Project CDR for the ESS Tuning Beam Dump Imaging System

Interface Definition Document

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1. SCOPE

This document defines the interfaces which are necessary to support the ESS Tuning Dump Imaging System, including details of both hardware and software specifications.

It also identifies the dependencies with the groups which will be required to cooperate with the ESS Beam Instrumentation Group in the installation, commissioning and maintenance of these systems.

2. CONTRIBUTORS

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3. ISSUING ORGANISATION

University of Oslo (in association with the University of Liverpool)

4. INTRODUCTION

The Tuning Dump Imaging System is located inside the dump tunnel, about 1.3 m upstream from the end of the dump beam-line where the proton beam enters the dump shielding within which is the beam dump itself. It will operate within an environment which is the responsibility of a number of groups and for its successful implementation relies upon a clear definition of the interfaces between the groups. These include:-

- Vessel design and supply STFC ASteC Group, Cockcroft Institute, Daresbury
- Dump physical configuration ESS Engineering
- Power and signals ESS Beam Instrumentation
- Dump beam conditions ESS Accelerator Group
- Operational profiles ESS Operations
- Control software and Alarms ESS ICS Group

5. CONTEXT (ASSUMPTIONS)

Interfaces identified in this document are based on information provided from a number of sources, including the referenced documents.

6. INTERFACES

6.1. Imaging Vacuum Vessel

The Tuning Dump Imaging System is housed in and around a vacuum vessel, the design and procurement of which are the responsibilities of STFC (Daresbury Laboratory, UK). The STFC design team has been consulted during the development of the vessel design to accommodate the evolving understanding of the requirements of the imaging system. STFC has also advised on the type of ***linear actuator*** best suited to providing the mechanism for imaging screen changing.

6.2. Physical Environment

The design of the dump line tunnel has been produced by ESS engineers, who are also responsible for the integration of the Imaging system into the dump line alongside other beam diagnostics which are to be provided, specifically the Beam Position Monitors (BPMs) upstream, and the Aperture Monitor immediately downstream.

Beam-line space allocation has been made for the imaging vessel and services.

6.3. Power Supply and Controls

Housing has been allocated in the remotely-located rack-room for two standard ‘***47u***’ racks, to house the power supply and control electronics for

- imaging cameras (x2)
- screen actuators (x2)

The racks will be shared with the controllers for other diagnostic systems on the tuning dump line. Cabling up to 40m in length with connect the system with the rack-room.

Beam trigger pulses will be available at the rack-room location, to facilitate the synchronisation of imaging camera data acquisition with the machine pulses.

6.3.1. Camera Interface

Communications will conform to the ***GiG-E Vision*** standard, *IEEE 802.3 1000BASE-T* interface [1]. Power requirement is typically *2.8W at 12V DC*.

Support for the camera control and software is provided by the standard EPICS control software developed by the ESS ICS Group.

6.3.2. Screen Actuators

Drive options for the preferred linear actuators [1] include stepper-motors, with a supply of *23 frame 8 wires 3A / phase*; or DC motors/linear encoders, requiring *24VDC*.

The control system to operate the screens will be based on Ethercat controller and drivers, a standard solution developed by ESS ISC and MCAG

6.3.3. Other Systems

There is currently no requirement for control or power supplies for remote mirror alignment; this will be carried out manually during tunnel access for maintenance.

6.4. Beam Delivery to Dump

The ESS Accelerator Division is responsible for specifying the parameters of the beam supplied to the dump-line from the LINAC. The absolute maximum beam width at the dump itself is estimated at 350mm diameter, compared with the dump entrance diameter of 500mm. An aperture monitor located immediately downstream of the imaging system will provide data for control over the beam size.

The absolute minimum beam size is set by the limit at which the screen, Dump Entrance Window and eventually the Tuning Dump itself will be damaged by beam heating. The specification for this can be found in the reference document ESS-0129564.

6.5. Operational Profiles

The ESS Operations Group has developed schedules for 5 modes of operation: Shutdown, Studies, Studies On Target, Start-Up and Production, in [3]. Only during Studies will the dump receive beam. The operational profiles, specifying the number of days/year with beam and the details day-by-day, have been used to predict total dose exposure to the imaging system and also residual dose-rates from activation after irradiation.

6.6. Maintenance of Instrumentation in the Tuning Dump Area

The instrumentation in the Tuning Dump, and in particular the imaging system, will eventually fail due to the radiation environment. In order to maintain availability and reliability, the need for maintenance for the cameras and for the operation of the screens must be anticipated. Access and safe operation during maintenance must be ensured. A detailed design should be delivered by ESS.

6.7. Radiation Environment

The Tuning Dump will generate a high flux of particles that are likely to activate the machine components in the area. One of the level 2 requirements stipulates that the accelerator tunnel must be a ‘Hands-on’ maintenance area. The radiation levels during operation and during maintenance have been calculated to ensure this requirement is satisfied. The document is referenced at [2].

In addition, the proton scattering in the screen will generate additional radiation in the area. This radiation has been calculated in order to verify the same requirement to be satisfied. The reference document is [2].

7. CONCLUSIONS AND RECOMMENDATIONS

Regular communication will be maintained with all groups having an input to or an interest in the Tuning Dump Imaging System. Any changes in developing ESS standards and practice will also be monitored.

8. GLOSSARY

Term	Definition
STFC	Science and Technology Facilities Council, UK research council responsible for large scale science facilities, including accelerators

9. REFERENCES

[1] 'System Design Document' (ESS Document ESS-0150756)
[2] 'Radiation Dose Estimates Document' (ESS Document ESS-0150754)
[3] Document *ESS-0011768*: 'Updated Report on Operations' (J Haines, Apr 27, 2016)

DOCUMENT REVISION HISTORY

Revision	Reason for and description of change	Author	Date
1	First issue	M G Ibison	<<YYYY-MM-DD>>