



SPARC at SIS100

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- **GSI Darmstadt**

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HELMHOLTZ
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- **HZDR, TU Dresden**

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- **TU Darmstadt**

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- **Uni Münster**

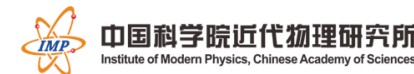
Axel Buß, Volker Hannen, Ken Ueberholz, Johannes Ullmann, Christian Weinheimer, Daniel Winzen



WESTFÄLISCHE
WILHELMS-UNIVERSITÄT
MÜNSTER

- **IMP-CAS, Lanzhou, China**

Dongyang Chen, Zhongkui Huang, Xinwen Ma, Weiqiang Wen, Hanbing Wang

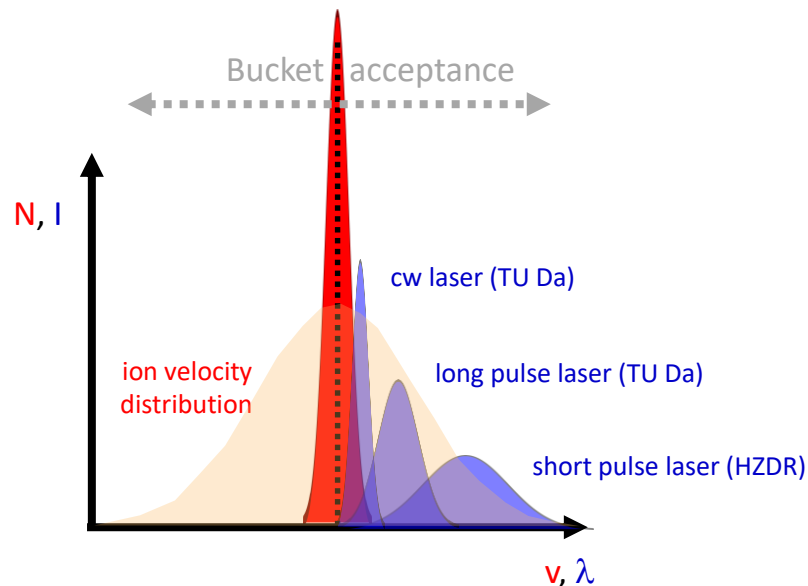


Motivation

- create **worldwide unique** laser cooling facility @ FAIR SIS100
- **first application of laser cooling at a large synchrotron** using novel cw & pulsed laser and detection systems
- possibility to **deliver very cold & very short ion bunches** to FAIR experiments (e.g. plasma physics)
- “efficiency” of laser cooling increases with ion beam energy (γ)
- highly relativistic ion energies of the SIS100 allow **cooling of many ion species** by exploiting the huge Doppler shift (γ up to 13): $Z = 10 - 54$
- laser spectroscopy of the electronic structure of heavy ions



3-beam laser cooling at the SIS100



Using **three** laser systems at the SIS100 simultaneously combines the advantages of:

- covering a large ion velocity range
- suppressing heating effects like IBS
- fast cooling (order of seconds)
- lowest possible longitudinal ion momentum spread $\Delta p/p \sim 10^{-7}$
- shortest ion bunch lengths (order of ~ 10 ns)

But ... requires overlap of ion and laser beams in space, time & energy !

3-beam laser cooling at the SIS100



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Authors of the
Technical Design Report for FAIR:
SPARC laser systems for laser cooling at the FAIR SIS100
of the APPA experiments

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14 June 2021

Approval of Technical Design Report, TDR 3_31

Dear colleagues,

We are happy to inform you that FAIR approves the Technical Design Report for the SPARC laser systems for laser cooling at the FAIR SIS100 for the APPA experiments following the recommendation by the Expert Committee Experiments (ECE) and Experiments Cost Scrutiny Group (ECSG) on 4 June 2021. Please find attached comments by the ECE/ECSG. We expect that you consider all of those seriously and take appropriate steps. Please note that a follow-up process has been implemented, for which we will require your cooperation. It is clearly expected that any future changes, which are likely to affect the work packages significantly, are reported back unsolicited.

