1.1 **ID Card**

ID06 (ID07) is dedicated to the development and test of new methods and instrumentation. Falling outside the standard ESRF user program, access to the beamline is open for in-house use and through collaborative development programs. This allows innovative technologies and scientific methods to be tested without risk of perturbation for standard ESRF user operation. Currently, active developments include extreme conditions (large volume press, high magnetic fields), beam position monitoring and nanofocusing optics.

1.2 **Scientific Case**

The successful implementation of the scientific programme of the ESRF will require the timely availability of high performance instrumentation. This is essential if the source improvements are to be fully exploited and not degraded by downstream components. For example, in the early stages of the Upgrade Programme it will be particularly important to validate new strategies for the management of the increased heat load and power density on the optical elements due to brilliance and flux improvements. Subsequently, it will be important to maintain a testing ground for new technologies and methods (be they in-house or external developments). The scope of such developments includes:

- White beam mirrors
- High heat-load and wide band-pass monochromators [1-3] (e.g using diamond or multilayer technologies)
- X-ray beam position monitors for white and monochromatic beams
- Beam conditioners: slits, absorbers [4]...
- Cooling systems
- Wavefront/coherence preservation [5,6]
- Micro-, nano-focusing optics [7, 8]
- Sample environments
- Detector systems [9]
- Software e.g. automatic beamline alignment
- New experimental methods.
Certain developments can only progress effectively with regular access to full power beams. However experience shows that the necessary in-beam testing is invasive and difficult to reconcile with the constraints of beamline operation within the user programme.

The current ID06 beamline was conceived to address these problems and is reserved for technical development activities by internal users and long-term collaborations with external groups. Examples of such collaborations include a high heat load optics testing programme with DESY (PETRA III) and the development and test of nanofocusing optics (NanoFOX JRA) under the FP7 ELISA I3 project. ID06 is a recent beamline equipped with the latest control systems and a high degree of flexibility both in terms of its hutchess and optical configuration. Consequently it would be the natural choice for the testing ground for new technologies for the Upgrade Programme. Unfortunately, ID06 is currently scheduled to scale down its instrumentation test programme at the end of 2010.

It is however, essential that a similar instrumentation testing capability is retained during the Upgrade Programme and beyond, to validate new technologies and explore new experimental methods without penalising the operation of user beamlines. We propose a solution whereby the existing ID06 methods and instrumentation beamline will continue to host instrumental test activities as far into the Upgrade as possible. However, the prototypes will, as far as possible, be designed around the future requirements of the user beamline which will ultimately take over the full available beamtime. In this way, the future operational ID06 beamline would inherit a park of well-characterised and commissioned instruments. The commissioning would be performed in cooperation with the future beamline staff to ensure a smooth transition to full user operation.

In parallel with this transition, the instrumental and experimental development activities previously hosted on ID06 would be transferred to ID07 as soon as an undulator insertion device has been installed that sector. Moreover, a future extension of ID07 to exploit the full 120m length of the EX2 in this sector would confer much flexibility to explore both the instrumental challenges and experimental opportunities offered by the Upgrade Programme outside the constraints of a user beamline, particularly for nanofocusing or coherence applications.

The core activities of the future Methods and Instrumentation Beamline (either at ID06 or ID07) would be strongly driven by the need to establish a well-characterised ‘toolbox’ of generic instrumental solutions which can be readily applied to the particular needs of the upgraded beamline portfolio. These solutions might be either purely in-house developments or externally sourced.

This CDR has to be placed into a context whereby competition for insertion device ports is fierce but we consider that the benefits which will be accrued largely justify the modest investment required, and that ultimately this strategy will prove effective in reducing the commissioning time necessary for the new beamlines and streamlining maintenance procedures (spares, internal expertise...), thus reducing the amount of down- and commissioning time on the user beamlines.
1.3 PROJECT HISTORY

This CDR is an evolution of the WIBIDI and TIBIDI proposals of the Purple Book. Initial experience of the ID06 operation shows that many aspects of the two projects can be reconciled on a single beamline. The basic requirements which led to the creation of the ID06 Methods and Instrumentation beamline, namely the development, testing and optimisation of instruments, software, detectors and methods prior to deployment on user beamlines have become increasingly important in the context of the Upgrade. This approach has proved its worth through the coexistence of many development projects on ID06 since its inception. These include the commissioning (and consequent improvement) of two prototype cryogenically cooled high heat-load fixed exit monochromators, development of experimental methods: (pulsed magnetic fields, large volume press), white beam position monitors and characterisation of nano-focusing optics. The nano-focusing optics testing programme at ID06 is an important component of the WP23 (NanoFOX JRA) of the FP7 I3 ELISA grant which began in March 2009.

