



# **Superconducting Undulators for hard X-ray Free-electron lasers**

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### **ABSTRACT**

To produce hard X-rays with a wavelength down to 0.03nm, harmonic lasing and inter-undulator chicanes are proposed [1]. High K-value (K=2.4), low period ( $\lambda_u$ =10 mm) and small gap (g=4 mm) undulators are needed. To achieve these performance, high temperature superconductor bulk materials are a possible enabling technology. In this work we present a detailed FEM magnetic model which has been at first benchmarked against the experimental results produced by R. Kinjo et al. at Kyoto University and then used to analyze a larger diameter configuration working at higher field. An outlook for further experimental characterization of the superconducting materials is finally addressed.



HTS bulks magnetized to produce the undulator field







# **3D modeling:**

## **3D Simulations Results on 8 periods**

**Screening currents induced by the** external applied field





# **Conclusions**

At Kyoto University GdBCO bulks have  $\bullet$ been tested showing the potentiality to reduce  $\lambda_{\mu}$  keeping a reasonable gap size. 

A FEM model based on the H-formulation has been developed to simulate the effect of the bulks magnetization including thermal and mechanical effects.

The model can be used to optimize the system.

HTS properties should be measured.

## References

[1] T. Schmidt, M. Calvi & G. Ingold (2015) Undulators for the PSI Light Sources,

Synchrotron Radiation News, 28:3, 34-38, DOI: 10.1080/08940886.2015.1037681

[2] R.Kinjo et al., Applied Physics Express 6 (2013) 04270