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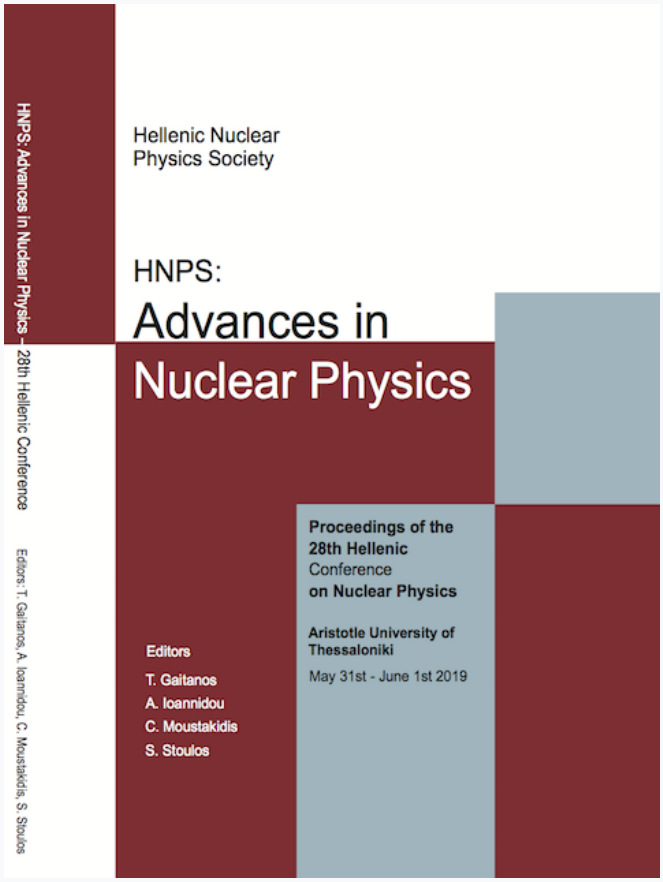

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CALIBRA: A national research infrastructure for accelerator-based research and applications

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Abstract: *CALIBRA stands for Cluster of Accelerator Laboratories for Ion-Beam Research and Applications, i.e., the Research Infrastructure proposed in 2014 to the General Secretariat for Research and Technology (GSRT) in response to the call for the establishment of the Greek National Roadmap for Research Infrastructures (RI). CALIBRA is planned to be completed in phases with the first one being implemented through the homonym project that is funded by the currently running Partnership Agreement for the Development Framework (ΕΣΠΑ 2014-2020).*

The CALIBRA project aims at establishing and operating an accelerator-based research infrastructure open to the national and the European scientific community to conduct research at excellence level, develop innovative applications of increased socioeconomic impact, and provide highly-specialized services, unique at the country level, to the public and private sector. CALIBRA is implemented at the Tandem Accelerator Laboratory of NCSR "Demokritos". The project had its kickoff meeting in November 2017.

Keywords *National Roadmap of Research Infrastructures, NSRF 2014-2020.*

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INTRODUCTION

CALIBRA stands for "Cluster of Accelerator Laboratories for Ion-Beam Research and Applications. Its concept was born when the advantages and numerous research opportunities of operating an ion-beam accelerator within a unique multidisciplinary scientific environment were realized. This environment has been successfully established over the years at NCSR "Demokritos", where Biosciences, Material and Nanoscience, Environmental and Cultural Heritage studies, Radiobiology and Radiopharmacy coexist with Nuclear Physics. Under these conditions, the operation of CALIBRA could contribute successfully to the overall scientific programme of "Demokritos" by providing ion beams and secondary neutrons not only for fundamental research but also for a wide spectrum of highly-specialized analytical services. CALIBRA was additionally motivated by the on-going establishment of various accelerator facilities all over the world, which is a clear proof of their contribution to a country's economic development and their importance in understanding issues of societal impact. For all these reasons, Greece shouldn't lack an accelerator-based research infrastructure, like CALIBRA.

