Eurizon Task 4.1 Diagnostics

kick-off meeting , 24 November 2022

DESY - ESRF

AGENDA

1. **introduction of all the present colleagues**
2. **summary of the EURIZON Task 4.1 status with focus on Diagnostics related milestones and deliverables**
3. **review and discussion of the topics to be addressed in this Eurizon Task 4.1 Diagnostics**
4. **discussion on the work organization**
5. **planning and scope of any visits in the near future**
6. **tentative scheduling of the next and (roughly) the future meetings**

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

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,
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 some help.

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)

Deliverables

D4.1.3 (**M48, DESY**) Technical report on beam diagnostics studies with detailed documentation. ← Jan. 2024

Milestones

M4.1.4 (**M36, DESY**) Beam Diagnostics: Definition of the work organization for beam diagnostics studies ← Jan. 2023

M4.1.5 (**M42, ESRF**) Beam Diagnostics: Selection of the shaker device ← July 2023

#	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 (M4.1.5)*			■	■	■	■	■						
5	*HW/FW/SW implementation aspects*						■	■	■	■	■			
6	*Summarize and write the report* (D4.1.3)											■	■	■

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:

- the **vertical beam exciter**, e.g. a shaker-device, or a stripline-device,
  and their control & power electronics for driving the electric signal.

- a **vertical emittance monitor**, that produces the vertical emittance value at a suitable rate.
  The selection of this emittance monitor is not part of this knowledge transfer, since 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**.

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?**
   a) **Amplitude range**
   b) **Frequency range**

2) **What is excited by using a beam shaker – physical concept to evaluate point 3)**
   a) **Intra-bunch excitation with broadband actuator for emittance control of every bunch?**
   b) **Bunch-to-bunch excitation using BW-limited actuator for emittance control of all bunches (integrated effect, while single bunch does not change the emittance)?**
   c) **Combination of the two (a and b)?**

3) **Evaluate the interaction of emittance excitation/compensation with the feedback systems.**
   a) **Interaction with MBFB system**
   b) **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 P4 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 slides :

some practical info on the ESRF striplines and shaker

SHAKER

2 shakers are installed in the SR (cell 1 and cell 26)

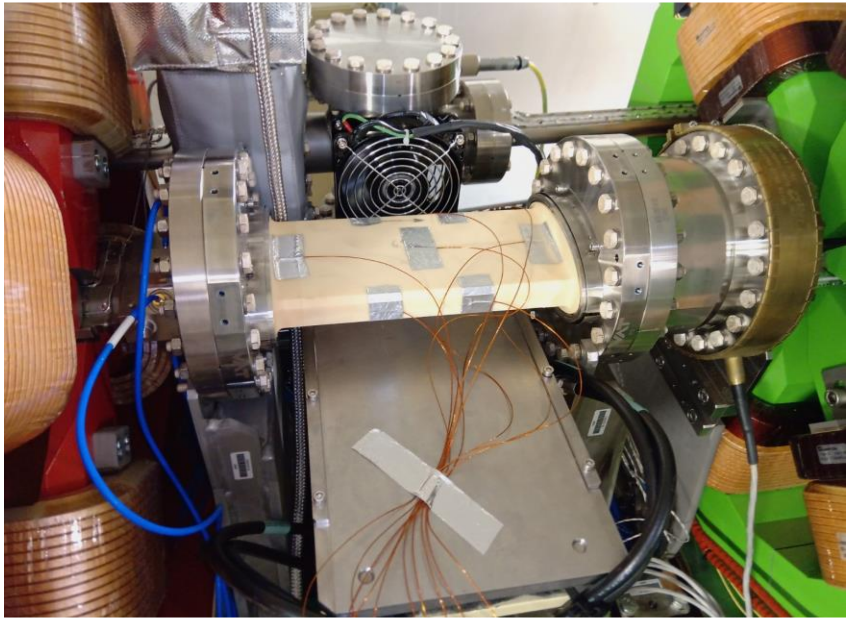
The shaker has to be installed around a ceramic chamber with Ti coating.

