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# Commissioning of the UNIST-EBIT: X-ray Resonant Spectroscopy of the Highly Charged Ions at PAL-XFEL

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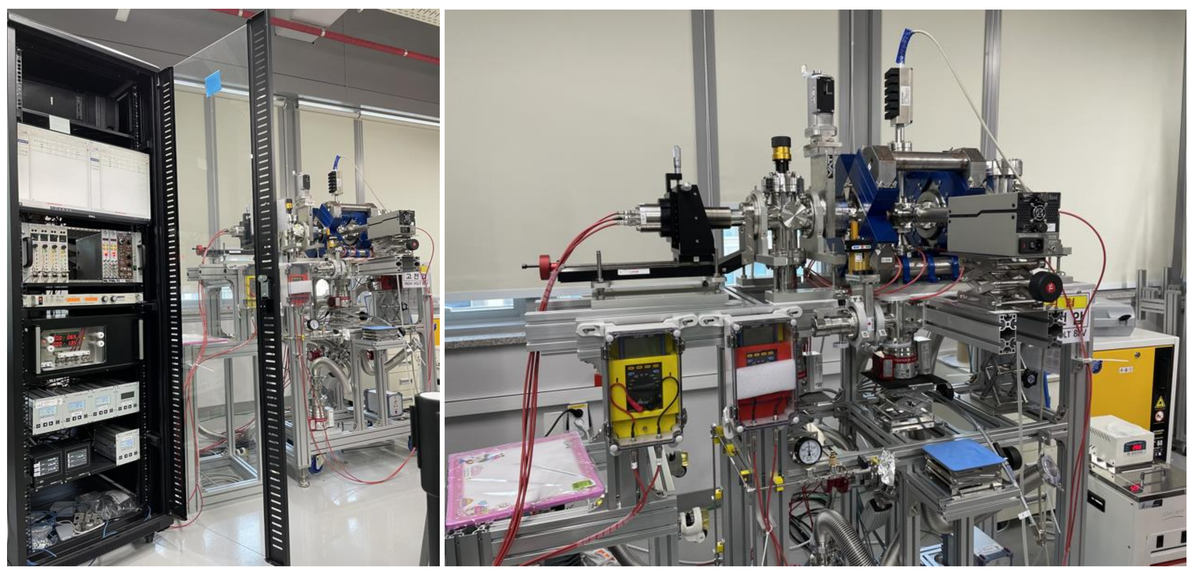
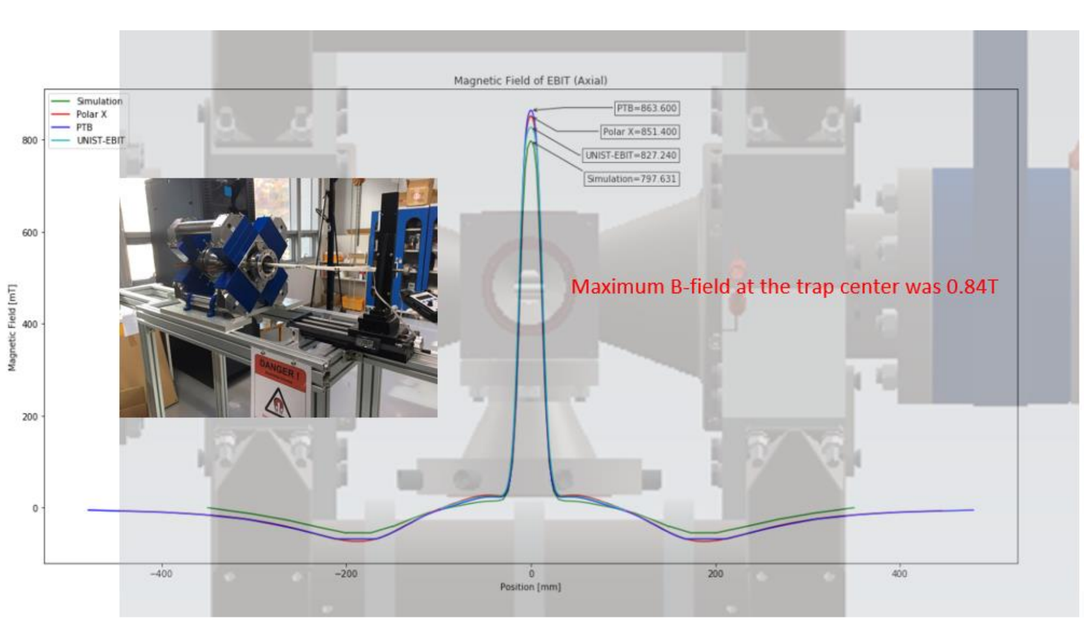
## Abstract