This document is the fruit of discussions between various members of the Mechanical Engineering Group, Technical Beamline Support Group and Optics Group (now grouped together in the Instrumentation Services and Development Division, ISDD). Through its nature, the beamline will promote the development of fully integrated solutions ready for use on user beamlines. It is expected that in future, this beamline could play a pivotal role in facilitating the close interaction between the future ISDD and the Experiments Division.

1.4 BASIC TECHNICAL CONSIDERATIONS

The beamline needs to be versatile: this implies access to a wide energy range and a modular design with the capacity to temporarily install all large parts of equipment in both the optics and experimental hutches.

Source

The need to test upstream components for the widest range of beamlines precludes the use of a canted beam port. After modification of the RF cavity distribution in the storage ring, the ID07 straight section would continue to host cavities but, according to current designs, could allow installation of two standard 1.6 m (in-air) insertion devices (including revolvers). Potentially, a slight decentering of the RF cavities along the 7 m straight section would allow installation of a short (2 m) in-vacuum undulator (previously developed for ID11) and a standard in-air carriage. Thus, the beamline could offer the widest flexibility in spectral range and importantly access high energies which are the particular specificity of the ESRF source. Due to the reduced available length of the ID07 straight the beam port could not generate the highest power densities possible at the ESRF but this is considered to be an acceptable compromise. Typically an in-vacuum U18 device and a standard U32 (current ID06 configuration) would permit operation from between 5-100 keV.
Front end

The front end should be capable of transmitting the photons from the undulators defined above. It would be equipped with a highly polished diamond absorber (~300 µm thick) to isolate the beamline from the ring vacuum. The front end should allow an unrestricted opening of the primary slits of 3.5 mm x 2 mm (H x V) situated at 27 metres.

Beamline Layout

Figure 1 shows the possible hutch and control cabin layout for a minimal Technique and Instrumentation test beamline on ID07, comprising an Optics Hutch (OH1) and a first (monochromatic beam) Experimental Hutch (EH1). This configuration allows a static, yet versatile optical scheme enabling the delivery of a well-defined and highly stable monochromatic beam to EH1. Space is reserved in the OH for temporary installations either in the white or monochromatic beam. Once the EX2 is completed the option to add a second experimental hutch (EH2) would become available.

**OH1:** The basic configuration of OH1 (Figure 2) would closely resemble that of ID06 today. Most of the upstream optics necessary for white-beam tests (cycling shutter, calorimeter, high-power diamond absorbers) could be transferred from ID06 to ID07. Items such as primary slits and basic vacuum equipment might be recovered from the old ID20 beamline. The major instrument investment would be for a permanently installed fixed-exit double crystal monochromator and its associated cryo-cooling system. Space would be reserved for testing in white beams (e.g. BPMs, monochromators, mirrors) and in monochromatic beams (e.g. BPMs, axial focusing systems).

**EH1:** Figure 3 shows the layout which would initially house the transferred micro-optics and detector test benches from ID06. As for OH1, space would be reserved for test of instruments requiring monochromatic beams (e.g. diffractometers). Basic costs for equipping this hutch would be limited to instrument cabling and control, secondary slits and beam diagnostics.
Figure 1. Proposed ID07 methods and instrumentation beamline.

Figure 2. Proposed OH1 configuration.
**EH2:** The optional EH2 on the EX2 high stability slab with a source-'sample' distance of ~120 m would be particularly valuable for testing of optics and end-station technologies for nanofocusing in the sub-100 nm range and for measurements requiring coherent illumination (the low-β source would offer a horizontal lateral coherence length of ~100 µm for 12 keV X-rays in EH2). This could also prove a valuable test ground in the event of a high magnetic field facility becoming available in this sector.

The beamline is a low-risk project which, if available early in the Upgrade Programme, has the potential to mitigate the technological risks on other upgraded beamlines.

1.5 REFERENCES