X-Ray Investigation on the Superconducting Source for Ions (SuSI)

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Abstract

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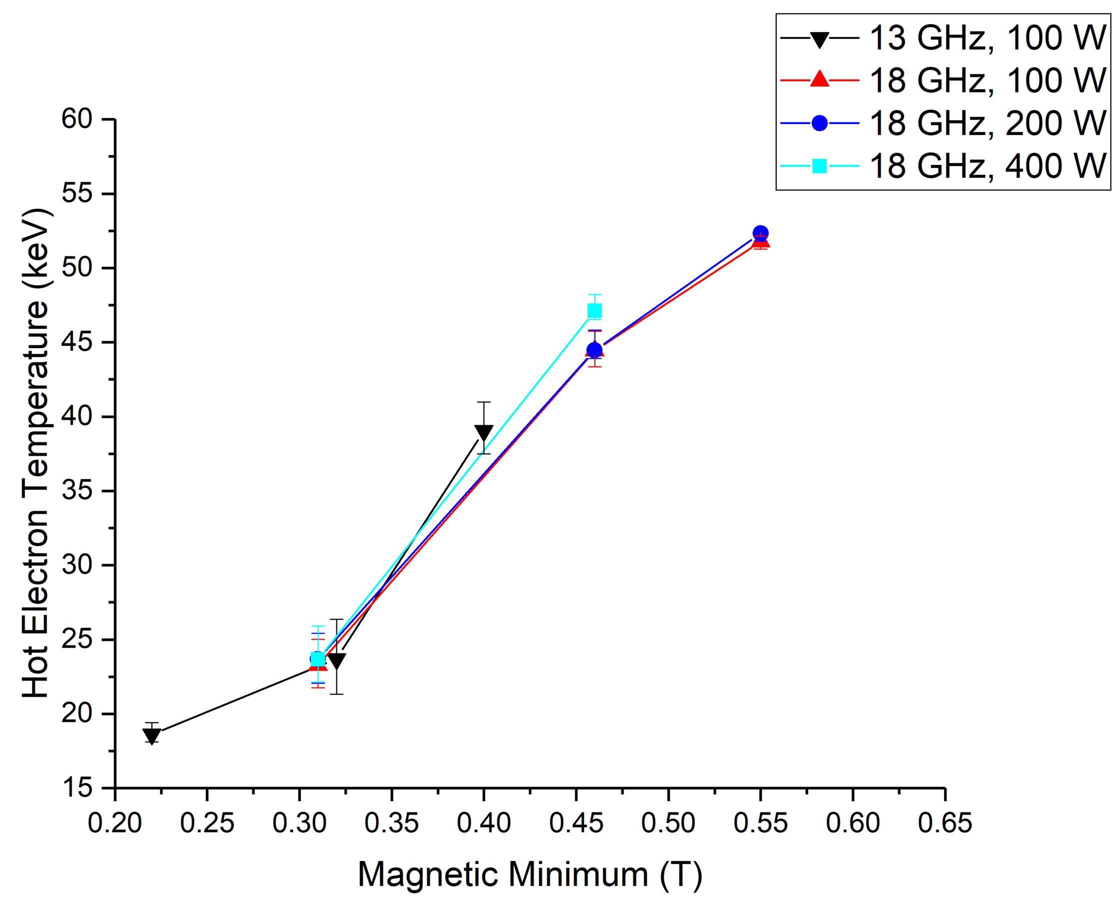
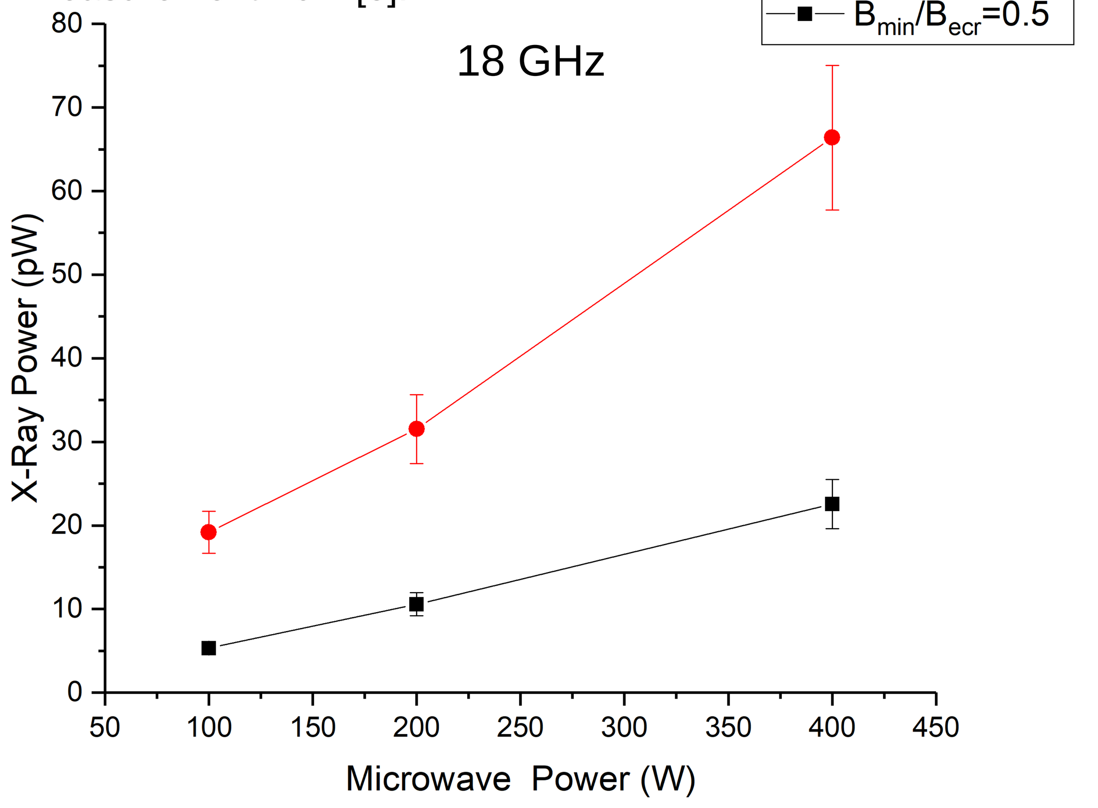
Heavy ion facilities such as the National Superconducting Cyclotron Laboratory (NSCL) often use ECR Ion Sources (ECRIS) for the production of highly charged ions to increase the efficiency of accelerating structures. Axial bremsstrahlung emission was studied on the Superconducting Source for Ions (SuSI) at the NSCL for 18 GHz and 13 GHz operation with oxygen. The hot electron temperatures were estimated from the bremsstrahlung high energy tail and seem to depend only on magnetic minimum in the same way as was found on VENUS [1], even in the case where 18 GHz and 13 GHz frequencies were compared for similarly sized ECR zones. Additionally, the time independent x-ray power increased at a significantly larger rate when operating the source in known regions of instability such as where the magnetic minimum approaches the ECR zone [2]. The results are discussed in the context of electron losses due to magnetic confinement.