Kindest regards,

Inti Lehmann
On behalf of the FAIR Research Management
Facility for Antiproton and Ion Research in Europe GmbH

Enclosed: Report by the committees

FAIR GmbH
Managing Director:
Professor Dr. Fausto Giubellino
Dr. Ulrich Meier
Jörg Blausack
Chair of the Council
Ministerpräsident Dr. Volker Dieter
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(TU Da)

use laser (HZDR)

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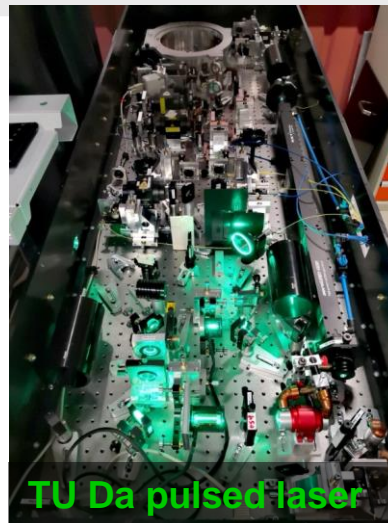
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But ... requires overlap of ion and laser beams in space, time & energy !

3 complementary laser systems → BMBF funding

■ cw laser system (TU Darmstadt):

- frequency-quadrupled diode laser (257 nm)
- narrow linewidth
- large scanning range
- av. power in UV ~1.5 W

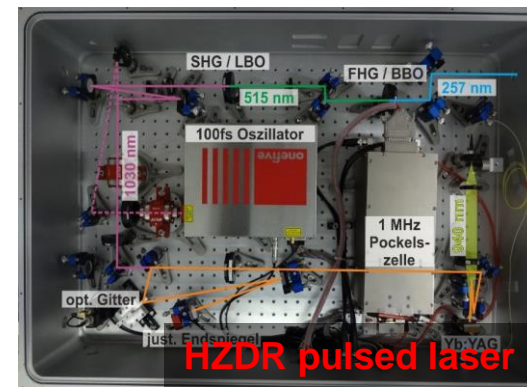


■ pulsed laser system (TU Darmstadt):

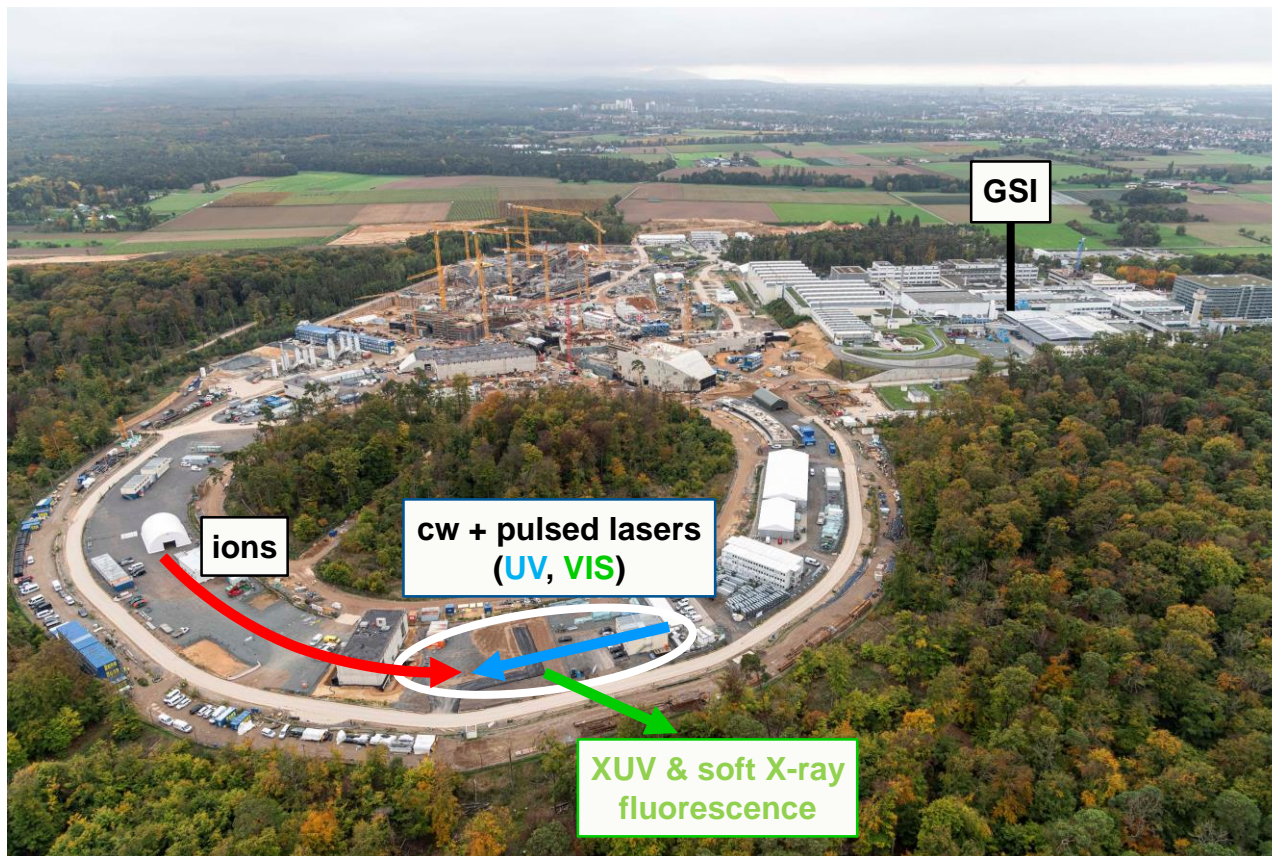
- frequency-quadrupled diode laser (257 nm)
- rep. rate 1-10 MHz
- pulse length 50 – 740 ps
- av. power in UV ~4 W

