

# Probing ultra-short-lived states in Be-like Carbon at the ESR

## Proposal for 2023 / 2024

R. Klas, J. Rothhardt, G. Weber, P. Gierschke, J. Limpert, T. Stöhlker et al.  
HI-Jena / FSU Jena / IOF Jena

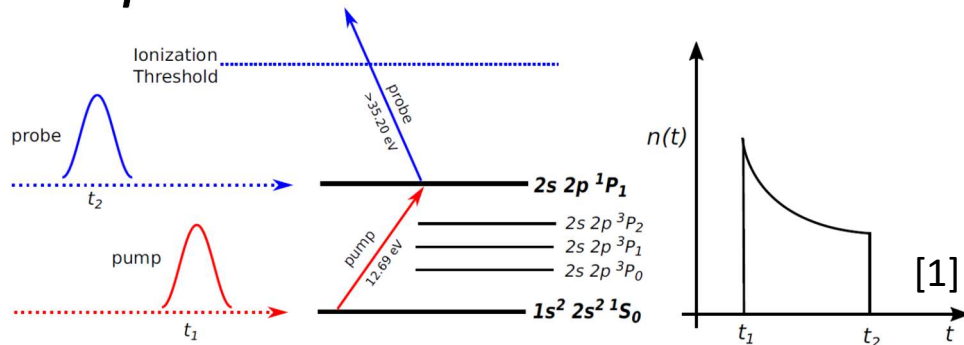
S. Schippers, P.-M. Hillenbrand et al.  
Justus-Liebig-Universität Gießen

U. Spillmann, M. Lestinsky, Z. Andelkovic, A. Bräuning-Demian, F. Herfurth, R. Sánchez, D. Winters, Y. Litvinov, T. Kühl et al.  
GSI Darmstadt

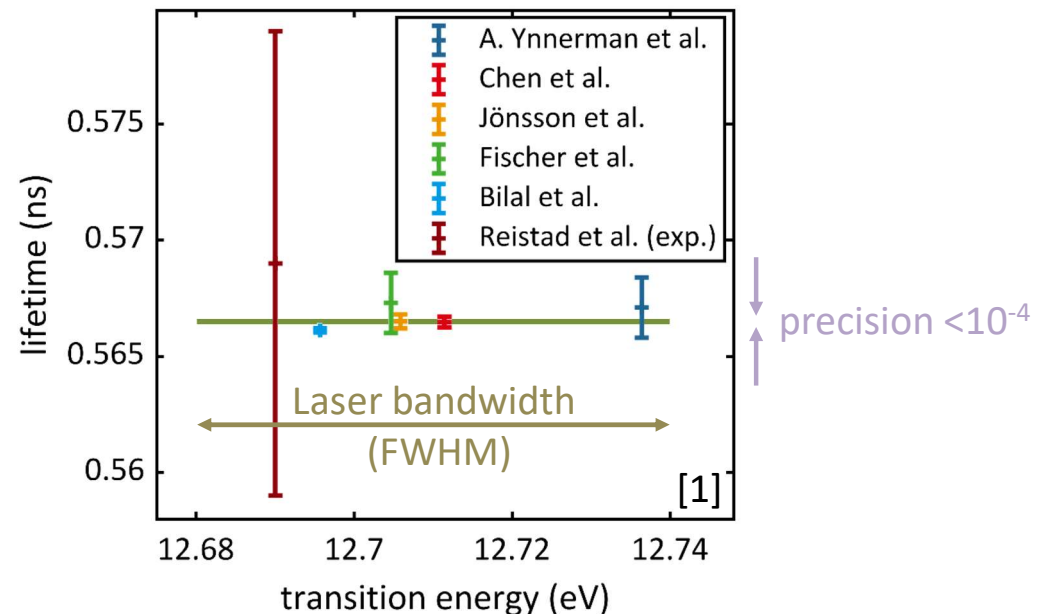
A. Stancalie, V. Stancalie, L. Mihai et al.  
National Institute for Laser, Plasma and Radiation Physics, Department of Lasers, Bucharest