THE FULL-SCALE CALIBRA RESEARCH INFRASTRUCTURE

The CALIBRA Research Infrastructure concept proposal was submitted to GSRT in February 2013. It was much based on ideas elaborated in the period 2008-2010, when two similar in context but more composite proposals were prepared. The first one coined "Center of Excellence for Low-energy Ion-

Beam Research and Applications, in short LIBRA, was submitted in 2008 to the EC within an FP7/REGPOT competitive funding program. LIBRA was evaluated by EC-assigned experts, scored excellent (14.5/15) and positioned at rank eight (8) among 474 competing proposals submitted within the specific call REGPOT/2008-1. LIBRA's success resulted in a grant of ≈1.45 million Euros.

The second infrastructure proposal, which provided many ideas and useful material for CALIBRA's concept and proposal drafting, was prepared and submitted in May 2010 to GSRT in response to its call of March 22, 2010, entitled "Research and Technology Infrastructure" of the so-called National Strategic Reference Framework (NSRF, in Greek ΕΣΠΑ), of the programmatic period 2007-2013. Unfortunately, the Priority Axis "Creation and exploitation of innovation supported of Research and Technology" of NSRF 2007-2013, under which the second proposal was submitted, was not implemented as initially scheduled by GSRT – most probably due to the Greek financial crisis of that time. As a result, the Research Infrastructure described in the proposal of May 2010 was not implemented. Moreover, no initiatives or even discussions for RIs of national impact were on table until February 4, 2013, when GSRT published a call addressed to the whole Greek scientific community for expression of interest to establish the National Roadmap of Research Infrastructures. The national roadmap was a long-standing obligation (ex-ante conditionality) of Greece before using European Structural and Regional funds within the subsequent programmatic period 2014-2020.

During the "idle" time from May 2010 to February 2013, the Group of the Tandem Accelerator Laboratory has elaborated additional ideas, identified and documented almost all needs of the Greek scientific community in using ion beams and neutrons, strengthened collaborations abroad and increased further the visibility of the laboratory within the European scientific community. As a result, a sound concept for a "Cluster of Accelerator Laboratories for Ion-Beam Research and Applications" was elaborated and transformed into a concept proposal, which was then submitted to GSRT in February 17, 2013. It was mainly focusing on the further upgrade of the 5.5 MV Tandem accelerator of NCSR "Demokritos", the establishment of a PET Cyclotron lab, based on a 17 MeV Cyclotron donated by the University Medical Center of Groningen, The Netherlands (UMCG), and the purchase, installation and exploitation of a new 3 MV single-stage electrostatic accelerator. CALIBRA's full proposal was submitted to GSRT in July 2013. In this, an all-encompassing accelerator-based research infrastructure was proposed. CALIBRA's concept, core idea and motivation, as well as the full-scale CALIBRA Research Infrastructure are briefly presented below.

The core idea behind CALIBRA (Fig. 1) is to take advantage of a wide variety of ion species delivered from the accelerators, partly with very high intensity, as well as of secondary neutron beams in order to produce new scientific knowledge in fundamental science (nuclear astrophysics, nuclear reaction studies and atomic physics with accelerators), develop novel analytical techniques and provide highly specialized services and products related to human health, cultural heritage, nanotechnology, environmental monitoring, and the development and testing of advanced materials and detectors. CALIBRA should operate as an open-access Research Infrastructure for national and European research groups, providing a wide spectrum of state-of-the art facilities for R&D and innovative applications, education and training for students. Furthermore, CALIBRA aims also at linking the local scientific community with ESFRI Infrastructures and other European large-scale accelerator facilities.

The establishment of the full-scale CALIBRA Research Infrastructure is not a single-step process: it requires five to seven years, at least, before its operation. CALIBRA's vision is to:

1. Replace the existing 5 MV accelerator with a modern 6 MV Tandem machine and expand the existing beam-line system from 6 to 13 beam-legs.
2. Establish a PET Cyclotron Lab based on the donated 17 MeV UMCG cyclotron.