Trend similar to the findings from [1].

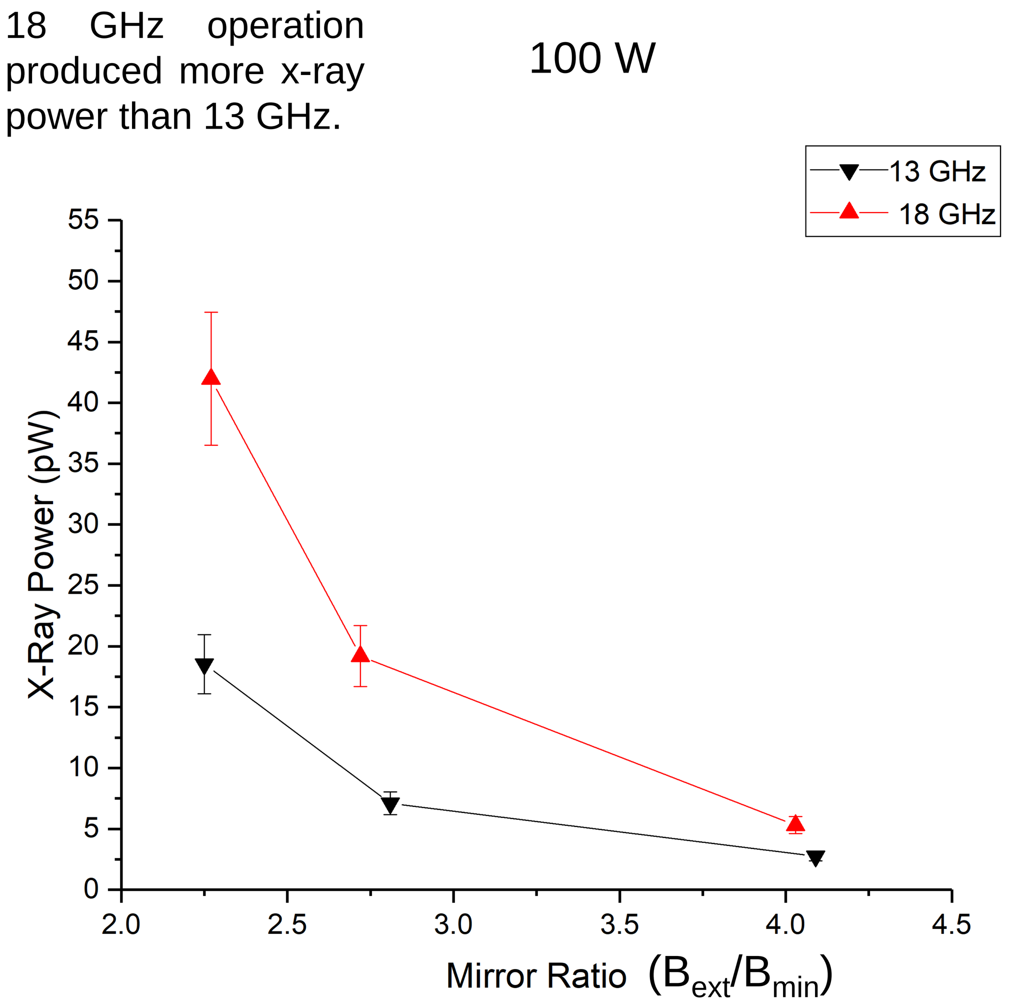


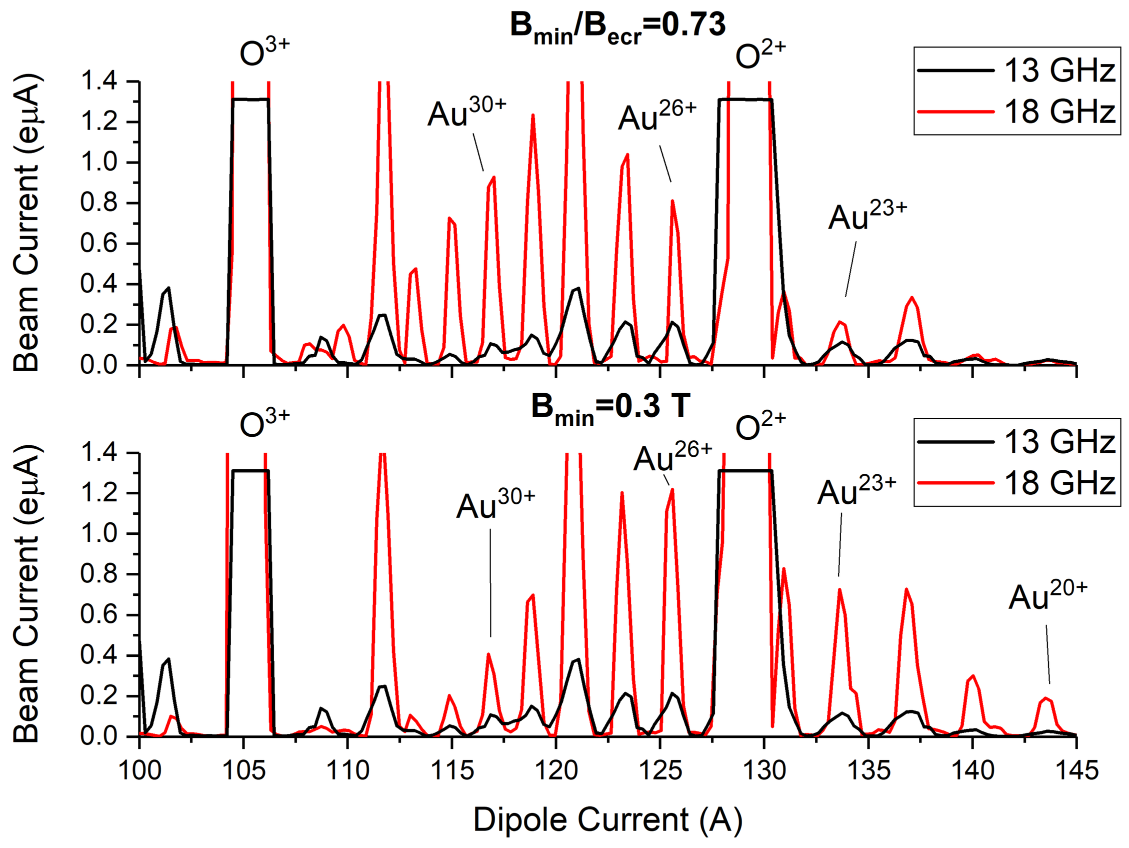
Trend similar to cryostat heat load measurement from [3].



