

CERN-TE-EPC

Power Converter Group Activities Overview

- **The worldwide biggest physics laboratory**



CERN Core Activity

- **Spying matter using:**

- **Accelerators**

- Powerful machines accelerating particles to very high energies

- **Detectors**

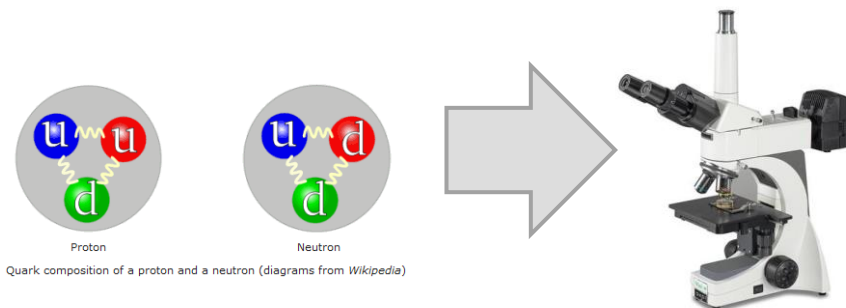
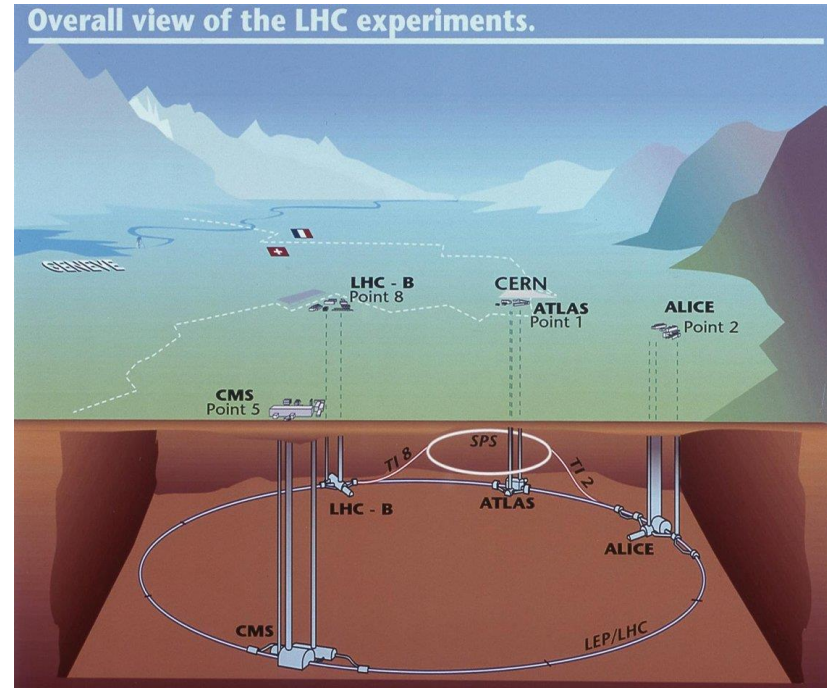
- Record particle collisions

- **Computer**

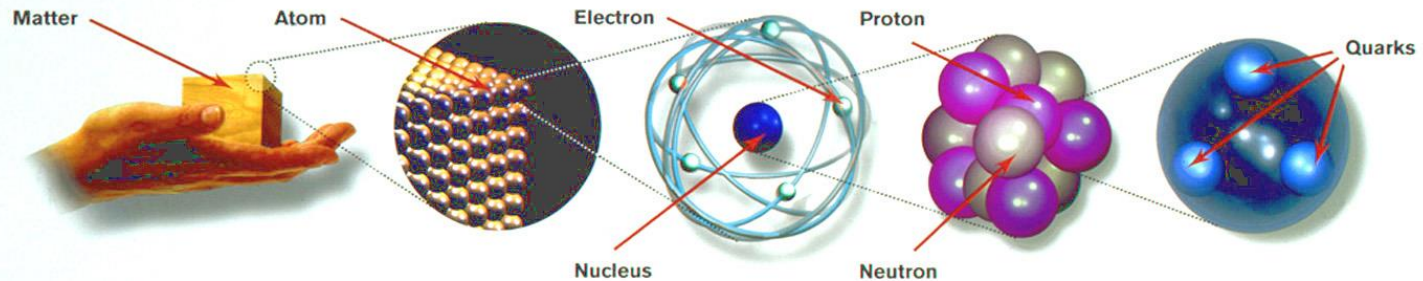
- Analyze enormous quantities of data generated by detectors

