PARTICLE ACCELERATOR PROJECTS AND UPGRADES

IPAC21

Virtual Edition

May 24th - 28th, 2021 | Brazil

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PARTICLE ACCELERATOR PROJECTS AND UPGRADES

For Industry Collaboration in the Field of Particle Accelerators

13th Edition

Compiled by

Centro Nacional de Pesquisa em Energia e Materiais – CNPEM

INTRODUCTION

"For many years, the European Physical Society Accelerator Group (EPSAG) that organizes the IPAC series in Europe has contacted major laboratories around the world to invite them to provide information on future accelerator projects and upgrades to exhibitors present at IPAC commercial exhibitions. This initiative has resulted in a series of booklets that is available to industry at the conferences or online. This current edition builds on previous editions with updated information provided by the laboratories and research institutes. We would also like to acknowledge and thank everyone for contributing to this booklet in an effort to foster a closer collaboration between research and industry."*

All of the information contained in this booklet is subject to confirmation by the laboratory and/or contact persons for each project.

The past 2020 booklet still containing relevant information. We could update just part of it. Visit the site https://www.ipac20.org/particle-accelerator-projects-and-upgrades/ to access this material.

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*IPAC20 Particle Accelerator Projects and upgrades

CONTENTS

Introduction

PROJECT REGION: AMERICAS 1

BELLA 2nd Beamline and iP2 2

Status of the Advanced Photon Source Upgrade (APS-U) Project" 4

The Cornell-BNL ERL Test Accelarator (CBETA) 6

The Proton Power Upgrade Project at the Spallation Neutron Source (SNS) 7

PROJECT REGION: ASIA 9

Australian Synchrotron BRIGHT beamline expansion 10

Australian Synchrotron Operational Upgrades 11

China Spallation Neutron Source 12

Establishment of Heavy Ion Medical Accelerator 13

HIAF (High Intensity heavy ion Accelerator Facility) 14

RAON 16

RIBF upgrade project 17

Siam Photon Source-II (SPS-II) accelerator complex 18

Third RF station for storage ring of Taiwan Photon Source 20

PROJECT REGION: EUROPE 21

Diamond II 22

European Spallation Source (ESS) 23

Future Circular Collider (FCC) Feasibility Study 24

High Luminosity LHC (also: HiLumi LHC, HL-LHC) 25

IFMIF-DONES 26

MYRRHA (phase 1 – Implementation) 27

PROJECT REGION: AMERICAS

BELLA 2nd Beamline and iP2

Project Location:	United States of America
Project Type:	Accelerator Improvement Projects
Project Description:	Two projects are extending the capability of the BELLA Center facility to advance the capability to develop Laser-Plasma Accelerators, based around the Center's Petawatt laser. The existing facility features a single long focal length laser beamline which has been used to accelerate electrons up to 7.8 GeV, and protons up to several MeV. The first project will enable splitting pf the laser pulse to deliver two independent pulses to the interaction point, supporting chaining of two laser-plasma accelerator stages at the multi-GeV level. This will be a critical step in establishing that such accelerators can meet future collider needs. It extends the existing program which is aligned to address the principal issues for a future lepton or photon collider at or above the TeV scale, including efficiency, beam quality, and energy gain. The second project will install a short focal length interaction chamber on the system. This will enable testing of novel ion acceleration regimes such as radiation pressure, to reach higher energies and beam quality. The two projects will also create a versatile facility enabling a broad range of other experiments at high repetition rate and precision.
Requirements List Available:	Yes
Approval Date:	2018
Status of Contracting:	
Construction scheduled to start:	2019
Estimated Project Cost:	
Estimated Construction Duration:	3 years
Type of Equipment to be Purchased:	Vacuum components, laser optics and compressors

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Status of the Advanced Photon Source Upgrade (APS-U) Project"