■ pulsed laser system (HZDR):

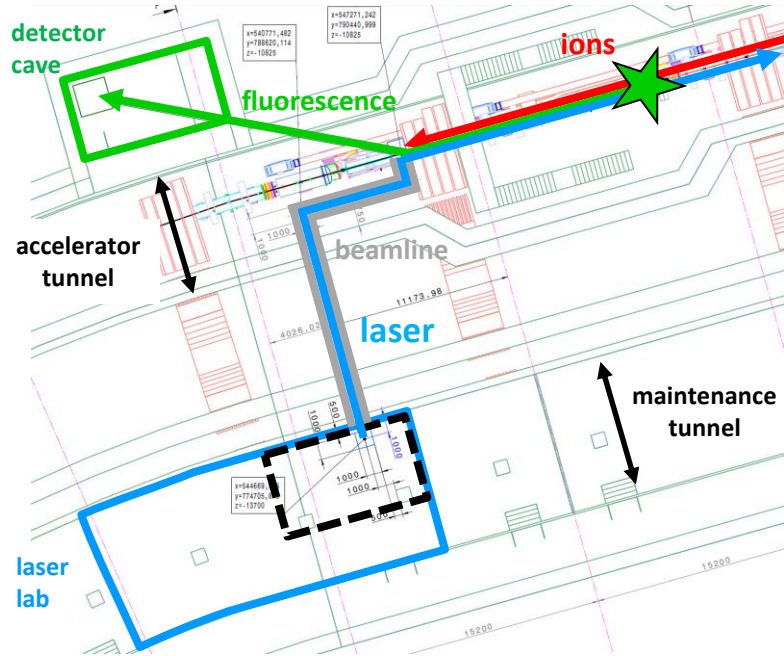
- frequency-quadrupled diode laser (257 nm)
- rep. rate ~5 MHz
- pulse length 1 – 100 ps
- av. power in UV ~2 W



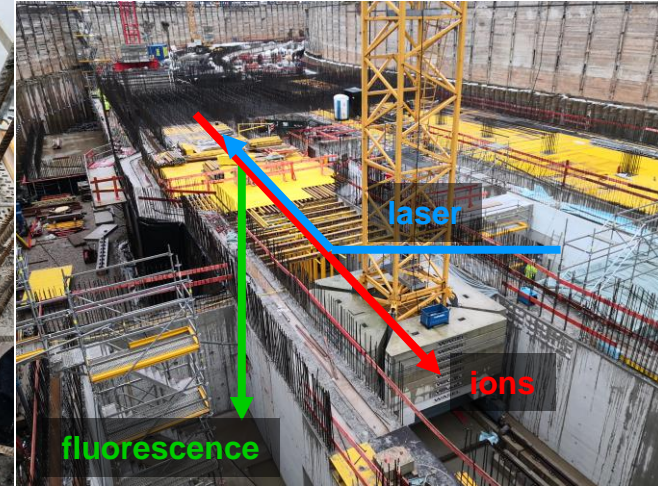
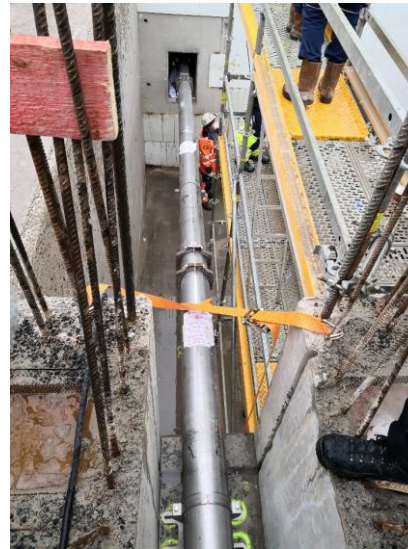
SIS100 laser cooling pilot facility



