**Project No. FP7 – 212348**

# NFFA

## Nanoscience Foundries and Fine Analysis

# D 4.5

## Assessment of the possible INTEGRATION of existing facilities that could be integrated in NFFA-RI in view of the implementation of the DEMONSTRATOR PHASE of NFFA

| | |
|---|---|
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| Task Leader | **C. David (PSI)** |
| Major Contributors | **G. Rossi, R. Gotter, D. Orani, R. Ciancio, C. Africh (CNR-IOM), G. Arthur (STFC), E. Lora-Tamayo, L. Fonseca, (CSIC-CNM), H. Amenitsch (OEAW), J. Gobrecht (PSI)** |
| Other Contributors | **N. Mahne, M. Kumar (CNR-IOM), K. Jungnikl (OEAW)** |

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# Deliverable D4.5: Assessment of the possible integration of existing facilities that could form the backbone of a NFFA Demonstrator Phase, possibly supported with specific FP7 measures (I3 WP 2012)

## 1. INTRODUCTION

### 1.1. Purpose of the document

The purpose of this document is to make a preliminary assessment of the facilities that could be integrated in a NFFA Demonstrator Phase as a first implementation of NFFA possibly submitted to the I3 call of FP7-WP-2012.

### 1.2. Application Area

The targets of this document are the members of the NFFA Project, the EC Project Officers, and the general public.

### 1.3. Sources

Description of Work (DoW). See at web site:
http://www.nffa.eu/UserFiles/file/Annex_I_DoW.pdf

The chapters of this document have been written by authors from various NFFA partner institutions. The authors are given in the respective chapters. In-house sources contributed to the technical information about the nanocentres described. Also information has been retrieved from their websites. Where appropriate, the links are given in the respective chapters.

#### 1.3.1. Objective of Work Package 4

The Objective of WP4 is to: (i) define the mission and the general structure of the future NFFA-RI, including general management of the central RI and of the local facilities, access criteria via quick international review of projects; (ii) to develop schemes for implementing a NFFA-RI repository of data and protocols and to make it available to the general users; (iii) to develop schemes for remote use of NFFA-R; (iv) to set quality standards of production; and (v) to define efficient users' access.

#### 1.3.2. Description of work broken down into tasks

Description of work broken down into tasks. Among the different tasks defined in WP4, this deliverable concerns specifically to T4.5): to assess possible agreements between NFFA-RI and other existing facilities for sharing/using instrumentation and services as well as for channelling knowledge. The deliverable will be a scheme for sharing facilities between NFFA-RI and other institutions interested in exchanging services and sharing costs for equipment and operation.

## 2. EXECUTIVE SUMMARY

A first implementation of NFFA is foreseen as an INTEGRATION, INTERNATIONALIZATION; INITIATIVE of WP-2012 of FP7. To this effect a Topic has been proposed that is included in the preliminary list of topics of WP-2012 that will be finalized and approved on April 1$^{st}$ 2011.

We analyze here the set of facilities, belonging to the NFFA DS partners, that could constitute the basis of the DEMONSTRATOR PHASE allowing the NFFA modus operandi to be implemented and tested for 3-4 years with FP7 support towards the open access and towards the implementation of the technical basis of NFFA, including the common metrology and the data repository.

The I3 project will be open also to other laboratories, currently not involved in NFFA DS, but sharing the characteristics of being co-located with large facilities for fine analysis of matter and capable of offering open access according with the criteria developed in the NFFA Design Study. A short list of such laboratories is give at the end of this text.

The analysis makes reference to what described in D3.7, but it is restricted to the subset of facilities that could operate effectively the DEMONSTRATOR PHASE, i.e. to implement the NFFA operation within the restricted financial potential of a I3 contract.

The Demonstrator will imply that specific agreements with the Large Scale Facilities will be set up in order to integrate the open access to the beamlines belonging to LSFs into the NFFA users programme. This may be implemented by adopting the BAG system (see User Access).

## 3. CURRENT FACILITIES AT NFFA PARTNER INSTITUTIONS

### 3.1 Laboratory for Micro- and Nanotechnology, Paul Scherrer Institut, Switzerland

The Laboratory for Micro- and Nanotechnology (LMN) as part of the Paul Scherrer Institute is co-located with Switzerland's national large scale research facilities: PSI operates a modern synchrotron light source (SLS) and a spallation-based neutron source (SINQ), both installations mainly being used for materials science through a large number of external and internal users. An X-ray free electron laser facility (SwissFEL) is planned, and expected to go into operation in 2016. These facilities are open to external users based on a scientific proposal system, and give access to roughly 2000 individual users every year (about 4000 user visits per year).

