WP11: electron and proton beam testing

ARIES annual meeting, BUDAPEST 08 - 11 April 2019

J. Schwindling / CEA Paris - Saclay

Thanks to R. Ruprecht (KIT), U. Dorda (DESY), A. Gleeson (STFC)

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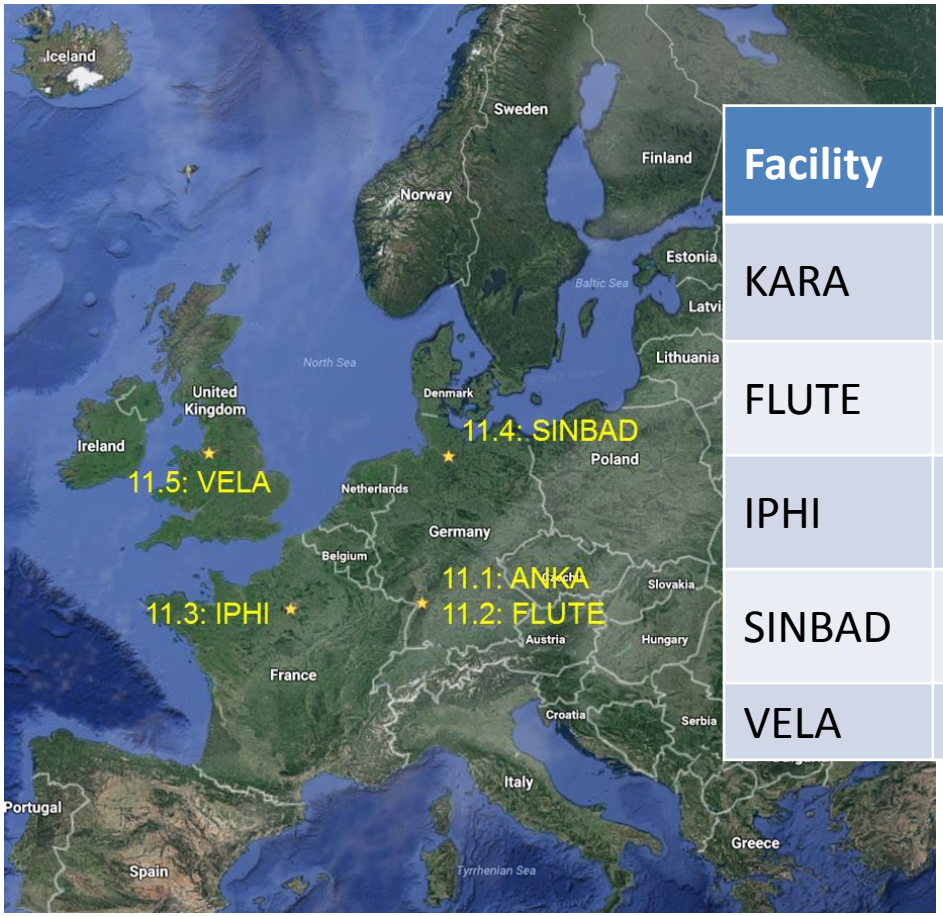
Facilities in WP11



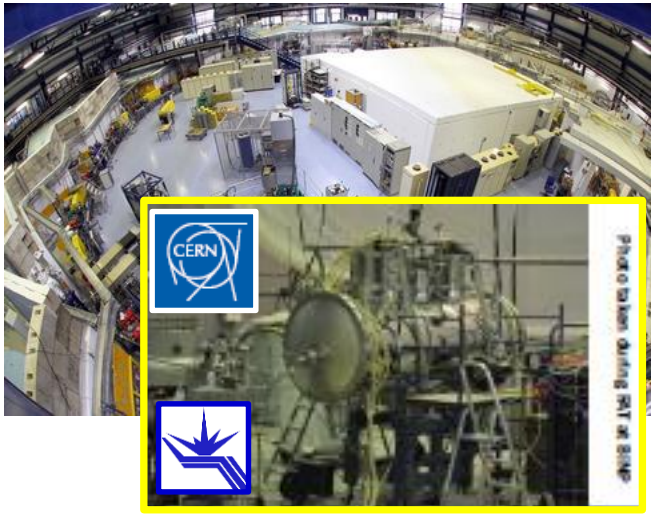
Facility	Part	(Foreseen) characteristics
KARA	e	0.5 – 2.5 GeV, bunch length 50 down to few ps
FLUTE	e	41 MeV, 1 → 300 fs, 10 Hz
IPHI	p	3 MeV, peak current ~ 60 mA, 5% dc
SINBAD	e	100 MeV, few fs, < 50 Hz
VELA	e	6 MeV → 40 MeV, 10 → 100 Hz

