



EDMS No.: XXXXX

Group Code: XXXX

X (Project) Document Ref.: XXXX

IT/DO-XXXX/DEPT/PROJECT

The X Project/Facility/Study

DRAFT- 20180410

## Invitation to Tender OR Price Enquiry

### Technical Specification

XXXX

#### Abstract

This technical specification concerns the supply of XXXX.

Delivery of the Supply is foreseen over XXXX years/months/weeks from notification of the contract.

Each Technical Specification must contain an abstract of no more than 100 words. Use 12-point size, Times Roman font, fully justified. The abstract summarizes the scope of the delivery in one or two sentences and explain when the delivery will be due.

Colours:
Black: in principle shall be kept
Yellow: to be completed or adapted
Blue: options to be considered on a case by case basis (please note that any of the proposed headings can be skipped if not relevant to this IT)
Green: examples
[Red]: comments and guidelines to be removed before the document is released

[Users of this template should refer to the style sheet of this document for all formatting, and the following link for a language guideline: <http://writing-guidelines.web.cern.ch/>.

Users should also consult 27 Key questions to ensure that safety aspects are integrated into invitations into tender: <http://edms.cern.ch/document/1334815>]



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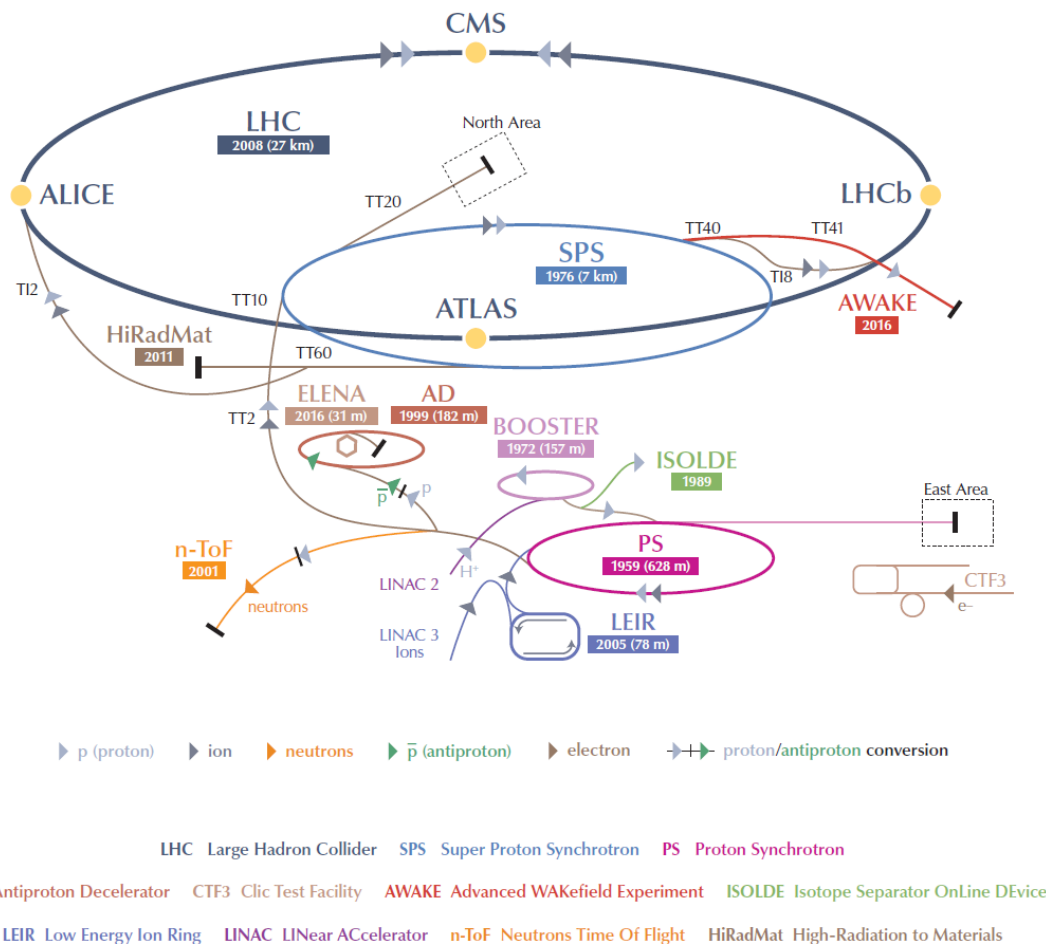
## 1. INTRODUCTION

### 1.1 Introduction to CERN

CERN, the European Organization for Nuclear Research, is an intergovernmental organization with over 20 Member States<sup>1</sup>. Its seat is in Geneva but its premises are located on both sides of the French-Swiss border (<http://cern.ch/fplinks/map.html>).

