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DELIVERABLE REPORT

WP2 MGT2 - Pilot scheme for the management of a distributed research infrastructure offering harmonized, interoperable and integrated services

D2.3
First assessment of access provision

Due date

M22

This initiative has received funding from the EU's H2020 framework program for research and innovation under grant agreement n. 101007417, NFFA-Europe Pilot Project

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Analysis of the demand, of the use of the IDRIN and of new potential developments

DUE DATE	ACTUAL SUBMISSION DATE
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NATURE

☒ R - Report

☐ P - Prototype

☐ DEC - Websites, Patent filing, Press & media actions, Videos, etc

☐ O - Other

DISSEMINATION LEVEL

☒ P - Public

☐ PP - Restricted to other programme participants & EC: (Specify)

☐ RE - Restricted to a group (Specify)

☐ CO - Confidential, only for members of the consortium

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1. EXECUTIVE SUMMARY

After **four quarterly calls**, NEP has received **about 150 proposals** from institutions from **35 different countries**. About **60%** of those proposals have been **granted access** to **80%** of NEP beneficiaries making use of **half of the techniques** offered in the NEP catalogue. The evaluation of proposals in terms of eligibility, feasibility and scientific merit has followed the already well-oiled procedure of former NFFA with TLNet and ARP as main actors.

The granted access amounts to **1282 Units of Access (UoA)**, which represents **26%** of the committed NEP offer. Since about sixteen calls are foreseen during the action lifetime, it can be considered that the demand received and the success rate associated to the evaluation procedure is adequate for the capacity mobilized by NEP.

The NEP catalogue is arranged around **six different installations** (**all have received demand**) covering collectively up to **43 different families of techniques** (**90%** of them have received demand). NEP capacity has been pre-distributed with a tentative split of UoA among the six installations and among the different beneficiaries/providers; no pre-arrangement has been defined for the relative weight of the different families of techniques, though. Details on installations, families of techniques and providers are given in section 2. Quantitative access data of the first four calls, and the assessment of how these installations, families of techniques and providers have fared in terms of access (demand, success rates…) is covered in section 3.

NEP contemplates a couple of capacity redistribution exercises at installation and provider levels. Section 4 covers further insights on how to adapt or re-steer NEP original provisions about access capacity to the demand obtained so far. It also has an open window of opportunity to extend the catalogue to newer directions. In terms of technical outreach, NEP has already increased its presence in the engineering, chemical and biological domains, as intended, but there are technical possiblities in the catalogue related to those areas that remain untapped. At this stage, it is considered better to consolidate the access to those communities to better exploit the current catalogue before attempting to reach any other new ones.

2. PREMISE

WP2 aims at optimizing the implementation of all access-related activities leading to integration and interoperability of a single Interoperable Distributed Research Infrastructure for Nanoscience (IDRIN). Optimization of user access experience, effectiveness of usage of the infrastructure and scientific output are the ultimate goals. To this effect, a continuous monitoring scheme for a smooth and harmonized operation is being put in place. Careful monitoring of the user proposals wallow identifying the scientific trends in user needs. Scientific outcomes are monitored and analyzed, both in terms of scientific publication and scientific data made available. To this effect one of its tasks is the technical and operational continuous upgrade of the IDRIN to better serve an expanding user community and to set the basis of an evolutionary model for an advanced and sustainable distributed research infrastructure.

Particularly, this deliverable originates from task 2.5 (*Technical and scientific evolution of the IDRIN*). It foresees the analysis of the use of the TA-VA infrastructure and its scientific outcome as a whole, identifying new user communities to be targeted and preparing the calls for additional providers.

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The collective effort of TA-VA WP leaders, as well as the TLNet, contributes to the evaluation the scientific use of the distributed installations, identifying capacity criticalities if any, and/or capturing new science opportunities to be supported by the offer to the nanoscience users. As a result, it is foreseen that the NEP catalogue undergoes periodical revisions giving an answer to both (i) identified unmet qualitative needs of users and (ii) quantitative needs resulting from oversubscription of the current capacity.

2.1 List of Techniques

As of today (month 22), the NEP TA catalogue is arranged in six installations, each one comprising several families of techniques totaling up to 178 individual techniques:

- 1: Lithography and Nano-patterning installation, **L&P** (18 techniques):
  - scanning probe lithography
  - patterning, replication, and sample navigation
  - electron and ion beam lithography
  - synchrotron-based lithography
  - photon-based lithography
- 2: Growth and Synthesis installation, **G&S** (20):
  - Chemical deposition of thin films.
  - Physical deposition of thin films.
  - Soft matter synthesis.
  - Synthesis of nanoparticles.
  - Thermal treatments.
- 3: Structural and Morphological Characterization installation, **SM Charact**. (40):
  - Dispersed-phases characterisation
  - Scanning probe microscopy
  - Electron and ion beam technologies
  - Light and acoustic microscopy
  - Neutron characterisation
  - HF magnetic field imaging
  - Surface/overlayer/interface characterisation
  - X-ray analysis
- 4: Electronic, Chemical and Magnetic Characterization installation, **ECM Charact.** (40):
  - Magnetic characterization
  - Neutron magnetic characterization
  - X-ray/soft-X-ray spectroscopy
  - Spectro-microscopy
  - Chemical analysis

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- Luminescence spectroscopy
- Electron spectroscopy
- Optical spectroscopy

➢ 5: Nano to micro/macro installation, **Ntmm** (54):

- Microfabrication
- 3D shaping
- Thick films and coatings
- Synthesis of dispersed phases
- 2D/3D bioprinting
- In vitro assays and cell analysis
- Biomolecules and biomaterials analysis
- Rheology analysis
- Mechanical analysis
- Thermal analysis
- Electrical analysis

➢ 6: Theory and Simulation installation, **T&S** (6):

- Structural and ground state electronic properties (SGSEP)
- Magnetic properties (MP)
- Excited state properties (ESP)
- Multiscale modeling of materials under extreme irradiation (MMMEI)
- Atoms and molecules in motion (AMM)
- Transport properties (TP)

Further information can be consulted at https://www.nffa.eu/offer/

2.2 List of Providers

Table 2 lists all the providers involved in NEP and the techniques offered at their sites. A given beneficiary may participate with different provider's sites (those in italics correspond to associated *Third Parties Against Payment*).

Table 1: List of providers

ACCESS PROVIDER	SHORT NAME OF INFRASTRUCTURE	OFFERED TECHNIQUES
CNR	IOM (TS) + (PG)	1: ICP, RIE, NIL, EBL, FIB, UV-IL 2: CVD, MBE, PLD, SSR 3: SEM, TEM / AFM, STM / XRD 4: MT, MOKE / IOS, XAS lsf, XMCD/XMLD / XPS, XPS lsf, ARPES, RESPED/RESPES, UPS / Pump-Probe - IPES, MOKE, BLS, RS 5: ECD, Standard depos., Standard etching, UVL, UV-SL / CCF, DH / OM 6: SGSEP, MP, ESP, AMM, TP (Quantum ESPRESSO package)

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	ISM	4: ML, PL, Pump-Probe, OS 6: SGSEP, MP, ESP, MMMEI (YAMBO package)
	DSCTM	2: ALS, CVD, GM, MS, PVDS, TE, TP 3: SEM, TEM / AFM, STM / NMR / XRD, SAXS* / CM /DLS, ζ-potential, UAC / ITCAM, BET, PA 4: HPLC, FTIR, XPS 5: FDM, Slip Casting, SLS / ARC, Ink-jet, SALbL, SS&RP, Tape Casting / DNP, EoC, FF / 3DBP / MM, Thixotropy, Viscosity / MP, TDA, TMP / DSC, HTM, STG-DSC-DTA, TC/D, TGA / (HTEC), TP
	ELETTRA	3: EXAFS-XAFS 4: DIPROI-FEL, XAS lsf / XPEEM/KPEEM/SPEM / FTIR
	UNI NAMUR	3: IBA, SIMS 4: XPS
CEA	LETI	3: SEM, TEM, FIB sample preparation for TEM, SIM, APT / AFM / XRT, XRD 4: AES/SAM, XPEEM/KPEEM/SPEM, CL, PL, XPS, UPS, Ellipsometry, RS, FTIR
CNRS	C2N	1: ICP, RIE, NIL, HE-FIB, EBL, FIB, TWL 2: ALD, CVD, EBE, MS, MBE, TE, TP 3: SEM, TEM / AFM / XRD 4: CL, ML, PL, Ellipsometry, RS, FTIR 5: ECD, Standard depos., Standard etching, UVL
	SOLEIL	3: XRT, XRM, XRI, XRD, SAXS 4: IXS, IOS, XAS, XMCD/XMLD / XPEEM/KPEEM/SPEM, SPELEEM / ARPES, XPS lsf
CSIC	CNM	1: AFML, ICP, NIL, BCL, EBL, FIB 2: ALD, CVD, GBM, SMP, TP 3: SEM, FIB preparation for TEM/ AFM / CM, OTFM 4: Ellipsometry, RS, FTIR 5: CD&P, DWL, ECD, I&GLS, II, SOTP, Standard depos., Standard etching, UVL / Ink-jet / MET, RF-VNAC
	ICMAB	1: RIE, EBL, SM-DWL 2: ALD, CSD, MS, MBE, PLD, TE, SMP, GIN, SP, TP 3: XRD / FM / DLS, WAS, NPTA, ζ-potential / ITCAM, BET 4: MFDC, EPR, SQUID, Magnetometry, MT, MOKE, Ellipsometry, RS, FTIR, OS 5: DWL, Standard depos., Standard etching, UVL / CCF, INA / Viscosity / DSC, TGA 6: AMM (LAMMPS package)
	ICMM	2: MICS 4: UPS, UHV-RAIRS, FTIR, XPS
	ALBA	3: XRM, XRD, SAXS, XRR, EXAS-XAFS 4: IOS, XAS, XMCD/XMLD / XPEEM/KPEEM/SPEM / UHV-RAIRS, FTIR / ARPES, XPS lsf
	CIC-BIOMAGUNE	3: AFM / TEM / NMR / LSCM