- All facilities now running but SINBAD (first beams Spring 2019)

KARA:TNA in the storage ring KARA at KIT

Karlsruhe Institute of Technology

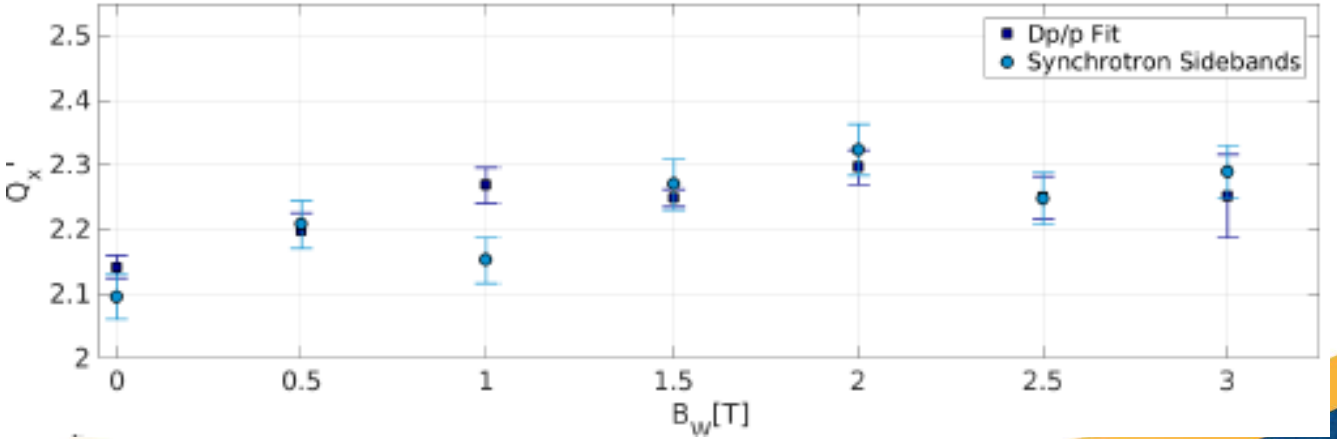
- 3 TNA finished + 1 ongoing + 1 in review
- 1st Example of TNA:



Turn-by-turn measurement benchmarking at KARA with the CLIC sc wiggler prototype

Measurement of tune and chromaticity of the electron beam during switching on / off the wiggler agree with the calculation using the NAFF code

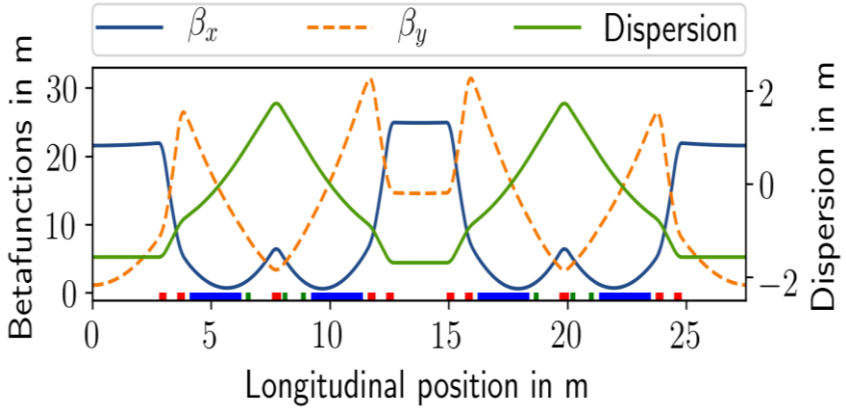
- NAFF = Numerical Analysis of Fundamental Frequencies algorithm or variants of this code, a quasi-periodic approximation