3. Establish an Accelerator Mass Spectrometry laboratory (AMS).
4. Acquire and install a 4 MV single-stage high-current accelerator equipped with an ECR source –or a similar machine– to deliver a variety of intense ion beams for single or dual-beam irradiations of materials and high intensity proton, deuteron and α-particle beams for basic and applied research and the production of neutrons.
5. Built under the earth's surface a neutron irradiation Time-of-Flight facility with a flight path of ≈40 m. Fast and moderated neutrons will be produced using beams from the accelerators. The operation of such a facility has become almost mandatory as the only Greek Research Reactor is about to be decommissioned.

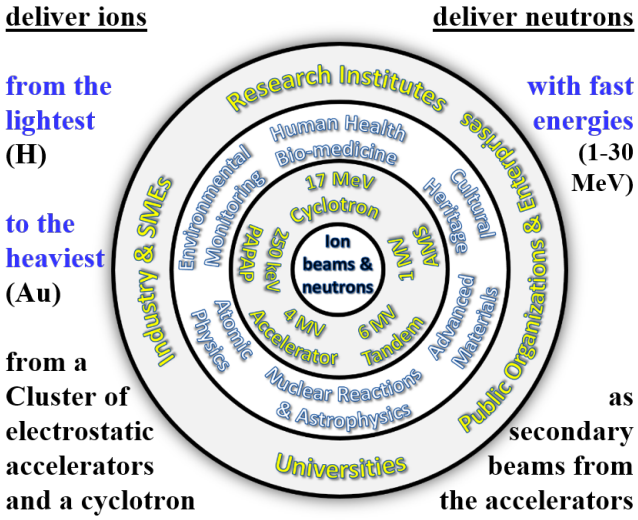

Figure 1. *The core idea of the full-scale CALIBRA Research Infrastructure*

The layout of the electrostatic accelerators as proposed in the full-scale CALIBRA Research Infrastructure is shown in Fig. 2. For the planned PET Cyclotron Lab, a preliminary design study for a new building has already been prepared. According to this, the proposed new building, shown, in Fig. 3, will comprise the cyclotron vault and a light civil construction (2 levels, total area of ≈800 sq. meters), according to the specifications set by the International Atomic Energy Agency (IAEA) [1].

THE MIS5002799-CALIBRA PROJECT: THE FIRST PHASE OF THE CALIBRA RI

After 45 months from its first ***concept proposal*** submission, the CALIBRA RI was, finally, about to receive funds in 2016. Surprisingly, the initial CALIBRA RI proposal, like any other RI proposal, had to be re-submitted for evaluation. What's more, the maximum allowed budget was set by GSRT to 4 M€ instead of the initially requested 23,5 M€. Hence, it became clear that the full-scale CALIBRA RI could not be implemented in one step. Instead, one could only consider a project to fund only the first phase of the full-scale CALIBRA RI's implementation.