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		4: XPS, ICP-MS, FCS, FS, RS 5: CCF, FC / QCMB / IC
	IREC	2: ALD 4: Ellipsometry, RS
DESY	NanoLab (+ PETRA III)	1: NOT&P 3: SEM / AFM, STM / XRD, SAXS 4: IXS, XAS / UHV-RAIRS/ XPS, XPS lsf
EPFL	EPFL	6: SGSEP, MP, ESP, AMM, TP (Quantum ESPRESSO and AIIDA packages)
FORTH	FORTH	1: ICP, RIE, EBL, TWL 2: ALD, CVD, MBE, PLD, SMP, GIN, SP, SSR 3: SEM / AFM / CM, LSCM, FM, NLM, OAM, OTFM DLS, WAS, ζ-potential / ITCAM / XRD, XRR 4: MFDC, SQUID, Magnetometry, HSI, MSI, ML, PL, Pump-Probe, UHV-RAIRS, RS, FTIR, OS 5: Standard depos., Standard etching, UV-SL / LSIVP / DNP, EoC, FF / CCF, LCI / Elisa- PR / DSC, TGA / MET, RF-VNAC 6: MMMEI
FZJ	MLZ	2: MBE 3: TEM, Cryo-TEM / AFM / Neutron diffraction, Neutron imaging, Neutron reflectivity, SANS 4: DNS, M-SANS, MNREFL 6: SGSEP, MP, ESP, AMM, TP (Fleur package)
ICN2	ICN2	1: ICP, RIE, EBL 2: EBE, PLD 3: SEM, TEM / XRD 4: ARPES, PS, FTIR, OS, XPS 5: Standard depos., Standard etching, UVL 6: SGSEP, MP, ESP, AMM, TP (SIESTA package)
INL	INL	1: ICP, RIE, NIL, EBL, FIB, SM-DWL 2: CVD, GBM, MS, PVDS 3: SEM, TEM, Cryo-TEM, FIB sample preparation for TEM 4: UPS, XPS
	INESC-MN	1: RIE, IBE, EBL, UV-IL 2: CVD, GBM, MS, PVED SMP FLA, TP 3: SEM / AFM / XRD / FM / SDI 4: Magnetometry, MT, Ellipsometry 5: D&P, DWL, ECD, Standard depos., Standard etching, UVL
JRC	ISPRA	3: SEM, TEM, SIMS / AFM / DLS, DCS, UAC, MALS, AFFF / BET / XRD 4: HPLC, ICP-MS, TR-XRF, FS, RS, FTIR, XPS 5: MS / (MHCACC), FC, INA, MHCACC / CD, DNAMS, Elisa-PR, QCMB, RT PCR, SPRB
KIT	KIT	1: DPN, RIE, HE-FIB, EBL, FIB, DXRL, SM-DWL 2: ALD 3: TEM, APT, SIMS / AFM, STM / XRI, XRD 4: XAS, XMCD/XMLD / XPEEM/KPEEM/SPEM /XPS lsf

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LU	LNL (+Nchrem)	1: ICP, RIE, NIL, EBL, FIB, SM-DWL, DTL 2: ALD, CVD, MS, TE, AD, FLA 3: SEM, TEM / AFM / XRD 5: 3DMP
	MAX IV	4: SPELEEM, Ellipsometry
PSI	LMN/SYN	1: ICP, RIE, NIL, EBL, SM-DWL, DTL, TWL, EUV-IL 2: ALD, EBE, TE 3: SEM / AFM, STM / OTFM / XRM / XRD 4: IXS, XAS, XMCD/XMLD / XPEEM/KPEEM/SPEM / RESPED/RESPES, ARPES, XPS, XPS lsf / OS 5: DWL, ECD, Standard depos., Standard etching, UVL
TUG	TUG	1: DXRL 3: DLS, WAS / SAXS 4: UHV-RAIRS, FTIR, OS
UAB	UAB	3: SEM / TEM / Cryo-TEM / CM, LSCM
UMIL	LFM	2: CBD, FSP 3: AFM
UNG	UNG	4: ARPES, Pump-Probe, XPS 6: SGSEP, MP, ESP, AMM, TP (YAMBO, Octupus, LAMMPS, LODIS, SAPPHIRE, Transiesta packages)
ENL nodes	IMM, NANOTEC + FEMTO-ST, IEMN, LTM, LAAS + *POLIFAB, FBK, IMT, UT, CEITEC, MMI*	1: AFML, T-SPL, ICP, RIE, IBE, NIL, EBL, FIB, SM-DWL, UV-IL, TWL 2: ALD, CSD, CVD, GBM, EBE, MS, MBE, PLD, TE, MICS, SP, FLA, TP 3: SEM, TEM, FIB sample preparation for TEM, SIMS / AFM, STM / CM, FM, OTFM / ITCAM, PTRMS / XRD, XRR 4: MFDC, EPR, Magnetometry, MT, MOKE, XAS, AES/SAM, HPLC, AT, ICP-MS, TR-XRF, FS, CL, PL, IPES, RESPED/RESPES, XPS, UPS, Pump-Probe, UHV-RAIRS, Ellipsometry, RS, OS 5: CD&P, DWL, ECD, I&GLS, II, SOP, Standard depos., Standard etching, UVL / (IM), LSIVP / ARC, Ink-jet, SS&RP / (LCA), MP / DSC / EC, (HTEC), MET, MPET, RF-VNSAC

2.3 Access Procedure

NEP offers free-of-charge combined access to a wide portfolio of services to users. It offers the possibility to carry out comprehensive projects for multidisciplinary research at the nanoscale. Activities are performed in any of the aforementioned six different types of Installations. NFFA-Europe proposals must generally include access to more than one type of Installation and should not be restricted to LSF-based fine analysis only. Whenever possible, access is granted to a single NFFA-Europe site for all research steps. Access to more than one site for a given proposal is considered only when technically or scientifically justified. Multiple access to the same facility (facilities) under the same proposal cannot be supported beyond standard reimbursement limits.

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The Single Entry Point (SEP) on this portal provides the overall list of tools and methods available and is the portal to submit a proposal. Proposals can be submitted at any time but are periodically collected for scientific evaluation. These periodic collections are taking place on 1 March, 1 June, 1 September and 1 December each year. After submission, each proposal firstly undergoes a feasibility check by the NFFA facilities staff, coordinated by the Technical Liaison Network (TLNet), and if positively assessed, its scientific merit is, then, evaluated by an independent Access Review Panel (ARP). The best ranked proposals are assigned to the most appropriate NFFA-Europe site(s). Before submission, users can contact the TLNet for clarifying any technical doubts they might have and for refining the proposal.

3. TA ACCESS

3.1 ACCESS DATA

Calls and proposals

To date, **four calls** have been opened (with deadlines on Sep '21, Dec '21, Mar '22 and Jun '22) with an average of **38 proposals per call** (151 in total) and fully processed through the technical feasibility and scientific evaluation stages, and so they are be the basis for the analysis of demand.

97% of the proposals received were **eligible**. Roughly, **95% of the eligible** ones have been deemed **feasible** and **71% of these** have been deemed **scientifically apt** yielding an overall **65% success rate (67%** excluding the non-eligible**)**. From the **98 approved projects** in the first four calls, **nine have been cancelled** (one for user declining interest, one from a Russian user, and the rest due to provider overbooking).

Table 2: Requested and accepted proposals and units of access

	PROPOSALS		UNITS OF ACCESS	
CALL	REQUESTED	ACCEPTED / ASSIGNED	REQUESTED	ACCEPTED / ASSIGNED
1	51	33 / 32	882	519 / 480
2	38	22 / 21	542	324 / 323
3	33	24 / 20	429	333 / 272
4	29	19 / 16	376	258 / 207
Total	**151**	**98/89**	**2229**	**1434/1282**

Users

In terms of users, the 151 proposals **received** in the first 4 calls involved up to **355 users**. 224 out of them composed the user teams connected with the **approved** proposals (222 of them ended up signing the User Access Policy form) although not necessarily all of them travelled to the provider premises.