ARIES WP7 uses storage ring KARA

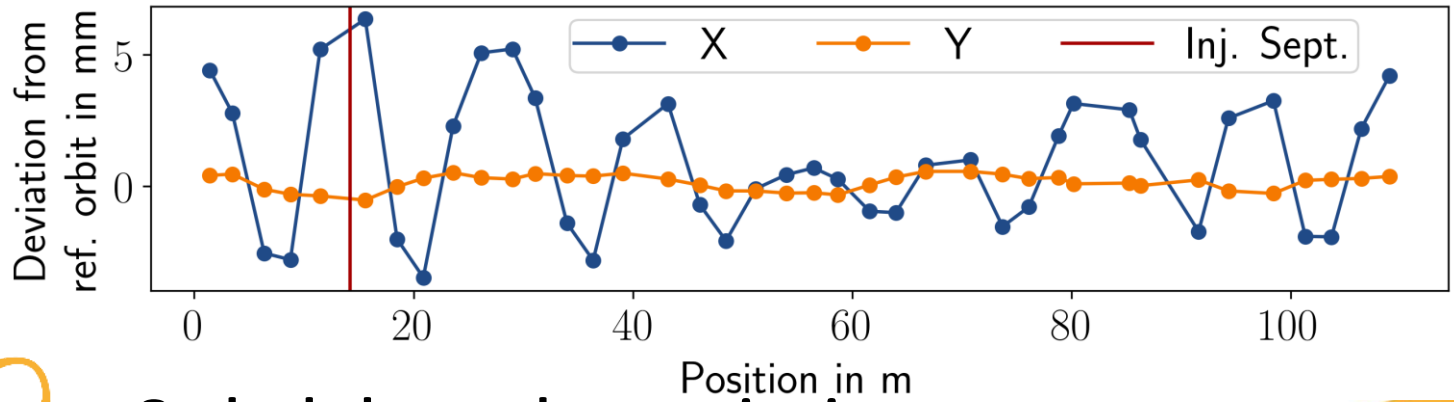
- Ongoing TNA together with WP 7:

Beam dynamics studies in negative momentum compaction factor regime i an electron storage ring: first results:



✓ **Injection into negative alpha optics at 500 MeV (up to 6.8 mA)**
✓ **Operation with different tunes, chromaticity and alpha**
✓ **<u>Measured</u> injection orbit at negative alpha condition**

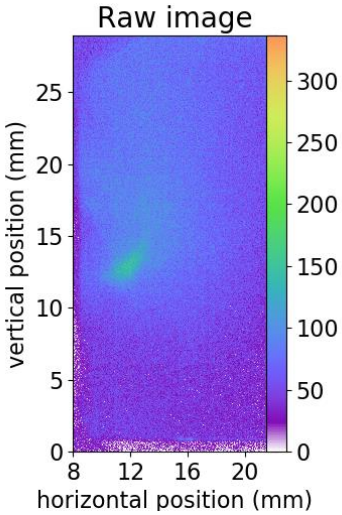
It seems injection bump needed due to septum stray field

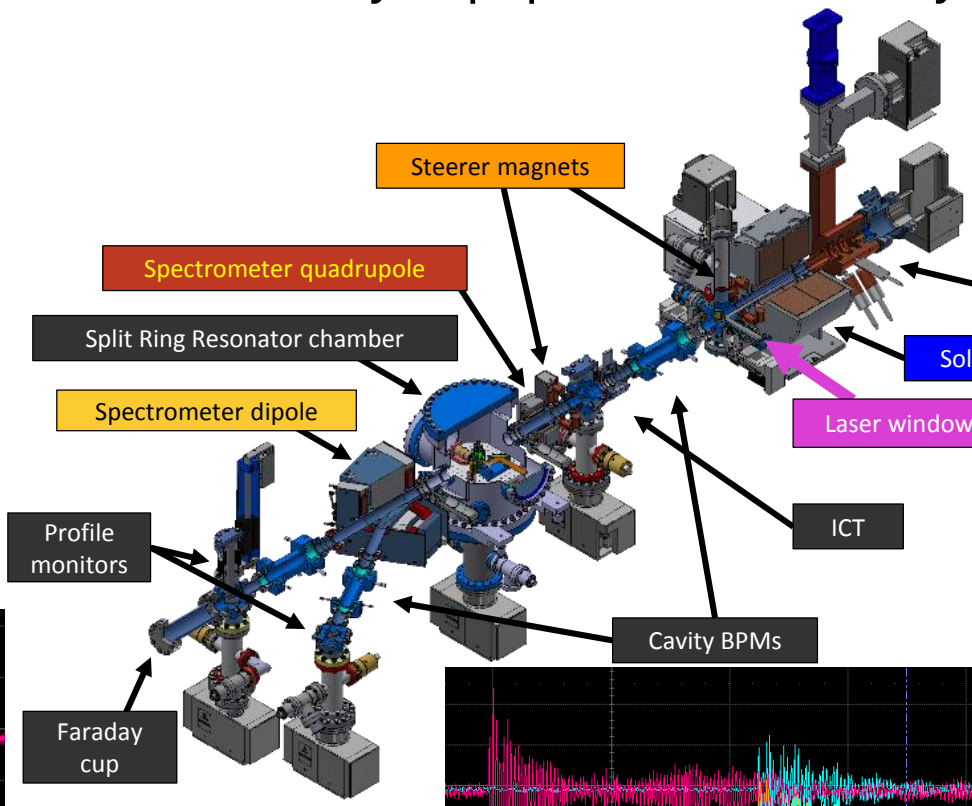


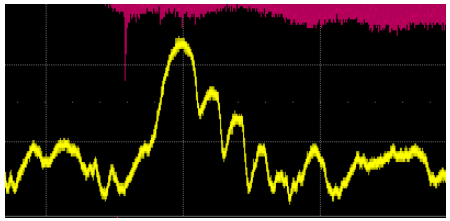
<u>Outlook:</u> beam characterization, etc.