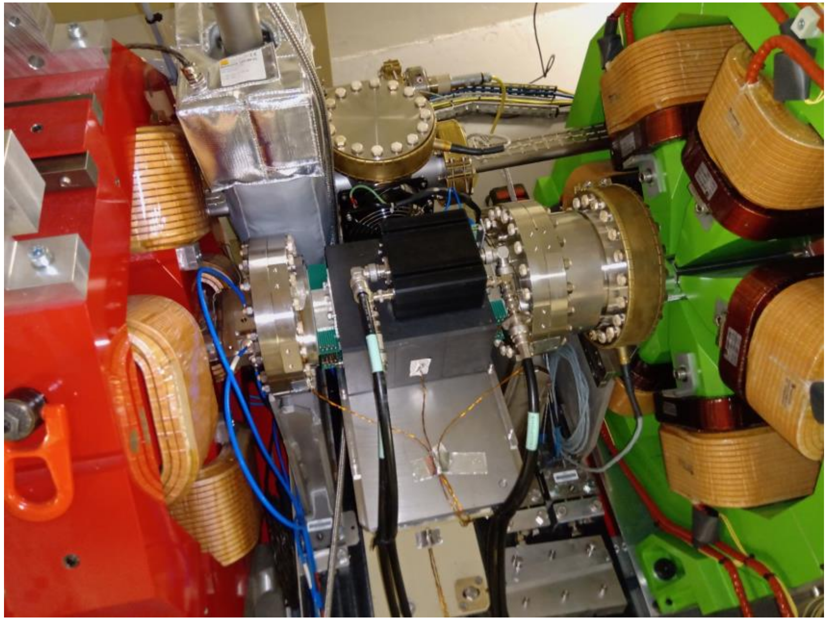
Ferrite Material: 8c11 (NiZn, μ_r=1200)

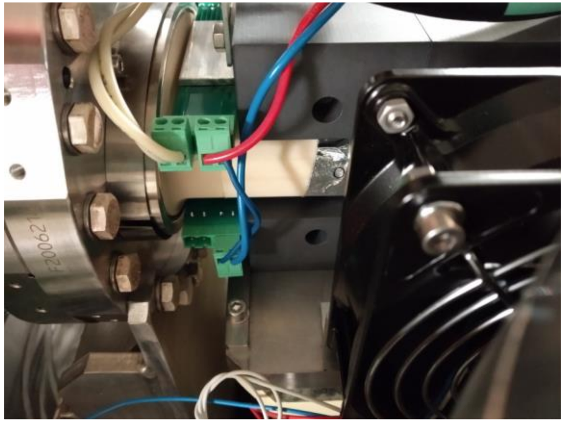
The windings inserted in the ferrite to produce the H and V magnetic fields are printed on a regular PCB glass/epoxy substrate.

Length	l	180 mm
Kick H	$l*B_H/R$	1.25 µrad/A
Kick V	$l*B_V/R$	1.2 µrad/A
Inductance H	L_H	18.5 µH
Inductance V	L_V	17,6 µH

