



Riccardo Bartolini, DESY

I.FAST 4th Annual Meeting, Krakow, 10.04.2025

Outline

- *Scope of WP7 and Task 7.2*
- *Ultra-low emittance rings network
latest developments
summary of IFAST activities in Task 7.2*
- *Conclusions and future work*

WP7: high brightness accelerators for light sources

- Scope: WP7 pursues the *R&D on new technical solutions for the design and construction of **accelerator-based light sources***, exceeding the performance of present machines. The research embraces both **storage ring based synchrotron light sources** and **free electron laser driven by Linacs**.

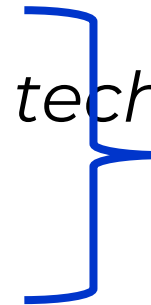
- Supporting **R&D and prototypes** on cutting edge technological aspects,

Magnets (7.3 Y. Papaphilippou)

C-band Guns (7.4 D. Alesini)

dedicated talks

X-band RF cavities (7.5 G. D'Auria)



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Networking in the ultra low emittance rings community

- The WP7 in Task 7.2 will continue to foster and disseminate the latest development in accelerator technology of ultra low emittance rings serving a large and ever growing community in EU and world*

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NETWORKING ACTIVITIES OF THE I.FAST PROJECT IN THE HIGH BRIGHTNESS ACCELERATOR FOR LIGHT SOURCES

A. Mochihashi* on behalf of the I.FAST Task 7.2
Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany

Abstract

The Innovation Fostering in Accelerator Science and Technology (I.FAST) project [1] aims to enhance innovation and networking in the particle accelerator community, mapping out and boosting the development of breakthrough technologies common to multiple accelerator platforms. Task 7.2 of the I.FAST project, Enabling Technologies for Ultra Low Emittance Rings, focuses on networking in the area of low emittance rings dominated by the recent X-ray storage ring upgrades and exploiting synergies with existing and future e^+/e^- colliders. The strengthening networking activities in key technologies ranging from magnet design, RF systems, vacuum, injection systems to feedback systems and beam

important to note that a profound understanding and knowledge of beam dynamics, which includes magnetic lattice and RF system design considering collective instabilities, is essential to achieve the state of an ultra-low emittance beam. To realize ultra-low emittance beams and utilize them for cutting-edge experiments, extensive research and development based on profound understanding and knowledge are necessary. Given the complexity of an accelerator system, which consists of a large number of hardware devices, and networking activities that enable the exchange and sharing of information and knowledge accompanied by technology transfer, are in a high demand for projects on ultra-low emittance rings.

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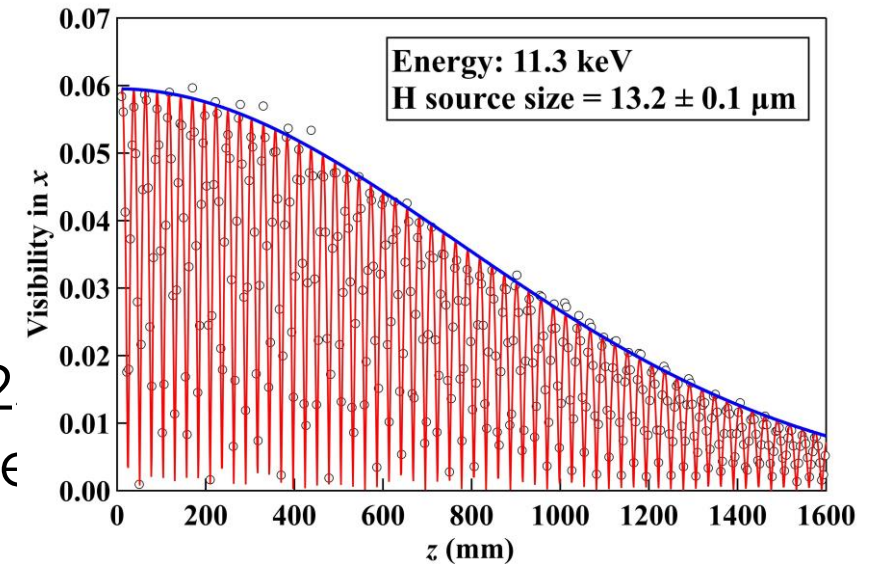
Harvesting successes with the projects launched in the last years

