



## 2023 HGF – OCPC – Programme

### for the involvement of postdocs in bilateral collaboration projects

**Title of the project:**

Atomic Spectroscopy on Trapped Highly Charged Ions

**Helmholtz Centre and institute:**

GSI Helmholtz Center for Heavy Ion Research GmbH

**Project leader:**

Priv.-Doz. Dr. Wolfgang Quint

**Web-address:**

[https://www.gsi.de/en/work/research/appamml/atomic\\_physics/experimental\\_facilities/hitrap/experiments/artemis.htm](https://www.gsi.de/en/work/research/appamml/atomic_physics/experimental_facilities/hitrap/experiments/artemis.htm)

**Department:** (at the Helmholtz centre or Institute)

Department Atomic, Quantum & Fundamental Physics

**Programme Coordinator** (Email, telephone and telefax)

Dr. Pradeep Ghosh

FAIR/GSI - International Programme for Students and Researchers (INTL)

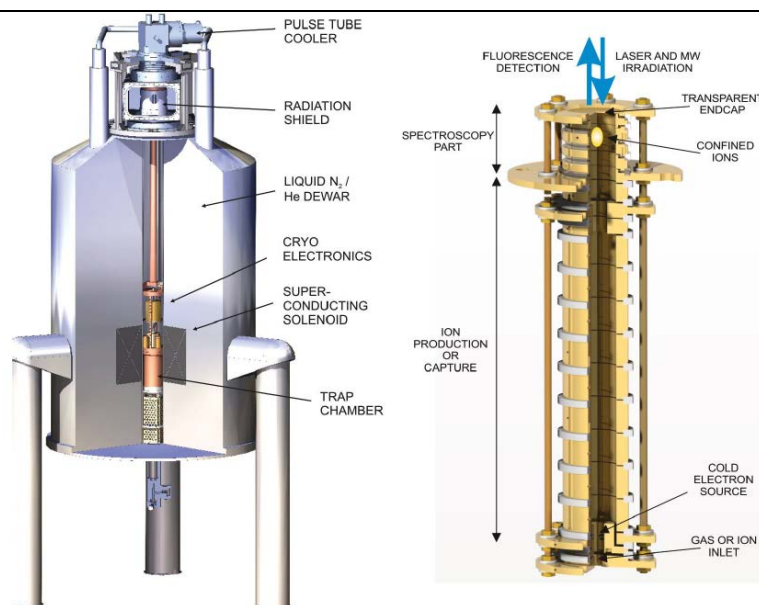
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**Description of the project** (max. 1 page):

ARTEMIS (AsymmetRic Trap for the measurement of Electron Magnetic moments in IonS) is a precision Penning trap experiment to measure the magnetic moments (g-factors) of electrons bound in highly charged ions (HCI) for testing the theory of Quantum Electrodynamics (QED) in strong fields. ARTEMIS aims to use the production capabilities of HCI at the accelerator facility of GSI with its storage rings and HITRAP (Heavy Highly Charged Ion Trap facility). Offline testing and commissioning of the ARTEMIS Penning trap is performed with light and medium-heavy HCI from Electron Beam Ion Trap (EBIT) sources. On its recent meeting in 2022, the General Programme Advisory Committee of GSI has approved beam time for ARTEMIS with ranking **A**, which is scheduled for 2024.



The ARTEMIS Penning trap has cylindrical electrodes with one section for in-trap production or capturing ions and another section for microwave and laser spectroscopy, see figure.

The magnetic field (7 Tesla) is provided by a superconducting magnet. Trapped ions are non-destructively detected with RF resonance circuits by the image currents induced in the trap electrodes. An extreme vacuum pressure of better than  $10^{-15}$  mbar is achieved by cryo-pumping with the trap chamber cooled to liquid helium temperature (4 Kelvin). g-Factor measurements and laser spectroscopy are planned to be performed on boron-like argon ions ( $\text{Ar}^{13+}$ ) from an EBIT ion source and on hydrogen-like bismuth ions ( $\text{Bi}^{82+}$ ) from the HITRAP facility. Theoretical interpretation of the experimental measurements is given by international cooperation with leading theory groups specialized on QED and atomic structure calculations.

The successful candidate for the postdoc position will take over a leading role in the ARTEMIS team which consists of typically 2-3 PhD students, 1-2 bachelor and master students, and 2 senior scientists. He/she will become acquainted with ion trap physics, detector and microwave technology, cryogenics, and laser physics, and can use the infrastructure of GSI, including machine shop, IT department and electronics group.

For further reading:

- S. Sturm, M. Vogel, F. Köhler-Langes, W. Quint, K. Blaum and G. Werth, *High-Precision Measurements of the Bound Electron's Magnetic Moment*, *Atoms* 2017, 5, 4; doi:10.3390/atoms5010004.
- M. S. Ebrahimi et al., *Resistive cooling of highly charged ions in a Penning trap to a fluidlike state*, *Phys. Rev. A* 98, 023423 (2018).

#### **Description of existing or sought Chinese collaboration partner institute (max. half page):**

We are seeking to start a cooperation with the Institute of Modern Physics, Department of Nuclear Science and Technology or Key Laboratory of Nuclear Physics and Ion-beam Application (MOE), both at Fudan University, Shanghai 200433, China.



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These institutes have groups working with low-energy ion beams, EBITs and Penning traps, which fits well into the scientific field of the Atomic Physics department at GSI.

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**Required qualification of the post-doc:**

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- PhD in physics
- Experience with experimental physics
- Additional skills in vacuum technology, computer control, RF electronics
- Language requirement: English