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Countries

In terms of country coverage, proposals from **35 countries** have been received in the first four calls open during the reported period:

- 21 from Member States (totalling 105 proposals),
- 6 from Associated Countries (totalling 18 proposals), and
- 8 non-European countries (totalling 28 proposals – Canada, China, India, Israel, Mongolia, Russia, UAE, USA).

Italy, Spain, India, UK, and Germany are the five countries requesting more proposals (approximately half of the total: 73 out of 151).

UoA and installations usage distribution

With regard to user demand and installations offer coverage, a first UoA distribution analysis has been performed. In terms of demand, **2229 UoA have been requested**, of which **1434 have been assigned** after the evaluation procedure. This represents a **64% success rate**, which is similar to the success rate at proposal level. The assigned UoA subtracting the ones of the cancelled projects are 1282, which is the value that is used for the capacity coverage analysis.

In order to have a more comprehensive image of overall user demand, this analysis has been done per installation. The six installations have been requested and afforded in relative fair agreement with the distribution of the capacity per installation originally defined in the Grant Agreement:

Table 3: Access performance at installation level

INSTALLATION	SUCCESS RATE (AV. 64%)	RELATIVE DEMAND	RELATIVE ASSIGNMENT	RELATIVE CAPACITY IN GA
Litho & Pattern	68%	11.8%	12.6%	16%
Growth & Synthesis	57%	12.0%	10.7%	16%
SM Characterization	70%	33.2%	36.3%	30%
ECM Characterization	66%	28.6%	29.4%	26%
Nano to micro/macro	49%	13.3%	10.1%	11%
Theory & Simulation	60%	1.1%	1.0%	1%
		100%	*100%*	*100%*

In orange colour, those values diverging by more -20% of the expected average in relative terms; in blue, those diverging by more than +20%

The difference between the relative demand and assignment for every installation obeys to their different success rates in the evaluation procedure that ranges from 70% for SM Characterization to 49% for Nano to micro/macro.

In any case, the characterization block (SM and ECM installations) is the most demanded (62%) and assigned (65%), while Growth & Synthesis is the one lagging behind more significantly in assignment.

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UoA and installations capacity coverage

It must be noted that the upfront total capacity of the NEP consortium is 4925 UoA, so the currently assigned UoA represent **26% of the foreseen total offer**, which is virtually matching the UoA consumption rate expectation since 16 total calls are foreseen (25%). With this figure in mind, and according to the results summarized in the next table, the relative installations coverage mostly replicates the observations of the previous paragraph: Growth & Synthesis is slightly below expectations, while SM Characterization is significantly above.

(For Theory & Simulation, 1 UoA means one full project, while for the experimental installations 1 UoA stands for an 8h-shift of work)

Table 4: Capacity coverage at installation level

INSTALLATION	CAPACITY IN GA	CAPACITY COVERAGE	EXPECTED COVERAGE
Lithography & Patterning	809	20%	25%
Growth & Synthesis	770	18%	
SM Characterization	1498	32%	
ECM Characterization	1257	29%	
Nano to micro/macro	546	24%	
Theory & Simulation	45	29%	
All installations	**4925**	**26%**	

In orange colour, those values diverging by more than -20% of the expected average in relative terms; in blue, those diverging by more than+20%

UoA balance (requested/assigned)

Although **53%** of the proposals were corrected in terms of the UoA after the feasibility evaluation, only **21%** required corrections larger than 20% of UoA. Moreover, the number of UoA corrected upwards was similar to the ones corrected downwards, so the finally 1434 assigned UoA represented 109% of the UoA demanded (1318) by the positively evaluated proposals.

Special cases: large scale facilities demand

38 out of the **151** received proposals included techniques to be performed at LSF, what it is in accordance to the spirit of NFFA. They represent **25%**. In terms of approved proposals, this percentage increases to 31% (28 out of 90 proposals) since the success rate of this type of proposals is 73%, which is higher than the average for all proposals (64%)

Special cases: industry interest

18 of the **151** received proposals were submitted by industrial organizations or proxies. They represent **12%**. In terms of approved proposals this percentage decreases to 8% (seven out of 90 proposals) because this type of proposals exhibit a success rate of **39%,** which is lower than the average for all proposals (**64%).**

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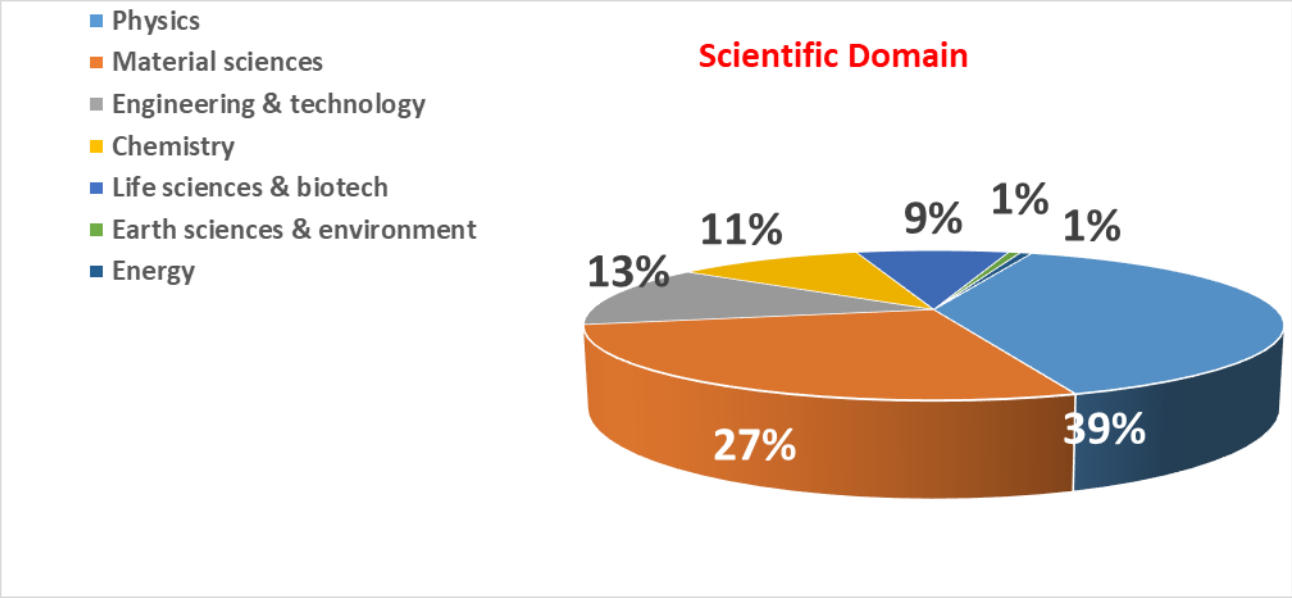
Proposals with **industry interest** and *asking for LSF techniques* have had a better success rate (60%) and represent **3%** of the received proposals and **3%** of the approved ones.

Scientific domain

A first analysis of the scientific distribution of the proposals is shown in the next figure according to the scientific domain the users identified when submitting them.



For comparison, in the previous NFFA project the declaration of the activity domain was as follows:

- Physics: 38%; Material Sciences: 35%; Engineering & technology:11%; Chemistry: 6.5%; Life sciences & biotech: 5%; Other: 4.5%

This means that apparently the engineering, chemical and biological domains are getting more attention in NEP as initially intended (**33%** vs **22.5%)**

3.2 Demanded Techniques

Table 3 summarizes the number of techniques offered at the different families of all installations, as well as the number of techniques demanded and assigned after the first four calls.

Out of the **43** families of techniques offered, only **four** have received not demand at all:

- Scanning probe lithography from L&P
- HF magnetic field imaging from SM Charact (involves only NMR)
- 2D/3D bioprinting from Ntmm
- Transport Properties from T&S

while **two** others, despite receiving demand, were not successful in terms of assignment:

- Mechanical analysis from Ntmm
- Electrical analysis from Ntmm.

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In addition, **seven** other families received demand for less than half of the techniques offered, namely:

- Photon-based lithography from L&P
- Dispersed-phases characterization from SM Charact.
- Surface/overlayer/interface characterization from SM Charact.
- X-ray analysis from SM Charact.
- Chemical analysis from ECM Charact.
- Thick films and coatings from Ntmm
- Biomolecules and biomaterials analysis from Ntmm

In terms of individual techniques, **97** techniques out of the **178** offered have received demand (55%), and **80** of them have been assigned (45%).

Only the Nano to micro/macro installation has received demand for less than half of the offered techniques (39%)

More specific information at installation level can be found in deliverables D3.1, D4.1, D5.1, D6.1, D7.1, D8.1.