- **Simplified view**

- A powerful microscope capable to look inside matter (nucleus)















Standard Model



Matter particles
All ordinary particles belong to this group

These particles existed just after the Big Bang. Now they are found only in cosmic rays and accelerators

LEPTONS				
FIRST FAMILY	Electron Responsible for electricity and chemical reactions; it has a charge of -1		Electron neutrino Particle with no electric charge, and possibly no mass; billions fly through your body every second	
	Muon A heavier relative of the electron; it lives for two-millionths of a second		Muon neutrino Created along with muons when some particles decay	
THIRD FAMILY	Tau Heavier still; it is extremely unstable. It was discovered in 1975		Tau neutrino not yet discovered but believed to exist	

QUARKS				
FIRST FAMILY	Up Has an electric charge of plus two-thirds; protons contain two, neutrons contain one		Down Has an electric charge of minus one-third; protons contain one, neutrons contain two	
	Charm A heavier relative of the up; found in 1974		Strange A heavier relative of the down; found in 1964	
	Top Heavier still		Bottom Heavier still; measuring bottom quarks is an important test of electroweak theory	

Force particles
These particles transmit the four fundamental forces of nature although gravitons have so far not been discovered

Gluons
Carriers of the strong force between quarks

Felt by: quarks

The explosive release of nuclear energy is the result of the **strong force**

Photons
Particles that make up light; they carry the electromagnetic force

Felt by: quarks and charged leptons

Electricity, magnetism and chemistry are all the results of **electro-magnetic force**

Intermediate vector bosons
Carriers of the weak force

Felt by: quarks and leptons

Some forms of radio-activity are the result of the **weak force**

Gravitons
Carriers of gravity

Felt by: all particles with mass

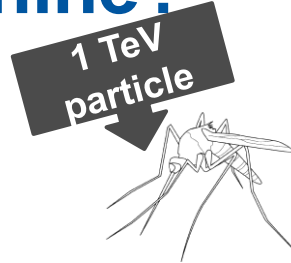
All the weight we experience is the result of the **gravitational force**

GRAPHICS: PETER CROWTHER

CERN & High Energy Physics

- LHC: a powerful machine?**

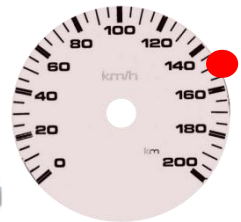
1 particle of 1 TeV \Leftrightarrow 0.1 μ J energy