In this environment, including the scientific community as well as infrastructure such as a User Office and a Guest House, LMN is ideally placed to participate in a DEMONSTRATOR PHASE of NFFA. In addition, LMN's scientific topics are very closely linked to nanotechnology and fine analysis as detailed in T3.7, Therefore, LMN's own research activities, its strategic position as well as its user community clearly show a large overlap with the mission of the NFFA initiative.

At present, LMN does not operate in an open access scheme. However, a large number of users profit from LMN's technological capabilities and infrastructure, either through direct access, or in form of services provided by LMN staff to external users. A significant part of these users are at the same time registered in the digital user office of PSI's large scale facilities.

#### 3.1.1 Infrastructure, Equipment, Capacity of Integration/Open Access

In the following we outline to what degree the use of LMN's infrastructure as listed in D3.7 could be extended within the financial potential of an I3 contract to satisfy the needs of external users in a DEMONSTRATOR PHASE of NFFA.

**Clean room, lab space, and office space infrastructure**

LMN runs class 100 clean room laboratories with a total size of about 500 m$^2$ in addition to several other labs. It hosts approximately 45 - 50 people, where scientists on permanent positions, postdoctoral researchers on temporal positions, students, and technical staff take approximately the same shares. In addition typically 5-10 external users have access to LMN's infrastructure on a regular base. In particular, the capacities of the clean room space are largely exhausted, and the building poses some restrictions to a significant extension of these capacities within the financial potential of an I3 contract. However, it seems realistic to accommodate a reasonable number of additional external users to be present at LMN.

**Free capacity of equipment infrastructure**

The present load on LMN's equipment and technical infrastructure varies significantly. The following list shows to what extent it can accommodate additional users at its present state (column 2) and within the financial limitations of an I3 contract (column 3). The numbers are based on a 10 hrs/day, 5 days/week operation mode, unless otherwise indicated.

| DAILY HOURS AVAILABLE FOR EXTERNAL USERS | | |
|---|---|---|
| | NO SIGN. EXTERNAL FUNDS | WITH ADDITIONAL EXTERNAL FUNDS |
| *DEPOSITION (spin-coating, wet & dry thermal oxidation, thermal evaporation, sputter-coating, LPCVD, PECVD, electroplating)* | **2** | **4** |
| *ETCHING: (wet etching, reactive ion etching (RIE), deep reactive ion etching (DRIE))* | **2** | **3** |
| *OPTICAL LITHOGRAPHY (mask aligners, Laser interference lithography (LIL))* | **0** | **1** |
| *EUV INTERFERENCE LITHOGRAPHY (Based on a 24 hrs/day, 7 days/week mode)* | **4** | **8** |
| *HIGH VOLTAGE E-BEAM LITHOGRAPHY (Based on a 24 hrs/day, 7 days/week mode)* | **1** | **1** |
| *LOW VOLTAGE E-BEAM LITHOGRAPHY (Based on a 24 hrs/day, 7 days/week mode)* | **4** | **8** |
| *NANOIMPRINT* | **1** | **3** |
| *FE-SCANNING ELECTRON MICROSCOPE* | **1** | **1** |
| *OTHER METROLOGY (light microscopy, UV/VIS/NIR spectroscopy, Photoluminescence, atomic force microscope (AFM), profileometers)* | **1** | **4** |
| *POLISHING, WIRE BONDING, DICING* | **1** | **2** |

### 3.1.2 Relevance to the NFFA Demonstrator Phase

The Laboratory for Micro- and Nanotechnology (LMN) as part of the Paul Scherrer Institute is well suited for a participation in a NFFA DEMONSTRATOR PHASE, as it is well embedded in an environment with experience with and infrastructure for external users (guest house, canteen, user office). An accommodation of additional external users in such a phase is realistic.

The highest impact could be provided by exploiting the free capacities in of some unique capabilities. In particular the high resolution lithography tools, i.e. EUV interference lithography and electron-beam are prone to attract external users due to their flexibility and wide spectrum of applications in nanoscience. The access capacity of some other technologies is limited, in as detailed above, which could be solved by upgrading the equipment capacity within such a DEMONSTRATOR PHASE.

