

Testing with Beams: WP11 report on TNA

5 Accelerator Test Facilities for ARIES TransNational Access

- WP11.1 KARA (ANKA) at KIT: Karlsruhe Research Accelerator,**
a synchrotron storage ring up to 2,5 GeV electron energy
- WP11.2 FLUTE at KIT: Ferninfrarot Linac- und Test-Experiment**
accelerates ultra-short e-bunches 5 to 50 MeV
- WP11.3 IPHI at CEA: Injector of Proton for High Intensity**
accelerates a 100 mA continuous p-beam up to 3 MeV
- WP11.4 ARES at DESY: Accelerator Research Experim. at SINBAD**
accelerates ultra-short e-bunches up to 155 MeV
- WP11.5 VELA at STFC: Versatile Electron Linear Accelerator**
ultra-high-performance injector up to 50 MeV, 250 pC

Robert Ruprecht, Florian Burkart, Anthony Gleeson, Michael Nasse,
Marcel Schuh, Jerome Schwindling et al.






WP11: electron and proton beam testing

Contact: Robert.Ruprecht@kit.edu



ARIES-TNA-Experiments within WP11

TransNational Access: workplan fulfilled & D11.1 delivered

ARIES-TNA WP 11		<i>TA offered in Annex 1 [h]</i>	TA for users [h]	<i>Users planned</i>	Served Users	<i>Projects planned</i>	Projects realized
WP11	all 5 facilities	1788	3700	78	75	19	18
	 KARA (ANKA)	900	2647	22	27	7	7
	 FLUTE	308	456	11	9	3	2
	 IPHI	72	72	8	18	1	3
	 ARES (SINBAD)	210	242	12	5	3	2
	 Science and Technology Facilities Council	288	184	25	16	5	4

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ARIES-TNA-Experiments within WP11

Overview and Boundary Conditions in 5 years ARIES-WP11-TNA:

Corona Virus Covid 19: lock-downs, no travelling in EU, worldwide

- In 2020 to 2022 only remote users, nevertheless
- **KARA, FLUTE, and ARES delivered more TNA hours as offered in Annex 1**
- FLUTE starts operation in P1, ARES (SINBAD) operation in P3, VELA start-up in Q3-2021, IPHI closed ARIES-TNA after 4 years

ARIES-TNA WP 11	TA offered in Annex 1 [h]	TA for users [h]
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Science and
Technology
Facilities Council

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ARIES-TNA-Experiments within WP11

Objectives of TransNational Access are still relevant:

- Some users want to continue or to start new TNA request → EURO-LABS
- Contributions to scientific breakthrough: few examples on following slides
- In ARIES invested resources were used in relation to the achieved progress, and their use respects the principles of economy, efficiency and effectiveness.
- Each ARIES partner invested significantly more own contributions than funded.
- The established “User Selection Panel” reviewed the scientific excellence of the users’ TA application, the accelerator facility management the feasibility.
- The performed experiments made a visible contribution to accelerator research and technology, providing input for applications of future compact, more energy-efficient or novel accelerators in research, medicine and industry.