- **APS-U (Argonne, USA)**

First stored beam **April 2024**

Nominal optics August 2024 (42 pm)

Nominal current 200 mA February 2025
working to reach specs in timing mode



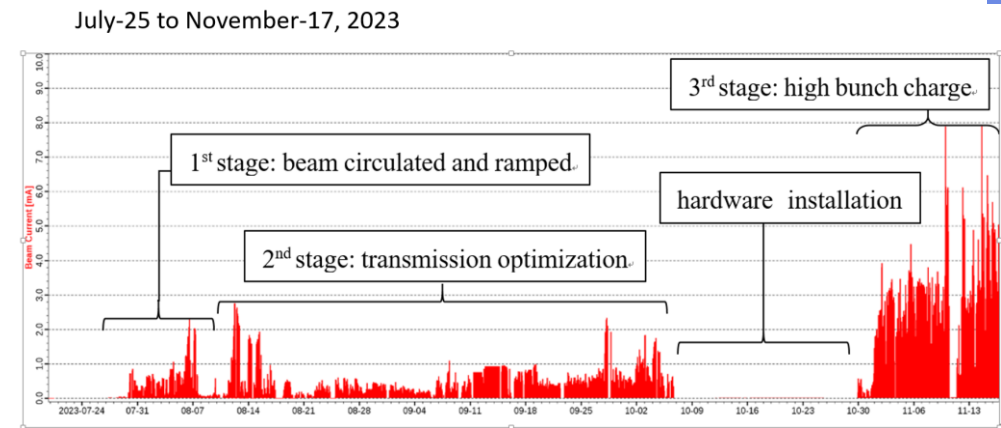
- **HEPS (Beijing, China)**

First turn **August 2024**

emittance larger than expected 75 pm
vs 35 pm

40 mA in December 2024

current limited by RF system installed



Harvesting successes with the projects launched in the last years

- **SLS-II (PSI, Switzerland) see R. Ganter ta**

first stored beam **January 2025**

optics corrected (130 pm)

full current 400 mA April 2025

extensive use of permanent magnets (also for quadrupoles)

reduction of the energy consumption despite increase in operation

energy

(from 24 GWh/year to 17 GWh/year from 2.4 GeV to 2.7 GeV)

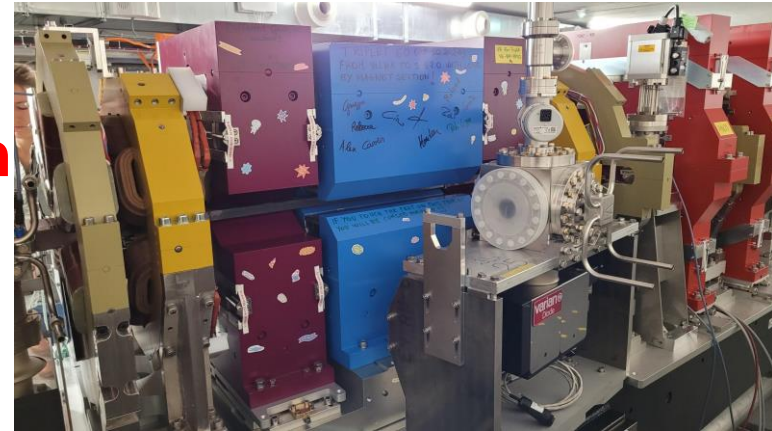
Several other upgrades under construction