Project Location:	USA
Project Type:	Advanced Photon Source Upgrade (APS-U) Project
Project Description:	The APS-U Project replaces the existing 1.1-km circumference, 7-GeV electron storage ring with a new very low emittance, 6-GeV 7BA lattice to increase spectral brightness and transverse coherence for X-rays >10 keV by two to three orders of magnitude. Nine state-of-the are X-ray beamlines will be built, and enhancements made to 15 existing beamlines. New permanent magnet and superconducting undulators will be provided. While the present RF cavity system will be preserved, virtually all other accelerator components will be replaced. The replacement of the present klystron-based RF power sources with solid state amplifiers is in process, but not included in the Project.
Requirements List Available:	Yes, in an internal Final Design Report not readily accessible by the public. Information can be provided on request.
Approval Date:	02-Feb-2016
Status of Contracting:	>60% of contracts have been issued
Construction scheduled to start:	25-Jul-2019
Estimated Project Cost:	815 M USD
Estimated Construction Duration:	4 years
Type of Equipment to be Purchased:	Magnets, vacuum components, supports, power supplies, RF amplifiers for feedback and bunch lengthening systems, diagnostics, X-ray beamline components and optics, X-ray instrumentation and detectors, control system components, etc.

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The Cornell-BNL ERL Test Accelarator (CBETA)

Project Location:	United States of America
Project Type:	New Project
Project Description:	The Cornell-BNL ERL Test Accelerator (CBETA) is a four-turn Energy Recovery Linac (ERL) with a single return loop of Fixed-Field Alternating-gradient optics. Using superconducting RF technology, permanent magnets, and energy recovery, it is considered a green accelerator. I was construced at Cornell University in collaboration with BNL.
Requirements List Available:	Yes
Approval Date:	31-Oct-2016
Status of Contracting:	Low-current beam commissioning completed 2020, high-current commissioning outstanding.
Construction scheduled to start:	01-Jan-2017
Estimated Project Cost:	Complete project with subcomponents: 57 M USD
Estimated Construction Duration:	Construction and low-current commissioning stage: 3.5 years
Type of Equipment to be Purchased:	Permanent combine-fuction Halbach magnets, electromagnets, vacuum system, power supplies, RF power amplifiers, beam diagnostis.

Project Leader(s):	Georg Hoffstaetter (Cornell), Dejan Trbojevic (BNL)
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The Proton Power Upgrade Project at the Spallation Neutron Source (SNS)

Project Location:	USA
Project Type:	Upgrade
Project Description:	The Proton Power Upgrade Project at the Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL) will double the proton power capability from 1.4 to 2.8 MW. This will be accomplished through an energy increase from 1.0 to 1.3 GeV and a beam current increase from 26 to 38 mA. The energy increase will be accomplished through the addition of 7 cryomodules to the linear accelerator (Linac). The beam current increase will be supported by upgrading several radio-frequency systems in the normal-conducting section of the Linac. Upgrades to the accumulator ring injection and extraction regions will accommodate the increase in beam energy. A new 2-MW-capable target and supporting systems will be developed and installed. Conventional facility upgrades include build-out of the existing klystron gallery and construction of a tunnel stub to facilitate future beam transport to the second target station. The project received approval to proceed with construction in October 2020. Procurements are in progress, and some installation activities have already occurred. Most of the installation will take place during three outages in 2022-2023.
Requirements List Available:	Yes
Approval Date:	April 2018
Status of Contracting:	>90% of the items are contracted
Construction scheduled to start:	October 2020
Estimated Project Cost:	$271.6M USD
Estimated Construction Duration:	5 years
Type of Equipment to be Purchased:	Superconducting RF cavities, cryomodules, high-power klystron-based RF systems, beamline magnets, mercury targets, conventional facilities.

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PROJECT REGION:

ASIA

Australian Synchrotron BRIGHT beamline expansion

Project Location:	Australia
Project Type:	Upgrade
Project Description:	An expansion of the Australian Synchrotron's beamline suite, with 8 additional beamlines and associated equipment.
Requirements List Available:	Yes
Approval Date:	01-Jan-2018
Status of Contracting:	60% of the items are contracted
Construction scheduled to start:	01-Jul-2019
Estimated Project Cost:	120 M AUD
Estimated Construction Duration:	8 years
Type of Equipment to be Purchased:	Photon Beamlines –End stations, X-ray optics, Vacuum Vessels, X-BPMs, and associated support equipment. Insertion Devices.

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Australian Synchrotron Operational Upgrades

Project Location:	Australia
Project Type:	Upgrade
Project Description:	In addition to the normal operations funding, this project is to maintain and upgrade many accelerator and beamline components at the Australian Synchrotron.
Requirements List Available:	NO
Approval Date:	01-Jul-2016
Status of Contracting:	Ongoing as needs arise
Construction scheduled to start:	01-Oct-2016
Estimated Project Cost:	50 M AUD
Estimated Construction Duration:	10 years
Type of Equipment to be Purchased:	RF hardware systems including klystrons and low level RF electronics, beam diagnostics for linac, transfer lines, booster synchrotron and storage ring, power amplifiers, feedback systems, power supplies.