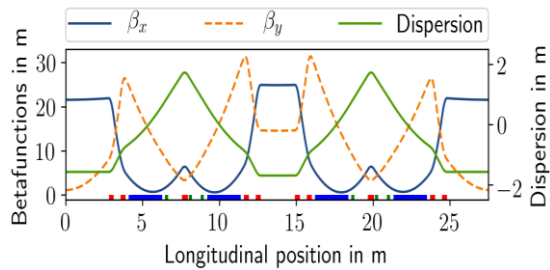


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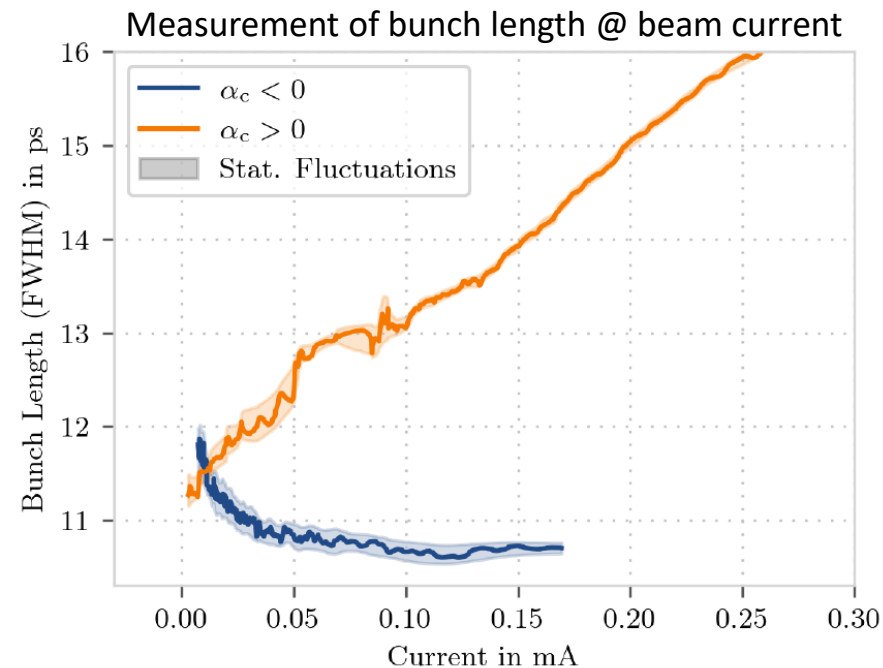
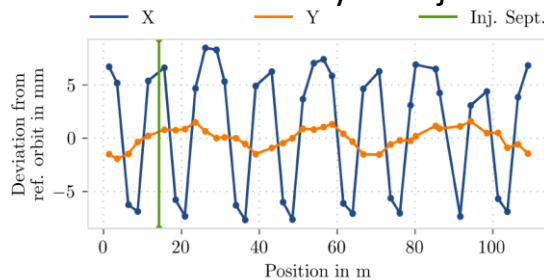
WP11: electron and proton beam testing

Contact: Robert.Ruprecht@kit.edu

- **Beam dynamics studies in the negative momentum compaction factor α_c regime in an e^- storage ring for future high brilliant light sources**
- Joint measurement campaign with SOLEIL and PSI
 - negative alpha optics at 500 MeV
 - Operation with different tunes, chromaticity and alpha



Large orbit deviations necessary for injection



- Collaboration with ARIES

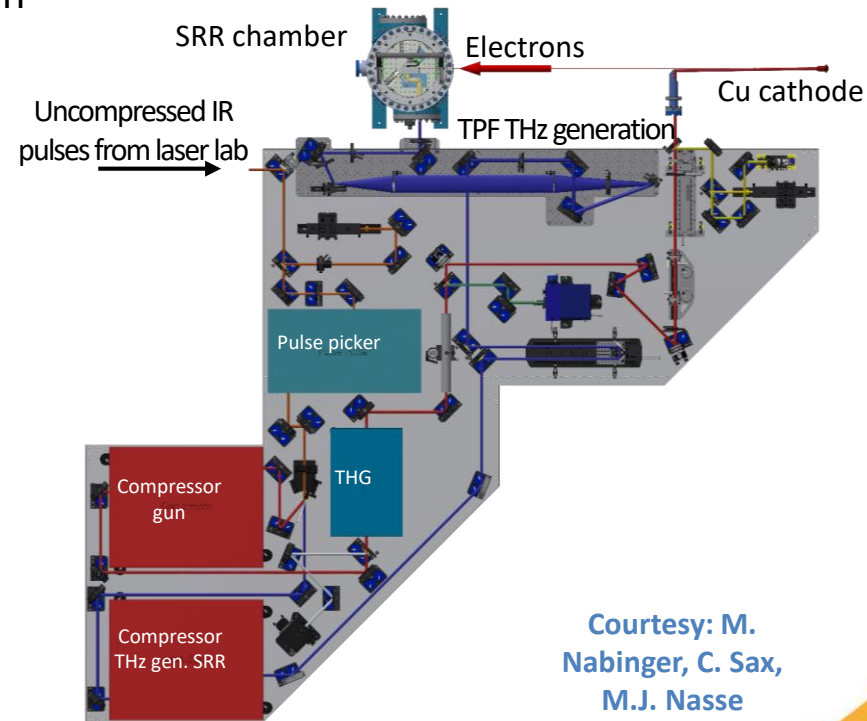
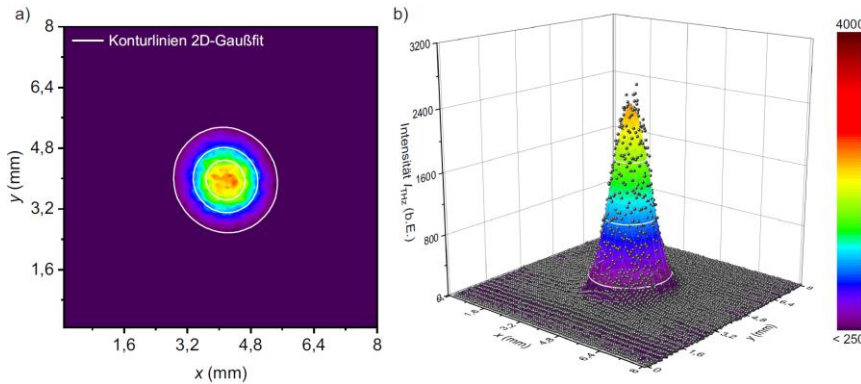
Courtesy:

P. Schreiber, M. Brosi,
A. Papash et al.

Split Ring Resonator experiment

- **Goal:** single shot longitudinal diagnostics based on THz-driven streaking using a SRR amplifier
- International collaboration with the University of Bern and PSI, CH

- Many experiment done



Done: control transversal and longitudinal laser beam shape with spatial light modulators [6]



Courtesy: M. Nabinger, C. Sax, M.J. Nasse

[1] J. Fabiańska et. al., *Sci. Rep.* 4, 5645 (2014)
 [3] M. Yan et al, *IPAC 2018, WEPAL029* (2018)
 [5] M. Nabinger, master thesis KIT (2021)

[2] V. Schlott et al, *IBIC 2017, TUPCC16* (2017)
 [4] M.J.Nasse et al., *IPAC2019, MOPTS018* (2019)
 [6] C. Sax, master thesis KIT (2021)

- Tests of neutron production using Beryllium targets in view of the French compact neutron source project SONATE
- 1st version of the target operated during ~ 100 hours at ~ 3.5 kW (500 W/cm²)
- A 50 kW version was developed and tested in 2021 with success



Beryllium target + cooling inside
½ moderator + shielding

Work financed by a grant from
the Ile – de – France region

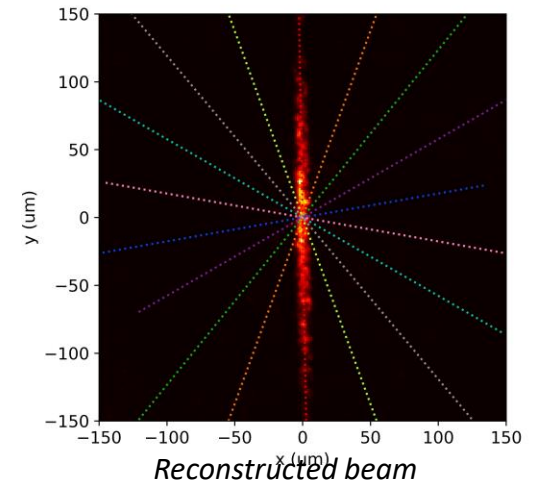
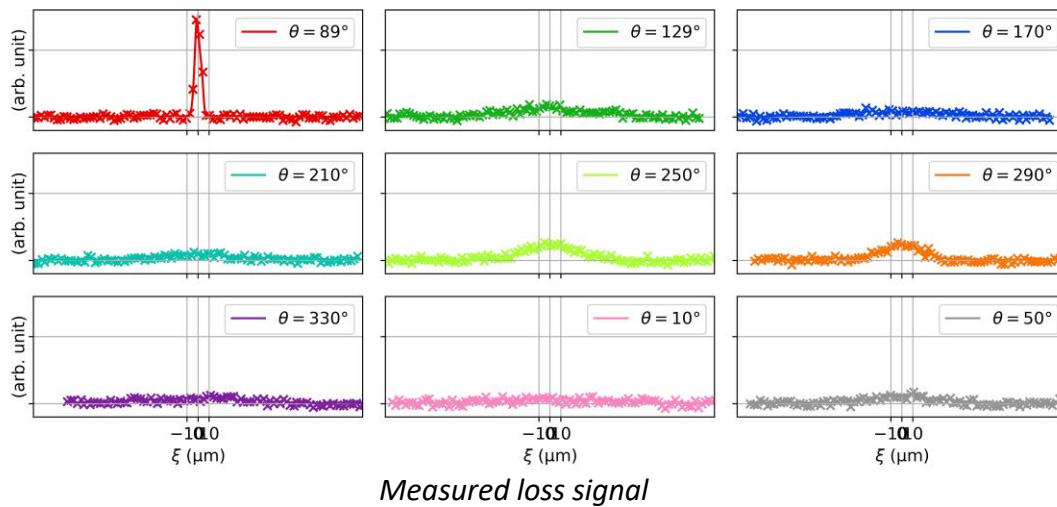


Accelerator IHPI: 3 MeV protons

ARIES-TNA-WP11.4 ARES, DESY



- PSI wire scanner tests to **characterize electron bunches with micron precision**



*“Successful test of the wire scanner at ARES and successful characterization of the electron bunch for both a 2D and 4D scan with extremely **high resolution.**”*