Hot electron temperature increased linearly with B_{min} similarly to what was reported in [1]. X-ray power increased linearly with microwave power in a manner similar to how the VENUS cryostat heat load increased with microwave power [3].

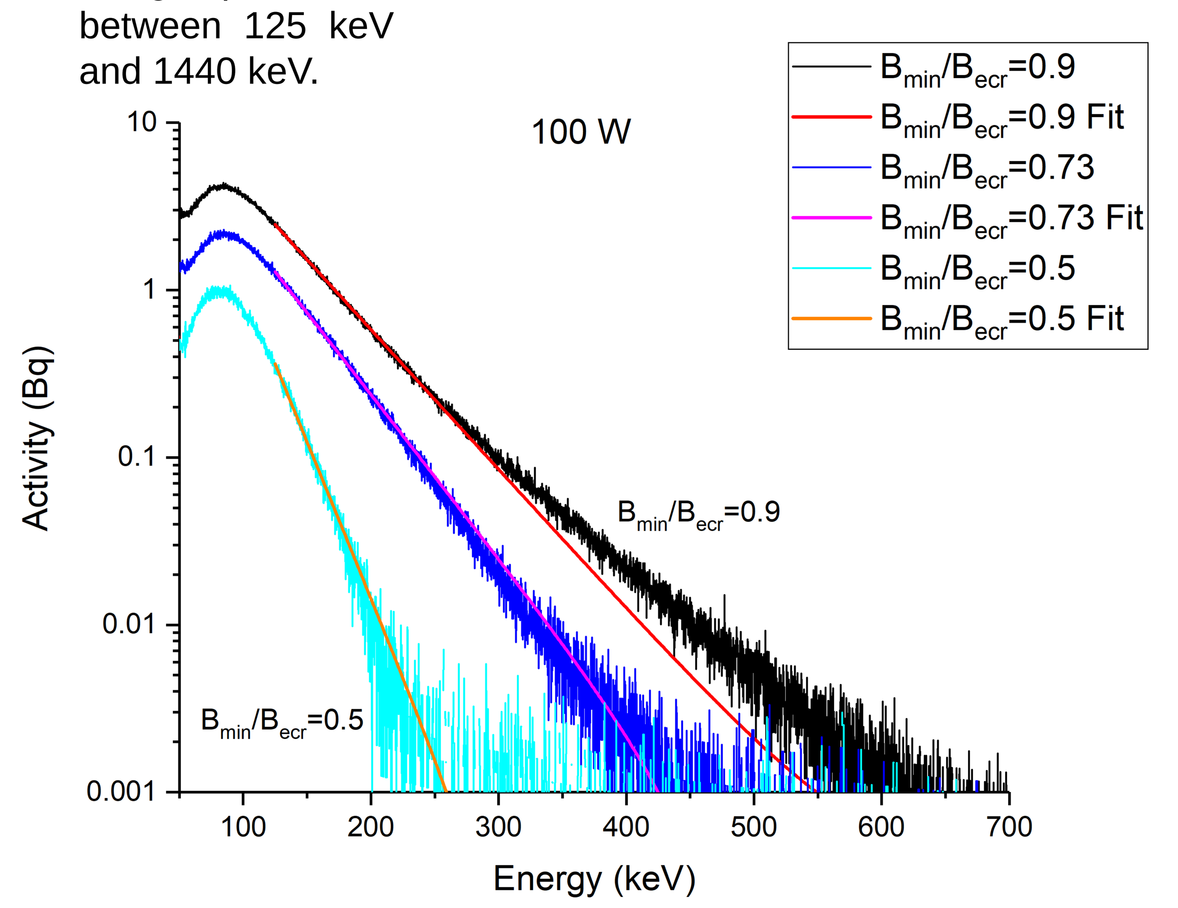
18 GHz operation produced more x-ray power than 13 GHz.