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China Spallation Neutron Source

Project Location:	Dongguan City, Guangdong Province,People's Republic of China
Project Type:	New Project
Project Description:	The CSNS facility is designed to provide multidisciplinary research
Requirements List Available:	No
Approval Date:	3-Sep-2011
Status of Contracting:	Completed construction, open to users
Construction scheduled to start:	20-Oct -2011
Estimated Project Cost:	1.86632 Billion CNY
Estimated Construction Duration:	6.5 years
Type of Equipment to be Purchased:	a 80-MeV H^- linac, a 1.6-GeV proton rapid cycling synchrotron (RCS),beam transport lines, a solid tungsten target station, and 3 initial instruments for the pulsed spallation .Beam power on target is 100kW.

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Establishment of Heavy Ion Medical Accelerator

Project Location:	Republic of Korea
Project Type:	New Project
Project Description:	Original R&D project was changed to turn-key based one for heavy ion therapy in Korea, where Seoul National University Hospital took over the project in 2019 from KIRAMS.
Requirements List Available:	Yes
Approval Date:	01-Apr-2010
Status of Contracting:	80% of the items are contracted
Construction scheduled to start:	01-Sep-2020
Estimated Project Cost:	250 M USD
Estimated Construction Duration:	5 years
Type of Equipment to be Purchased:	ECRIS for carbon and helium beam, RFQ+DTL, HI synchrotron, HEBT, scanning irradiation system, accelerator control system, rotating gantry and other treatment system

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HIAF (High Intensity heavy ion Accelerator Facility)

Project Location:	People Republic of China
Project Type:	New Project under construction
Project Description:	HIAF is a new accelerator facility for advances in the nuclear physics and related research fields in China. The HIAF facility plan was approved by central government of China in December 2012 and now is under construction. The design concept and layout of HIAF facility have evolved from the scientific requirements. The whole layout of HIAF accelerator consists of superconducting ECR source, superconducting linac as injector, synchrotron booster, radioactive beam separator, and storage rings for in-ring experiments. ECR source is the next generation ECR source with high operation frequency, the superconducting linac can provide the highest intensity heavy ion beam for low energy research and synchrotron injection. The output energy is the about 17-25MeV, we keep the free space for update to 100MeV/u in the future. The central part of the HIAF facility is a synchrotron complex consisting of two rings. Both rings have nearly the same circumference and will be installed in the same tunnel. A series of new and innovative technologies have adopted for HIAF, the prototypes have been developed for these technical challenges and critical issues for the varication of the feasibility, reliability and performance. The machine design was optimized based on these prototypes developments, details of technical design has been finished and some hardware systems already go into production. The civil construction and common system are also going smoothly.
Requirements List Available:	yes
Approval Date:	31-Dec-2015
Status of Contracting:	Under progress
Construction scheduled to start:	31-Dec-2018
Estimated Project Cost:	$450 million currency
Estimated Construction Duration:	7 years
Type of Equipment to be Purchased:	Irradiation protection magnet, Power supply for fast ramping rate magnets, magnetic alloy loaded cavity, High intensity beam diagnosis devices, Vacuum system devices,

	Superconducting RF cavity, Power amplifiers, Feedback systems.

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RAON

Project Location:	Republic of Korea
Project Type:	New Project
Project Description:	Rare isotope and stable ion beam facility with 400-kW, 200-MeV/u (for uranium beam) driver linac and 70-MeV proton cyclotron as ISOL driver.
Requirements List Available:	Yes
Approval Date:	20-Dec-2011
Status of Contracting:	Contracting
Construction scheduled to start:	20-Dec-2011
Estimated Project Cost:	946 M USD (excluding site cost)
Estimated Construction Time:	10 years
Type of Equipment to be Purchased:	SC cavities, cryomodules, SC magnets (HTS, LTS), 28 GHz ECR ion source, RFQ, solid state RF amplifiers, vacuum systems, control system