- Elettra 2.0 in shutdown **July 2025**

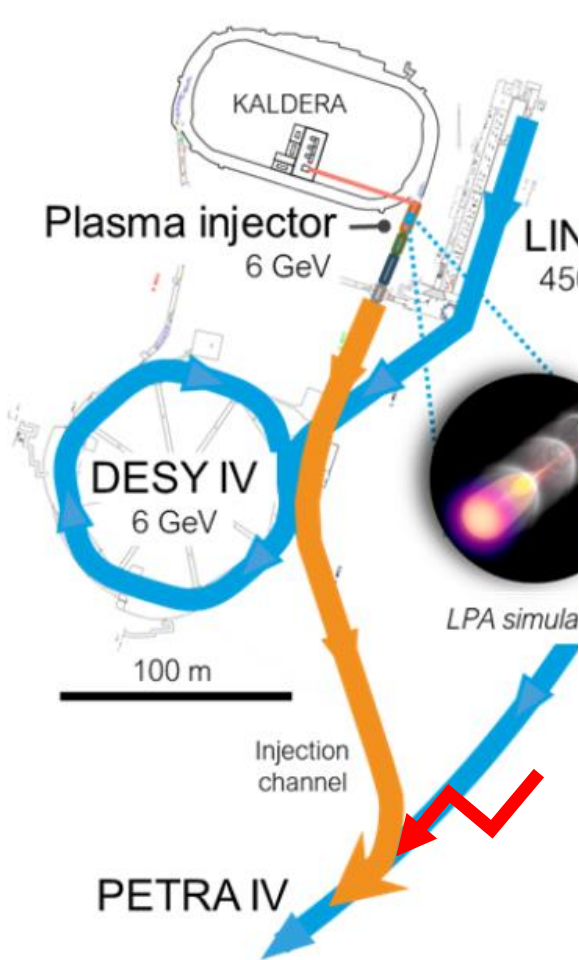
- Diamond II in shutdown **December 2027**

- SPRing8-II (50 pm, 6GeV), SOLEIL-II (83 pm, 2.75 GeV), Korea-4GSR (58 pm, 4 GeV) funded

- PETRA-IV funding expected 2026, ALBA in prototype phase – both in shutdown in 2030



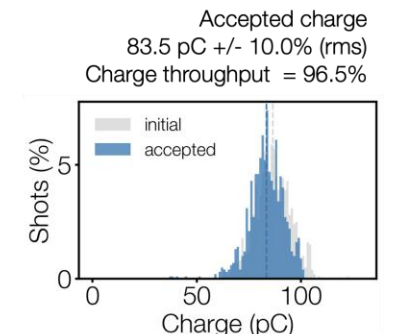
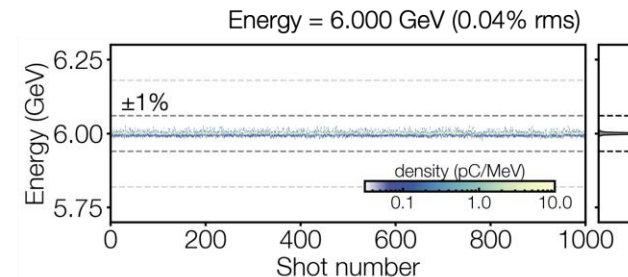
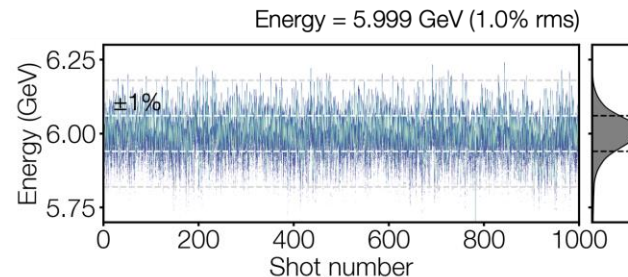
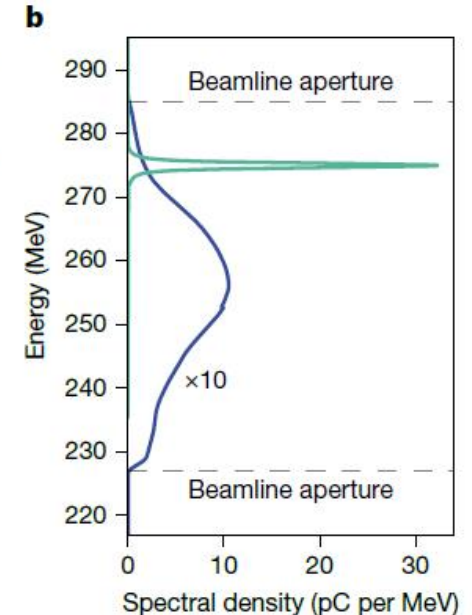
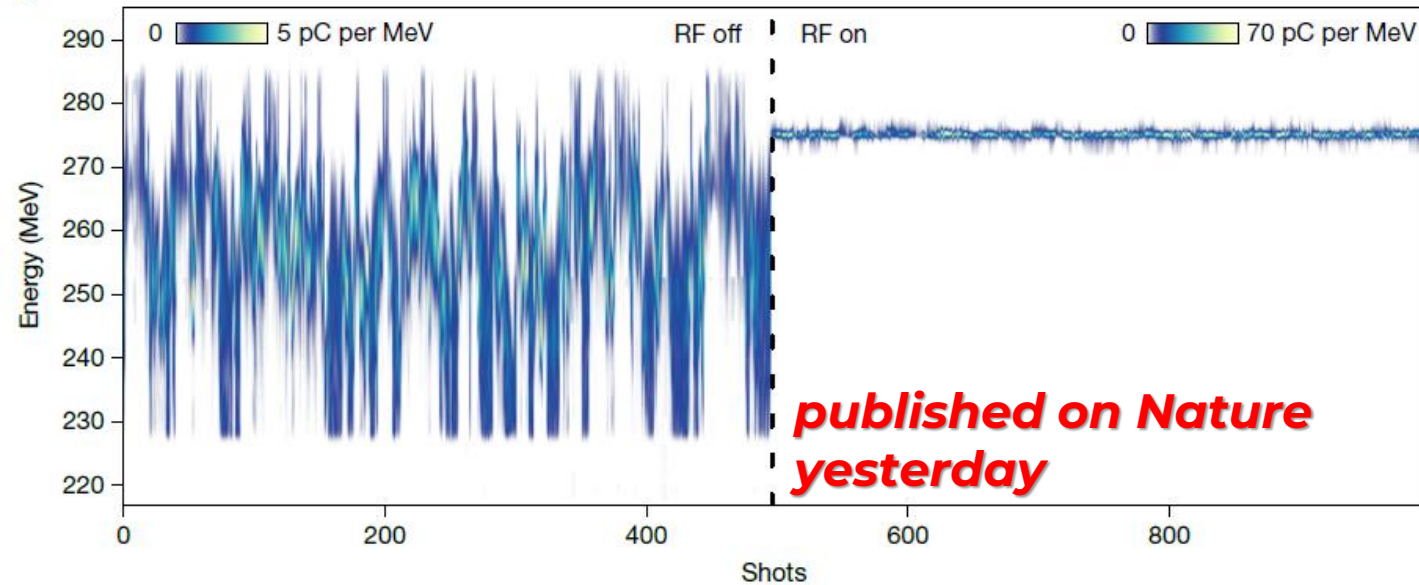
Alternative options for the pre-accelerator: LPA injector