CERN's mission is to enable international collaboration in the field of high-energy particle physics research and to this end it designs, builds and operates particle accelerators and the associated experimental areas. At present more than 10 000 scientific users from research institutes all over the world are using CERN's installations for their experiments.

The accelerator complex at CERN is a succession of machines with increasingly higher energies. Each machine injects the beam into the next one, which takes over to bring the beam to an even higher energy, and so on. The flagship of this complex is the Large Hadron Collider (LHC) as presented below:



**Figure 1:** CERN Accelerator Complex

Further information is available on the CERN website: <http://cern.ch>

<sup>1</sup> <http://home.web.cern.ch/about/member-states>

## 1.2 Introduction to the X Project/Facility/Study

[Please select the appropriate introduction in the list of project specific optional introductory paragraphs attached to this template]

## 1.3 Introduction to Unit

Department

Group

Section

## 2. SCOPE OF THE SUPPLY

[Please note that the “Contractor” (i.e. the successful bidder) must be referred to as the “Contractor” or “it”. Do not use terms like “firm”, “company”, “bidder”, “supplier” or other]

CERN intends to place a Contract for the supply of XXXXX (hereinafter referred to, in whole or in part, as the “Supply”).

The successful bidder (hereinafter referred to as the “Contractor”) shall perform the Contract as defined in this technical specification, including its annexes.

The Supply includes:

- Deliverables, including XXX, as specified in § 4;
- Activities, including XXX, as detailed in § 5;
- Documentation, including XXX, as detailed in § 6;
- XXX

CERN will provide the following items and services:

- ;
- XXXXX

The Contractor shall ensure that the Supply complies with the requirements specified in the following paragraphs and the documents/drawings forming part of the Invitation to Tender (see Annex XXX).

## 3. APPLICABLE NORMS, STANDARDS AND RULES

The Supply must be compliant with laws, in particular with all relevant professional and technical norms, standards and rules, including CERN’s safety rules available under: <http://cern.ch/safety-rules>

## 4. SPECIFICATION OF THE SUPPLY

The Supply includes the following deliverables:

- Item XXXX;
- Item XXXX;
- Spare parts;
- ...

#### 4.1 Performance

The Supply must/shall comply with the following performance requirements:

- XXXXX ;
- XXXX ;
- .....

[Including reliability indices (Mean Time Between Failures).]

#### 4.2 Operational and Environmental Conditions

[I.e. the conditions in which the Supply will be operated, for example voltage, current, pressure, temperature, etc.]

[I.e. environmental conditions that the Supply will operate in, for example the ambient and peak temperature, the relative moisture, the dew point, access conditions, underground area, radioactivity, etc.]

#### 4.3 Specific Material

The Supply must/shall comply with the following specific material requirements:

- XXXX;
- XXXX;
- .....

#### 4.4 Dimensions and Tolerances

The Supply must/shall comply with the following dimensions and tolerances:

- XXXXX ;
- XXXX ;
- .....

#### 4.5 Industrial Controls

[The aim of this section is to provide information and requirements on the industrial systems (e.g. PLC brands and models, architecture strategy, fieldbus characteristics, database aspects, data logging, etc.)]

Computing security aspects

#### 4.6 Options

[Optional § used to list what is outside the basic Supply.]

The following optional supply units/services may be ordered by CERN within the framework of the contract:

- XXXX
- XXXX
- Etc...

## 4.7 Warranty

The warranty period defined in the General Conditions of CERN Contracts is two years from the date of acceptance (§7.5 of the present technical specification).

[Should the warranty period be longer, please consult your procurement officer.]

OR

[If different from the above, specify duration and conditions of warranty for this particular contract.]

## 5. ACTIVITIES

### 5.1 Activities at the Contractor's Premises

The activities to be performed by the Contractor at its premises must include but not be limited to the following:

- Design (§ 5.1.1);
- Prototyping (§ 5.1.2);
- Pre-series and Series Manufacturing (§ 5.1.3);
- Testing (§ 5.3.1)
- Packing and Shipping (§ 5.1.4);

#### 5.1.1 Design

XXXX

#### 5.1.2 Prototyping

Production of the series follows the production of XXXX prototypes and is subject to prior written acceptance by CERN of such prototypes.