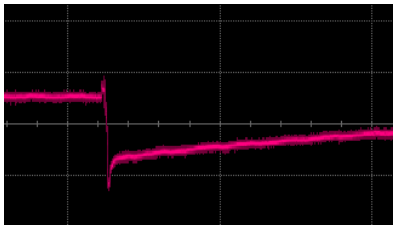
FLUTE at KIT

- 1 TNA finished + 1 ongoing at **F**erninfrarot **L**inac- **u**nd **T**est **E**xperiment
- FLUTE injection section is in operation, first signals of diagnostics: Cavity BPMs, ICT, Faraday cup, profile monitors by PAUL SCHERRER INSTITUT PSI



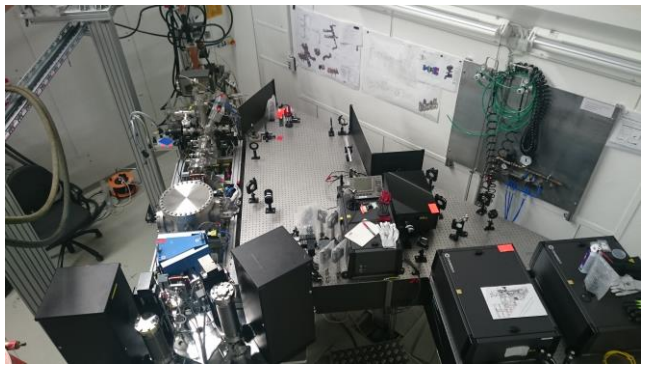


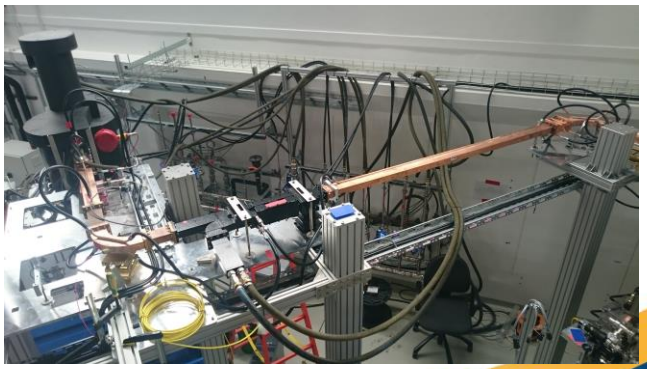




FLUTE at KIT

- Status
  - Time delay caused by fabrication defects and component failures
  - Feb 2019: first laser-synchronized electron beams in coll. with
  - RMS beam size: 1.17 mm horizontal, 1.59 mm vertical
  - Profile monitors in forward direction + energy spectrometer calibrated
- Outlook:
  - Now: increasing RF power for electron energy from 3 to 7 MeV
  - Systematic parameter studies and diagnostics of bunch profiles
  - Reducing beam size, <100 µm necessary for 2nd TNA-FLUTE
  - Finalizing preparation for experiments with split ring resonators





IPHI at CEA Saclay

- The accelerator has been running during 4 weeks in September – October to accommodate 3 experiments including tests of the BPM + electronics from Bilbao + ESS