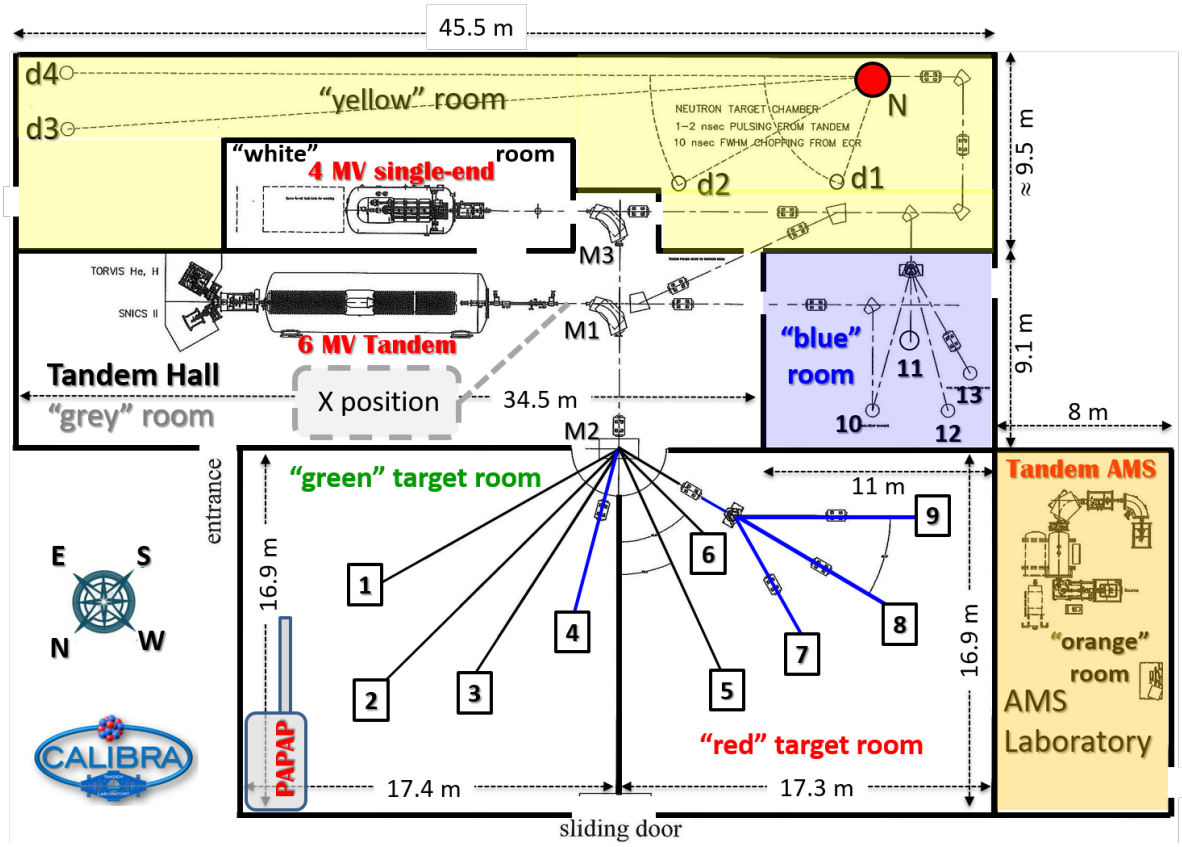

Figure 2: *Layout of the electrostatic accelerators as proposed in the full-scale CALIBRA RI. The colored areas indicate building expansions of the current Tandem accelerator lab (in white). The "yellow" room is built under the earth's surface. The red solid circle labeled "N" is the position of the target for the production of secondary neutrons. In this arrangement, a total number of 13 different beamlines will be available to host dedicated experimental setups. In addition, depending on the desired neutron energy, setups can be installed at different angles with respect to the beam direction, as indicated by the tentative positions marked as d1, d2, d3, and d4.*