#### 5.1.3 Pre-series and Series Manufacturing

Production of the series follows the production of XXXX pre-series units and is subject to prior written acceptance by CERN of such pre-series.

#### 5.1.4 Packing and Shipping

The Contractor shall be responsible for the packing and, where so specified by CERN, for the transport to CERN. In all cases, the Contractor shall ensure that the Supply is delivered to CERN without damage and any possible deterioration in performance due to transport conditions.

The Contractor shall comply with professional regulations in matters of packing and shipping. In particular with the following:

- XXXX.

[Please check coherence with provisions in the tender form]

### 5.2 Activities on the CERN Site

The activities to be performed by the Contractor on the CERN site, in accordance with the provisions of § 7.2, include but are not limited to:

- Dismantling, Installation and/or Commissioning (§ 5.2.1);

- Testing (§ 5.3.2);
- Maintenance (§ 5.2.2);
- Training of CERN Personnel (§ 7.4).

**5.2.1 Dismantling, Installation and/or Commissioning**

The Contractor shall carry out the dismantling, installation and commissioning in accordance with following conditions:

- Unloading and unpacking ;
- XXXX ;
- .....

**5.2.2 Maintenance**

The preventive and/or corrective maintenance shall be performed as specified in the §§ below. [Should the Contract include specific acceptance and warranty conditions please contact the Procurement officer in view of drafting tailor-made provisions in the technical specification.]

[For Supplies installed in beam facilities: if the Contractor is not expected to intervene on the CERN site for installation and commissioning, but only for corrective maintenance in case of breakdown, then it may be wise to consider the transfer of the equipment to a surface workshop to avoid its intervention in an ionized radiation area and to ease intervention.]

**5.2.2.1 Preventive Maintenance**

The Contractor shall perform preventive maintenance interventions according to the following frequency and conditions:

- during warranty period: xxxxx
- after warranty period: xxxxx

**5.2.2.2 Corrective Maintenance**

The Contractor shall perform corrective maintenance interventions according to the following frequency and conditions:

- during warranty period: xxxxx
- after warranty period: xxxxx

**5.3 Tests**

**5.3.1 Tests Carried Out at the Contractor's Premises**

The Contractor shall carry out the following tests at its premises:

- Production Tests (§ 5.3.1.1);
- Factory Acceptance Tests – FAT (§ 5.3.1.2).

CERN or a representative of its choice, reserves the right to attend any tests carried out at the Contractor's or its subcontractors' premises. The Contractor shall notify CERN in writing at least ten working days before the proposed date for any such tests.

**5.3.1.1 Production Tests**

xxxxx



### 5.3.1.2 *Factory Acceptance Tests (FAT)*

XXXX

### 5.3.2 *Tests Carried Out at CERN*

CERN will carry out the following Site Acceptance Tests (SAT) on its site:

- Test XXXX;
- Test XXXX.

[In case tooling might become contaminated, please contact HSE in order to complete this section with specific requirements]

## 6. DOCUMENTATION

The Contractor shall ensure that the Supply includes the requested technical documentation (§ 6.1) and those related to the performance of the Contract (§ 6.2).

### 6.1 Documents Related to the Supply

The documents related to the Supply shall include:

- Detailed Design File (§ 6.1.1);
- Technical Documentation (§ 6.1.2);
- Maintenance Documentation (§ 6.1.3);

• .....

#### 6.1.1 *Detailed Design File*

The Contractor shall submit a detailed design file including:

- XXXXX;
- XXXX;
- .....

Any start of component ordering and equipment manufacture shall be subject to CERN's written prior approval of the detailed design file.

#### 6.1.2 *Technical Documentation*

The technical documentation shall include:

- XXXXX;
- XXXX ;
- ....

#### 6.1.3 *Maintenance Documentation*

The maintenance documentation shall include:

- Preventive Maintenance Plan;
- XXXX;
- ....

## 6.2 Documents Related to the Contract Performance

The documents related to the Contract performance shall include:

- Quality Assurance Plan (§ 6.2.1);
- Safety Documentation (Risk prevention plan, etc...) (§ 6.2.2);
- ....

## 6.3 Document Formatting

The Contractor shall comply with professional and/or CERN's standards/codes in matters of document editing, design/drawing process, design reviews and approval, naming conventions and tagging, quality assurance/control, in particular with:

- XXXX;
- XXXX.
- Etc...