ESS BILBAO Beam Position Monitor

Profile monitors for ESS

Emittancemeter for MYRTE / MYRRHA

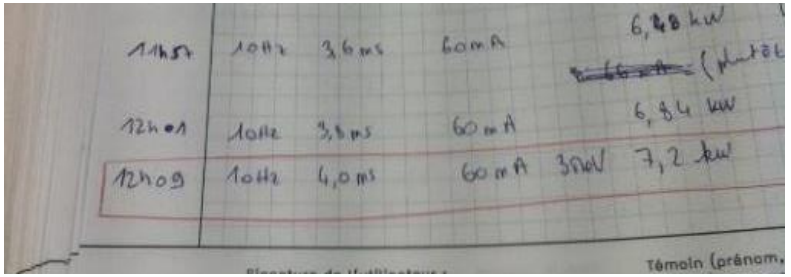
BPM tests at IPHI

- Tight schedule, but efficient collaboration

Test/task	Test description	Priority	Check
High frequency response to short beam	Investigate possible errors introduced on the measurement due to high frequency components of the beam signal.	Day1	ok
Phase and position resolution	Phase and position resolution as function of the beam current.	Day1	ok
BPM self trigger for low current beam	Test the feature for low current and real beam. Test for ESS commissioning beam. Find the correct values.	Day1	ok
Set the correct BPM sensitivity factor for position measurements.	Check the correct values from Seadat simulations	Day1	ok
Beam current dependence	Change beam current and measure the position and phase dependence introduced by the measurement system.	Day2	ok
Beam energy dependence	Verify how the BPM system responds as function of the energy.	Day2	not possible
Measurements at different frequencies	After checking the signal amplitude at 352 and 704 MHz harmonics, check the response to both harmonics.	Day3	ok
Measurements at 352 MHz	Repeat measurements for the 352 MHz harmonics.	Day3	ok
Check the response to different matching schemes	Short, 50 Ohms and open configuration. Measure position and phase resolution. Analyze the raw data spectrum and the oscilloscope time domain measurements to the three different schemes.	Day4	not possible
Long term measurements	Acquire several measurements	Day5	ok
Current sweep for short pulse	150 us pulse length and current from 3 mA to max	Day 2	ok
Beam energy measurements	Time of Flight measurements	Day 3	ok
Bunch length measurements	Compare the bunch length at 352 and 704 MHz by measuring the 2nd and 3rd harmonics	Day 5	ok
Correlate NMP and BPM measurements	Steering experiment by changing the vertical beam position and comparing BPM data to NPM data.	Day 4	ok

Status of IPHI

- These experiments were performed at low duty cycle (at most 0.3%)
- After a very smooth RF conditioning, the beam duty cycle was increased to 4% on Oct. 19th



- A neutron production setup has been installed and has started operation last week @ 1 kW

- Test of the SoNDe neutron detector for ESS foreseen beg. of May (first tests in pulsed mode)

Project abstract (please write a short summary of the project and its objectives in the box below)

SoNDe is a prototype detector for neutron capable of handling high fluxes such as to be delivered by the future European Spallation Source (ESS) under construction at Lund (Sweden). This detector is made out of commercial Multi-PhotonMultiplier, with 6x6 mm^2 pixel size, located after a scintillator, and mounted on fast read-out electronic.
For every neutron measured, the detector should give the neutron wavelength and its spatial localization.

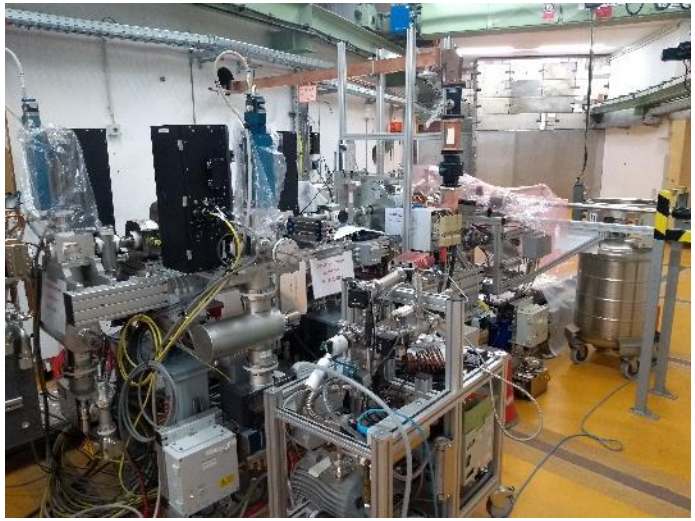
SINBAD at DESY, Hamburg

- Electron linac
  - E = 100 MeV
  - Charge: 0.5 - 20 pC
  - bunch length: few fs
  - transverse norm. emittance < 0.5 mm*mrad
  - Target arrival time jitter stability < 10 fs RMS
  - rep-rate: < 50 Hz

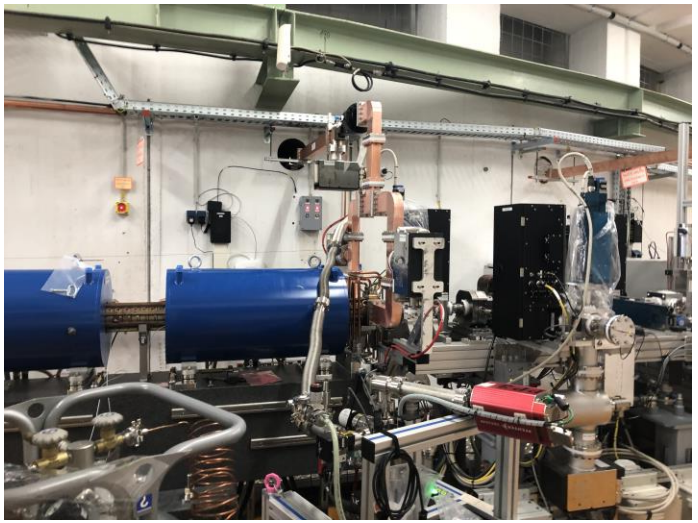
- Gun conditioning ongoing
- Linac installation progressing: spring 2019