UNIST (Ulsan National Institute of Science and Technology) built a device called an Electron Beam Ion Trap (EBIT) to generate and study highly charged ions (HCI). In January 2022, preliminary experiments were carried out on highly charged argon ions. EBIT was delivered to Pohang city, where the PAL-XFEL (Pohang Accelerator Laboratory X-ray Free Electron Laser) is located, and successfully connected to the hard X-ray beamline. Over the two R&D beam times, we set the trigger signal to match the time when the PAL-XFEL photon bunch interacts with the HCI clouds. By the time coincidence, suppressing the background by a factor of 1000 was possible. In this work, we present in-situ highly charged argon ion spectroscopy as well as the PAL-XFEL measurements. Prior one is the fluorescence signal due to the electron beam sweep while the other was due to the photon beam sweep.

## UNIST Electron Beam Ion Trap(EBIT)

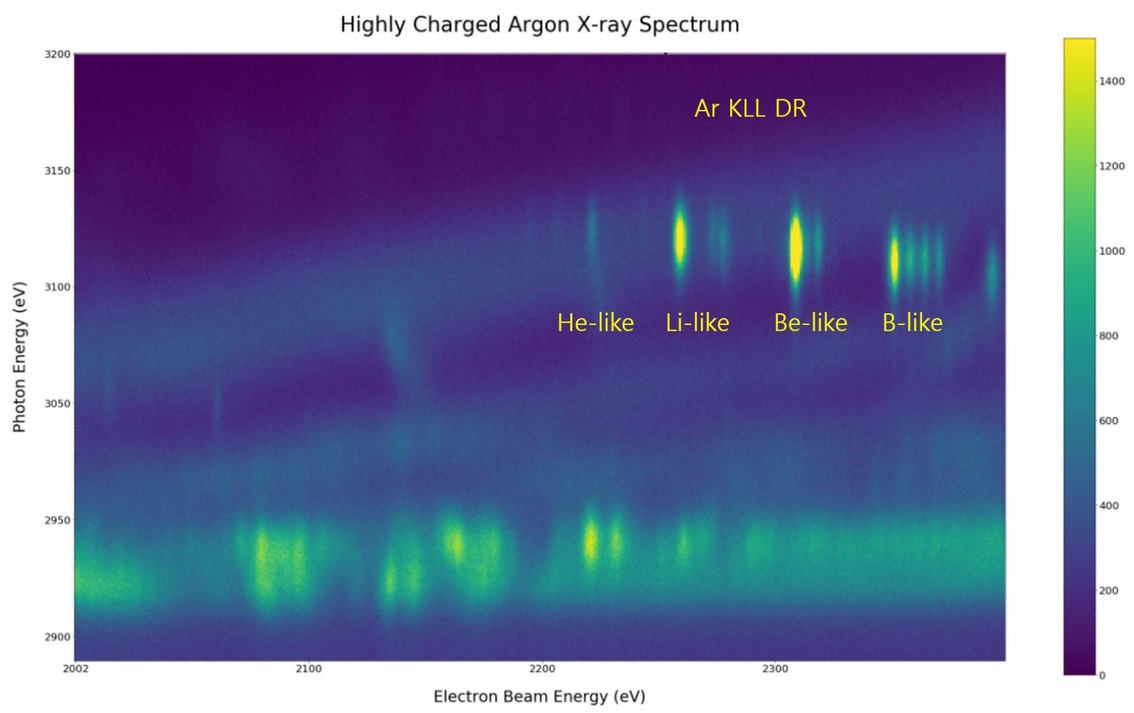


UNIST - EBIT



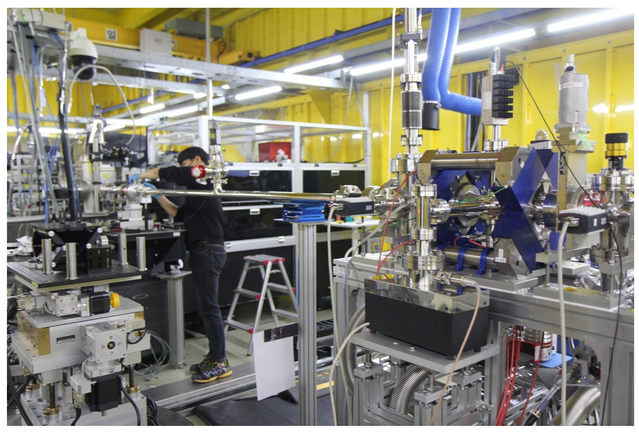

Magnetic Field inside the EBIT

- 72 Permanent Magnets, 0.84T at trap center
- Tunable electron beam energy to 8 keV, current up to 80mA