The Contractor shall submit all documents produced in electronic format:

- Drawings in CATIA<sup>®</sup>, AUTOCAD<sup>®</sup> and/or HP-GL<sup>®</sup> format;
- Text documents in Microsoft Word<sup>®</sup> and/or PDF<sup>®</sup> format;
- Cost breakdowns and equipment lists in Microsoft Excel<sup>®</sup> format;
- Schedules in Microsoft Project<sup>®</sup> format.

## 7. PERFORMANCE OF THE CONTRACT

### 7.1 Execution Schedule

[Please check that the delivery dates are coherent with the ones defined in the Tender Form.]

The Contractor shall deliver the Supply in accordance with the following execution schedule, starting from the date of reception of the Contract by the Contractor:

Number	Milestones	Weeks
T <sub>0</sub>	Reception of Contract by the Contractor	
	<i>Delivery of Design for Manufacturing file</i>	T <sub>0</sub> +XX
T <sub>1</sub>	Acceptance by CERN of the Design for Manufacturing file	
	<i>Delivery of Qualification Test file</i>	T <sub>1</sub> +XX
T <sub>2</sub>	Acceptance by CERN of the Qualification Test file	
	<i>Delivery of Manufacturing and Test file for the Pre-series</i>	T <sub>2</sub> +XX
T <sub>3</sub>	Acceptance by CERN of Manufacturing and Test file for pre-series and written agreement for shipping	
	<i>Delivery of pre-series units at CERN (xx units) (batch no. 0)</i>	T <sub>3</sub> +XX
	<i>Delivery of Manufacturing and Test file for series batch no. 1</i>	T <sub>3</sub> +XX
T <sub>4</sub>	Acceptance by CERN of Manufacturing and Test file for series batch no. 1 and written agreement for shipping	

	<i>Delivery of series batch no. 1 at CERN (xx units)</i>	T <sub>4</sub> +x
	<i>Delivery of Manufacturing and Test file for series batch no. x</i>	T <sub>4</sub> +xx
T <sub>5</sub>	Acceptance by CERN of Manufacturing and Test file for series batch no. x and written agreement for shipping	
	<i>Delivery of series batch no. x at CERN (xx units)</i>	T <sub>5</sub> +xx

CERN reserves the right to amend this execution schedule before the start of the installation works. In such case, CERN will inform the Contractor in writing two weeks before the new start date the on-site installation.

CERN shall have free access to the manufacturing or assembly sites during normal working hours, including any subcontractor's premises during the contract period. The change of manufacture place is subject to prior written approval by CERN.

The execution schedule shall take into account CERN's official holidays as well as weather and other conditions that may affect the performance of the Contract.

## 7.2 Working on the CERN Site

For any intervention on the CERN site, the Contractor shall take into account and implement the rules and provisions defined in the document *Working on the CERN Site* available under: <http://procurement.web.cern.ch/key-reference-documents>

The Contractor shall take into account the following features of the CERN site:

[Depending on the nature of the activities on the CERN site]

- Custom formalities since the installations straddle the Swiss-French border;
- Underground and radiation areas;
- Extent of the territory and distances between sites;
- XXXX.

### 7.2.1 Location of the Activities

The Contract will be performed on the French part only of the CERN site.

[OR]

The Contract will be performed on the Swiss part only of the CERN site.

[OR]

The Contract will be performed on both the French and the Swiss parts of the CERN site. The foreseeable preponderant share of the activities to be provided under the Contract and to be determined in accordance with the applicable agreements<sup>2</sup> will be located on the French/Swiss part of the CERN site. The Contractor shall take note of the above-mentioned agreements and the resulting obligations for contractors and their sub-contractors.

<sup>2</sup> Accord entre le Gouvernement de la République Française, le Conseil Fédéral Suisse et l'Organisation Européenne pour la Recherche Nucléaire (CERN) sur le droit applicable aux entreprises intervenant sur le domaine de l'Organisation afin d'y réaliser des prestations de services revêtant un caractère transnational and Protocole d'amendement de la Convention entre le Gouvernement de la République française et le Conseil fédéral suisse relative à l'extension du domaine de l'Organisation européenne pour la Recherche nucléaire conclue le 13 septembre 1965, available on <https://procurement.web.cern.ch/law-applicable-to-contractors-personnel>.

[Paragraph to be inserted in cases where the Contract will be executed on both the French and the Swiss parts of the CERN site. The applicable law will be determined on the basis of a memorandum provided by the Procurement Service at the beginning of the invitation-to-tender procedure.]

### 7.2.2 Contractor's Personnel and Training

The Contractor shall assign a sufficient number of qualified personnel for the performance of the Contract. The personnel assigned by the Contractor to the Contract shall at all times remain under the sole direction and responsibility of the Contractor.