- Outside TNA, SINBAD will be used to study compression methods, inject into advanced acceleration schemes, diagnostics development, …

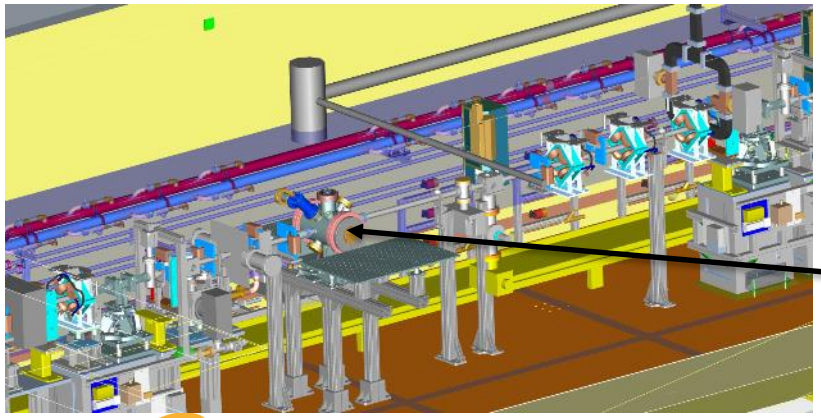
SINBAD: status



Commissioning of the gun region has started

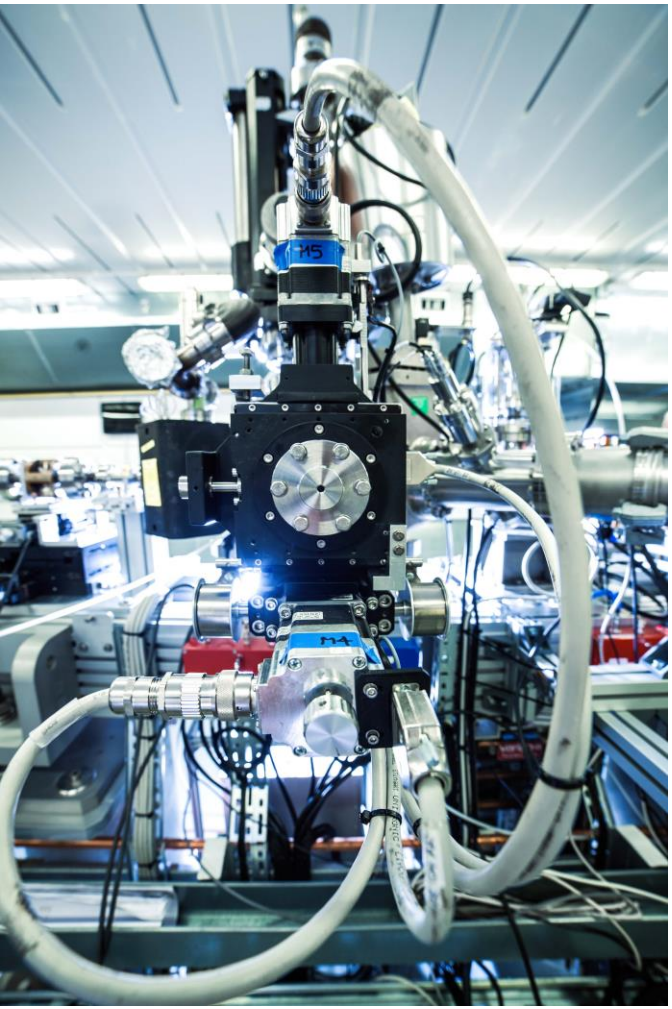


The installation of the linac beam line elements was continued (t.b. finished in April)



- A 4.2m long section after the linac is available for experiments (+ diagnostics downstream)
- If users want, an experimental chamber incl hexapod can be used (available starting summer 2019)