(For the Theory & Simulation installation, 'family of techniques' equals 'techniques')

Table 5. Requested and assigned demand per technique and family of techniques

INSTALLATION FAMILIES OF TECHNIQUES	# TECHS OFFERED	# TECHS DEMANDED	# TECHS ASSIGNED
L&P			
Scanning probe lithography	3	0	0
Patterning, replication, and sample navigation	6	6	5
Electron and ion beam lithography	3	3	3
Synchrotron-based lithography	2	1	1
Photon-based lithography	4	1	1
G&S			
Chemical deposition of thin films	4	3	2
Physical deposition of thin films	6	4	3
Soft matter preparation	1	1	1
Synthesis of nanoparticles	5	3	3
Thermal Treatments	4	2	1
SM Charact			
Scanning probe microscopy	2	2	2
Electron and ion beam technologies	7	7	7
HF magnetic field imaging	1	0	0
Dispersed-phases characterisation	8	2	2
Light and acoustic microscopy	6	3	3

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Surface/overlayer/interface characterisation	5	1	1
Neutron characterisation (Methods currently unavailable)	4	2	2
X-ray analysis	7	2	2
ECM Charact			
Magnetic Characterization	6	4	3
Neutron Magnetic characterisation	3	2	1
X-ray/soft-X-ray spectroscopy	5	3	3
Spectro-microscopy techniques	5	3	3
Chemical analysis	3	1	1
Luminescence spectroscopy	6	5	4
Electron spectroscopy	5	4	2
Optical spectroscopy	7	6	6
Ntmm			
Microfabrication	10	4	3
Thick films and coatings	5	1	1
3D Shaping	5	2	1
Synthesis of dispersed phases	3	3	1
2D/3D bioprinting	2	0	0
In vitro assays and cell analysis	5	3	3
Biomolecules and biomaterials analysis	7	1	1
Rheology analysis	3	1	1
Mechanical analysis	3	2	0
Thermal analysis	6	3	2
Electrical analysis	5	1	0
T&S			
Structural and ground state electronic properties	1	1	1
Magnetic properties	1	1	1
Excited state properties	1	1	1

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Multiscale modeling of materials under extreme irradiation	1	1	1
Atoms and molecules in motion	1	1	1
Transport properties	1	0	0

In orange colour, those families for which less than half of the offered techniques have received demand; in darker grey, those cases with zero demand or zero assignment.

3.3 Provider Involvement

The involvement of beneficiaries (and related internal providers) has varied in intensity in the first four calls depending on how well the demand matched the particular offers and the criteria that were followed for ascribing assignment in cases of multiple matching offers.

Table 4 summarizes such results when all installations are considered globally. Partial results per installation can be consulted in D3.1, D4.1, D5.1, D6.1, D7.1, D8.1.

Given the number of total calls foreseen in NEP, the average involvement in terms of capacity coverage would be 25% after four calls.

There are three beneficiaries showing a coverage exceeding such average by more than an extra absolute 12.5% (deviance of 50% of the expected coverage), which are highlighted in light blue in the table: CNR (43%), FORTH (51%), PSI (43%).

Conversely, there are seven beneficiaries whose coverage is below the average by a similar (negative) percentage; they are highlighted either in light brown, INL (5%), JRC (7%) and LUND (8%), or light grey, if they have not offered any access so far: EPFL, ESRF, UAB, UNG.

The same color code has been applied for the different providers since internal differences may developed for multi-site beneficiaries.

Table 6. Requested and assigned units of access, total capacity and % capacity coverage for all providers

ACCESS PROVIDER SHORT NAME	SHORT NAME OF INFRASTRUCTURE	UNIT OF ACCESS ASSIGNED	UNIT OF ACCESS CAPACITY	% CAPACITY COVERAGE
CNR	IOM (TS) + (PG) + (ISM)	265	620	43
	DSCTM	20	160	13
	Elettra	6	80	8
	Uni-Namur	5	60	8
CEA	LETI	44	240	18
CNRS	C2N	46	227	20
	Soleil	32	76	42
CSIC	CNM	24	110	22
	ICMAB	52	241	21
	ICMM	34	70	49
	CIC-biomaGUNE	20	100	20
	Alba	20	44	45
	IREC	0	80	0

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DESY	NanoLab+Petra III	31	145	21
EPFL	EPFL	0	4	0
ESRF	ESRF	0	36	0
FORTH	FORTH	259	505	51
FZJ	MLZ	58	177	33
ICN2	ICN2	63	228	28
INL	INL	14	135	10
	INESC-MN	0	140	0
JRC	ISPRA	15	210	7
KIT	KIT	36	155	23
LU	LNL+nCHREM+ MAX iV	11	131	8
PSI	LMN + SYN	140	329	43
TUG	TUG	24	117	21
UAB	UAB	0	21	0
UMIL	LGM	16	121	13
UNG	UNG	0	45	0
ENL nodes	IMM, NANOTEC + FEMTO-ST, IEMN, LTM, LAAS + POLIFAB, FBK, IMT, UT, CEITEC, MMI	47	52 + 94 + 172	15

In orange colour, those values diverging by more than -12.5% (absolute) of the expected average; in blue, those diverging by more than+12.5%. In darker grey, beneficiaries/providers with zero offer so far.

4. ANALYSIS OF ACCESS PROVISION

After the first 4 calls, the coverage of NEP access capacity (26%) is matching expectations (25%) so the amount and rate with which proposals are being received and approved appear to be adequate. Nevertheless, attention shall be paid to the slight decreasing trend in received proposals (after a very successful first call, probably explained by the latency time between NFFA and NEP).

All six installations have received demand as well as 90% of all families of techniques included, although with different intensities. 80% of the beneficiaries have received demand at this stage, again with different intensities.

Regarding demand, the characterization block (SM and ECM characterization) is overperforming in terms of access according to initial provisions, while Growth & Synthesis is underperforming. This installation is getting less demand than expected and also suffering from a lower success rate in the evaluation process. In terms of success rate, though, the Nano to micro/macro installation is the one with the lowest, although the overall assigned access to it has not suffered because of its large initial demand. In any case, deviations in the access split among installations is going to prompt actions in the foreseen UoA redistribution exercises, with cascade results on the capacity allocation for the different beneficiaries.

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A joint exercise with the ARP would be also advisable in order to analyse the possible causes of the low success rate of particular types of proposals, as for instance those related to the Growth & Synthesis or the Nano to micro/macro installations (with close to 40% rejection of feasible UoA while the other experimental installations feature a 25% rejection rate) or those labelled as of industrial interest (with a 44% rejection of proposals compared to an average 25% for non-industry related proposals). This will help to identify actions to improve the appraisal of such proposals by the evaluators and/or devise recommendations for the users to improve the quality of those proposals.

In terms of families of techniques, just 10% of them did not received demand to date (while the percentage of them having not received *assignment* grows to just 15%). However, when speaking of individual techniques, there is an important number of them in the catalogue that have not yet received demand. There are two ways to react to this fact. One is to *adapt* the offer to the demand, decreasing the number of offered techniques by eliminating non-demanded techniques, and the other is to *spur* the demand of techniques less successful so far. At this stage of the project a mixed course of action seems wiser: since we are moving out of the pandemics, the intensity of dissemination activities has not been at the same level than in the previous NFFA, so there is room for a targeted effort, especially for those techniques that should appeal to the new communities considered in NEP; in addition, an analysis on the rationalization of the technique portfolio is being performed to identify redundancies.

There is no clear indication that there is a need to include new techniques in the NEP catalogue. The number of unfeasible proposals, which could mask some unmet needs from the users, is very low (5% of the eligible ones). It is difficult to identify lacks from within the catalogue, since we do not get demand of what is missing. A direct consultation will be performed to our user base to gather intelligence about they may find missing.

Additional comments follow on the impact and corrective measures regarding both extremes of demand: heavily demanded techniques and techniques attracting little attention.

Very demanded techniques

This particular set of techniques puts under certain stress the catalogue offer with implication in the capacity offered by the involved providers and the offer split among them, which should be brought to balance if it is not the case. If the demand for certain techniques exceeds the capacity collectively mobilized within the consortium, there may be need of additional extra-consortium capacity. This can be especially true for those techniques for which there is a single provider.

In the **L&P installation**, EUV-IL and TWL are the most demanded techniques followed by EBL and BCL. EUV-IL has been assigned exclusively to PSI, which is an oversubscribed provider for lsf lithography, since it is the only provider of EUV-IL in the consortium. However, given the scheduled shutdown of the PSI synchrotron in the 4th quarter of 2023 for about 2 years, this oversubscription is actually not problematic. PSI will probably be able to afford a few more shifts until the March 2023 call. Unfortunately, no other provider inside or outside the consortium (in Europe) can offer EUV-IL. Therefore, it is expected that the technique will become unavailable from the June 2023 call onwards and until the end of the synchrotron upgrade. Regarding TWL, there has been a large demand for this technique and a large number of shifts has been assigned to 2 of the 4 providers, namely PSI and FORTH. In the next calls, eligible proposals asking for TWL should be distributed equally among the providers (C2N and ENL are offering it, as well) to avoid extra burden on oversubscribed providers such as FORTH. EBL poses no risk at the moment, as it is a technique offered at a large number of providers. BCL should be monitored as it is provided at a single site (CSIC-CNM). There is no need at the moment to involve a new external provider, but if the high demand continues some

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measures should be taken, such as a redistribution of UoA. Finding an alternative external partner for this particular technique might not be straightforward as it is a technique that was developed at CSIC-CNM through the joint research activities of the previous NFFA.