# Lifetime measurements in highly-charged ions

- Lifetime measurements provide sensitive tests of state-of-the-art theories **complementary to precision energy measurements.**
- Theory supports  **$10^{-4}$  precision [1]**, but previous experiments provide only  **$10^{-2}$ .**
- **We want to probe ultrashort lifetimes with  $10^{-4}$  precision**



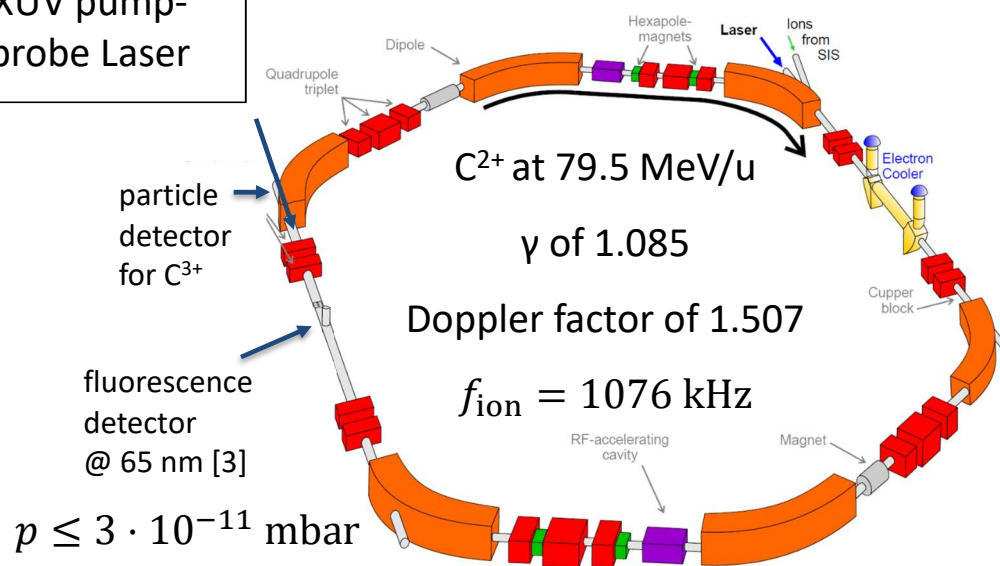
$1s^2 2s 2p \ ^1P_1 - 1s^2 2s^2 \ ^1S_0$   
transition in **Be-like  $C^{2+}$**



# Proposed setup @ ESR

ESR is required to provide sufficient Doppler-shift

XUV pump-probe Laser



First pump-probe experiments on highly charged ions

Key components & know-how are already available in SPARC collaboration

We are experts at:

- XUV Laser [1]
- XUV and ion beam overlap (E129 @ CRYRING)
- UHV coupling unit [2]

We need help with:

- particle detector for  $C^{3+}$  placed inside a magnet
- XUV fluorescence detector @ 65 nm [3]

[1] V. Hilbert et al., AIP Adv. **10**, (2020).

[2] M. Tschernajew et al., Vacuum **178**, (2020).

[3] V. Hannen et al., J. Instrum. **8**, (2013).

J. Rothhardt et al., "Lifetime measurements of ultrashort-lived excited states in Be-like ions," X-Ray Spectrom. **49**, 165–168 (2020).

# Summary

**First femtosecond pump-probe experiment on ultra-fast dynamics in highly charged ions!**

**Requested beamtime in 2024: ~30 shifts at ESR**

Beamtime (shifts)	1-3	4-6	7-9	10-12	13-15	16-18	19-21	22-24	25-27	28-30
Beam overlap	x	x								
Tune ion velocity on pump transition			x	x	x					
optimize ion signal						x				
Perform measurements for various delays							x	x	x	x

**Similar experiments will later be possible at HESR at much higher energies and shorter time scales!**