Injector power usage
(during injection)



Building on the strong R&D for the development of LPA at DESY, we propose to build a 6 GeV LPA injector for PETRA IV.



**Simulations courtesy
A. de la Ossa, S. Antipov**

Latest activities in Task 7.2


Activities organized/supported in fourth year:

- 17th-20th September 2024 (PSI, Bern): topical workshop on *Longitudinal Electron beam Dynamics for Coherent Light Sources* (LEDS 2024). <https://indico.psi.ch/event/15973/>
- 17th-19th March 2024 (KIT, Karlsruhe): topical workshop on *Stability of Storage Ring based Light Sources* <https://indico.scc.kit.edu/event/4809/>
- 20th-20st March 2024 (KIT, Karlsruhe): *beam measurements campaign* at KARA to test procedure for Beam-Based Alignment and beam based stability data.

In preparation

- August 2025, (TBC), *10th Low Emittance Ring General Workshop*
- Regular meetings scheduled for Task. 7.2 chaired by A. Mochihashi (KIT)

Workshop on Longitudinal Electron Beam Dynamics for Coherent Light Sources



Workshop on Longitudinal
Electron beam Dynamics for
coherent light Sources 2024
(LEDs 2024)

Sep 17–20, 2024
Bern, Switzerland
Europe/Zurich timezone

Overview
Timetable
Contribution List
Registration
Registration and Payment Information
Participant List
Venue and Travel Information
Lodging Information
PSI Lab Tour
Spam Email Alert
Dinner on Wednesday, September 18th
Contact
thomas.lucas@psi.ch
shawn.bell@psi.ch