The comparatively three more demanded techniques in the **G&S installation** are PLD, MBE, followed by MICS. For the first two techniques there are available several providers (from four to six) so a huge demand can be accommodated. The issue, even with highly demanded techniques, is if the particular material systems the users may be interested in are available at the sites providing such techniques. MICS, on the other hand, is provided only by CSIC-ICMM and it is a rather novel and special technique. Alternative partners may be hard to find. If this is case, the only solution is to modulate the internal distribution of NEP offer of this partner and evaluate if its global share could be increased if advisable; in any case, MICS demand will have to restrict to ICMM capability of delivering access.

For SM Characterization, TEM and SEM are the two more demanded techniques, but the offer base is large enough to not lead to criticalities and several providers also have extra capacity from less used techniques that they can offer. The situation is similar for XRD within the family X-ray analysis. However, in the case of STM, which is also highly demanded by users, it is important to observe the demand, since STM is only offered by three providers (CNR-TS, PSI, DESY and also ENL). Since these providers are each well demanded (especially CNR-TS and PSI), it should already be considered if another partner could offer STM. This could be also the case of NLM, which is only offered by FORTH, which is one of the providers that are consuming faster their initially allotted overall unit of access in NEP.

In the **EMC Characterization** installation, XPS, BLS, XAS and PL are the most demanded techniques. BLS is offered by a single provider (CNR-IOM/PG) so an additional reinforcement may be advisable. The situation of the other three techniques is non-critical since they are offered by several providers. PL should be watched, anyway, since two of their five providers are currently in an oversubscription path. In general terms, several providers at LSF facilities are oversubscribed, what should be considered in NEP internal redistribution exercises.

In the **Ntmm installation**, CCF and LSIVP are the most demanded techniques. To date they have been assigned to FORTH, which is an oversubscribed beneficiary. Proposals asking for CCF shall be addressed to already existing non-oversubscribed alternative providers (e.g. ICMAB, CIC-bioMAGUNE). FORTH and ENL are the only providers for LSIVP, so, if extra capacity would be needed beyond current capabilities, a possible new external provider(s) may be considered

In the **T&S installation**, SGSEP and AMM are the most demanded techniques but are virtually offered by all T&S providers, so the situation is controlled from a provider point of view and redistribution in case of oversubscription can be handled. No necessity of extra capacity is appreciated.

Families of techniques receiving 'little' attention

Those families of techniques receiving none or very little demand are summarized in section 3.2. Reaction to this situation would take n specific dissemination effort and the mobilization of the involved providers. With the exception of the G&S installation, the rest of them have some example of such families.

L&P hosts one of the families without demand so far (Scanning probe lithography) and one with poor demand (Photon-based lithography). In the first case, most probably our user base is not well acquainted with such techniques. Since they are offered by single providers, KIT, CNM and ENL, they should try to mobilize demand on their own, and NEP should consider them specifically in any

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dissemination effort. This can be extended to a technique, DXRL, that does not belong to any of the two troubled families but has got no demand yet and is provided only by TUG. On the other hand, UV-IL, DTL, and SM-DWL are the unsuccessful techniques of the Photon-based lithography. They are provided in more than one site (IOM, INESC, ENL, PSI, LUND) but have got no demand. The first two are techniques based in interference of light and may be competing with the very successful EUV-IL technique. The third is similar to DWL from the Ntmm (they involved the same machines). In both cases, it would be advisable to clarify the differences among those techniques in dissemination activities.

Within **SM Charact.**, there is one family of techniques without any request: "HF magnetic field imaging". It comprises only NMR, which is a new addition to the NEP catalogue. Although NMR is a versatile technology, it is possible that is not so readily combined with technologies in other installations (as required for an standard NEP proposal). If there is continued lack of demand, providers of this technique (CNR-DSCTM, CIC-bioMAGUNE and KIT) should hold discussions regarding possible reasons and solutions. There are other three families in this installation with less than half of their techniques requested. It is the case of "Surface/overlayer/interface characterization" which comprises five techniques of which only one (ITCAM) has been requested so far. The non-demanded technologies address a variety of forms of materials, from the quantitative determination of volatile organic compounds in air (PTMRS) to mass transport properties of low molecular weight compounds in polymeric materials (PA), the determination of nanoparticle size (BET) and the inspection of magnetic, electrical and defects in metal surfaces (SDI). When targeting dissemination activities to stimulate interest in these technologies, it is important to also consider how they may be combined with techniques in another installations. Special mobilization is required from CNR-DSCTM, ENL and INESC since they are the single providers of three of those techniques. Within the family "X-ray analysis", there are five unrequested techniques besides two XRD and SAXS, which profusely offered and in good demand. Those techniques are XRT, XRM, X-ray imaging, EXAFS/XAFS and X-ray Reflectivity. Here, the important providers to mobilise are SOLEIL, ALBA, ELETTRA, PSI, FORTH, ENL, and KIT. Finally, less than half of the techniques have been requested also within the family "Dispersed-phases characterization" – these technologies are applied to the characterisation of particle size, molecular mass, and investigate the distribution in a range of systems such as emulsions, suspensions or powders. In addition to the relatively oversubscribed provider FORTH, the on-average requested TUG and CSIC-ICMAB as well as the relatively undersubscribed partners JRC-ISPRA and CNR-DSCTM need to be mobilised to promote the use of these technologies by the target user community.

In **ECM Charact**., only one family appears to be not so demanded, 'Chemical analysis', for which only one ICP-MS) out of three techniques has been requested. AT (singly provided by ENL) and HPLC (provided by CNR-DSCTM and JRC-ISPRA) have received no demand, so those partners need to be mobilized.

The **Ntmm installation** hosts two of the families that have received demand for less than half of their techniques, one of the families that have received no demand at all, and the two, that having received demand, have not succeeded in getting assignment. Those families relate to the domains NEP wants to reinforce: microdevice making (Electrical analysis), chemistry (Mechanical analysis, Thick films and coatings) and the bio-domain (2D/3D bioprinting, Biomolecules and biomaterials analysis). This points to the need of better/targeted dissemination into those communities, and in the two last cases to the need of an effort from the newly added partners, mostly DSCTM and JRC-ISPRA, to spread the potential of their offered techniques and/or mobilize their collaborative networks.

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For **T&S**, the only non-demanded technique is TP (transport properties). Few requests for TP were also received in previous NFFA-Europe. Apparently, providers themselves are lately less involved scientifically in this technique. If deemed still of relevance a targeted effort is needed for encouraging potentially interested users to apply.

The above analysis has been made at the level of families of techniques. Details at technique level can be found in Annex I. Mobilization of providers is advisable for those techniques that have not received any access request (those techniques of the third column of table 7 that starts with '0/0'), especially for those techniques with a single provider

Provider involvement

The disparity of provider involvement demands analysis and reaction as well. Again, a mixed approach between *adapting* and *correcting* such disparity seems in order. Some capacity rearrangement among providers will follow in the coming months to rebalance their offer and demand. This rearrangement may have two dimensions, one *intra-partner*, readjusting the internal weights of the different installation's capacity in response to their relative success, and one *inter-partner* by enabling partial transfer of capacity from those partners less successful to those more successful. However, the overconcentration of access in some partners needs to be analysed, and the access assignment protocols should be revised to check if they are contributing to it. Indeed, access to some of such providers has been suspended in the late calls to avoid major disruptions in the redistribution exercises to come. Corrective measures to foster the balanced involvement of alternative providers already present in the consortium should be contemplated by

(i) reconsidering the assignments when different providers have a common offer in favour of the underused

(ii) encouraging the latter to stimulate the demand for their own portfolio, especially for those techniques they may be specialty providers.

Extended communities

One of the objectives of NEP is to overcome the boundaries of material aspects of nanoscience and nanotechnology and increase the appeal to users in the bio-domain, in the chemistry domain and in the device-making domain. For this reason, the catalogue has been populated with many techniques (especially, but not only, in the Nano to micro/macro installation) that could be interesting for those communities. A first order analysis of the scientific domains of the received proposals already points in a good direction when compared with previous NFFA (see section 3.1). However, many of the less demanded families of techniques identified in section 3.3, and discussed in the previous paragraphs, correspond to those fields, so much is still to be gained if demand is attracted by:

(i) a better concerted dissemination to stress NEP potential in those domains (starting by a friendlier introduction to those items in our website)

(ii) the activation of the networks of the beneficiaries providing such techniques (word of mouth was in fact very important for consolidating the original offer of NFFA)

Many of the relevant providers in these domains are new to NEP, so it is normal that it may take some time for them to align with access granting procedures. However, their mobilization is a must to succeed in generating demand. DSCTM in the chemical field and JRC-ISPRA in the biochemical / biological field are centric to this effort given their allotted capacity.