## 3.2 Current facilities at STFC – Micro and Nanotechnology Centre, RAL

STFC's Micro and Nanotechnology Centre (MNTC) at the Rutherford Appleton Laboratory (RAL) was originally set-up as an academic photomask shop for UK HEIs and was unique in using only e-beam tools for pattern writing. Construction was approved in 1976 and the facility came on-line in July 1979.

Over the years MNTC has diversified its research, from processes devoted to mask-making, through semiconductor manufacturing techniques to now being STFC's MNT Centre. Rutherford Appleton Laboratory is located on the Harwell Science and Innovation Campus (HSIC). RAL has two Large Scale Facilities; ISIS (spallation neutron source) and the Central Laser Facility (CLF) and is also the major shareholder in the Diamond Light Source synchrotron – all located on HSIC. HSIC is located about 25 km south of Oxford and 75 km west of Heathrow airport.

MNTC has 25-30 members (full-time staff, visiting researchers, students) and operates in three modes; (a) in support of the local LSFs, (b) with universities on grant-funded research, and (c) with commercial companies. It has a wide portfolio of research projects and proposals for the future, ranging from biomedical to aeronautical. Examples include:

- nanofibres formed by electrospinning
- electroactive polymers
- microfluidics for microbioreactors, microlitre-scale SAXS sample cells*
- microcantilevers for a wide range of nanoscience applications
- "artificial materials" (e.g. meta materials, photonic structures);
- hydrogen storage materials^
- materials for fuel cells
- nano-imprinting to create application-specific surfaces to materials
- micro-targets for high power lasers[#]
- x-ray lenses*

* = in collaboration with Diamond
^ = in collaboration with ISIS
[#] = in collaboration with Central Laser Facility

### 3.2.1 Spin-in/spin-out companies

Over recent years MNTC has a good record for attracting companies as well as spinning-out new companies, including; Qudos, Applied Microengineering Ltd., Microvisk, Tip-Chip, The Electrospinning Company Ltd., and Oxensis. Some of these companies are co-located at HSIC and there processing equipment is available for use by RAL.

### 3.2.2 Equipment infrastructure

To make possible the research described above, MNTC has approximately 550 m$^2$ of cleanroom to Class 100 (ISO 5 classification), several other labs and semi-clean areas, and in-house equipment including:

- Deposition:
  - spin-coating
  - wet & dry thermal oxidation
  - sputter-coating
  - LPCVD
  - electro-deposition

- Etching:
  - wet etching
  - reactive ion etching (RIE)
  - deep reactive ion etching (DRIE)
- Optical lithography:
  - wafer stepper
  - mask aligner
- E-beam lithography
- Nanoimprint
- Screen and stencil printing
- Bonding
  - adhesive
  - anodic
  - direct (high & low temperature unique RADICAL activation)
  - eutectic
  - glass frit
  - thermo-compression
- Interconnect
  - high density indium bump-bonding
  - wire bonding
- Metrology:
  - scanning electron microscope (SEM)
  - scanning acoustic microscope (SAM)
  - atomic force microscope (AFM)
  - profileometer
  - non-contact (optical) thin film measurement
- Polishing and CMP
- Electro-spinning
- Centrifuge sedimentation of nanomaterials
- Powder-blasting
- Dicing

### 3.2.3 Possible available capacity for the "Demonstrator Phase" of NFFA

The standard working year at STFC for the equipment is based upon a 46 week year with 37 hours per week, the percentage of time which might be made available to the Demonstrator Phase of NFFA is given in Table 1 below. Subject to approval from senior management of STFC, a small percentage of time may be available with only minimal funding. Table 1 shows the percentage of time which would be available with external funding (for example, I3).

| Process type | % time (with external funding) |
|---|---|
| Deposition | 60 |
| Thermal processing | 40 (24/5) |
| Etch | 40 |
| Optical Lithography | 50 |
| E-beam Lithography | 40 (24/7) |
| Metrology | 50 |
| Experimental facilities (e.g. electrospinning, nanoimprint, centrifuge sedimentation) | 55 |
| Other (e.g. bonding, AFM, Polishing & CMP, powder blasting) | * |

**Table 1.** Process availability at MNTC.

Figures shown are based upon the standard year, except where shown (i.e. 24/7 indicates the equipment is available 24 hours per day, 7 days per week, 24/5 is 24 hours per day and 5 days per week)

* indicates services provided by spin-in companies as mentioned earlier and is subject their availability.

