IPAC22

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IMPACT FORUM
Muangthong Thani
Bangkok, Thailand

PARTICLE ACCELERATOR PROJECTS AND UPGRADES BOOKLET

Siam Photon

THAI SYNCHROTRON NATIONAL LAB

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THAILAND CONVENTION & EXHIBITION BUREAU

Particle Accelerator Projects and Upgrades

For Indusrty Collaboration in the Field of Particle Accelerators

14th Edition

Complied by

Synchrotron Light Research Institute
(Public Organization)

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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Centro Nacional de Pesquisa em Energia e Materiais – CNPEM

Contents

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	United States of America
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	Feb 02 2016
Status of Contracting	>60% of contracts have been issued
Construction scheduled to start	Jul 25 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.

Project Leader(s)	Robert Hettel (Director), Jim Kerby (Project Manager), Elmie Peoples-Evans (Deputy Project Manager)
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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	Oct 31 2016
Status of Contracting	Low-current beam commissioning completed 2020, high- current commissioning outstanding.
Construction scheduled to start	Jan 01 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	United States of America
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	2018 April
Status of Contracting	>95% of the items are contracted
Construction scheduled to start	2020 October
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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Proton Power Upgrade Project

Project Location	United States of America
Project Type	Proton Power Upgrade project
Project Description	Double the proton beam power from 1.4 MW to 2.8 MW at the Spallation Neutron Source.
Requirements List Available	Yes
Approval Date	2018 Jan
Status of Contracting	80%
Construction scheduled to start	2020 Oct.
Estimated Project Cost	272 M (USD)
Estimated Construction Duration	4 years
Type of Equipment to be Purchased	Superconducting RF cryomodules, high power RF equipment

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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	Jan 01 2018
Status of Contracting	60% of the items are contracted
Construction scheduled to start	Jul 01 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	Jul 01 2016
Status of Contracting	Ongoing as needs arise
Construction scheduled to start	Oct 01 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	Sep 03 2011
Status of Contracting	Completed construction, open to users
Construction scheduled to start	Oct 20 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	Apr 01 2010
Status of Contracting	80% of the items are contracted
Construction scheduled to start	Dec 01 2022
Estimated Project Cost	250 M USD
Estimated Construction Duration	4 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

Project Location	China
Project Type	New Project
Project Description	HALF :A fourth generation light source based on a diffraction limited storage ring with energy of 2.2 GeV
Requirements List Available	Yes
Approval Date	Oct 11 2021
Status of Contracting	0% of the items are contracted
Construction scheduled to start	Aug 01 2022
Estimated Project Cost	2880Million (CNY)
Estimated Construction Duration	~ 5.4 years
Type of Equipment to be Purchased	optical elements, vacuum components, RF-equipment, beam diagnostics, magnets, etc.

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Heavy Ion Research Facility at Lanzhou

Project Location	China
Project Type	Accelerator Improvement Project
Project Description	The upgrade project of the HIRFL facility is to increase heavy ion beam power. The existing facility consists of two cyclotrons (SFC and SSC) and two cooling storage rings (CSRm and CSRe). In the upgrade project, a linac with the energy of 1.5 MeV/u will be made as the injector of SSC. The dipole power supply and several quadropoles power supplies of CSRm will be replaced. New vacuum chambers will be installed at the injection and extraction sections of CSRm. Some beam diagnostics will be improved. With the upgrade, the charge state of Uranium beam in CSRm will be increased from 28+ to 72+. Correspondingly, the extraction energy will be improved from 120 MeV/u to 500 MeV/u. The project received approval to proceed with construction in 2019. The linac has already installed except the last two DTL cavites. Most of installations will take place before 2023.
Requirements List Available	Yes
Approval Date	2019
Status of Contracting	>70% of the items are contracted
Construction scheduled to start	2021 Aug
Estimated Project Cost	20 M (CNY, linac is not included)
Estimated Construction Duration	4 years
Type of Equipment to be Purchased	Vacuum chamber and pumps, quadrupols power supplies, electronics, RF components

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High Intensity heavy-ion Acelerator Facility