The Contractor shall forthwith replace, if so requested by CERN, any member of its personnel assigned to the Contract whose conduct or whose administrative situation could adversely affect or is adversely affecting the proper performance of the Contract or any other activities on the CERN site.

The Contractor shall, at its own expense, ensure that its personnel assigned to the Contract has suitable training to comply with the requirements of the present Contract.

Furthermore, before the start of the Contractor's activities on the CERN site, the Contractor shall ensure that its personnel has completed the specific training CERN deems necessary. The CERN site specific training will be provided by CERN.

The Contractor shall systematically evaluate the training of its personnel at the end of each training course and shall provide CERN with evidence that the personnel has been successfully trained.

CERN may also make its own evaluation by setting up a series of tests and refuse the assignment of a member of the Contractor's personnel who has not been trained successfully.

### 7.2.3 Safety Requirements related to Activities on the CERN Site

In accordance with the provisions of § 3.1 of the document *Working on the CERN site*, the activities performed by the Contractor on the CERN site will be classified as:

- "Category 1" worksite;

[OR]

- "Category 2" worksite or activity;

[OR]

- "Category 2" activity, but it will be part of an existing worksite classified as a "Category 1" worksite (Shutdown (LS1)' case for example).

[OR]

- "Technical stops".

The Contractor shall inform CERN in writing of any change in the potential risks as and when they arise. Some activities are subject to a notice of starting work to be issued by CERN (*Impact* system).

The Contractor shall comply with the following specific safety requirements:

[Depending on the nature of the activities on the CERN site]

- Asbestos aspect for maintenance or minor jobs;
- Activities in radiation areas;
- Activities in an experimental area;
- Activities in confined space;

- Activities in a potentially explosive atmosphere;
- Specific worksite rules;
- XXXX.

In accordance with § 7 of the Safety regulation CERN SR – SO “Responsibilities and Organisational Structure in Matters of Safety at CERN”<sup>3</sup>, the Contractor shall appoint a Safety Correspondent who shall act as his representative at CERN in matters of Safety.

### 7.3 Contract Follow-Up and Progress Monitoring

The Contractor shall assign a person responsible for the technical execution of the Contract and its follow-up, as well as a person responsible for the commercial follow-up, throughout the duration of the Contract. They shall be able to communicate in one of the official languages of CERN (English or French).

The Contractor shall send a written progress report to CERN every XXXX months until completion of the Contract. All communications and documents shall be in English or French.

This report shall include all the necessary information, in particular:

- Actual progress in comparison to scheduled progress;
- Updates of Safety documents.

### 7.4 Training of CERN Personnel

The contractor shall provide training for the CERN personnel concerned, in the field of XXX and as follows:

- within XXX days following the SAT;
- in both French and English, in two dedicated sessions;
- for up to XXX persons per session;
- including all training material;
- including training manual, in file.pdf, in both French and English;
- at least XX hours per session;
- addressing in writing all theoretical and practical questions;
- including the control system;
- including the safety instructions, operator level maintenance and operator level failure analyses.

After the training, the CERN personnel concerned shall be able to:

- program and XXX;
- XXX;
- conduct a failure analysis;
- XXXXX
- ...

---

<sup>3</sup> Lien ?

## 7.5 Acceptance

Acceptance of the Supply shall be granted by CERN in accordance with the procedure stated in clause 21 of the General Conditions of CERN Contracts (CERN/FC/5312-II/Rev.).

OR

Acceptance of the Supply will be notified by CERN if the following conditions are fulfilled:

- the delivered/installed/commissioned Supply is in conformity with the Contract, including documentation referred to in this technical specification;
- all tests specified in § 5.3 herein have been successfully completed and all tests results or other requested certificates have been submitted to CERN and found compliant

[Specify acceptance tests schedule as the case may be]

## 8. CERN CONTACT PERSONS

Persons to be contacted for technical matters:

Name/Department/Group	Telephone	Email
Mr Mrs XXXX XX/XX	Tel: +41 22 767 XXXX	XXXX.XXXX@cern.ch
In case of absence:		
Mr Mrs XXXX XX/XX	Tel: +41 22 767 XXXX	XXXX.XXXX@cern.ch

Persons to be contacted for commercial matters:

Name/Department/Group	Telephone	Email
Mr Mrs XXXX XX/XX	Tel: +41 22 767 XXXX	XXXX.XXXX@cern.ch
In case of absence:		
Mr Mrs XXXX XX/XX	Tel: +41 22 767 XXXX	XXXX.XXXX@cern.ch

## 9. ANNEXES

- Technical documents/drawings
- XXXX ;

# GUIDELINES FOR AUTHORS

## Guide for Text, Tables, Figures, Units, References

### [1. Text style]

All text is 12-point size except for figure captions, table contents, headers, first page contents, and references which are 10-point size and footers that are 9-point size. Use single space. All text is fully justified.