## 3.3 National Microelectronics Centre, Barcelona, Spain

The National Microelectronics Centre (CNM) is a research centre belonging to the Spanish High Council of Scientific Research (CSIC). It was created in 1985 and it is located within the Campus of the University Autonomous of Barcelona, close to the “ALBA” LSF, a synchrotron about to start operation. CNM’s activity is focused on devices, circuits and micro/nanosystems, based mostly but not exclusively on Silicon.

The activities of the CNM-IMB began in the year 1985 and today the centre gathers around 200 people and a bunch of different Laboratories and scientific /technical infrastructures, among them the Clean Room, core part of the so called CNM - ICTS “CNM’s Infraestructura Cientifico Tecnologica Singular” (one of the two dozens of facilities recognised by the Spanish Government as National Facilities) integrated in the CNM, as main Laboratory. The Clean Room, recently expanded ad upgraded, has a total surface area of 1.500 square meters, in a h*ouse in house* structure, with Class 100-10.000 depending on the areas. It houses the equipment necessary to carry out the following processes:

- Thermal processes and CVD
- Ion Implantation
- PVD and Metallisation
- Lithography (proximity and stepper)
- Nano-lithography (electron beam, AFM and nano-imprint)
- Direct laser writing

- Dry etching
- Wet etching and cleaning
- Wet and dry micromachining
- Wafer grinding and Chemical Mechanical Planarization (CMP)

The main aspects of the technology offer available at ICTS are the following:
- Integrated micro-nano fabrication
- Fully operability in 100 mm wafers and partial in 150 mm wafers
- Many of the equipment are double to accommodate the processing of samples that may be considered contaminating from a CMOS perspective.

The operation modality of the ICTS's Clean Room is twofold from the point of view of the users:
- hands off access (samples and equipment are handled by in-house engineers/operators). This mostly applies to the microtechnology area.
- hands-on access (samples and equipment are handled by qualified users themselves). This mostly applies to the nanotechnology area (although hands-off access is also possible in this area).

### 3.3.1 Infrastructure, Equipment, Capacity of Integration/Open Access

It is worth noticing that in addition to its own research lines, CNM already hosts a programme for Clean Room open access of external users. Within this programme, which is nationally funded, around 50, mostly short, projects are run every year. Granted users may be not only Spanish, but also European and Latin American. At current conditions CNM can still offer some capability to the Demonstrator Phase of NFFA. Nevertheless such offer can be significantly increased if external resources (I3-like) are obtained to fund such phase beyond the expected consumables. In the next table the CNM capability offer per facilities is shown under both circumstances (no significant external funding / external funding in the range of 400-500k€/year).

The table below shows the daily available usage hours that may be dedicated to additional external users' projects at the different facilities. The percentages in brackets indicate the maximum ratio of those hours over the total existing/resulting availability. Once deduced the consumables, most of the eventual external funds will be invested in hiring new personnel that may extend in 4-5 hours the effective Clean Room working hours, rather than in new equipment since CNM Clean Room has been recently upgraded.

Translating those hours into a number of users or users' projects would demand to know how involving those projects are, or to define an average user. Yearly, CNM performs around 500 micro-nanofabrication runs involving an average of 6 wafers and 10 single steps per run. If it is considered that a user project may demand 3 of those runs, a total number of 160 of such users are served every year. This means that provided that the associated consumable costs are covered, 15-20 external users could be presently supported. If those external funds are able to extend the working operator/equipment availability to 30-40%, then the total number of supported users would be 65-85.