Thank you for attending the LEDs workshop 2024

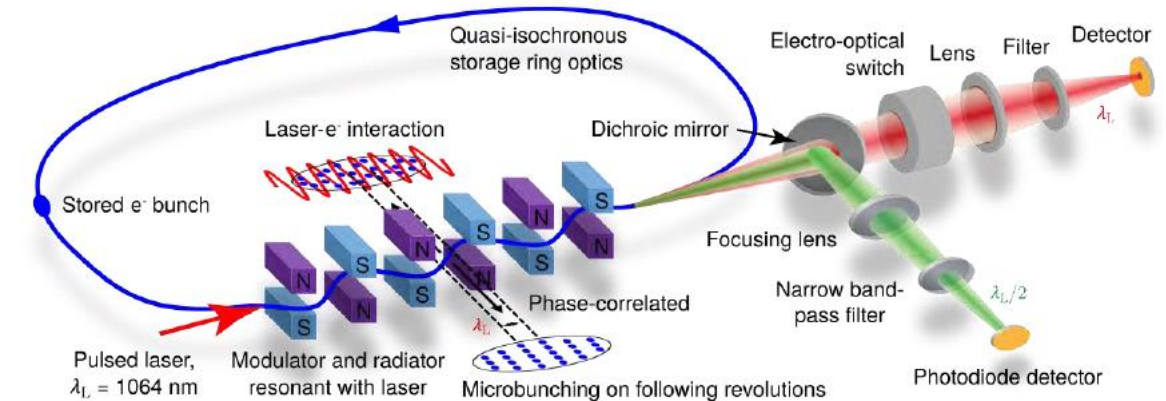
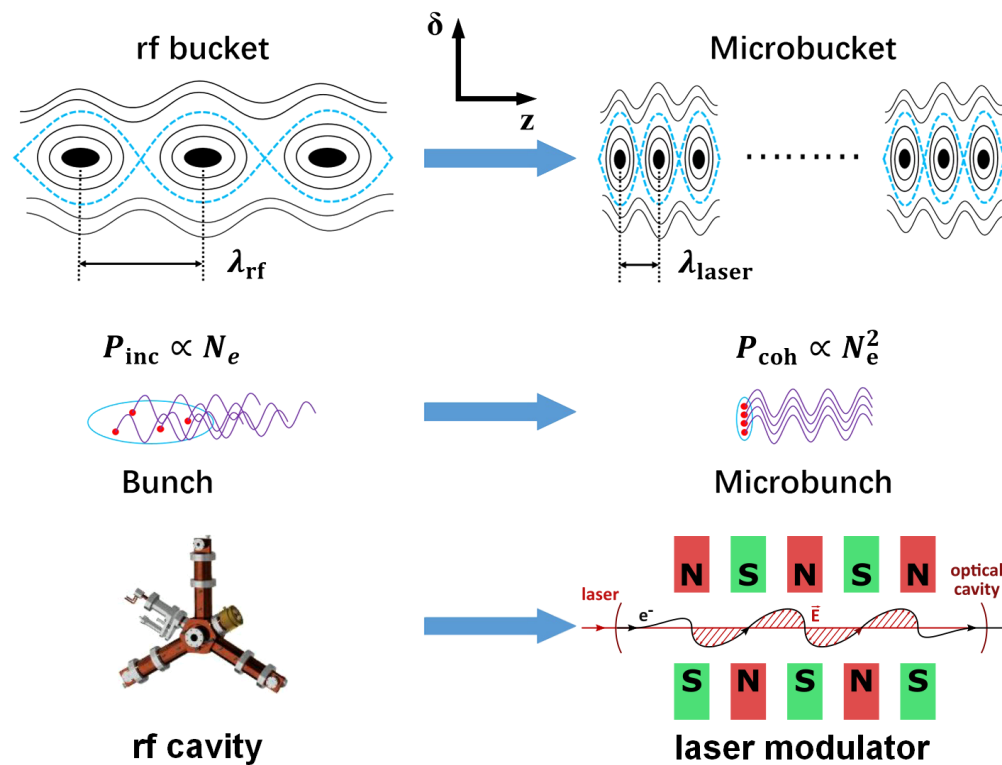
The second annual workshop on Longitudinal Electron beam Dynamics for coherent Sources (LEDs'24) will be run by the **Paul Scherrer Institut** and aims to collect the most recent advancements in high brightness electron machines. This year's event will focus particularly on scattering, instabilities, and other collective effects that impact brightness in FELs and storage rings. The workshop will run from **September 17th to 19th** in **Bern, Switzerland**, and will be a **talk by invitation-only, in-person event**. On the **20th of September**, we will have a visit to PSI. The event is limited to 40 people. We aim for an open exchange of ideas, and we will leave ample time for discourse and discussions. If you would like to participate in the workshop please contact the organisers Thomas Lucas (thomas.lucas@psi.ch) or Simone Di Mitri (simone.dimitri@elettra.eu). We look forward to welcoming you to the city of Bern.