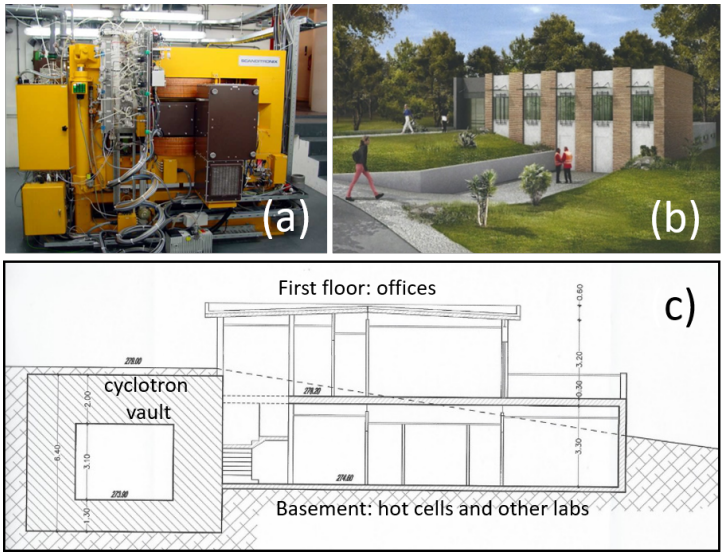

Figure 3. *(a) The donated 17 MeV SCANDITRONIX PET Cyclotron; (b) Perspective of the proposed new building to host the planned PET Cyclotron Lab; (c) Cross section of the proposed new building.*

Under these conditions, the CALIBRA ***project proposal*** was submitted on October 31, 2016, in the framework of an invited call of the Action entitled "Support of Research Infrastructures". This action belongs to the Key Priority entitled "Development of mechanisms to enhance entrepreneurship", one of the three major funding priorities of the Operational Programme (OP) coined "Competitiveness, Entrepreneurship and Innovation 2014-2020" [2].

In concordance to its Greek acronym (ΕΠΑνΕΚ), this OP is abbreviated in English as "EPAnEK 2014-2020". It is one of the seven sectoral OPs of the currently running strategic plan for growth in Greece, called "Partnership Agreement (PA) for the Development Framework 2014-2020". This plan is widely known as the National Strategic Reference Framework NSRF 2014-2020. As such, NSRF (abbreviated in Greek as "ΕΣΠΑ") is the reference document for the distribution of European Union Funds at national level for the programmatic period 2014-2020. NSRF's implementation is now administered by the Ministry of Development and Investments.

The CALIBRA project proposal submitted on October 31, 2016, was "evaluated" (for the third time!) by an expert under the responsibility of the EPAnEK Managment. According to this evaluation, the expert proposed a drastic reduction of SP 1 by 44%. For the remaining SPs no reduction was proposed by the expert. Hence, the budget of the CALIBRA project was finally decreased from 4 to 3.422 M€ despite the formal appeal submitted to the Mininstry. To date, the distribution of funds across the Sub-Projects (SPs) and Work Packages is as follows: SP1 21.5%, SP2 55%, SP3 8.5%, SP4 3%, SP5 4.5%, SP6 4.5% and SP7 3%.