| **MICROFACILITY** [DAILY HOURS AVAILABLE FOR EXTERNAL USERS] | | |
|---|---|---|
| | NO SIGN. EXTERNAL FUNDS | WITH EXTERNAL FUNDS |
| THERMAL PROC & CVD | **1** (10%) | **6** (40%) |
| IMPLANTATION | **2** (20%) | **7** (50%) |
| PVD AND METALLISATION | **1** (10%) | **6** (40%) |
| LITHOGRAPHY | **1** (10%) | **6** (40%) |
| DIRECT LASER WRITTING | **1** (10%) | **6** (40%) |
| DRY ETCH | **1** (10%) | **6** (40%) |
| WET ETCHING AND CLEANING | **1** (10%) | **6** (40%) |
| WET MICROMACHINING | **1** (10%) | **6** (40%) |
| GRINDING AND CMP | **2** (20%) | **7** (50%) |
| **NANOFACILITY** [DAILY HOURS AVAILABLE FOR EXTERNAL USERS] | | |
| | NO SIGN. EXTERNAL FUNDS | WITH EXTERNAL FUNDS |
| SEM | **5** (40%) | **9** (56%) |
| E-BEAM | **1** (8%) | **5** (30%) |
| FOCUSED ION BEAM | **3** (25%) | **7** (44%) |
| NANOIMPRINT LITHOGRAPHY | **7** (58%) | **11** (69%) |
| AFM | **1** (8%) | **5** (30%) |

**Table 2**

*1 hour daily will correspond roughly to ca. 230 hours yearly (46 weeks, 5 days per week)

## 3.4 IOM-CNR

IOM-CNR (Istituto Officina dei Materiali: Institute of the Materials Works of the National Research Council) has its roots in the National Facilities of the Commissioni Trasversali (Transversal Committees) of INFM (National Institute for the Physics of Matter) regarding Synchrotron Radiation Spectroscopy, Neutron Spectroscopy and Super-Calculus.

It was initially born as the TASC-INFM National Laboratory and located inside the Elettra synchrotron site as a facility for surface science, advanced catalysis and materials synthesis, has developed the scientific background for the bottom-up approach for the incoming nanotechnologies. Since the end of the ninety's a continuous investment in the field of lithography techniques and the top-down approach started. In this way self assembly as well as nano-fabrication and imprinting methodologies are used and investigated for continuous improvements.

The TASC Laboratory is now part of the wider institute IOM-CNR, whose actual facilities, including TASC (national laboratory on nanoscience and 6 beamlines on the Elettra storage ring), DEMOCRITOS (centre for research and development dedicated to computer simulation and modellization) and OGG (operative group at Grenoble dedicated to neutron spectroscopy at ILL and synchrotron radiation spectroscopy at ESRF) were dimensioned to support the Italian users.

The contributions of IOM to NFFA can be evaluated keeping in mind that an upgrade to European size is needed for all activities except of the beamlines that are already fully operating in open-access mode within general agreements with the LSFs (Elettra, ESRF, ILL).

Detailed information on instruments and their applications were given in the Deliverable 3.7 report. In the following we estimate the degree of possible integration and open-access offer that the existing IOM research laboratories can sustain in the framework of the NFFA Demonstrator Phase, provided personnel resources and operational costs towards open-access are covered by fresh cash resources.

### 3.4.1 Infrastructure, Equipment, Capacity of Integration/Open Access

Detailed information on instruments and their applications were given in the Deliverable 3.7 report. In the following we estimate the degree of possible integration and open-access offer that the EXISTING IOM research laboratories can sustain in the framework of the NFFA Demonstrator Phase, provided personnel resources and operational costs towards open-access are covered by fresh cash resources.

**Imaging**

- FEG-SEM: Scanning Electron Microscope — 6 hours/day*
- FEG-TEM: Transmission Electron Microscopy — 1-1.5 hours/day
- LT-STM: Low Temperature - Scanning Tunneling Microscope — 1.5 hours/day
- VT-STM: Variable Temperature – Fast Scanning Tunneling Microscope — 1.5 hours/day

**Analysis**

- XPS-XPD: X-ray photoemission spectroscopy and photoelectron diffraction — 1.5 hours/day
- IPES: Inverse PhotoEmission Spectroscopy — 0.5 hours/day
- Microluminescence — on demand**
- RRM: Renishaw Raman Microscope — on demand
- Low-temperature magnetotransport — 1 hours/day
- HRXRD: High Resolution X ray Diffraction — 6 hours/day
- Surface profiler: ALPHA-STEP 500 — on demand

**Micro-nano fabrication and manipulation**

- XBEAM: electron and ion beam combined lithography microscopy system — 1 hours/day
- Optical Lithography — on demand
- ICP: deep etching ICP — on demand
- Hot plates press — on demand
- OM-FSM: Optical Manipulation and Force Spectroscopy Microscope — on demand