10E7 particles of 1 TeV \Leftrightarrow 1 Joule

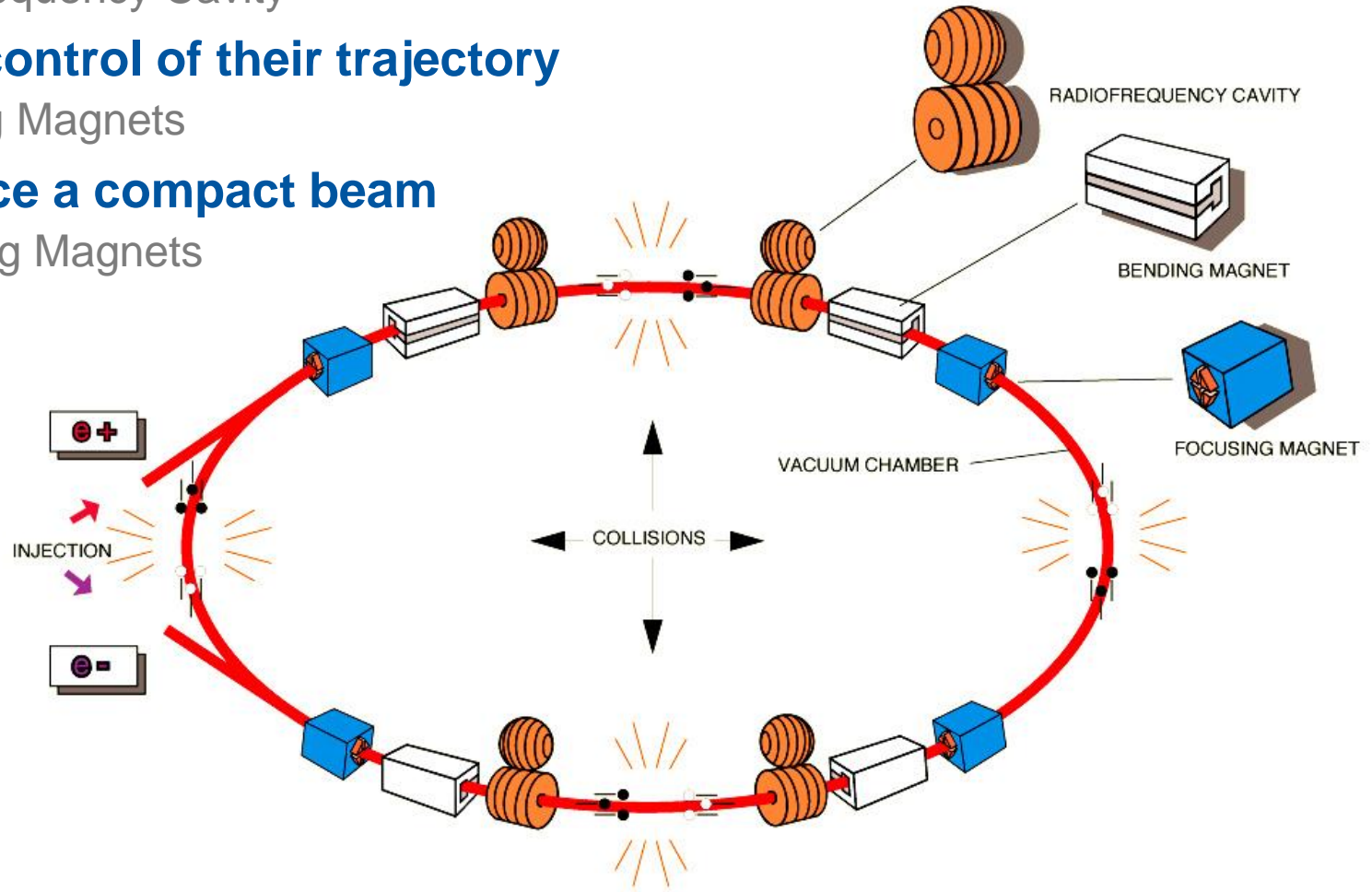


5E14 particles of 7 TeV \Leftrightarrow LHC Beam



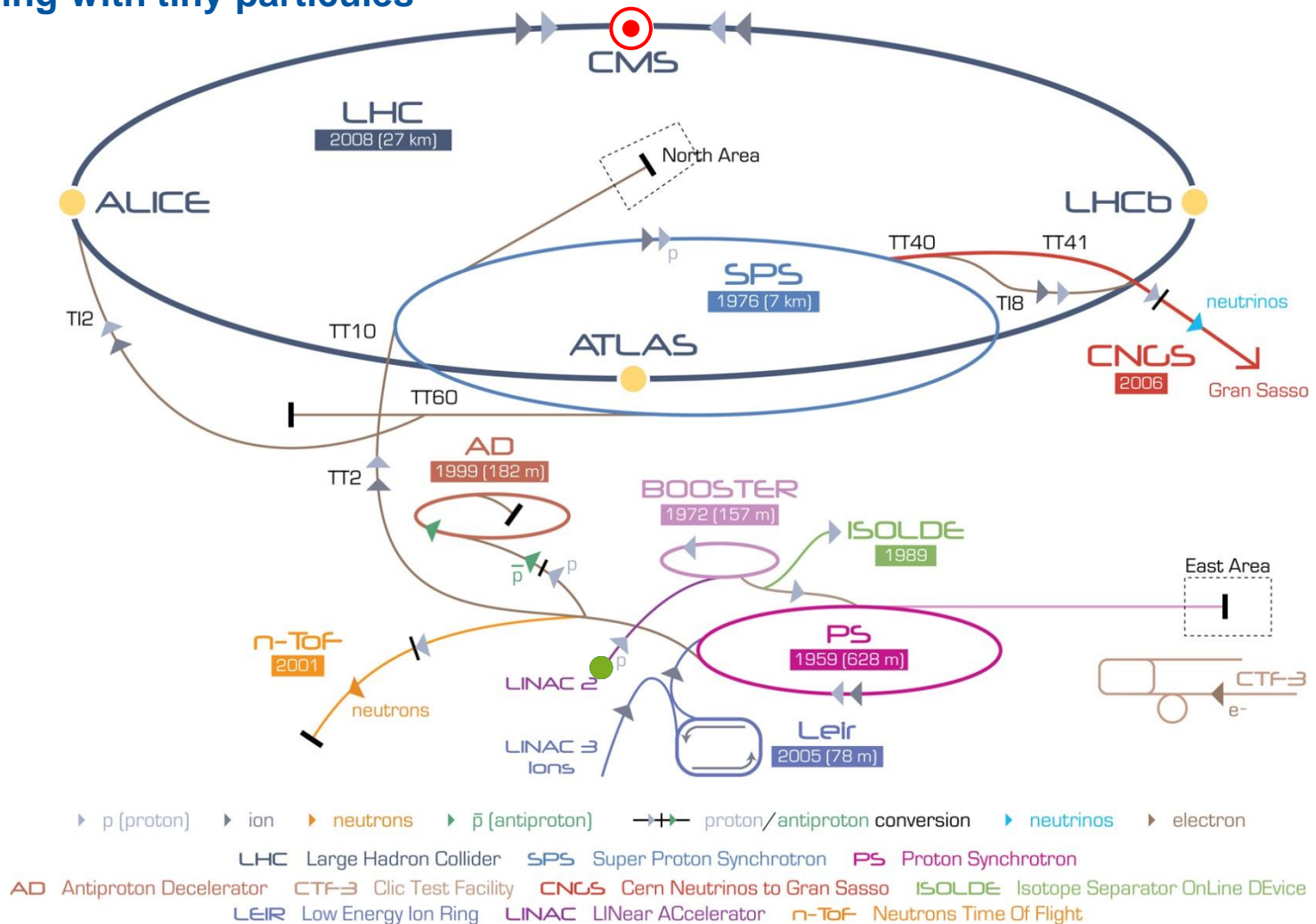
Accelerator Principles

- **Accelerating Particles**
Radiofrequency Cavity
- **Keep control of their trajectory**
Bending Magnets
- **Produce a compact beam**
Focusing Magnets



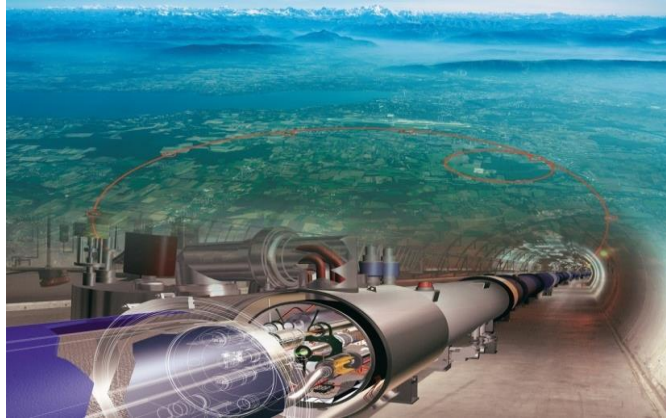
LHC, A huge machine...