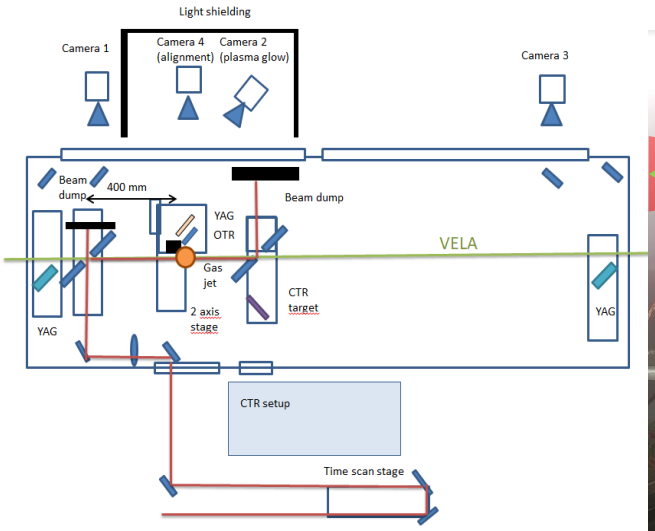
VELA: status

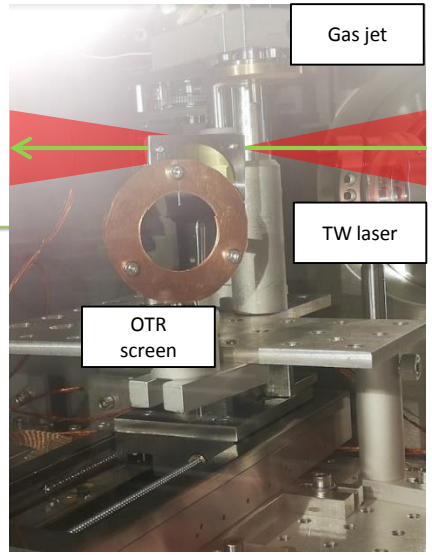


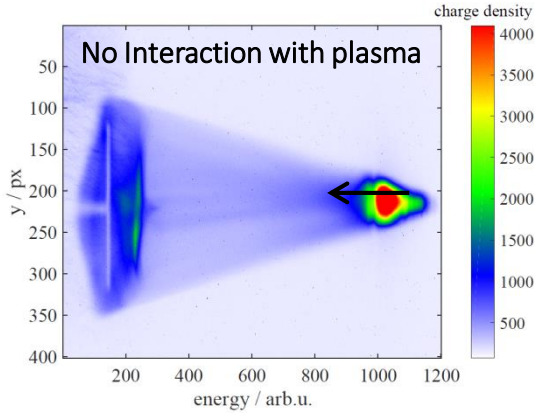
- Recent VELA external user programme delivered through Q4 2018 and Q1 2019
- Successfully enabled two beamtime allocations via ARIES Transnational Access scheme:
  - Micha Dehler (PSI) - 5 days, Jan 2019 – "*Proof of principle test of THz driven deflector structures with beam*"
  - Alexander Knetsch (DESY) - 5 days, Feb 2019 – "*Plasma afterglow attosecond metrology*"
- Next available beamtime for ARIES TNA: Q4 2019 - Q1 2020

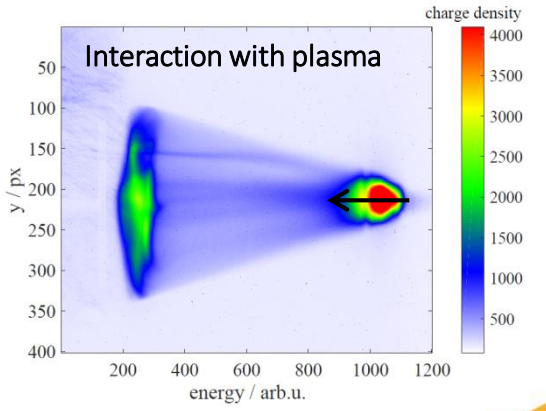
Plasma afterglow attosecond metrology

- A. Knetsch[1], O. Apsimon[2], L. Boulton[1,3], A. Gleeson[5], H. Jones[2], G. G. Manahan[3], A. Nutter[3], T. Pacey[5], L. Reid[4], P. Scherkl[3], Edward Snedden[5], D. Ullmann[3], D. Walsh[5], L. Corner[4], B. Hidding[3]
- [1]DESY [2]University of Manchester [3]University of Strathclyde [4] University of Liverpool [5]STFC Daresbury Laboratory