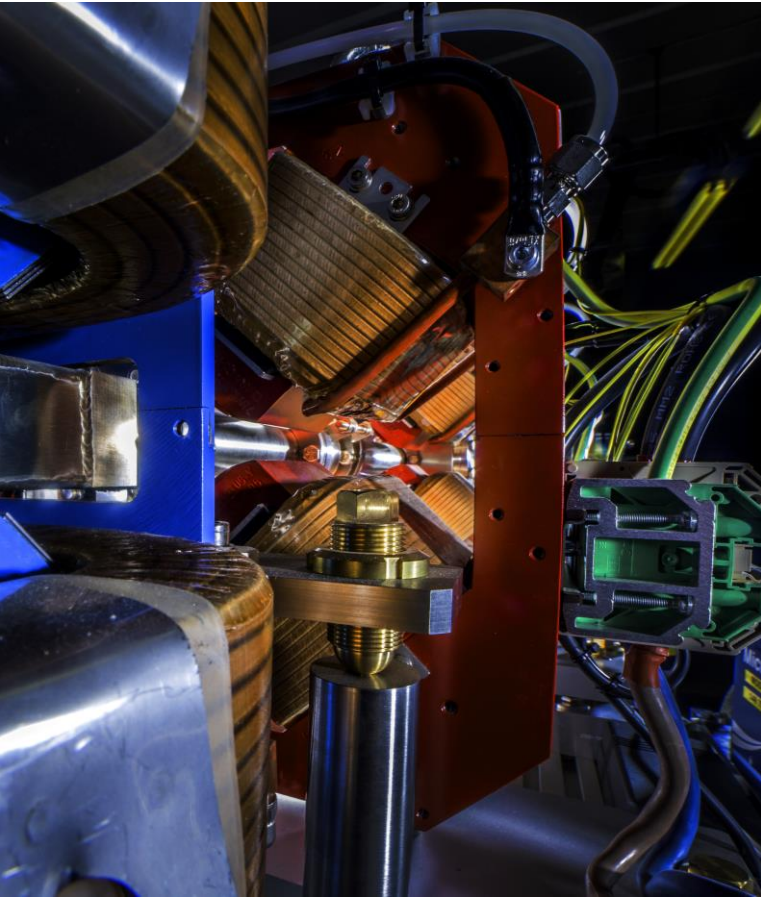
Wirescanner with 1 micron thick gold wires. Installed in the ARES UHV experimental chamber

Courtesy:
F. Burkart



ARIES-TNA-Experiments within WP11.5

VELA: Status



- successful delivery of TNA e.g.
- for DESY (Knetsch *et al.*) following-up on their previous work on **plasma afterglow metrology** and
- for PSI (Frojdth *et al.*) evaluating the **Jungfrau hybrid pixel detector for electron diffraction at MeV energies.**

ARIES-TNA-WP11.4 ARES, DESY

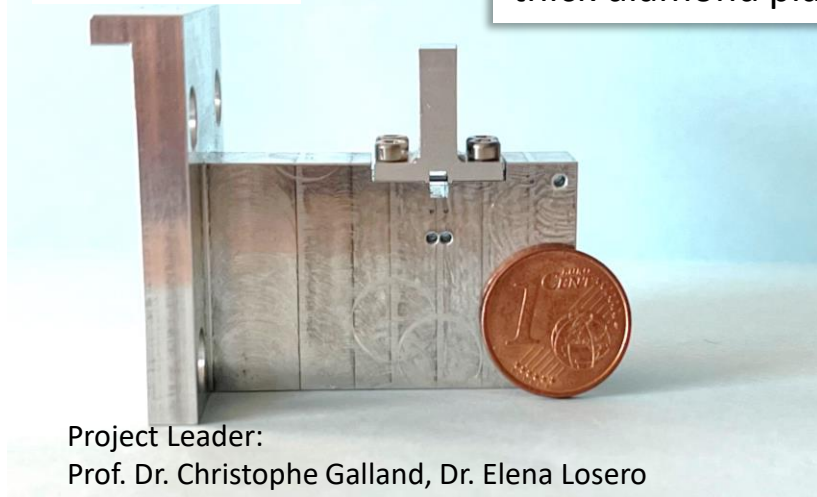


- High energy & high dose irradiation of diamond samples

**beam irradiation finished,
analysis ongoing**

EPFL

3 mm x 3 mm x 0.3 mm
thick diamond plate



Project Leader:
Prof. Dr. Christophe Galland, Dr. Elena Losero

Exploring the physics of high energy electron irradiation of diamond for **increasing the yield of nitrogen vacancy (NV) center creation**, with potential benefits for quantum sensing.

Courtesy:
F. Burkart



On the sustainability of ARIES – WP11 - TNA

TNA will be continued within Horizon Europe EURO-LABS: upgrades

- ARIES offered TNA for medium-term applications for medicine and industry, TNA procedures & structures (USP) proved their worth.
- KARA as accelerator test facility and storage ring of the KIT light source have got power supplies with improved stability in 2022.
- FLUTE is getting a new RF photoinjector and new RF units until autumn 2022 to improve beam stability and reduce dark current.
- VELA/CLARA facility undergo further developments to complete CLARA Phase 2, including commissioning of the 250 MeV Full Energy Beam for Exploitation (FEBE) facility.
- User meetings will be held at Daresbury Laboratory and KIT to provide information on forthcoming machine updates and schedules to motivate & prepare TNA request within EURO-LABS.