Another way to spur proposals looking for activities extending materials systems into tests structures and devices is to advantageously exploit those techniques labelled as 'standard' and that can be

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accessed remotely, which could ease the demand by attracting local user communities. Also, a temporary or permanent waiving of the two-installations internal rule for the Nano to micro/macro installation (as it has been done in the past for some special cases – theory proposals, and SMEs) may be considered, provided enough internal diversity is present in the proposals, which should not be a problem for an installation that already contains subsets of lithography and patterning, growth and synthesis and various characterization of techniques.

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ANNEX I – DEMAND & ACCESS AT TECHNIQUE LEVEL

Details are provided in the following table, whose information is arranged in the following way:

- 1st column (FAMILY) depicts the different families of techniques for the different installations.
- 2nd column (#TECHS) gives an indication of the coverage of techniques at each family by showing the number of techniques that has been requested / assigned (granted access) / and the total number of offered techniques in that family.
- 3rd column (#PARTNERS) gives an indication of the overall coverage of the providers involved at each family, technique by technique, by showing the number of providers that have received a request for a given technique / that have been assigned an access to do so / and the total of involved providers for each technique.
- 4th column (#PROPOSALS) gives an indication of the interest of a given technique at proposal level, by showing the number of proposals that requested a given technique / and the number of them that were finally assigned.
- 5th column (#UNITS OF ACCESS) gives an indication of the interest of a given technique at units of access level, by showing the number of UoA that have been requested for a given technique / and the number of them that were finally assigned.

Table 7. Requested and assigned demand per technique and family of techniques in terms of proposals and units of access

FAMILY	#TECHS REQUEST. /ASSIGN. /OFFER.	# PARTNER REQUEST. /ASSIGN. /OFFER.	# PROPOSALS REQUEST. /ASSIGN.	# UNITS OF ACCESS REQUEST. /ASSIGN.
L&P				
Scanning probe lithography	0/0/3	DPN 0/0/1 AFML 0/0/2 T-SPL 0/0/1		
Patterning, replication, and sample navigation	6/5/6	**RIE** 1/1/12 **IBM** 0/1/2 **NIL** 3/2/7 **BCL** 1/1/1 **NOT&P** 1/1/1 ICP 2/0/9	**RIE** 1/1 **IBM** 1/1 **NIL** 4/2 **BCL** 3/2 **NOT&P** 2/2 ICP 3/0	**RIE** 2/2 **IBM** 3/3 **NIL** 25/11 **BCL** 24/16 **NOT&P** 4/5 ICP 10/0
Electron and ion beam lithography	3/3/3	**He-FIB** 1/1/2 **EBL** 4/4/12 **FIB** 2/2/7	**He-FIB** 2/1 **EBL** 7/3 **FIB** 3/2	**He-FIB** 8/3 **EBL** 43/24 **FIB** 15/10
Synchrotron-based lithography	1/1/2	**EUV-IL** 1/1/1 DXRL 0/0/1	**EUV-IL** 3/3	**EUV-IL** 45/47
Photon-based lithography	1/1/4	**TWL** 2/2/4 SM-DWL 0/0/6 UV-IL 0/0/3 DTL 0/0/2	**TWL** 6/4	**TWL** 84/39

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G&S				
Chemical deposition of thin films	3/2/4	**ALD** 2/2/10 **CSD** 1/1/2 CVD 1/0/9 GBM 0/0/5	**ALD** 3/3 **CSD** 1/1 CVD 2/0	**ALD** 7/7 **CSD** 2/2 CVD 5/0
Physical deposition of thin films	4/3/6	**EBE** 2/1/4 **MBE** 2/2/6 **PLD** 3/2/5 MS 1/0/7 PVD 0/0/3 TE 0/0/5	**EBE** 3/1 **MBE** 9/4 **PLD** 8/3 MS 1/0	**EBE** 14/10 **MBE** 76/36 **PLD** 81/36 MS 7/0
Soft matter preparation	1/1/1	**SMP** 2/2/5	**SMP** 2/1	**SMP** 17/12
Synthesis of nanoparticles	3/3/5	**CBD** 1/1/1 **GIN** 1/1/2 **MICS** 1/1/2 AD 0/0/1 FSP 0/0/1	**CBD** 3/2 **GIN** 3/2 **MICS** 2/2	**CBD** 20/12 **GIN** 7/5 **MICS** 26/26
Thermal Treatments	2/1/4	**FLA** 2/1/3 TP 1/0/6 SP 0/0/4 SSR 0/0/2	**FLA** 3/1 TP 1/0	**FLA** 4/1 TP 1/0
SM Charact				
Scanning probe microscopy	2/2/2	**AFM** 9/7/18 **STM** 1/2/6	**AFM** 20/10 **STM** 6/5	**AFM** 68/29 **STM** 47/42
Electron and ion beam technologies	7/7/7	**SEM** 10/8/17 **TEM** 8/8/14 **Cryo TEM** 2/1/4 **FIB prep** 3/3/4 **APT** 1/1/2 **SIMS** 2/2/5 **IBA** 1/1/1	**SEM** 46/27 **TEM** 23/16 **Cryo TEM** 3/3 **FIB prep** 4/3 **APT** 2/1 **SIMS** 2/2 **IBA** 1/1	**SEM** 205/91 **TEM** 127/97 **Cryo TEM** 11/14 **FIB prep** 20/22 **APT** 8/12 **SIMS** 7/8 **IBA** 3/5
HF magnetic field imaging	0/0/1	NMR 0/0/3		
Dispersed-phases characterisation	2/2/8	**DLS** 3/1/6 **ζ-potential** 1/1/3 WAS 0/0/3 NPTA 0/0/1 DCS 0/0/1 UAC 0/0/2 AFFF 0/0/1 MALS 0/0/1	**DLS** 4/1 **ζ-potential** 3/1	**DLS** 21/1 **ζ-potential** 6/2
Light and acoustic microscopy	3/3/6	**CM** 3/2/5 **LSCM** 1/1/3 **NLM** 1/1/1 FM 0/0/4	**CM** 5/2 **LSCM** 1/1 **NLM** 7/6	**CM** 22/10 **LSCM** 3/3 **NLM** 43/36

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		OAM 0/0/1 OTFM 0/0/3		
Surface/overlayer/interface characterisation	1/1/5	**ITCAM** 1/2/4 BET 0/0/3 PA 0/0/1 PTRMS 0/0/1 SDI 0/0/1	**ITCAM** 3/2	**ITCAM** 14/8
Neutron characterisation (Methods currently unavailable)	2/2/4	**Neut. Reflect.** 1/1/1 **SANS** 1/1/1 Neut. diffraction 0/0/1 Neut. imaging 0/0/1	**Neut. Reflect.** 1/1 **SANS** 2/2	**Neut. Reflect.** 3/6 **SANS** 8/16
X-ray analysis	2/2/7	**XRD** 7/9/17 **SAXS** 3/2/5 XRT 0/0/1 XRM 0/0/3 X-ray imaging 0/0/2 EXAFS/XAFS 0/0/1 X-ray Reflect. 0/0/3	**XRD** 22/15 **SAXS** 8/4	**XRD** 82/53 **SAXS** 42/25
ECM Charact				
Magnetic Characterization	4/3/6	**MFDC** 1/1/3 **SQUID** 2/1/2 **MT** 2/1/4 Magnetometry 1/0/4 MOKE 0/0/3 EPR 0/0/2	**MFDC** 1/1 **SQUID** 4/2 **MT** 3/2 Magnetomet 1/0	**MFDC** 3/3 **SQUID** 19/10 **MT** 13/8 Magnetomet 2/0
Neutron Magnetic characterisation	2/1/3	**M-SANS** 1/1/1 MNREFFL 1/0/1 DNS 0/0/1	**M-SANS** 1/1 MNREFFL 1/0	**M-SANS** 6/6 MNREFFL 6/0
X-ray/soft-X-ray spectroscopy	3/3/5	**XAS lsf** 4/3/8 **XMCD/XMLD** 4/3/8 **IOS** 1/1/3 IXS 0/0/3 DIPROI-FEL 0/0/1	**XAS lsf** 9/9 **XMCD/XMLD** 5/3 **IOS** 1/1	**XAS lsf** 39/34 **XMCD/XMLD** 31/20 **IOS** 4/4
Spectro-microscopy techniques	3/3/5	**XPEEM lsf** 4/3/6 **SPELEEM lsf** 1/1/2 **AES/SAM** 1/1/2 HSI 0/0/1 MSI 0/0/1	**XPEEM lsf** 6/3 **SPELEEM lsf** 1/1 **AES/SAM 1/1**	**XPEEM lsf** 33/18 **SPELEEM lsf** 4/5 **AES/SAM** 3/4
Chemical analysis	1/1/3	**ICP-MS** 2/2/3 AT 0/0/1 HPLC 0/0/3	**ICP-MS** 3/2	**ICP-MS** 19/11
Luminescence spectroscopy	5/4/6	**FS** 1/1/3 **ML** 1/1/3 **PL** 3/2/5 **CL** 1/1/3 FCS 1/0/1 TR-XRF 0/0/2	**FS** 1/1 **ML** 1/1 **PL** 11/6 **CL** 1/1 FCS 1/0	**FS** 3/3 **ML** 14/10 **PL** 62/30 **CL** 3/5 FCS 10/0