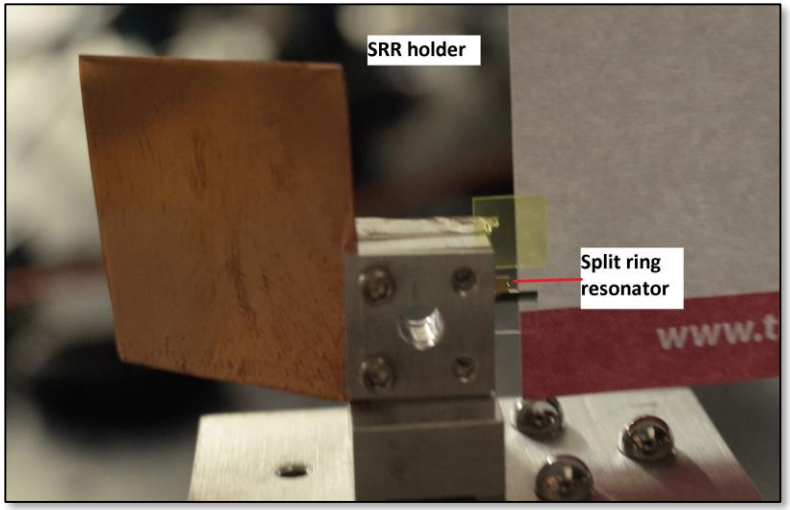


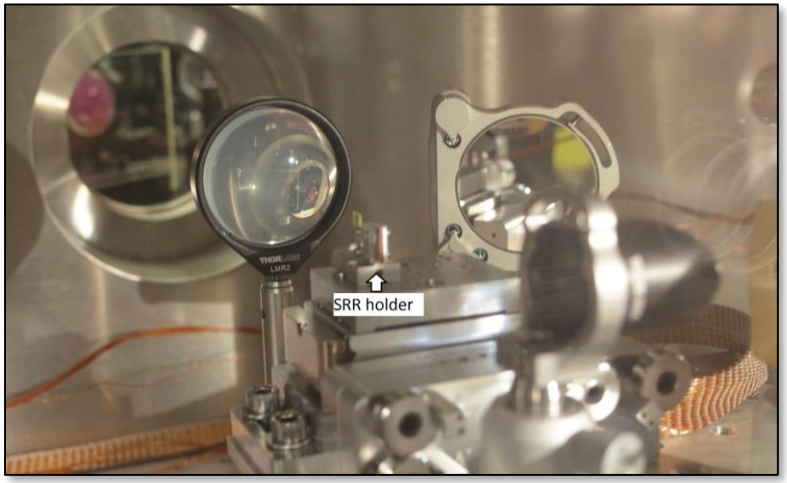


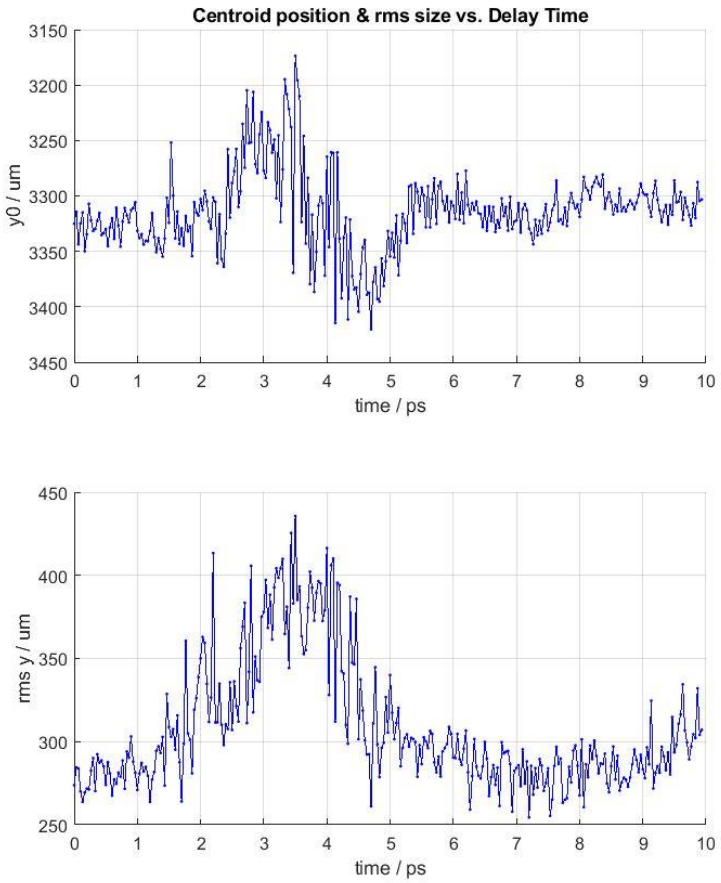


- Successful synchronisation and alignment of laser, electron beam and gas jet.
- First interaction of VELA electron beam with laser-ionized plasma.

THz driven deflector structures with beam







Accepted submission for IPAC'19 'Proof of principle test of THz driven deflector structures', Dehler et al.

Conclusions

- A total of 10 experiments performed, with interesting measurements
  - IPHI and VELA provided first TNA since last october
  - SINBAD will start very soon, as anticipated

- Some of these experiments would not have been performed without ARIES

- Please advertise in your laboratories the use of our electrons, protons and neutrons !

Summary WP11

Facility	No. of projects	Total no. of projects Annex 1	No. of users	Total no. of users Annex 1	No. of access units	Total no. of access units Annex 1
ANKA	4	8	10	64	216	480
FLUTE	2	8	9	40	76	320
IPHI	2	12	10	72	112	1,440
SINBAD	0	9	0	36	0	630
VELA	2	14	16	56	80	336