First level headings are capitalized, all headings are bold, and headings from third level on are italic.

### [2. Example of table style]

#### List of tables

Table 1: Title of the table ..... 13

Left align long text, centre short text and centre or right align numbers in tables. Centre tables in the text area. Cite table in the text.

Table 1: Example Title of the table

Term	Definition

### [3. Example of figure style]

Cite figure in the text.

#### List of figures

Figure 1: Example Title of figure ..... 13

Figure 2: CERN Accelerator Complex.....**Error! Bookmark not defined.**



Figure 1: Example Title of figure

[Insert figure here]

### [4. Units]

Use SI units. Separate value and unit by a space. Keep value and unit on the same line. Additional (non SI) units can be added in exceptional cases in parenthesis.

Example 5 W/m-K (2.9 Btu/hr-ft-R)

### [5. Equations, formulas]

Use subscript and superscript where appropriate. Examples:  $fb^{-1}$ ;  $p_{inlet} = 7 \text{ mbar}$ ;  $Al_2O_3$

### [6. Example of document reference]

All referenced documents must be released in English, without mention of the author and public.

<http://edms.cern.ch/document/1234567>

### [3. Example of figure style]





## LIST OF OPTIONAL INTRODUCTORY PARAGRAPHS

### [Introduction to LHC]

The Large Hadron Collider (LHC) is the most recent accelerator constructed on the CERN site. The LHC machine accelerates and collides proton beams but also heavier ions up to lead. It is installed in a 27 km circumference tunnel, about 100 m underground. The LHC design is based on superconducting twin-aperture cryo-magnets which operate in a superfluid helium bath at 1.9 K.

### [Introduction to Linac4 Project]

CERN has recently built the Large Hadron Collider (LHC), a superconducting circular particle accelerator designed for colliding two beams of protons at 7 TeV energy. The LHC is housed in a 27 km circumference tunnel, about 100 m underground.

In order to improve LHC performance, CERN has launched a long-term program for the progressive replacement or upgrade of the old chain of accelerators presently used as injectors for the LHC. The Linac4 project is the first element of this program.

Linac4 is a linear accelerator for negative Hydrogen ions ( $H^-$ ), which will replace the old Linac2 as linear injector for the CERN accelerators. Its higher energy of 160 MeV will give increased beam intensity in the downstream machines. Linac4 is about 100 m long, normal conducting, and is housed in a tunnel about 12 m below ground on the CERN Meyrin site. A surface building houses the Linac4 equipment. The Linac4 tunnel is connected to the existing chain of accelerators and can be extended to the new injection chain.

### [Introduction to LIU]

CERN has recently built the Large Hadron Collider (LHC), a superconducting circular particle accelerator designed for colliding two beams of protons at 7 TeV energy. The LHC is housed in a 27 km circumference tunnel, about 100m underground. It is actively used for physics since 2010.

In order to improve the performance of the LHC, and in particular the rate of collisions observed in the detectors (“luminosity”), the accelerator complex supplying the LHC with particles must also be improved. Two linear accelerators (Linac3 and Linac4) and four synchrotrons (LEIR, PSB, PS and SPS) are concerned. It is the purpose of the LHC Injectors Upgrade (LIU) project to implement in these accelerators the modifications and upgrades required for the LHC to reach its enhanced luminosity goal.

### [Introduction to ELENA]

ELENA (Extra Low Energy Antiprotons) is a 30-m circumference ring for cooling and further deceleration of 5.3 MeV antiprotons delivered by the CERN Antiproton Decelerator (AD) down to 100 keV, where the physics programme consists of trapping antiprotons to create antihydrogen atoms after recombination with positrons. The ultimate physics goal is to perform spectroscopy on these antiatoms at rest and to investigate the effect of the gravitational force on matter and antimatter. With the current set-up, most (99.9 %) of the antiprotons produced are lost due to the deceleration process. By using a ring equipped with beam cooling, an important increase in phase-space density and a high experiment injection efficiency can be obtained, resulting in an increased number of trapped antiprotons. With the construction of the ELENA ring, the AD experiments expect improvements of

up to two orders of magnitude. In addition, ELENA will be able to deliver beams almost simultaneously to up to four experiments resulting in an essential gain in total beam time for each experiment. This also opens up the possibility of accommodating an extra experimental zone.