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Electron spectroscopy	4/2/5	**XPS lab** 7/4/14 **+** **XPS lsf** 5/5/6 **ARPES lsf** 2/2/6 UPS 1/0/5 IPES 2/0/2 RESPED-RESPES 0/0/3	**XPS lab** 9/7 **+** **XPS lsf** 11/11 **ARPES lsf** 3/3 UPS 1/0 IPES 2/0	**XPS lab** 38/30 **+** **XPS lsf** 45/51 **ARPES lsf** 11/8 UPS 3/0 IPES 12/0
Optical spectroscopy	6/6/7	**Pump-Probe** 2/2/5 **Ellipsometry** 2/1/8 **RS** 5/4/11 **FTIR** 4/3/12 **OS** 2/2/7 **BLS** 1/1/1 UHV-RAIRS 0/0/6	**Pump-Probe** 4/2 **Ellipsometry** 2/1 **RS** 7/4 **FTIR** 6/3 **OS** 7/3 **BLS** 13/6	**Pump-Probe** 33/8 **Ellipsometry** 9/6 **RS** 30/13 **FTIR** 18/11 **OS** 26/9 **BLS** 138/54
Ntmm				
Microfabrication	4/3/10	**UVL** 1/1/8 **II** 1/1/2 **STAND. ETCHING** 1/1/10 DWL 2/0/6 I&GLS 0/0/2 UV-SL 0/0/2 SOTP 0/0/2 CD&P 0/0/2 ECD 0/0/7 STAND. DEPOS. 0/0/10	**UVL** 1/1 **II** 2/1 **STAND. ETCHING** 1/1 DWL 3/0	**UVL** 2/2 **II** 12/6 **STAND. ETCHING** 18/18 DWL 8/0
Thick films and coatings	1/0/5	SS&RP 0/0/2 TAPE CASTING 0/0/1 ARC 0/0/2 SALBL 0/0/1 INK-JET 1/0/1	INK-JET 1/0	INK-JET 3/0
3D Shaping	2/1/5	**LSIVP** 1/1/2 3D MP 1/0/2 SLS 0/0/1 FDM 0/0/1 SLIP CASTING 0/0/1	**LSIVP** 13/4 3D MP 1/0	**LSIVP** 90/26 3D MP 5/0
Synthesis of dispersed phases	3/1/3	**DNP** 1/1/2 EOC 1/0/2 FF 1/0/2	**DNP** 2/1 EOC 1/0 FF 1/0	**DNP** 5/3 EOC 4/0 FF 1/0
2D/3D bioprinting	0/0/2	3DBP 0/0/1 MS 0/0/2		
In vitro assays and cell analysis	3/3/5	**INA** 1/1/2 **CCF** 2/1/4 **LCI** 1/1/1 **SPRB** 1/1/1 DH 0/0/1 FC 0/0/2	**INA** 1/1 **CCF** 8/4 **LCI** 7/2 **SPRB** 1/1	**INA** 3/5 **CCF** 64/35 **LCI** 24/4 **SPRB** 5/4

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Biomolecules and biomaterials analysis	1/1/7	CD 0/0/1 ELISA-PR 0/0/2 OM 0/0/1 DNAMS 0/0/1 RT PCR 0/0/1 QCMB 0/0/2		
Rheology analysis	1/1/3	**THIXOTROPY** 1/1/1 MM 0/0/1 VISCOSITY 0/0/2	**THIXOTROPY** 2/1	**THIXOTROPY** 2/3
Mechanical analysis	2/0/3	MP 2/0/2 TMP 1/0/1 TDA 0/0/1	MP 3/0 TMP 1/0	MP 9/0 TMP 1/0
Thermal analysis	3/2/6	**DSC** 1/1/4 **TGA** 2/2/3 TC/D 0/0/1 STG-DSC-DTA 0/0/1 HTM 0/0/1 IC 1/0/1	**DSC** 2/1 **TGA** 4/2 IC 2/0	**DSC** 5/3 **TGA** 10/12 IC 14/0
Electrical analysis	1/0/5	TP 0/0/1 RF-VNAC 0/0/3 EC 1/0/1 MET 0/0/3 MPET 0/0/1	EC 3/0	EC 6/0
T&S				
Structural and ground state electronic properties	**1/1/1**	**4/4/6**	**7/6**	**5/4**
Magnetic properties	**1/1/1**	**1/1/6**	**1/1**	**1/0.5**
Excited state properties	**1/1/1**	**3/2/6**	**4/2**	**4/3**
Multiscale modeling of materials under extreme irradiation	**1/1/1**	**1/1/2**	**4/2**	**10/2**
Atoms and molecules in motion	**1/1/1**	**4/2/6**	**7/5**	**5/3.5**
Transport properties	0/0/1	0/0/5		

In **bold** those techniques that received requests and were granted access at some provider site

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ANNEX II- SCIENTIFIC GOALS OF THE USERS PROJECTS

The objectives of the user projects approved in the first four calls cover a very wide range of materials and applications.

The *materials systems* considered (not necessarily obtained at NFFA premises – often provided by the users themselves) encompass different types of formats: inorganic (and inorganic-organic composites) films, 2D materials, and different types of nanostructures or nanoobjects, e.g. nanowires, nanoparticles:

- Films, composites: Silicon carbide, Diamond Like Carbon coatings, nanocolumnar TaZrN coatings, Co based nano-hetero-structured thin films, Thin photoresist materials for Extreme Ultraviolet Lithography, Carbon-silica thin-film modified with metal (Cu, Ag) nanoparticles, CaMnO3/BaTiO3/LaNiO3 and CaMnO3 thin films, Ge-based halide perovskites, Block copolymer hyperbolic metamaterials, thin film Nd1-xCox, Ni80Fe20, Co magnets, [Co/Pd]N super-lattice on flexible polyimide substrate, Tantalum Sulfide Selenide (1T-TaS1.2Se0.8), NiO/coumarin films, High Entropy Alloys, novel materials for 4D liquid crystals, topological metal (Cu3Sn), La0.67Sr0.33MnO3 /La0.2Sr0.8MnO3 heterostructures, functional oxides (BiFeO3, ZnO, La0.7Sr0.3MnO3) in polymers matrices (PDMS, PET), covalent organic frameworks of boron-containing molecules, conducting porous scaffolds, biomimetic polymer constructs, PEDOT:PSS/Carbon composites, nano-SiC coated CNT/Mg composites, ZPO / TPO (chemical) composite materials, Organic molecules on SiO2 microstructures
- 2D materials: graphene WS2, MoS2, MoSSe, PtSe2, hexagonal BN, Two-dimensional porphyrin network
- Nanostructures / nanoobjects: SiC nanowhiskers, Zn3P2 nanowires, GaAs/AlGaAs heterostructures and nanowires, WOx nanostructured assemblies, hybrid Au-Si nanostructures, self-assembled Co3O4/CoTe2 heterostructures, GaN QW, halide perovskite nanoparticles, functional oxides nanoparticles (CeO2, ZnO, Fe3O4, tin oxyhydroxide, Cu oxide, vanadate and phosphate-molybdate), metal nanoparticles (Au, Ag, Cu, Pd) and others (CsPbBr3, Cu2SnS3), Glyco-Gold nanoparticles, doxorubicin nanogels, gold nanoneedles

This huge variety of material has been studied in relation to several applications such as fundamental phenomena, advanced processing, energy related applications, medical/biotechnology applications, among others:

- Molecular dynamics;
- Wear resistant coatings, materials welding, lightweight structure metal composites for aeronautics and automotive;
- Electrocatalysis / photocatalysis;
- 3D printing, EUV lithography;
- Light emitting diodes, photovoltaics; Optoelectronics, nonlinear optical systems, single photon sources, light responsive microactuators;
- Spintronics, nanomagnetism, magnonic-based logic architectures; magnetoelectricity; High-speed electronics, data storage devices and transistors;
- Quantum technologies (spin qubits and quantum memories, quantum light sources for quantum information processing, Valleytronics devices);

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- Power electronics (e.g. electric vehicles)
- Ultrasensitive gas sensing, responsive surfaces and sensors; sensors for pollutant analysis in water; eco-friendly processing of advanced materials for applications in the agri-food industry and desalination; Optical biosensing and biomedical applications (e.g. 3D tissue engineering models and organ/membranes-on-chip for in vitro toxicology), biosensing for healthcare and food safety; drug delivery; bioelectronic interfacing, neural interfaces

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ANNEX III – TECHNIQUE GLOSSARY