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RIBF upgrade project

Project Location:	Japan
Project Type:	Upgrade
Project Description:	This project aims at increasing the intensity of the radioactive isotope beams by 20 times more than what is available now at RIKEN RI Beam Factory (RIBF).
Requirements List Available:	No
Approval Date:	
Status of Contracting:	
Construction scheduled to start:	
Estimated Project Cost:	10,000M YEN
Estimated Construction Time:	8 years
Type of Equipment to be Purchased:	Magnets, power supplies, rf amplifiers, vacuum system, beam diagnostics, and high-power beam dump

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Siam Photon Source-II (SPS-II) accelerator complex

Project Location:	Thailand
Project Type:	New Project
Project Description:	Siam Photon Source-II (SPS-II) accelerator complex is the second synchrotron light source in Thailand. It consists of three main components: a 150 MeV injector linac, a 3 GeV full energy booster synchrotron, and a 3 GeV electron storage ring. The booster structure is a modified FODO lattice with defocusing quadrupole fields combined in bending magnets. Circumference of the booster synchrotron is 307 m. It is designed to share the same tunnel with the storage ring. The 3 GeV storage ring has a circumference of 321 m and the electron beam emittance of 0.9 nm-rad. The ring consists of 14 Double Triple Bend Achromat (DTBA) cells, resulting in 14 long and 14 short straights. Maximum stored beam current will be 300 mA. Beam injection to the storage ring is executed with a Pulsed Multipole magnet, which is designed based on the Non-Linear Kicker (NLK) magnet developed for BESSY-II. The storage ring RF system has a frequency of 119 MHz with the accelerating voltage of 2.2 – 3.6 MV. All the RF cavities are normal conducting and the RF power is supplied by solid-state RF amplifiers together with Digital Low-Level RF (DLLRF) controllers. Third harmonic cavities (Landau cavities) will be installed to suppress beam instabilities. Stainless steel is the preferred material for SPS-II vacuum chambers.
Requirements List Available:	Yes
Approval Date:	21 January 2019
Status of Contracting:	-
Construction scheduled to start:	2023
Estimated Project Cost:	300M USD
Estimated Construction Duration:	7 years

Type of Equipment to be Purchased:	150 MeV linear accelerator, RF system, beam diagnostics, vacuum components, vacuum pumps, power supplies, insertion devices, injector magnets and control instruments

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Third RF station for storage ring of Taiwan Photon Source

Project Location:	Thailand
Project Location:	Taiwan
Project Type:	Upgrade
Project Description:	Construct 3rd RF station including SRF cavity, transmitter and LLRF to support more beam line operation under 500mA beam current
Requirements List Available:	Yes
Approval Date:	01-Jan-2018
Status of Contracting:	90 % completed
Construction scheduled to start:	01-Jan-2018
Estimated Project Cost:	7 M USD
Estimated Construction Duration:	5 years
Type of Equipment to be Purchased:	500MHz KEKB-type SRF module,500MHz 320kW solid-state power amplifier, circulator, ferrite load, DLLRF system, vacuum components etc.

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Contact Person(s):	Same as Project Leader(s)
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e-mail:	

PROJECT REGION:
EUROPE

Diamond II

Project Location:	UK
Project Type:	Upgrade
Project Description:	Diamond-II: replacement of the Diamond storage ring and booster synchrotron
Requirements List Available:	No (CDR available from: https://www.diamond.ac.uk/Home/About/Vision/Diamond-II.html)
Approval Date:	31-12-21 (nominal)
Status of Contracting:	0 %
Construction scheduled to start:	April 1st 2022 (nominal)
Estimated Project Cost:	
Estimated Construction Duration:	Project ends June 2027 (nominal)
Type of Equipment to be Purchased:	Magnets, r.f. cavities and solid-state amplifiers, vacuum vessels and instrumentation, girder supports, diagnostic components, insertion devices etc. etc.