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TNA will be continued within Horizon Europe EURO-LABS: upgrades

- ARIES offered TNA for medium-term applications for medicine and industry, TNA procedures & structures (USP) proved their worth.

- KARASOURCE

May thanks to task leaders and WP11 members for excellent contribution.

- FLUTAUTUM

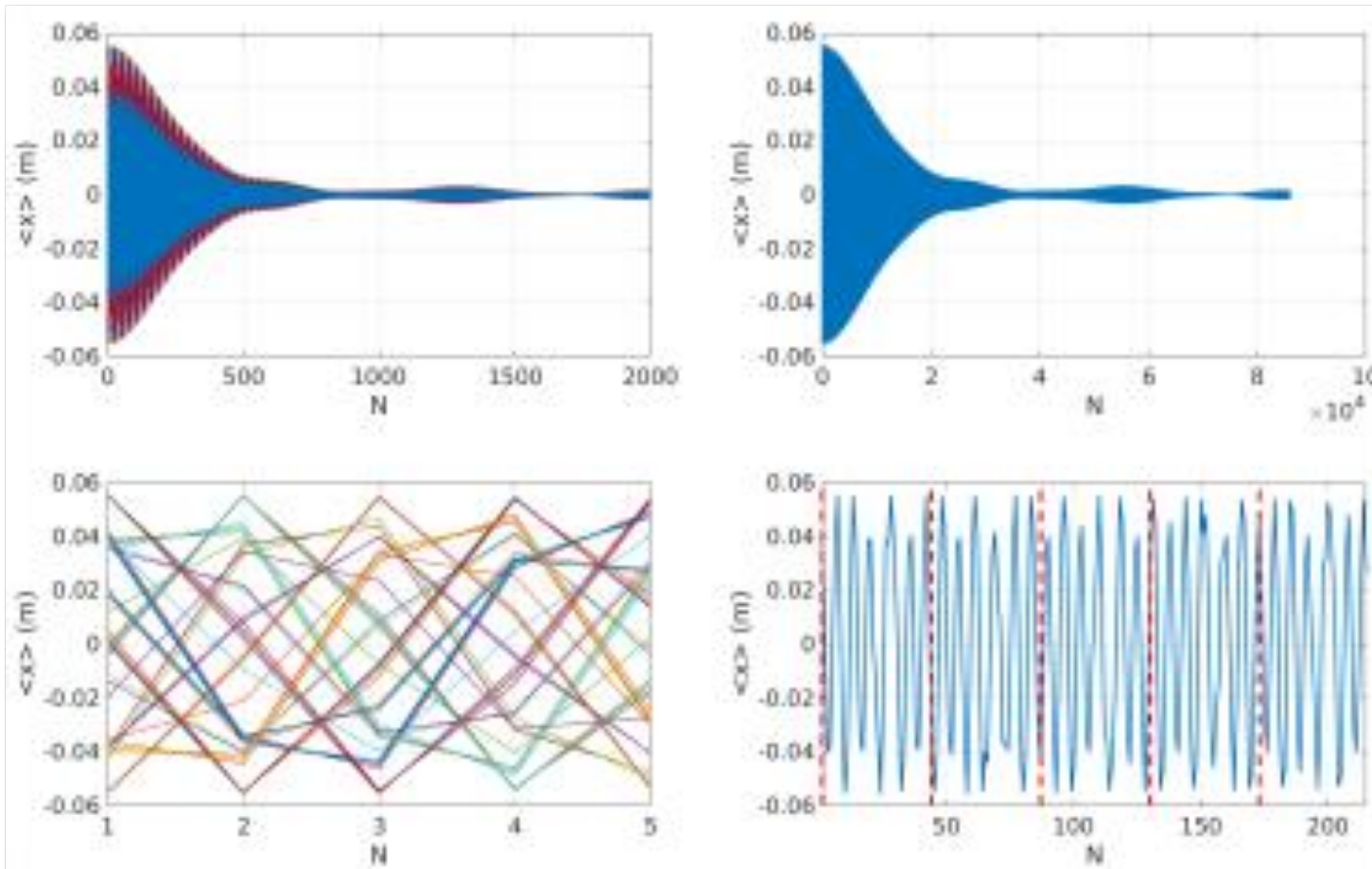
- VELARCLAR Energy

Many warm thanks to Maurizio, Valerie, Svetlomidir, Sabrina and the CERN team for their support, help and patience!