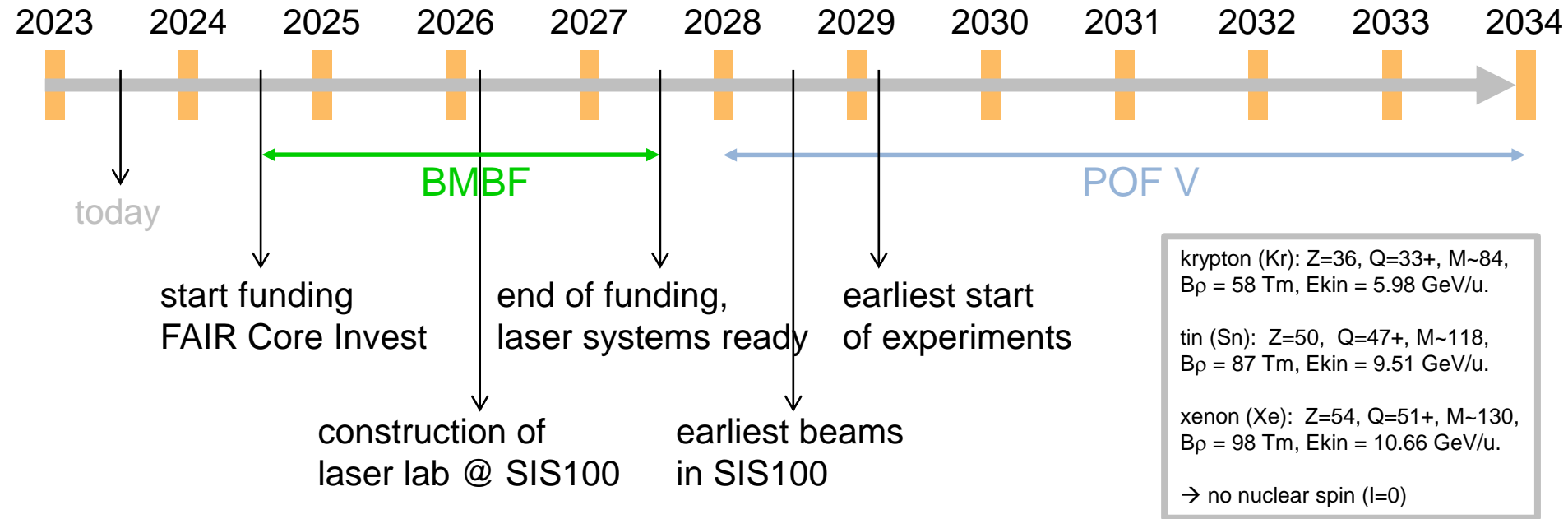
Picture: GSI Helmholtzzentrum für Schwerionenforschung, D. Fehrenz



➤ first FAIR SIS100 accelerator component installed



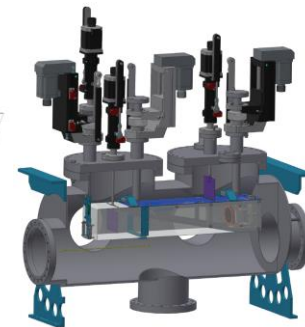
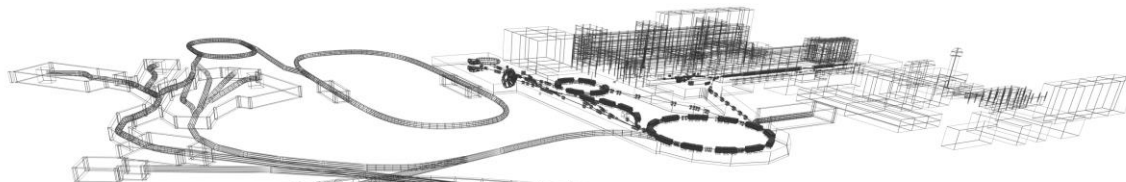
Timeline & milestones



- TU Darmstadt applied for BMBF funding: FAIR Core Invest (235 k€, 2005)
- TU Dresden applied for BMBF funding: FAIR Core Invest (192 k€, 2005)



'laser in' chamber



*XUV / soft X-ray
detector system
→ Uni Münster*

**Thank you
for your
attention!**

detector cave