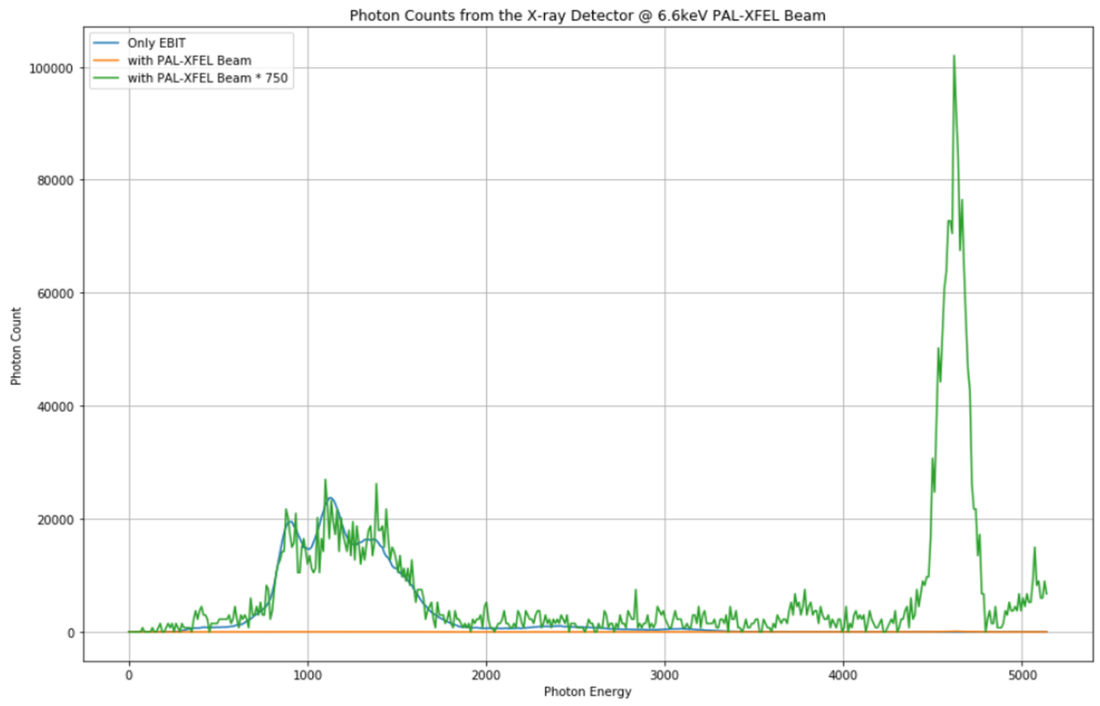

Highly Charged Argon Spectroscopy

## PAL-XFEL Beamtime (Jan 2022)



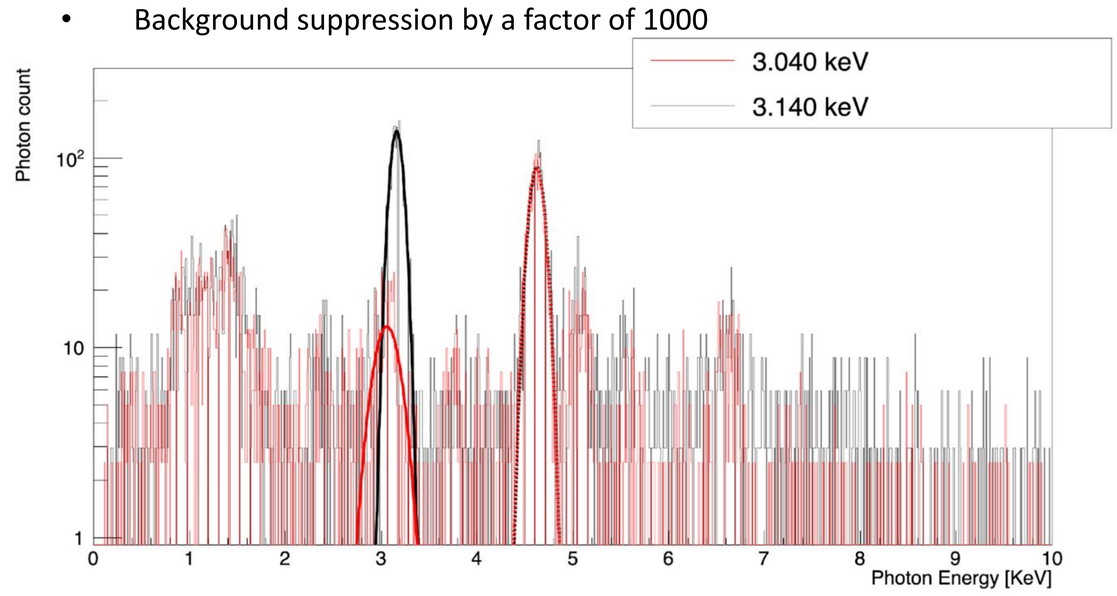
- PAL-XFEL hard X-ray beamline
- R&D beamtime at PAL-XFEL from 2022.01.26 - 2022.01.27

## Result of PAL-XFEL R&D Beamtime




| Case | Without X-FEL | With X-FEL |
|---|---|---|
| X-FEL | X | O |
| Cathode | O | O |
| Trigger | O | O |
| Time Window | $12.6\mu s, 60Hz$ | $12.6\mu s, 60Hz$ |
| Acquisition Time | 1,984.053 | 301.855 |
| Event Count | 7,071 | 18,962 |
| Count Comparison | 0.0594/$12.6\mu s$ time window | 1.047/$12.6\mu s$ time window |
| Difference | (0.988/$12.6\mu s$ time window or 0.988/pulse) count only due to the FEL | |

- Interaction with 60Hz pulsed X-ray at 6.6keV
- Opening the time window for $12.6\mu s$
- Background suppression by a factor of 1000




- Ar fluorescence signal due to the pulsed hard X-ray from the PAL-XFEL.
- Photon energy sweep near 3.1 keV (Acquisition for 180s)

## References

[1] P. Micke et al., Rev. Sci. Instrum. 89, 063109 (2018)

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