- User meetings will be held at Daresbury Laboratory and KIT to provide information on forthcoming machine updates and schedules to motivate & prepare TNA request within EURO-LABS.

ARIES-TNA-WP11 backup slides

- Optics characterisation at KARA including the **high wiggler field**

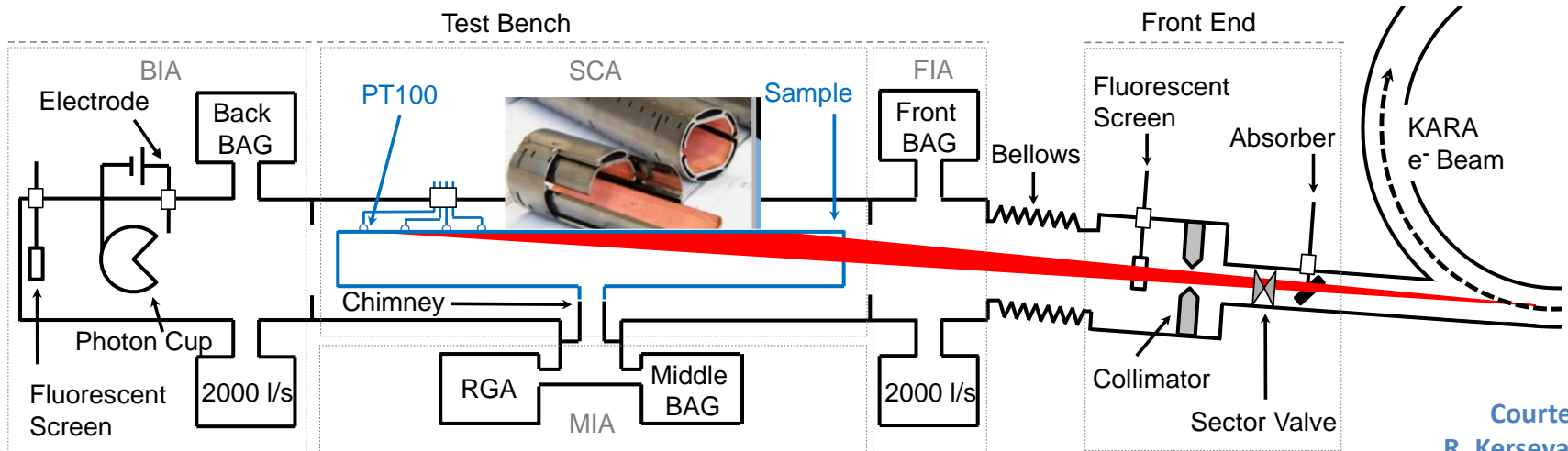


- Tune and chromaticity measurements based on turn by turn orbit data using NAFF
- Presented at the 1st ARIES Annual Meeting by P. Zisopoulos

NAFF = Numerical Analysis of Fundamental Frequencies allows a fast convergence to the tunes in the order of $1/N^4$

P. Zisopoulos et al., https://indico.cern.ch/event/699219/contributions/2929063/attachments/1654466/2647866/ARIES18_Zisopoulos.pdf

