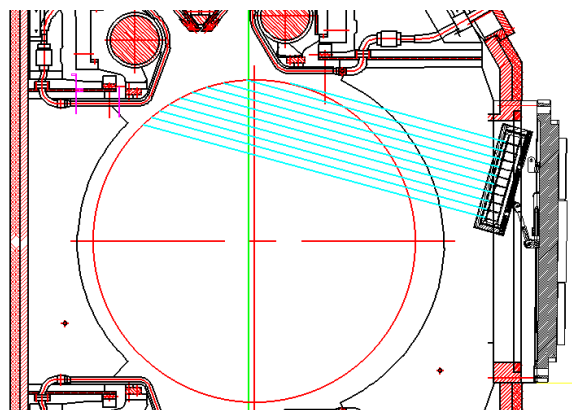


Figure 2. Beam path diagram of the newly developed hard X-ray camera on HL-2A tokamak. It is designed to face the plasma peripheral region.