Project Location	China
Project Type	New Project
Project Description	HIAF is a new accelerator facility under constructed at the Institute of Modern Physics (IMP) in China. The research mission of HIAF is to study interdisciplinary on nuclear physics, nuclear astrophysics, atomic physics and heavy ion applications. The facility consists of a superconducting ECR ion source (SECR), a CW super-conducting ion linac (iLinac), a fast ramping booster synchrotron (BRing) and a high precision spectrometer ring (SRing). A fragment separator (HFRS) is used to connect BRing and SRing. Six experimental terminals will be built at HIAF. The maximum magnetic rigidity is 34 Tm. The civil construction was already started in December of 2018. The accelerator is under constructed and planned to provide the first beam in 2025.
Requirements List Available	Yes
Approval Date	Dec 31 2015
Status of Contracting	~60% of items are contracted
Construction scheduled to start	Dec 23 2018
Estimated Project Cost	450 M (USD)
Estimated Construction Duration	7 years
Type of Equipment to be Purchased	Superconducting magnets, diagnostics, vacuum chamber, beam line magnets, conventional facilities, electronics

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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	Dec 20 2011
Status of Contracting	Contracting
Construction scheduled to start	Dec 20 2011
Estimated Project Cost	946 M USD (excluding site cost)
Estimated Construction Duration	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 Duration	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	Jan 21 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 / 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	Jan 01 2018
Status of Contracting	90 % completed
Construction scheduled to start	Jan 01 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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Project Region: EUROPE

Advanced Rare Isotope Facility - ARIEL-II

Project Location	Canada
Project Type	Upgrade
Project Description	ARIEL-II is the second stage of the rare isotope beam (RIB) production at TRIUMF. The first stage, ARIEL-I, funded in 2010 delivered the ARIEL building and a super-conducting cw-electron linear accelerator, designed to deliver 10mA electron beams at 50MeV. An initial stage is operational to deliver beams at 30MeV. The second stage, ARIEL-II, will increase the scientific productivity by exploiting the new electron accelerator in terms of final beam power (10 mA at 30 MeV) and reliability to produce a wider variety of exotic isotope species at higher intensities and to deliver multiple beams in parallel. The project comprises a new target station for an intense 100 kW electron beam using photo fission for rare isotope production, a new proton beam line for a 100 μA proton beam from the existing 520 MeV cyclotron to a new isotope production proton target station in the ARIEL building. In addition, ARIEL-II comprises about 200 m of RIB transport beam line and a new beam preparation and charge breeding system CANREB, which has been completed. The ARIEL-I SRF e-linac completion to its design specifications, the new driver beam transport lines and the new high-power target stations for the electron and proton beams are presently under construction.
Requirements List Available	Yes
Approval Date	Oct 06 2016
Status of Contracting	70% of the items are contracted
Construction scheduled to start	Oct 01 2017
Estimated Project Cost	45 M CAD
Estimated Construction Duration	9 years
Type of Equipment to be Purchased	Target ion sources, EBIS, target hall infrastructure (shielding, remote handling equipment etc.), beam line components and vacuum components, RF-equipment, beam diagnostics, beamline magnets, EPICS controls.

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Diamond II

Project Location	United Kingdom
Project Type	Upgrade
Project Description	Upgrade the linac, replace booster synchrotron and storage ring
Requirements List Available	No
Approval Date	Apr 01 2023
Status of Contracting	0% of the items are contracted
Construction scheduled to start	Apr 01 2023
Estimated Project Cost	140 M GBP
Estimated Construction Duration	5 years
Type of Equipment to be Purchased	beam diagnostics, controls equipment, front-ends, injection and extraction elements, insertion devices, magnets, mechanical supports, power supplies, RF-equipment, vacuum vessels and components 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,
Requirements List Available	Yes
Approval Date	June 01 2014
Status of Contracting	>95% of accelerator items for construction phase are contracted
Construction scheduled to start	June 01 2014
Estimated Project Cost	2.891 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 colider 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	Nb3Sn accelerator magnets with a field of about 16 T, SRF cavities with afrequency 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	Nov 01 2013
Status of Contracting	Tendering Components and launching Series Production for new equipment
Construction scheduled to start	Jan 01 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	989 M CHF (material cost) including R&D and in-kind contributions; Industrial contracts are about 500 M CHF
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	Sep 07 2018
Status of Contracting	The present protoyping will gradually lead to industrial supplies in the coming years.
Construction scheduled to start	Mar 01 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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