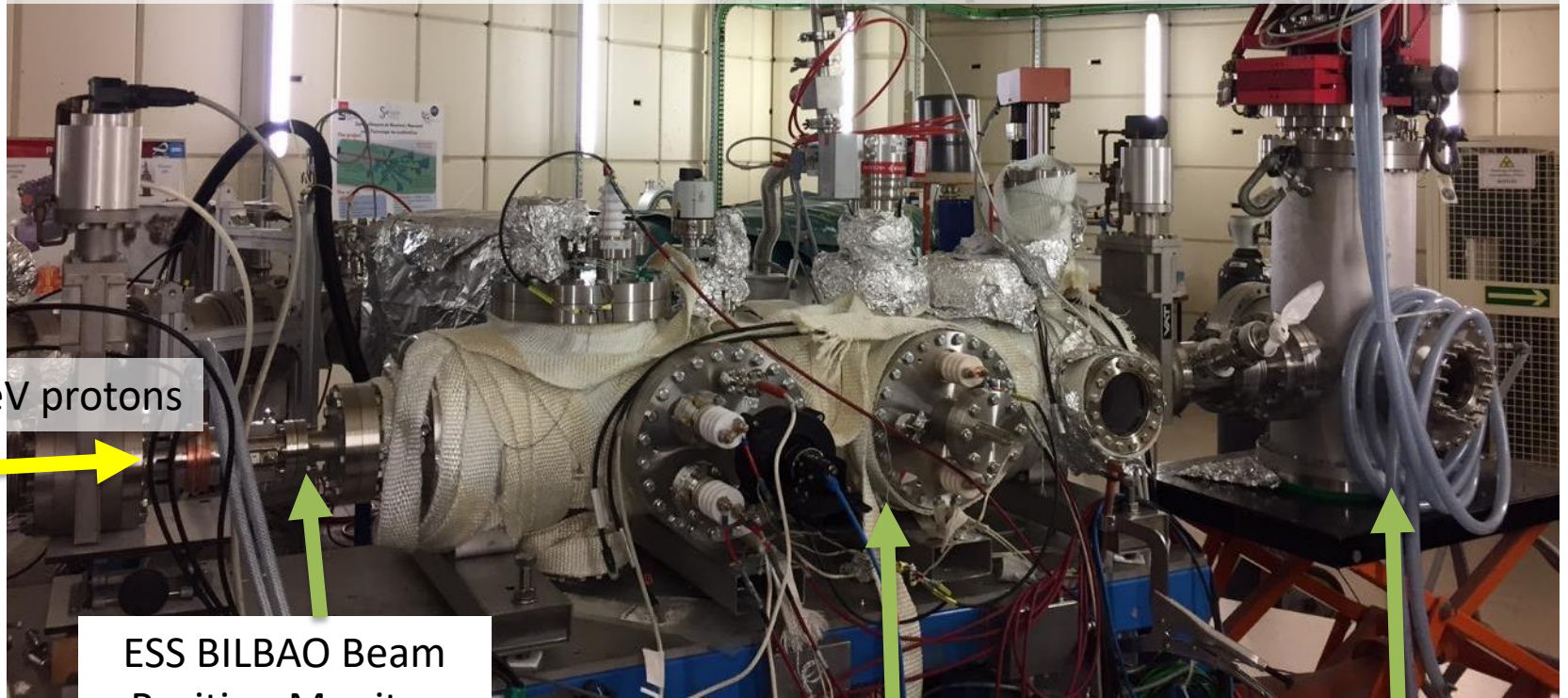
- **BESTEX at KARA**
 - **FCC-hh Beam Screen prototypes** including the baseline design tested at CERN's BESTEX beamline at KARA
 - test under cryogenic conditions (liquid Nitrogen cooling)



Courtesy:
R. Kersevan et al.

ARIES-WP11.3 IHPI, CEA

- The accelerator IPHI was running during 4 weeks in September – October 2018 to accommodate experiments including tests of the **BPM + electronics from Bilbao + ESS (TNA)**



3 MeV protons

ESS BILBAO Beam
Position Monitor

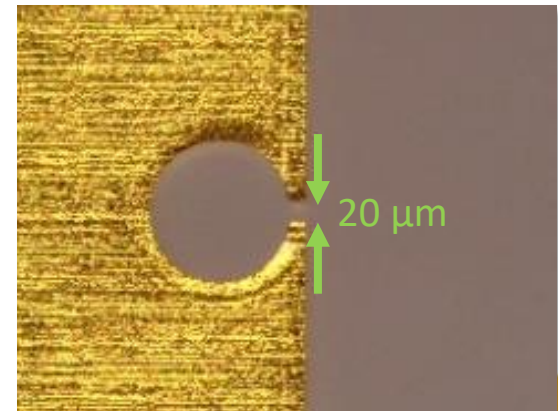
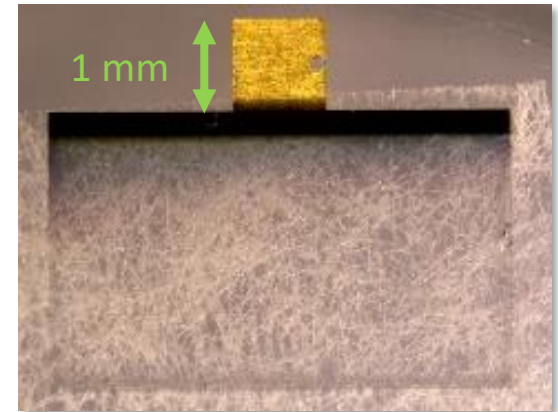
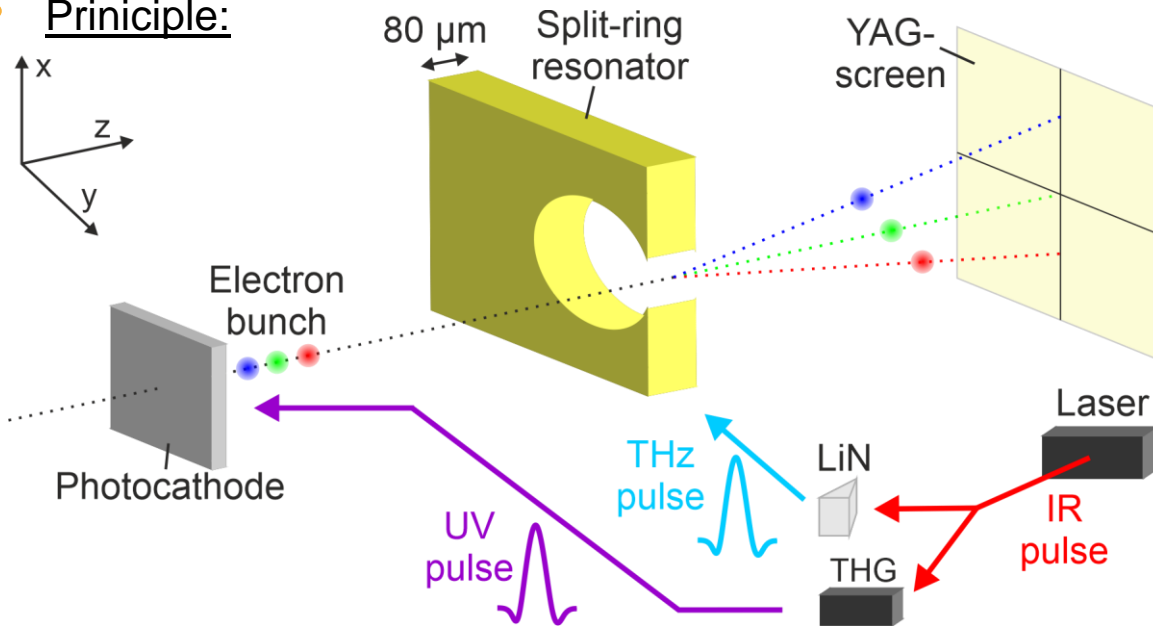
Profile monitors for
ESS