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European Spallation Source (ESS)

Project Location:	Sweden
Project Type:	New project
Project Description:	The European Spallation Source (ESS) is a multi-disciplinary research facility based on the world's most powerful neutron source. The unique capabilities of this new accelerator-driven facility will both greatly exceed and complement those of today's leading neutron sources, enabling new opportunities for researchers across the spectrum of scientific discovery, including life sciences, energy, environmental technology, cultural heritage and fundamental physics.
Requirements List Available:	Yes
Approval Date:	1-June-2014
Status of Contracting:	>95% of accelerator items for construction phase are contracted
Construction scheduled to start:	1-June-2014
Estimated Project Cost:	1.843 B EUR (2013)
Estimated Construction Duration:	Construction phase 2013-2025, Initial Operations phase 2019-2025, Steady State Operations phase 2026 onwards
Type of Equipment to be Purchased:	RF modulators, RF power sources, vacuum equipment, power supplies, spare parts, consumables, services and materials related to installation, tooling and lifting

Project Leader(s):	Kevin Jones (Director General), Mark Anthony (Project Director), Mirko Menninga (Head of Supply, Procurement and Logistics Division)
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Future Circular Collider (FCC) Feasibility Study

Project Location:	Switzerland and France
Project Type:	New Project
Project Description:	Investigating the technical and financial feasibility of a future hadron collider at CERN with a centre-of-mass energy of at least 100 TeV and with an electron-positron Higgs and electroweak factory as a possible first stage. Complementing the placement and layout optimization, the feasibility study includes the refined design of both colliders and their injector chains, along with targeted R&D programmes to develop the needed accelerator technologies and the technical infrastructure.
Requirements List Available:	No; Product Breakdown Structure under development
Approval Date:	2028 (expected)
Status of Contracting:	R&D phase
Construction scheduled to start:	2030 (expected)
Estimated Project Cost:	7,400 MCHF for civil engineering and technical infrastructure; 3,100 MCHF for e^+e^- Z, W, H factory plus additional 1,100 MCHF for e^+e^- top factory; 17,500 MCHF for hadron collider following e^+e^-
Estimated Construction Duration:	≥10 years
Type of Equipment to be Purchased:	Nb_3Sn accelerator magnets with a field of about 16 T, SRF cavities with a frequency in the 400-800 MHz range, efficient RF power sources, vacuum chambers appropriate for high synchrotron radiation, advanced cryogenics, novel manufacturing techniques, warm accelerator magnets, collimation system, etc.

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High Luminosity LHC (also: HiLumi LHC, HL-LHC)

Project Location:	Switzerland
Project Type:	Upgrade Project
Project Description:	https://hilumilhc.web.cern.ch/content/hl-lhc-project https://project-hl-lhc-industry.web.cern.ch/
Requirements List Available:	Yes
Approval Date:	01-Nov-2013
Status of Contracting:	Tendering Components and launching Series Production for new equipment
Construction scheduled to start:	01-Jan-2016
Estimated Project Cost:	989 M CHF (material cost) including R&D and in-kind contributions; Industrial contracts are about 500 M CHF
Estimated Construction Duration:	Up to mid 2027
Type of Equipment to be Purchased:	SC Magnets & components; SC RF cavities & components; Powering and controls devices for Magnets and Cavities; Collimators & precision mechanics special equipment; Vacuum equipment and beam diagnostics; Cryogenic plants and cryogenic equipment; SC links in MgB2 and High temperature superconductor current leads; Large & precision mechanical tools; technical infrastructures, manufacturing services.

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IFMIF-DONES

Project Location:	Europe- Granada (Spain)
Project Type:	New Project
Project Description:	A fusion-like (deuteron beam on Li target) neutron source for nuclear fusion materials research
Requirements List Available:	Engineering design available
Approval Date:	2021-2022
Status of Contracting:	Not yet started. Only engineering work under development
Construction scheduled to start:	2021
Estimated Project Cost:	600 M€
Estimated Construction Duration:	8 years
Type of Equipment to be Purchased:	The accelerator will be a 125 mA CW 40 MeV deuterons superconducting linac

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MYRRHA (phase 1 – Implementation)

Project Location:	Belgium
Project Type:	New project
Project Description:	MYRRHA is designed as an Accelerator Driven System. In a first stage to a 600 MeV super-conducting linac, a 100 MeV proton linac will be constructed (until 2026). A connected proton target facility will serve for radio-isotope production.
Requirements List Available:	High level available, prototyping ongoing
Approval Date:	07 September 2018
Status of Contracting:	The present protoyping will gradually lead to industrial supplies in the coming years.
Construction scheduled to start:	01-March-2020
Estimated Project Cost:	300 MEURO
Estimated Construction Duration:	7 years
Type of Equipment to be Purchased:	100 MeV proton linac consisting ofa 17 MeV injector with 15 copper CH-cavities followed by a superconducting spoke linac with 60 single spoke cavities. A proton target station is foreseen.

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