**Growth and synthesis**

- MBE: Molecular Beam Epitaxy for III-V and II-VI materials — 1 hours/day
- HM-MBE: High Mobility Molecular Beam Epitaxy for III-V — 1.5 hours/day
- Sputtering — on demand
- Metal deposition by electron bombardment — on demand
- PECVD: Plasma Enhanced Chemical Vapour Deposition — on demand
- OxMBE: Oxide Molecular Beam Epitaxy — 0.5 hours/day
- PMCS: Pulsed Microplasma Cluster Source AMPHYRO — 1 hours/day
- Size-Selected Cluster Source — 2 hours/day

**Synchrotron light beamlines at Elettra:**

- ALOISA: Advanced Line for Overlayer Interface and Surface Analysis 0.5 hours/day
- APE: Advanced Photoemission Experiment 0.5 hours/day
- BACH: Beamline for Advanced diCHroism 0.5 hours/day
- BEAR: Bending Magnet for Absorption Emission and Reflectivity 0.5 hours/day
- GAPH: Gas Phase Photoemission 0.5 hours/day
- LILIT: Interdisciplinary Lithography Laboratory 4 hours/day
- SISSI: Infrared Spectroscopy in extreme conditions 0.5 hours/day

**Synchrotron light beamlines at ESRF:**

- GILDA: XAS, XAFS, EXAFS X-diffraction at hard X-ray energies 0.5 hours/day

**Neutron radiation beamlines at ILL**

- BRISP: Small Angle Inelastic Scattering. 0.5 hours/day
- IN13: thermal neutron backscattering spectrometer. 0.5 hours/day

**Modelling and Simulation**

- Quantum ESPRESSO on demand

** on demand: always available, only queue reservation constraints to observe

## 3.5 IBN at the Austrian Academy of Sciences, Graz, Austria

The Institute for Biophysics and Nanosystems Research (IBN) is located in Graz and operates the Austrian SAXS beamline as outstation at the Synchrotron Elettra, Trieste. The IBN (containing the majority of the staff and laboratory infrastructure) is located 280 km from the SAXS-beamline at Elettra, therefore it cannot serve as an example for a research institution that is physically closely connected to a large scale facility but can be considered as an example for an association with a LSF.

**Scheme of the IBN research areas:**

| Nanosystem Research | | Molecular Biophysics | |
|---|---|---|---|
| **Synchrotron SAXS** | **Physical Chemistry** | **Nano-Lipo** | **Functional Lipidomics** |
| **Methodological Developments**<br><br>**Synchrotron based Research In biology, material, science, chemistry & physics** | **Membranes**<br>Membrane Physics<br>Membranes at Interfaces<br><br>**Methodological Development**<br>Lab SAXS | **Lipoproteins**<br>**Liposomal Nanoparticles**<br>Lipid based Nanoparticles for Diagnosis and Therapy | **Antibiotics Resistance**<br><br>**Anti-Tumor Peptides**<br>Bio-interfaces<br>Peptides targeting PS |

**Table 3**

The IBN originates from research institutions with strong focus on X-ray structure research located in Graz and became part of the Austrian Academy of Sciences in 1974. The outstation for Synchrotron research started operating in 1995/96. The interdisciplinary scientific profile of the IBN on Nano- and Biophysical sciences was strongly shaped by the instrumental possibilities that X-rays provide on the nanoscale and by the access to synchrotron radiation at Elettra.

The IBN has at present about 30 members (including full-time staff, visiting researchers and students). Collaborations with scientific and industrial partners include the Technical University, Joanneum Research and the Medical University of Graz, in particular the Centre for Medical Research (ZMF). A close cooperation for instrumental development exists with the X-ray camera producing spin-off company HECUS. The international collaborations of the IBN are related to synchrotron research in the area of molecular Biophysics (Lipidomics, Membrane Physics, Peptides, …) and methodological development of in-situ synchrotron instrumentation for nanosystems characterization.