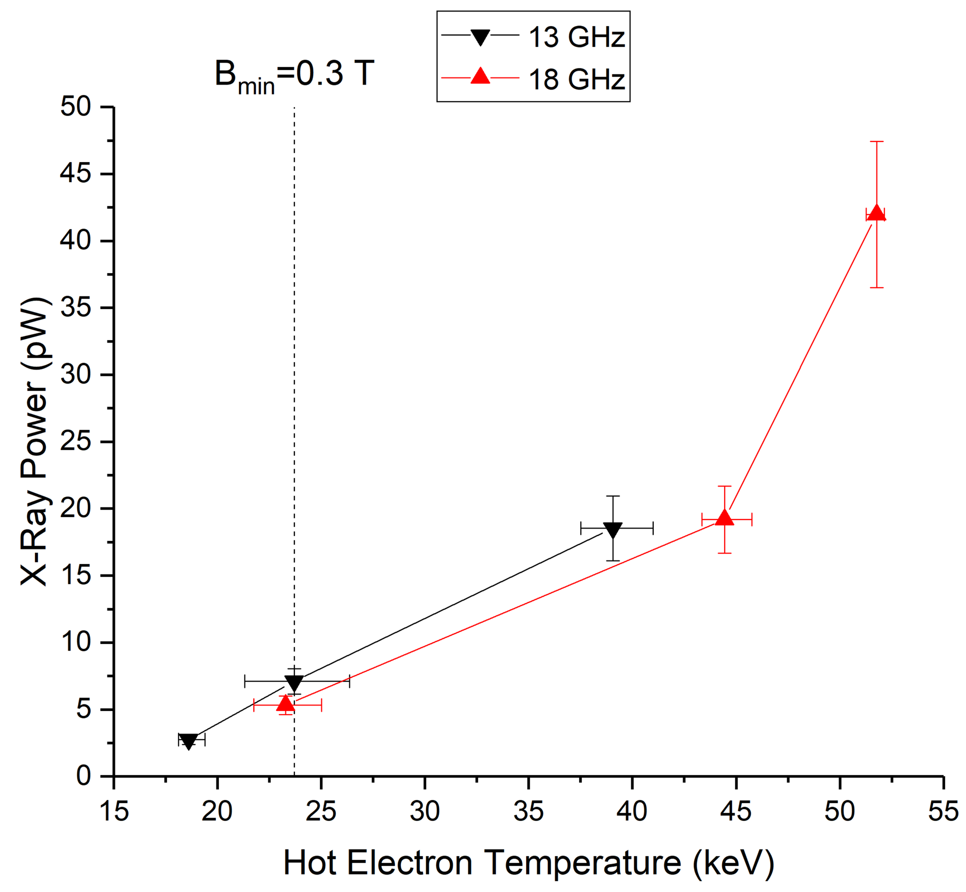




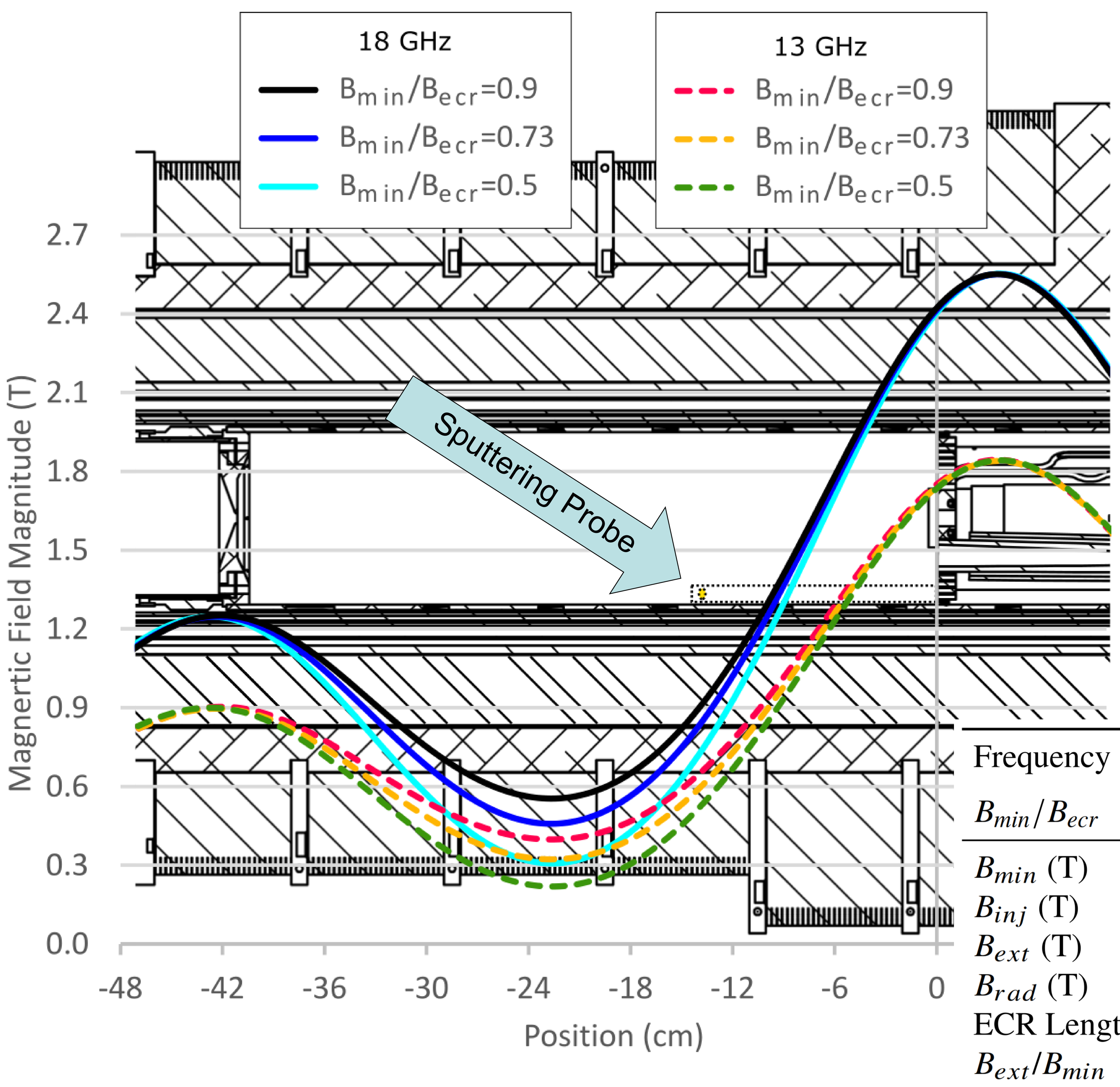
The plasma density was lower for 13 GHz than at 18 GHz for constant microwave power, magnetic minimum, and ECR zone.