Covering instabilities in high brightness electron beams
both in storage rings and in LINAC/FELS:

IBS, CSR
Steady state microbunching

36 participants
<https://indico.psi.ch/event/15973/>

Steady State MicroBunching (SSMB) as a new operating mode for storage rings



Generate coherent radiation from microbunches in storage rings

- longitudinal focusing at optical wavelengths
- Enhance radiation emission in the <10 nm wavelengths
- Ultra small phase slippage required

Proposed so far with pulsed lasers.

Can theoretically be extended to CW operation.

Workshop on Stability of Storage Ring Based Light Sources at KIT



<https://indico.scc.kit.edu/event/4809/>



- 17-19 March 2025: **Workshop**
- 20-21 March 2025: **Joint Experiment**
- Joint organization with SOLEIL and KIT
- Venue: KIT Campus North
- Session blocks:
 - Source position stability feedbacks
 - Diagnostics (e-BPM and X-BPM)
 - Infrastructure for stability
 - Challenging issues
- Participants:
 - Onsite 52 + Online 34 = **86**
 - Research and industrial areas
 - From Europe, Asia Pacific, America
- Number of talks: **26**

Joint Experiment at KARA

- 20-21 March: Joint experiment (1.5 days) as a EURO-LABS project activity
 - Study on source position stability ([beam-based alignment techniques](#))
 - Stability due to [changing thermal load](#)
 - Workshop participants and I.FASF-WP7 members joined the experiment
 - Systematic measurements ... the data analysis is ongoing, and the data are being shared with the participants



WP7 Task 7.1 and 7.2: milestones and deliverables

D7.1	Final report on the development of high brightness electron beams for light sources	7.1	UOXF	R	PU	48	MS25	General workshop on Task7.2 activity summary	7.2	42	Indico page
D7.2	Report on enabling technology for ultralow emittance ring	7.2	KIT	R	PU	45	MS26	Magnet specifications based on optics calculations for ELETTRA. Magnetic and mechanical design including fabrication drawings	7.3	24	Report
D7.3	Longitudinally variable bend prototype fabrication	7.3	CERN	DEM	PU	40	MS27	Prototype acceptance tests	7.3	46	Report
D7.4	Mechanical realization and low power RF test of the two RF guns	7.4	INFN	DEM	PU	38	MS28	Electromagnetic and mechanical design of the two guns	7.4	24	Report
D7.5	Construction of the XLS accelerating structure pre-prototype.	7.5	ELETTRA-ST	DEM	PU	24	MS29	High-power test stand setup and final results of the high-power tests	7.4	46	Report
D7.6	Construction of the XLS accelerating structure full prototype.	7.5	ELETTRA-ST	DEM	PU	36	MS30	Construction and RF tests of CompactLight accelerating structure prototype	7.5	21	Prototype in operation

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MS25 done, D7.2 done; D7.1 in preparation (April 2025)

Other tasks covered in next talks by Y. Papaphilippou, D. Alesini,
and G. D'Auria

Conclusions and perspectives

Ultra low emittance ring community is very active with several projects

being commissioned (APS-U, HEPS, SLS II)

funded (ELETTRA 2.0, Diamond II, KOREA-4GSR)

in TDR/CDR phase (PETRA IV, SOLEIL-II, ALBA-II, ..)

WP7 Task 7.2 has supported and fostered interactions in the community of ultralow emittance rings in the last 4 years, with about 15 workshops and experimental sessions

Aim to conclude the series of workshops with the:

- 10Th general low emittance ring workshop (location TBD)

before the end of the I-FAST project



iFAST

Thanks A. Mochihaschi (KIT) and Y.
Papaphilippou (CERN)
Thank you for your attention!



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