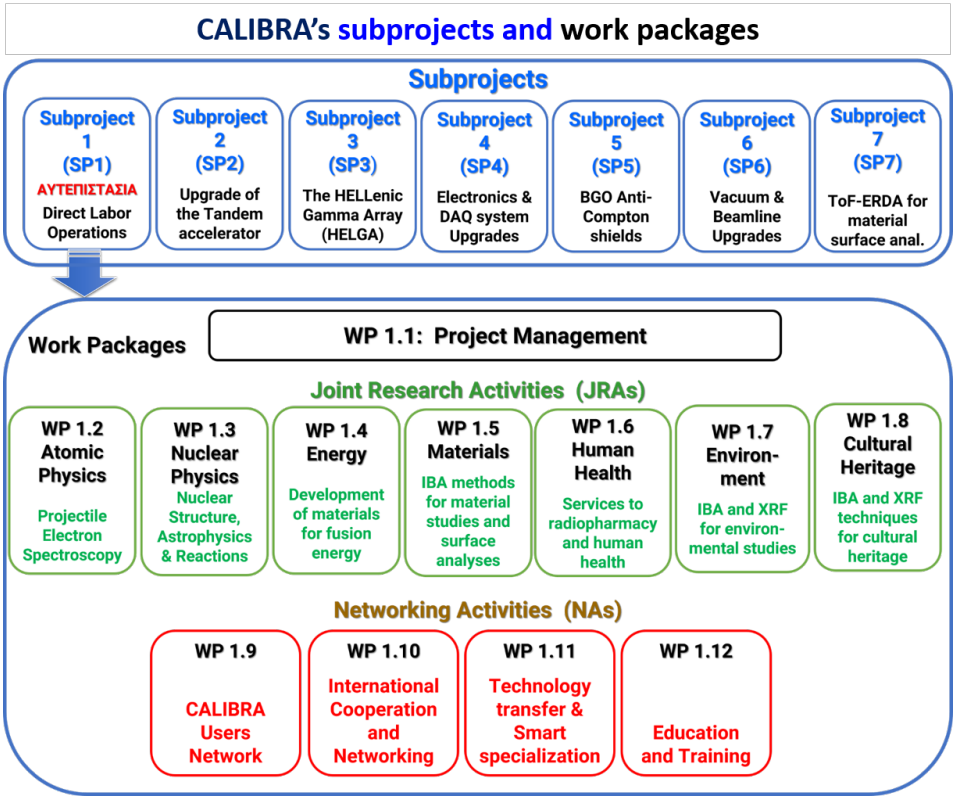

Figure 4. *CALIBRA project composition in Sub-projects (SPs) and Work Packages (WPs).*

Notably, the major part of the budget is directed to SP2 that aims at the full refurbishing of the Tandem accelerator. This includes: a) replacement of the existing ion sources with two new state-of-the art ones, that will allow for ion beam currents of at least one order of magnitude higher that the currently available intensities on target, b) conversion of the currently installed belt-based upcharging system to a pelletron chain, c) installation of a state-of-the art foil as well as gas stripper, d) installation of new voltage stabilizer system with GVM and new corona probe, e) installation of beam-profile monitors, f) the installation of a computer-based accelerator operation control system that will allow for its simple and stable operation, even by students, and g) new beam optics optimization. SP3 together with SP5 focus on the procurement of an array of HPGe detectors equipped with Anti-Compton shields, whereas SP4 aims at purchasing nuclear digital electronics for Data Acquisition. With SP6's budget, all old oil-based pumping units will be replaced with turbomolecular pumps. SP7 is finally focuses on the procurement and installation of a ToF-ERDA system for materials analysis. Last but not least, almost 0.4 M€ from SP1's budget is used to hire new scientific personnel for a period of ≈30 months.

The structure of the CALIBRA project are schematically shown in Fig. 4. As shown therein, the project comprises 7 Sub-Projects (SPs). SP1 concerns direct labor activities (Management, Joint Research Activities and Networking Activities) that are implemented under the direct financial supervision of NCSR "Demokritos". The activities of SP1 are grouped into 12 Work Packages (WPs). Sub-Projects 2 to 7 aim exclusively to refurbish or procure scientific instruments and machinery through tenders (national and International). In line with Greek legislation, each of these tenders has a budget exceeding 60,000 Euros.

OUTLOOK

The project had its kickoff meeting in November 6, 2017. This event was attended by 60 scientists from 14 research institutions and state agencies. In the period between November 2017 and June 2018, the project received no funding due to the inefficacy of Demokritos' management to clarify issues related to project's indirect costs. As result of this and the delays of EPANeK's management to resolve these issues, CALIBRA's funding started in July 2018.

In spite of the severe delays in its funding, the project is evolving well achieving steadily its milestones and producing the planned deliverables. As such, it is expected that by the end of 2019, all tenders related to Sub-Projects 2 to 7 will be completed. The instruments to be purchased through SP3, SP4, SP5, and SP6 are expected to be in place by summer 2020. The upgrade works at the Tandem accelerator and the commissioning of the ToF-ERDA setup are expected to be completed during the first quarter of 2021.

Acknowledgements

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References

[1] International Atomic Energy Agency, Cyclotron Produced Radiopharmaceuticals: Guidelines for Setting-up a Facility, Technical Report Series No. 471, IAEA, Vienna, 2009; https://www.iaea.org/publications/8046/cyclotron-produced-radionuclides-guidelines-for-setting-up-a-facility
[2] http://www.antagonistikotita.gr/epanek_en/index.asp