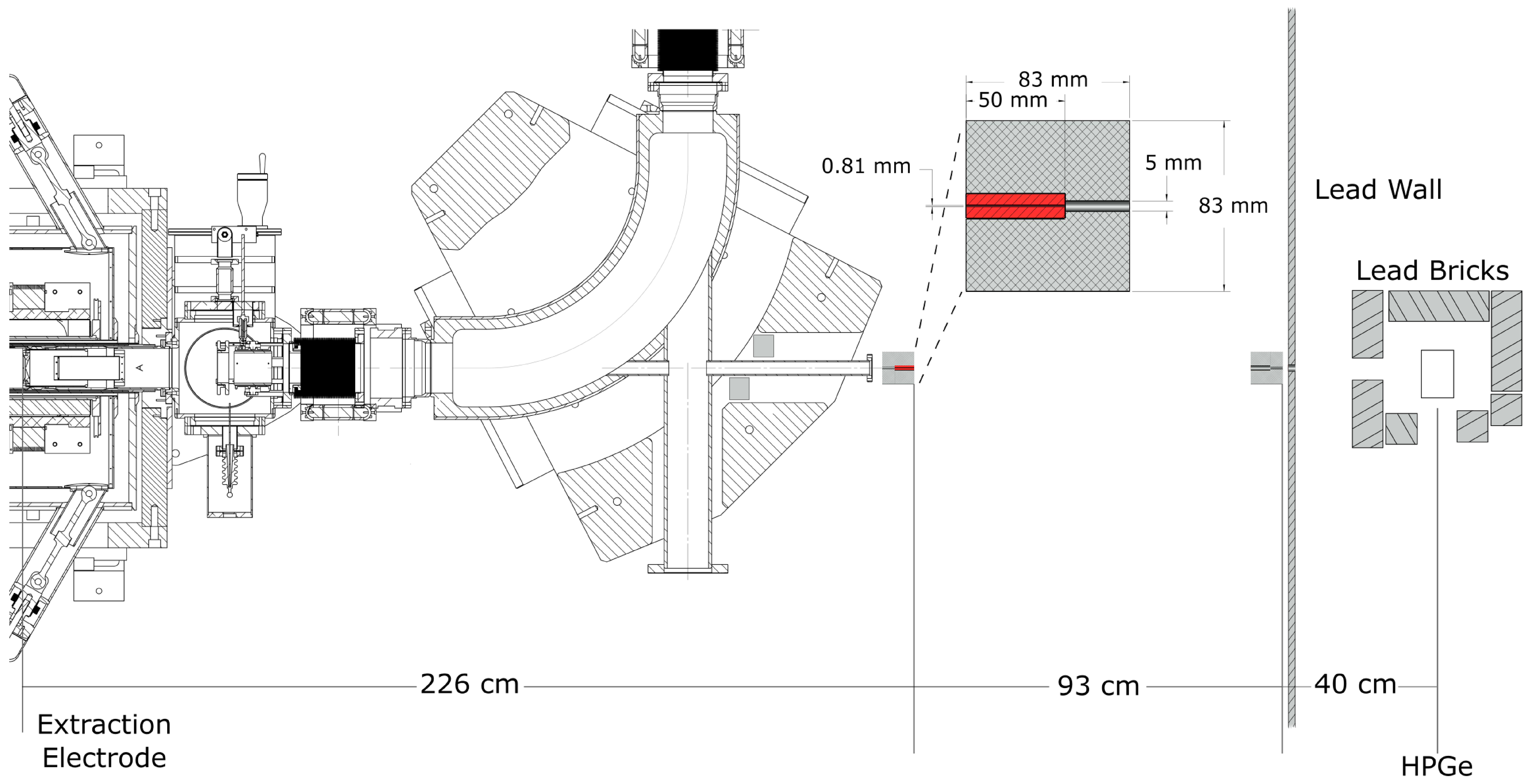
Bremsstrahlung fitting performed between 125 keV and 1440 keV.





X-ray power doubled for a 17% increase in hot electron temperature, and could be the result of instabilities that appear for B_{min}/B_{ecr}>0.7 [2].





Frequency	18 GHz			13 GHz		
B_{min}/B_{ecr}	0.5	0.73	0.9	0.5	0.73	0.9
B_{min} (T)	0.31	0.46	0.55	0.22	0.32	0.40
B_{inj} (T)	2.55	2.55	2.55	1.84	1.84	1.84
B_{ext} (T)	1.25	1.25	1.25	0.90	0.90	0.90
B_{rad} (T)	1.25	1.25	1.25	0.93	0.93	0.93
ECR Length (cm)	16.3	12.8	9.3	16.5	13.0	9.3
B_{ext}/B_{min}	4.03	2.72	2.27	4.09	2.81	2.25

The x-ray collimation system had an opening angle of 20 minutes projecting a 13 mm diameter circle on the extraction electrode with 8 mm aperture.

The sputtering probe was 14.5 cm long and the outer insulator was 1.14 cm in diameter. The sputtering sample consisted of a spheroid approximately 4 mm in diameter.

REFERENCES:

[1] J. Benitez *et. al.*, in *Proc. ECRIS'16, 2016,* paper MOCO04, pp. 23-29.
[2] O. Tarvainen *et al., Plas. Sourc. Sci. Technol.*, vol. 23, p. 025020, 2014.
[3] D. Leitner *et. al., Rev. Sci. Instrum.*, vol. 79, p. 033302, 2008.

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