#### [Introduction to PS]

The Proton Synchrotron (PS) is a key component in CERN's accelerator complex, where it usually accelerates either protons delivered by the PS Booster or heavy ions from the Low Energy Ion Ring (LEIR). In the course of its history it has juggled many different kinds of particles, feeding them directly to experiments or to more powerful accelerators.

The PS first accelerated protons on 24 November 1959, becoming for a brief period the world's highest energy particle accelerator. The PS was CERN's first synchrotron. It was initially CERN's flagship accelerator, but when the laboratory built new accelerators in the 1970s, the PS's principal role became to supply particles to the new machines. Over the years, it has undergone many modifications and the intensity of its proton beam has increased a thousandfold.

With a circumference of 628 m, the PS has 277 conventional (room-temperature) electromagnets, including 100 dipoles to bend the beams round the ring. The accelerator operates at up to 25 GeV. In addition to protons, it has accelerated alpha particles (helium nuclei), oxygen and sulphur nuclei, electrons, positrons and antiprotons.

#### [Introduction to SPS]

The Super Proton Synchrotron (SPS) is the second-largest machine in CERN's accelerator complex. Measuring nearly 7 kilometres in circumference, it takes particles from the Proton Synchrotron and accelerates them to provide beams for the Large Hadron Collider, the NA61/SHINE and NA62 experiments, the COMPASS experiment and the CNGS project.

The SPS became the workhorse of CERN's particle physics programme when it switched on in 1976. Research using SPS beams has probed the inner structure of protons, investigated nature's preference for matter over antimatter, looked for matter as it might have been in the first instants of the universe and searched for exotic forms of matter. A major highlight came in 1983 with the Nobel-prize-winning discovery of W and Z particles, with the SPS running as a proton-antiproton collider.

The SPS operates at up to 450 GeV. It has 1317 conventional (room-temperature) electromagnets, including 744 dipoles to bend the beams round the ring. The accelerator has handled many different kinds of particles: sulphur and oxygen nuclei, electrons, positrons, protons and antiprotons.

#### [Introduction to ISOLDE]

The On-Line Isotope Mass Separator ISOLDE is a facility dedicated to the production of a large variety of radioactive ion beams for a great number of different experiments, e.g. in the field of nuclear and atomic physics, solid-state physics, life sciences and material science. At ISOLDE, radioactive nuclides are produced in thick high-temperature targets via spallation, fission or fragmentation reactions. The targets are placed in the external proton beam of the PS Booster, which has an energy of 1.4 GeV and an intensity of about 2  $\mu$ A. ISOLDE involves more than 500 scientists from 26 countries and 100 institutions.

#### [Introduction to HIE-ISOLDE]

The High Intensity and Energy (HIE) ISOLDE project is a major upgrade of the ISOLDE and REX-ISOLDE facilities at CERN. The Radioactive ion beam EXperiment (REX) at ISOLDE has provided the nuclear physics community with a wide range of post-accelerated radioactive ion beams (RIBs) since 2001 and can currently deliver beams with energies up to 2.8 MeV/u using a normal conducting

linear accelerator. The aim of the HIE-ISOLDE project is to greatly expand the physics programme compared to that of REX-ISOLDE. The most significant improvement will come from replacing most of the existing REX accelerating structure with a superconducting linear accelerator composed ultimately of four high energy and two low energy cryo-modules installed in series, and containing superconducting RF quarter-wave resonators and solenoids. Together they will allow a maximum energy of 10 MeV/u to be attained with full energy variability of the RIBs. This would allow all ISOLDE beams to be accelerated to energies well below and significantly above the Coulomb barrier, facilitating a broad programme of nuclear structure and nuclear astrophysics studies using different classes of nuclear reactions.

#### [Introduction to ATLAS]

ATLAS, or A Toroidal LHC ApparatuS ([www.atlas.ch](http://www.atlas.ch)), is a particle physics experiment at the Large Hadron Collider (LHC) at CERN. The ATLAS detector is designed and constructed to make new particle discoveries resulting from head-on collisions of protons produced by the LHC of extraordinarily high energy. ATLAS will investigate the basic forces that have shaped our Universe since the beginning of time and that will determine its fate. Among the possible discovery candidates are particles that could explain the origin of mass, confirm the existence of extra dimensions in space, unification of fundamental forces, and evidence of dark matter in our Universe. The ATLAS detector is located in an underground cavern on the Swiss part of CERN. The experiment is in operation and produces physics results. The ATLAS collaboration involves more than 3000 scientists from 174 institutions in 38 countries.