### 3.5.1 Equipped infrastructure at the IBN

**Standard laboratories for biochemical, analytical and crystallisation work**

**X-Ray Laboratories**

- Small- and wide angle X-ray cameras (SWAXS, Hecus XRS Graz, line collimation) with real-time read-out PSDs (position sensitive detectors) and autosampler for serial, high-throughput measurements.
- GISAXS-attachment for the analysis of surface-supported nanostructured films.
- Protein Crystallography Station
- Crystallisation robot (Oryx Robot, Douglas Instruments, UK)
- Particle size measurements (Zetasizer 3000 HAS, Malvern Instr. Ltd, Worcestershire, UK)

**Spectroscopy**

- Electron spin resonance spectrometer (EPR), Bruker ECS 106
- Fluorometer (Jobin-Yvon)

**Thermodynamics**

- Differential scanning microcalorimeters (VP-DSC, Microcal, Northampton, MA, USA) Temperature- and pressure-scanning densitometry (DSA 5000, A. Paar, Graz, Austria).
- Monolayer trough, custom-designed (MDT-Nanotechnology Corp., Moscow, Russia, Brewster Angle Microscope (BAM-2, NFT, Göttingen, Germany).

### 3.5.2 Infrastructure at the ELETTRA outstation

The SAXS beamline provides a chemistry lab with basic equipment for sample preparation and an X-ray lab source for off-line SAXS/WAXS characterisation measurements. Additionally the group operates a lab for microfluidics, including various pump systems, optical bench for characterization of microfluidic devices. Moreover the group has experience of manufacturing of bio- and nanomaterial films (by dip-, spin-coating and drop casting) and aerosol synthesis of nanopowders.

The *in-situ* instrumentation at the beamline is specialised for observing biological and chemical self-assembly processes in the size domain from 1 to 100 nm in the millisecond range. The equipment includes devices for controlled environments (temperature, humidity) and pressure jumps and standard equipment as *in-situ* furnaces and flow through capillaries.

The increasing throughput can be explained by hiring of additional personnel after subtracting of the additional consumables required for the external users. Translating the hours into user projects we expect a throughput of about 24 users year for the lab facilities and between 3 and 6 users/year for the synchrotron facility in case of no additional funding.

| **SAXS LAB** [DAILY HOURS AVAILABLE FOR EXTERNAL USERS] | | |
|---|---|---|
| | NO SIGN. EXTERNAL FUNDS | WITH EXTERNAL FUNDS |
| WET CHEMISTRY LAB | **1** (20%) | **2** (40%) |
| X-RAY LAB | **1** (20%) | **2** (40%) |
| MICROFLUIDICS LAB | **1** (10%) | **2** (20%) |
| SURFACE DEPOSITION LAB | **1** (10%) | **2** (20%) |
| **SAXS BEAMLINE** [DAILY HOURS YEARLY AVAILABLE FOR EXTERNAL USERS] | | |
| | NO SIGN. EXTERNAL FUNDS | WITH EXTERNAL FUNDS |
| SAXS BEAMLINE (BASED ON 5000 H YEARLY) | **250** (5%) | **500** (10%) |

**Table 4** Daily/yearly available usage hour at the different facilities for additional external user projects for the demonstrator phase (*1 hour daily will correspond roughly to ca. 230 hours yearly, i.e. 46 weeks, 5 days per week; the synchrotron operates 5000 h/year.)

# 4. OTHER POSSIBLE EUROPEAN INTEGRATION CANDIDATES

## 4.1 List of other potential candidate institutions to an Integration measure

In addition to the institutions within the NFFA consortium listed in D3.7, there are the following sites within Europe that have expertise in Nanotechnology and, collocated, Large Scale Facilities suitable for fine analysis:

- **Karlsruhe Institute of Technology (KIT), Germany**

The KIT, a joint institution of the Karlsruhe Research Centre and the University of Karlsruhe, has an excellent record in Micro- and Nanofabrication and Nanoscience. On the campus of the Karlsruhe Research Centre, KIT operates the ANKA synchrotron including various analytical beam lines foe materials science and life science.

- **Lund University, Sweden**

Lund University runs state-of-the-art laboratories including clean room facilities for nanofabrication and the National Laboratory for Synchrotron Radiation. In the near future, the European Spallation Neutron Source ESS will be built in direct vicinity.

- **Grenoble, France**

Inside the Polygone Scientifique in the south of Grenoble, two of Europe's major Large Scale Facilities are operated: the European Synchrotron Facility ESRF and the neutron reactor Institut Laue Langevin ILL. Europe's flagship laboratory for basic research in molecular biology the European the European Molecular Biology Laboratory (EMBL) is located at the same site. In the direct vicinity of these European facilities, the Grenoble Institute of Technology and the CEA jointly run one of the world's largest nanotechnology laboratories MINATEC, comprising 10'000 square meters of clean room space.