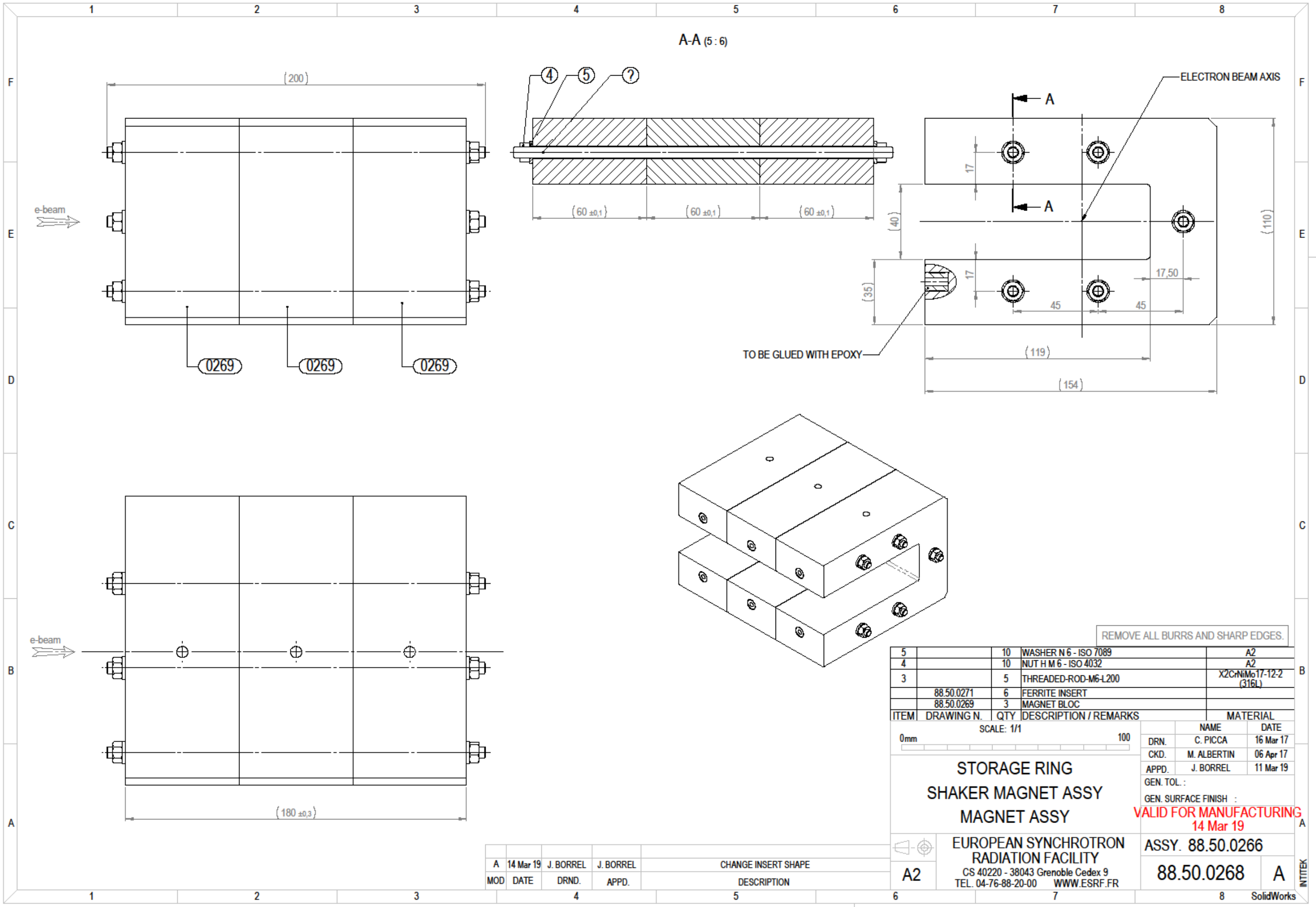
SHAKER







Assembly


A-A (5 : 6)
(200)
e-beam
0269
ELECTRON BEAM AXIS
(60 ±0,1)
(40)
(110)
(35)
17
17,50
45
(119)
(154)
TO BE GLUED WITH EPOXY
(180 ±0,3)
REMOVE ALL BURRS AND SHARP EDGES.
5 | 10 | WASHER N 6 - ISO 7089 | A2
4 | 10 | NUT H M 6 - ISO 4032 | A2
3 | 5 | THREADED-ROD-M6-L200 | X2CrNiMo17-12-2 (316L)
88.50.0271 | 6 | FERRITE INSERT
88.50.0269 | 3 | MAGNET BLOC
ITEM | DRAWING N. | QTY | DESCRIPTION / REMARKS | MATERIAL
SCALE: 1/1
NAME DATE
DRN. C. PICCA 16 Mar 17
CKD. M. ALBERTIN 06 Apr 17
APPD. J. BORREL 11 Mar 19
GEN. TOL. :
GEN. SURFACE FINISH :
STORAGE RING
SHAKER MAGNET ASSY
MAGNET ASSY
VALID FOR MANUFACTURING 14 Mar 19
A 14 Mar 19 J. BORREL J. BORREL CHANGE INSERT SHAPE
MOD DATE DRND. APPD. DESCRIPTION
A2
EUROPEAN SYNCHROTRON RADIATION FACILITY
CS 40220 - 38043 Grenoble Cedex 9
TEL. 04-76-88-20-00 WWW.ESRF.FR
ASSY. 88.50.0266
88.50.0268 A
SolidWorks
INTITEK

SHAKER

In order to drive these winding with a regular RF amplifier, these shakers must exhibit an impedance of 50ohms at their operating frequency.

The winding is terminated with a 50ohm RF load, in // with a 2.2nf capacitor, which will result in a bandwidth of about 1.5MHz.

STRIPLINE