# EURIZON - *European network for developing new horizons for RIs*

**WP4 Collaboration with X-ray light sources in Europe**

**Task 4.1:** Concepts of 4th generation synchrotron machines in Europe [ESRF, DESY]

# Beam Diagnostics Part

## Colleagues involved

ESRF colleagues involved :  
**Elena Buratin** is the PostDoc colleague specifically assigned to this collaboration,   
she is not a direct expert on the exciter, but in daily contact with Benoit Roche (in the same Diagnostics group), and she will be the principle liaison person for this task.  
**Benoit Roche** is our expert of orbit feedback and responsible for the above mentioned exciters.  
Wherever needed he will be involved, either directly, or through Elena.  
**Simone Liuzzo** is the leader of this WP4 4.1 task  
**Kees Scheidt** is in principle only involved for supervisory tasks, or when needed for help with practical aspects.

DESY colleagues involved:

**Ilya Agapov** (Accelerator physics expert, WP leader for PETRAIV, beam dynamics expertise)   
**Holger Schlarb** (MSK (accelerator beam controls) group leader)   
**Gero Kube** (Diagnostics expert, WP leader for PETRA IV)   
**Szymon Jablonski** (MBFB designer for PIV)   
**Sven Pfeiffer** (Feedback WP leader for PETRA IV)   
**Sajjad Mirza** (FOFB designer for PIV)

## Main achievements

Deliverables

D4.1.3 (M48, DESY) Technical report on beam diagnostics studies with detailed documentation.

Milestones

M4.1.4 (M36, DESY) Beam Diagnostics: Definition of the work organization for beam diagnostics studies

M4.1.5 (M42, ESRF) Beam Diagnostics: Selection of the shaker device

## Definition of the task

Name and purpose of this task:

Vertical emittance control, i.e. by applying a controlled excitation to the beam in the vertical plane, the real beam emittance is stabilized, i.e. kept constant, at a pre-defined value, and no longer fluctuating with e.g. the change an ID gap values in the numerous undulators by beam-line users. Following hardware components are required:

1. the vertical beam exciter, e.g. a shaker-device, or a stripline-device, and their control & power electronics for driving the electric signal.
2. a vertical emittance monitor, that produces the vertical emittance value at a suitable rate.

The selection of emittance monitor (part b)) is not part of the knowledge transfer from ESRF to DESY (WP4, task 4.1). It is assumed that the diagnostic experts at DESY do not need the specific ESRF advice to produce such an emittance monitor. So, this specific knowledge transfer would therefore be focused on that exciter (only), and notably first of all on the best possible choice to be made between a shaker and a stripline.

Timeline – work organization – Task #1:

* M36 – 01/2023
* M42 – 07/2023
* M48 – 01/2024

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| # | Task/Month | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 |
| 1 | *Define the work organization (M4.1.4)* |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 2 | *Simulation task* |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 3 | *Emittance monitor selection* |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 4 | *Shaker evaluation / selection (M*4.1.*5)* |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 | *HW/FW/SW implementation aspects* |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 | *Summarize and write the report (*D4.1.3*)* |  |  |  |  |  |  |  |  |  |  |  |  |  |

People involved in each task:

- Simulation Tasks (M42-45, no time to be done earlier by relevant colleagues): Sven Pfeiffer, Ilya Agapov, Elena Buratin, Simone Liuzzo, Benoit Roche, ...

- Emittance monitor selection (M36-M41, last discussion will take place during DEELS workshop): Sven Pfeiffer, Elena Buratin, Gero Kube, Friederike Ewald, ...

- Shaker Evaluation/Selection M4.1.5 (M38-M45, depends on simulations task, starts under the assumption that PETRAIV has similar parameters to EBS (chromaticity, beta, …)): Sven Pfeiffer, Elena Buratin, Benoit Roche, ...

- HW/FW/SW implementation aspects (M38-M45, depends on simulations task, starts under the assumption that PETRAIV has similar parameters to EBS (chromaticity, beta, …)): Sven Pfeiffer, Elena Buratin, Benoit Roche, ...

- summarise and write report D4.1.3 (M48, DESY): see above underlined names for each subparagraph

Simulations required – Task #2:

For better understanding of the excitation of the beam shaker (underlining concept) a simulation using PETRA IV lattice is required. This simulation, performed by DESY accelerator physics group (Task 4.1 – beam dynamics group), should answer the following aspects for PETRA IV ring integration:

1. What range of excitation do we need for PETRA IV integration in timing / brilliance operation mode?
   1. Amplitude range
   2. Frequency range
2. What is excited by using a beam shaker – physical concept to evaluate point 3)
   1. Intra-bunch excitation with broadband actuator for emittance control of every bunch?
   2. Bunch-to-bunch excitation using BW-limited actuator for emittance control of all bunches (integrated effect, while single bunch does not change the emittance)?
   3. Combination of the two (a and b)?
3. Evaluate the interaction of emittance excitation/compensation with the feedback systems.
   1. Interaction with MBFB system
   2. Interaction with FOFB system

Emittance monitor selection – Task #3

The selection and the integration of the emittance monitor from beamline into the emittance control scheme will be in close collaboration with the DESY beam diagnostics group to address following aspects:

1. Expected resolution of emittance monitor
2. Expected update rate/time for feed-forward/feedback integration
3. Expected processing time/latency of the monitor

The relevant expertise of ESRF – Task #4, #5:

At the ESRF we operate such vertical emittance control permanently and since long (2 years after the commissioning of EBS) to full satisfaction. For this we use a shaker-device, and a chain of electronics for control and power-driver. We also have and operate striplines, both horizontal and vertical, in our Storage Ring and Injector, and so we have practical experience & insight in using these in the most adequate manner for different applications. We therefore think we can provide valuable advice to DESY, for the future Petra-4 ring, in first of all on the choice between the 2 different type of exciters, with their respective pros and cons, and also: the concept, the practical design & implementation aspects, the encumbrance issues, the technological complexities, the electronics for control & power-driving, the companies capable of realizing this hardware, the cost aspects etc.

Next steps:

1. Preparation of the agreement on the definition of this task, and the practical work involved and a tentative schedule.
2. Kick-off meeting, to endorse the above agreement, and to define precisely the actions and work for the remaining time of this collaboration.