#### [Introduction to ALICE]

ALICE, or A Large Ion Collider Experiment (<http://aliweb.cern.ch/>), is a heavy-ion physics experiment at the Large Hadron Collider (LHC) at CERN. The ALICE detector is designed and constructed to study matter under extreme conditions of temperature and density created in head-on collisions of heavy nuclei produced by the LHC at unprecedented high energy. ALICE will investigate the basic properties of primordial matter from which today's Universe has emerged and which prevailed for a fleetingly short time just after the Big Bang. The fundamental questions that ALICE will try to answer are, among others, about the origin of the mass of ordinary matter, how the strong force organizes the elementary constituents of matter, what is the structure of vacuum associated to the strong force and how did primordial matter turn into ordinary matter. The ALICE detector is located in an underground cavern on the French part of CERN. The experiment is in operation and produces physics results. The ALICE collaboration involves around 1200 scientists from 132 institutions in 36 countries.

#### [Introduction to CMS]

The Compact Muon Solenoid, or CMS (<http://cms.cern.ch>), is a particle physics experiment at the Large Hadron Collider (LHC) at CERN. The CMS detector is designed to study particles produced in high-energy proton-proton and heavy ion collisions to seek answers to fundamental questions such as: "understanding why the world is the way it is, why some particles weigh more than others and what constitutes the dark matter in the Universe". The CMS detector is located 100 m underground at the French village of Cessy near Geneva. The experiment is in operation and the data now being collected by CMS is distributed to institutes around the world to be analysed. The CMS collaboration involves 4300 particle physicists, engineers, technicians, students and support staff from 179 universities and institutes in 41 countries.

### [Introduction to LHCb]

LHCb, or Large Hadron Collider beauty ([lhcb.web.cern.ch](http://lhcb.web.cern.ch)), is a particle physics experiment at the Large Hadron Collider (LHC) at CERN. The LHCb detector is designed to study the slight asymmetries between matter and antimatter using particles containing beauty quarks. Although absent from the Universe today, beauty quarks were common in the aftermath of the Big Bang, and are generated in their billions in proton collisions of extraordinarily high energy produced by the LHC. By studying the slight differences in decay between the particles containing beauty quarks and their antiparticles to unprecedented precision, LHCb is shedding light on one of the Universe's most fundamental mysteries: why do we find ourselves today in a Universe made only of matter? The LHCb detector is located in an underground cavern located in Ferney-Voltaire, in France. The experiment is in operation and produces physics results. The LHCb collaboration involves around 700 scientists from 52 institutions in 14 countries.

### [Introduction to Compact Linear Collider (CLIC)]

The Compact Linear Collider (CLIC) is an international study for a future high-gradient, multi TeV electron-positron linear collider, a machine which would complement the LHC at the energy frontier.

CLIC relies upon a novel two-beam acceleration concept where pulses of 12 GHz RF power are generated by high-current electron drive beams running parallel to the main beams. The drive beams are decelerated in power extraction structures and the extracted RF power is transferred to room-temperature structures accelerating the main electron and positron beams. Thanks to its modular structure, CLIC would be built in stages of increasing beam energy. Many key aspects of the CLIC scheme are experimentally addressed in the CTF3 test facility operating at CERN and other test facilities in collaborating institutes. In parallel, detector and physics studies for CLIC are taking place, including specific technical developments and test-beam measurements.

The CLIC study, hosted by CERN, is organized as an international collaboration with 46 participating institutes from 24 countries. It published the CLIC Conceptual Design Report in 2012 and is now engaged in project preparation.

### [Introduction to HL-LHC]

The Large Hadron Collider (LHC) is the most recent accelerator constructed on the CERN site. The LHC machine accelerates and collides proton beams but also heavier ions up to lead. It is installed in a 27 km circumference tunnel, about 100 m underground. The LHC design is based on superconducting twin-aperture cryo-magnets which operate in a superfluid helium bath at 1.9 K.

High Luminosity LHC (HL-LHC) is a project aiming to upgrade the LHC collider after 2020-2025 in order to maintain scientific progress and exploit its full capacity. By increasing its peak luminosity by a factor five over nominal value it will be able to reach a higher level of integrated luminosity, nearly ten times the initial LHC design target. To this aim, HL-LHC is exploring new beam configurations and new advanced technologies in the domain of superconductivity, cryogenics, rad-hard materials, electronics and remote handling.