Emittance meter for
MYRTE / MYRRHA



Split Ring Resonator (SRR) experiment

- Goal: single shot longitudinal diagnostics based on THz-driven streaking using a SRR amplifier
- International collaboration with the University of Bern and PSI
- Principle:



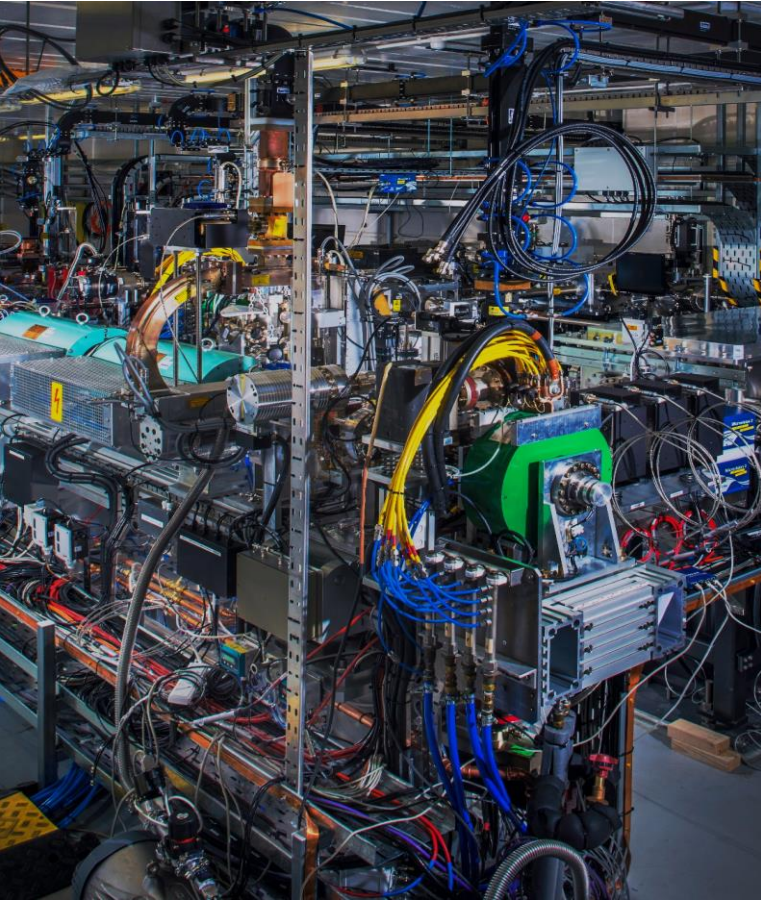
Courtesy M. Nabinger

Photos M.J. Nasse

TNA [h]	P3	overall
FLUTE	320	456

ARIES-TNA-Experiments within WP11.5

VELA: Status



- The VELA/CLARA facility will now undergo further developments to complete CLARA Phase 2, including commissioning of the 250 MeV Full Energy Beam for Exploitation (FEBE) facility
- The next round of beam exploitation is anticipated in 2024, with the intention to offer TNA access to VELA/CLARA under the Horizon Europe EURO-LABS project.

TNA [h]	P3	overall
VELA	104	184