# Bremsstrahlung Photons Emission in 28-GHz Electron Cyclotron Resonance Plasma

M.J Kumwenda[1], J.K Ahn[2], J. Lee[2], I.J Lugendo[1], S.J Kim[3], J.Y Park[3], M.S Won[3]

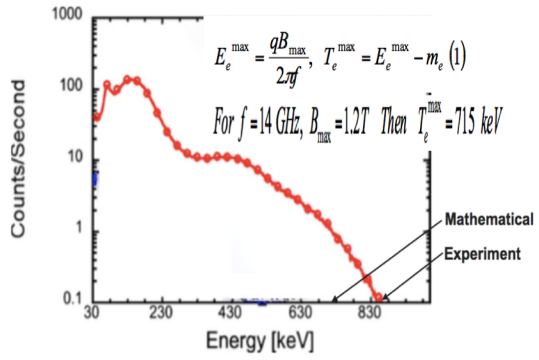
1. Department of Physics, University of Dar es Salaam, Dar es Salaam, Tanzania
2. Department of Physics, Korea University, Seoul 02841, Republic of Korea.
3. Busan Center, Korea Basic Science Institute, Busan 46241, Republic of Korea.

## Abstract

Radial measurements of bremsstrahlung photons show high-energy intensity beyond a critical energy from electron cyclotron resonance (ECR) heating and its nature is not well understood so far. For the first time we have measured the bremsstrahlung photons energy intensity from 28-GHz ECR ion source at Busan Center of KBSI. Three round type NaI(Tl) detectors were used to measure the bremsstrahlung photons emitted at the center of the ECRIS at the same time and one NaI(Tl) detector placed at the view port. Bremsstrahlung photons energy intensity were measured at three azimuthal angles at RF power of 1kW. To obtain true bremsstrahlung photons spectra from measured ones, direct matrix inversion unfolding method was applied based on Geant4 simulation results. The unfolding method was based on a full geometry Geant4 model of the ECR ion source. The high energy intensities of the bremsstrahlung photons at the center of the ECRIS were explained by the internal structure and shape of ECR plasma.

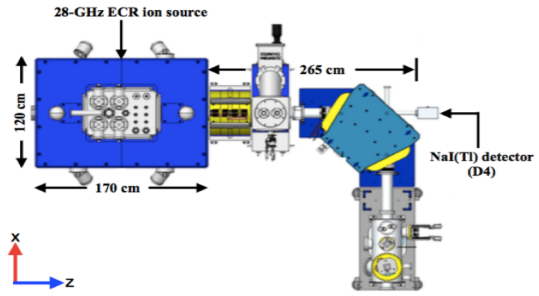
## Research Motivation

Noland et al.,Rev.Sci.Intrum.81,02A308 (2010)

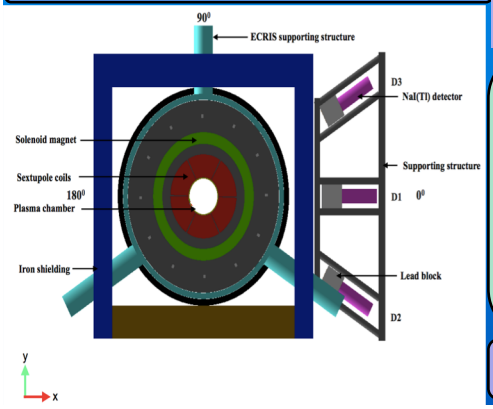



The experimental energy tail is near 840keV which is beyond maximum K.E available from ECR heating.

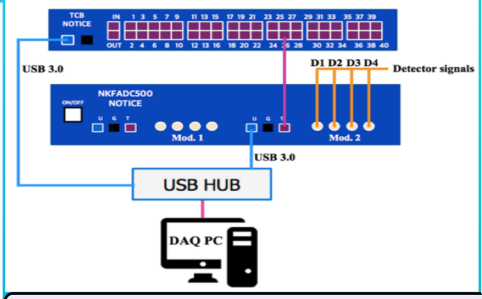
## Experimental Setup at the View Port

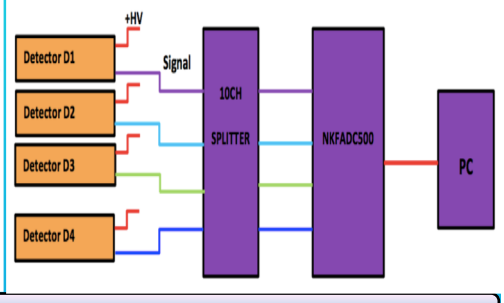



## The Experimental Setup (Radial)

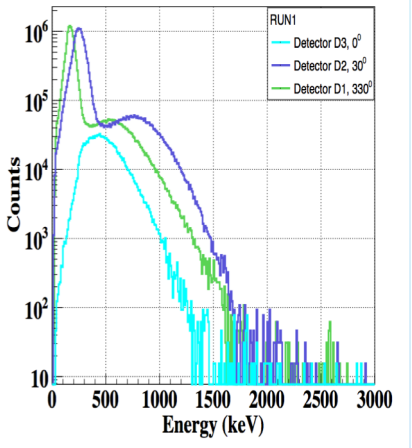


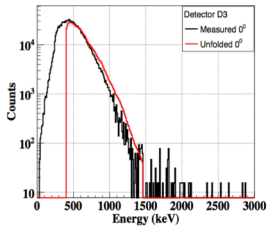

## Trigger and Data Acquisition System

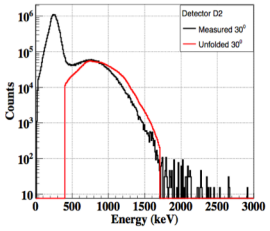


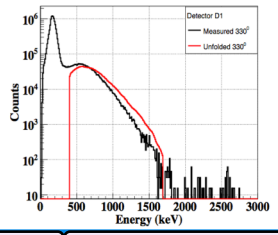




## Energy Spectra and Angular Distributions of Bremsstrahlung Photons




(a) (b)

(a) The measured photon energy intensity before deconvolution (b) Bremsstrahlung photons energy intensity obtained after unfolding.

## Conclusion

At the center position, the ECR plasma is formed in the shape basically the same with the six-arm star, due to the hexapole magnetic fields. The six corners of the plasma shape correspond to the angles of 30⁰, 90⁰, 150⁰, 210⁰, 270⁰ and 330⁰, that means after every 60⁰ there should be maximum angle. Electrons at two angles namely 30⁰ and 330⁰ of the hexagon shapes at the center position of the ECR ion source can collide easily with the chamber wall and produce the bremsstrahlung photons. Hence, the high photon intensities at angles 30⁰ and 330⁰ can be explained by the shape of the ECR plasma.

*Dr. Mwingereza J. Kumwenda, Physics Department, University of Dar es Salaam. E-mail: kmwingereza@udsm.ac.tz Mobile: +255 758 984126*