	ACRONYM	FULL NAME
L&P		
Scanning probe lithography	DPN	Dip Pen Nanolithography
	AFML	Atomic Force Microscopy Lithography
	T-SPL	Thermal-Scanning Probe Lithography
Patterning, replication, and sample navigation	RIE	Reactive Ion Etching
	ICP	Inductively Coupled Plasma Etching
	IBM	Ion Beam Milling
	NIL	NanoImprint Lithography
	BCL	Block Copolymer Lithography
	NOT&P	Nano Object Transfer and Positioning
Electron and ion beam lithography	He-FIB	He-Focused Ion Beam & He Microscopy
	EBL	Electron Beam Lithography
	FIB	Focused Ion Beam
Synchrotron-based lithography	EUV-IL	Extreme Ultra Violet – Interference Lithography
	DXRL	Deep X-ray Lithography
Photon-based lithography	TWL	Two Photon Lithography
	SM-DWL	Sub-micron Direct Writing Lithography
	UV-IL	Ultra Violet – Interference Lithography
	DTL	Displacement Talbot Lithography
G&S		
Chemical deposition of thin films	ALD	Atomic Layer Deposition
	CSD	Chemical Solution Deposition
	CVD	Chemical Vapor Deposition
	GBM	Graphene-based materials
Physical deposition of thin films	TE	Thermal Evaporation
	EBE	e-beam evaporation
	MBE	Molecular Beam Epitaxy
	PLD	Pulsed Laser Deposition
	MS	Magnetron Sputtering
	PVDS	Physical Vapor Deposition by Sputtering
Soft matter preparation	SMP	Soft Matter Preparation
Synthesis of nanoparticles	CBD	Cluster Beam Deposition
	GIN	Growth of Inorganic Nanocrystals
	MICS	Multiple Ion Cluster Source
	AD	Aerosol Deposition
	FSP	Flame Spray Pyrolysis
Thermal Treatments	FLA	Flash Lamp Annealing
	TP	Thermal Processes
	SP	Sintering Processes
	SSR	Solid State Reaction

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SM Charact		
Scanning probe microscopy	AFM STM	Atomic Force Microscopy Scanning Tunnelling Microscopy
Electron and ion beam technologies	SEM TEM Cryo TEM FIB prep APT SIMS IBA	Scanning Electron Microscopy Transmission Electron Microscopy Cryo-TEM Focused Ion Beam preparation Atomic Probe Tomography Secondary Ion Mass Spectroscopy Ion Beam Analysis
HF magnetic field imaging	NMR	Nuclear Magnetic Resonance
Dispersed-phases characterisation	DLS ζ-potential WAS NPTA DCS UAC AFFF MALS	Dynamic Light Scattering ζ-potential Wide Angle Static and Laser Diffraction Nanoparticle Tracking Analysis Disk Centrifuge Sedimentation Analytical Ultra centrifuge Asymmetric Field Flow Fractionation Multiangle Light Scattering
Light and acoustic microscopy	CM LSCM NLM FM OAM OTFM	Confocal Microscopy LSCM Laser Scanning Confocal Microscopy NLM Non-linear microscopy Fluorescence microscopy Optoacoustic microscopy Optical Thin Film Metrology
Surface/overlayer /interface characterisation	ITCAM BET PA PTRMS SDI	Interfacial Tension and Contact Angle Measurement Brunnaer-Emmett-Teller method Permeability Analysis Proton Transfer Reaction Mass Spectrometry Surface Direct Inspection
Neutron characterisation	NR SANS ND NI	Neutron Reflectivity Small Angle Neutron Scattering Neutron Diffraction Neutron Imaging
X-ray analysis	XRD SAXS XRT XRM XRI EXAFS/XAFS XRR	X-ray Diffraction Small Angel X-ray Scattering X-ray Tomography X-ray Microscopy Extended X-ray Absorption Fine Structure X-ray imaging X-ray Reflectivity
ECM Charact		
Magnetic Characterization	MFDC SQUID MT Magnetometry MOKE EPR	Magnetic/Ferroelectric/Dielectric Characterization Superconducting Quantum Interference Device Magneto-Transport Magnetometry Magneto-Optic Kerr Effect Electron Paramagnetic Resonance

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Neutron Magnetic characterisation	M-SANS	Magnetic-Small Angle Neutron Scattering
	MNREFL	MNREFFL Magnetic Neutron Reflectivity
	DNS	Diffuse Neutron Scattering
X-ray/soft-X-ray spectroscopy	XAS lsf	X-ray Absorption Spectroscopy
	XMCD/XMLD	X-ray Magnetic Circular/Linear Dichroism
	IOS	In-Operando Spectroscopy
	IXS	Inelastic X-ray Scattering
	DIPROI-FEL	Coherent Diffraction Imaging @ Free Electron Laser
Spectro-microscopy techniques	AES/SAM	Scanning Auger Microscopy
	HSI	Hyperspectral Imaging
	MSI	Multispectral Imaging
	XPEEM lsf	X-ray Photoemission Electron Microscopy
	SPELEEM lsf	Spectroscopy Photoemission & Low Energy Electron Microscopy
Chemical analysis	ICP-MS	ICP-Mass Spectroscopy
	AT	Automated Titration
	HPLC	High Performance Liquid Chromatography
Luminescence spectroscopy	FS	Fluorescence Spectroscopy
	ML	Microluminescence
	PL	Photoluminiscence
	CL	Cathodoluminescence
	FCS	Fluorescence Correlation Spectroscopy
	TR-XRF	Total Reflection X-ray Fluorescence Spectrometer
Electron spectroscopy	XPS	X-ray Photoemission Spectroscopy
	ARPES lsf	Angle Resolved Photoemission Spectroscopy
	UPS	Ultraviolet Photoemission Spectroscopy
	IPES	Inverse Photoemission Spectroscopy
	RESPED-RESPES	Resonant Photoemission Spectroscopy/Diffraction
Optical spectroscopy	Pump-Probe	Pump-Probe Spectroscopy
	Ellipsometry	Ellipsometry
	RS	Raman Spectroscopy
	FTIR	Fourier Transform Infrared Spectroscopy
	OS	Optical Spectroscopy
	BLS	BLS 13/6
	UHV-RAIRS	UHV-Reflection Absorption Infrared Spectroscopy
Ntmm		
Microfabrication	DWL	Direct Writing Lithography
	I&GLS	I & g-line Steppers
	UV-SL	Ultraviolet Soft Lithography
	UVL	Ultraviolet Lithography
	SOTP	Silicon Oxidation and Thermal Processes
	II	Ionic Implantation
	CD&P	Chip Dicing and Packaging
	STAND. ETCHING	Standard Etching
	ECD	Electrochemical Deposition
	STAND. DEPOS.	Standard Deposition
Thick films and coatings	SS&RP	Screen Stencil & Roller Printer
	TAPE CASTING	Tape Casting
	ARC	Automated Rod Coater
	SALB	Spray Assisted Layer by Layer

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	INK-JET	Ink-Jet Printing
3D Shaping	3D MP SLS FDM SLIP CASTING LSIVP	3D Microprinting Selective Laser Sintering Fused Deposition Modeling Slip Casting Laser Surface and in-Volume Patterning
Synthesis of dispersed phases	DNP EOC FF	Dispersion of Nanoparticles Engineering of Colloids Formulation of Fluids
2D/3D bioprinting	3DBP MS	3D Bioprinting Microspotter
In vitro assays and cell analysis	DH FC INA CCF LCI	Digital Holography Flow Cytometry In-vitro Assays Cell Culture Facilities Live Cell Imaging
Biomolecules and biomaterials analysis	CD OM DNAMS SPRB RT PCR QCMB ELISA-PR	Circular Dichroism Optical Manipulation DNA Microarray Scanner Surface Plasmon Resonance Biosensor Real-Time Polymerase Chain Reaction Quartz Crystal Microbalance Enzyme-Linked Immunosorbent Assay Plate Reading
Rheology analysis	MM THIXOTROPY VISCOSITY	Mechanical Moduli THIXOTROPY Viscosity
Mechanical analysis	MP TMP TDA	Mechanical Properties Thermo-mechanical Properties Thermo-Dilatometric Analysis
Thermal analysis	HTM IC DSC TGA TC/D STG-DSC-DTA	High Temperature Microscopy Isothermal Calorimetry Differential Scanning Calorimetry Thermo-gravimetric Analysis Thermal Conductivity/Diffusivity Simultaneous Thermogravimetric/differential calorimetry
Electrical analysis	TP RF-VNAC EC MET MPET	Thermoelectric Properties Radio Frequency Vector Network Analysis Electrochemical Characterization Microprobe Electrical Testing Mercury Probe Electrical Testing
T&S		
Structural and ground state electronic properties	N/A	N/A
Magnetic properties	N/A	N/A
Excited state properties	N/A	N/A
Multiscale modeling of	N/A	N/A

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materials under extreme irradiation		
Atoms and molecules in motion	N/A	N/A
Transport properties	N/A	N/A

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