...Playing with tiny particles

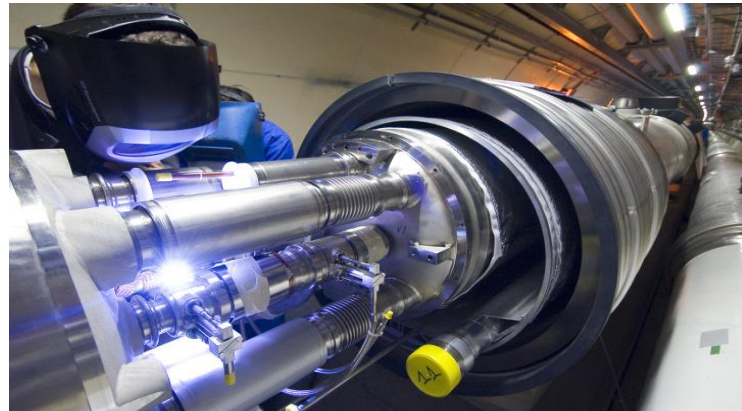


ACCELERATOR LHC Overview

- LHC a 27km Tunnel at 100m below ground level



- Thousands of equipments installed underground



Particle Detector & Experiments

- **Principle**

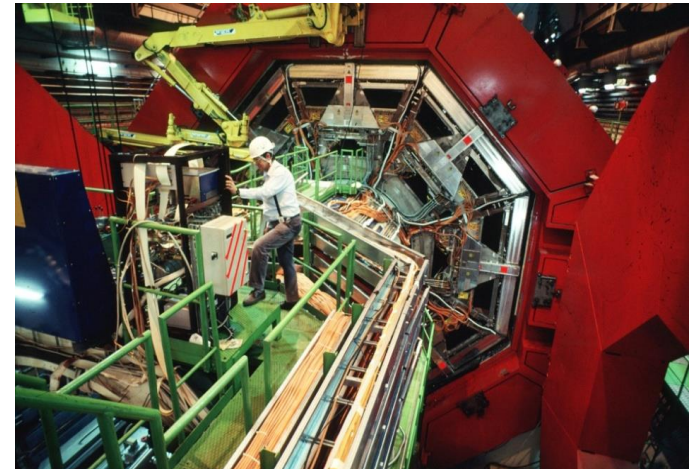
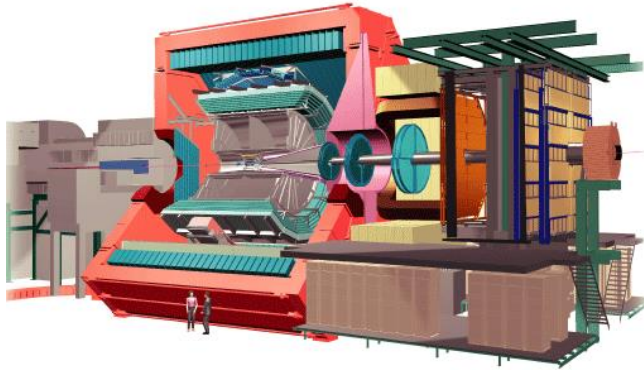
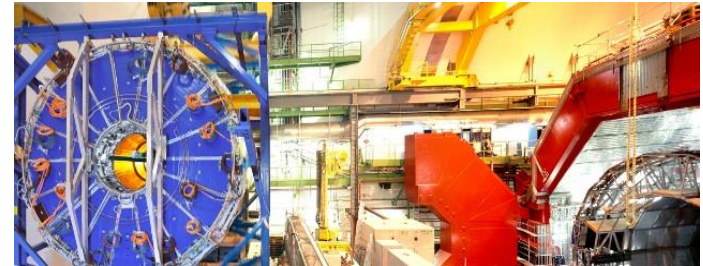
- Based on interaction between Particles and Matter

- **Goal**

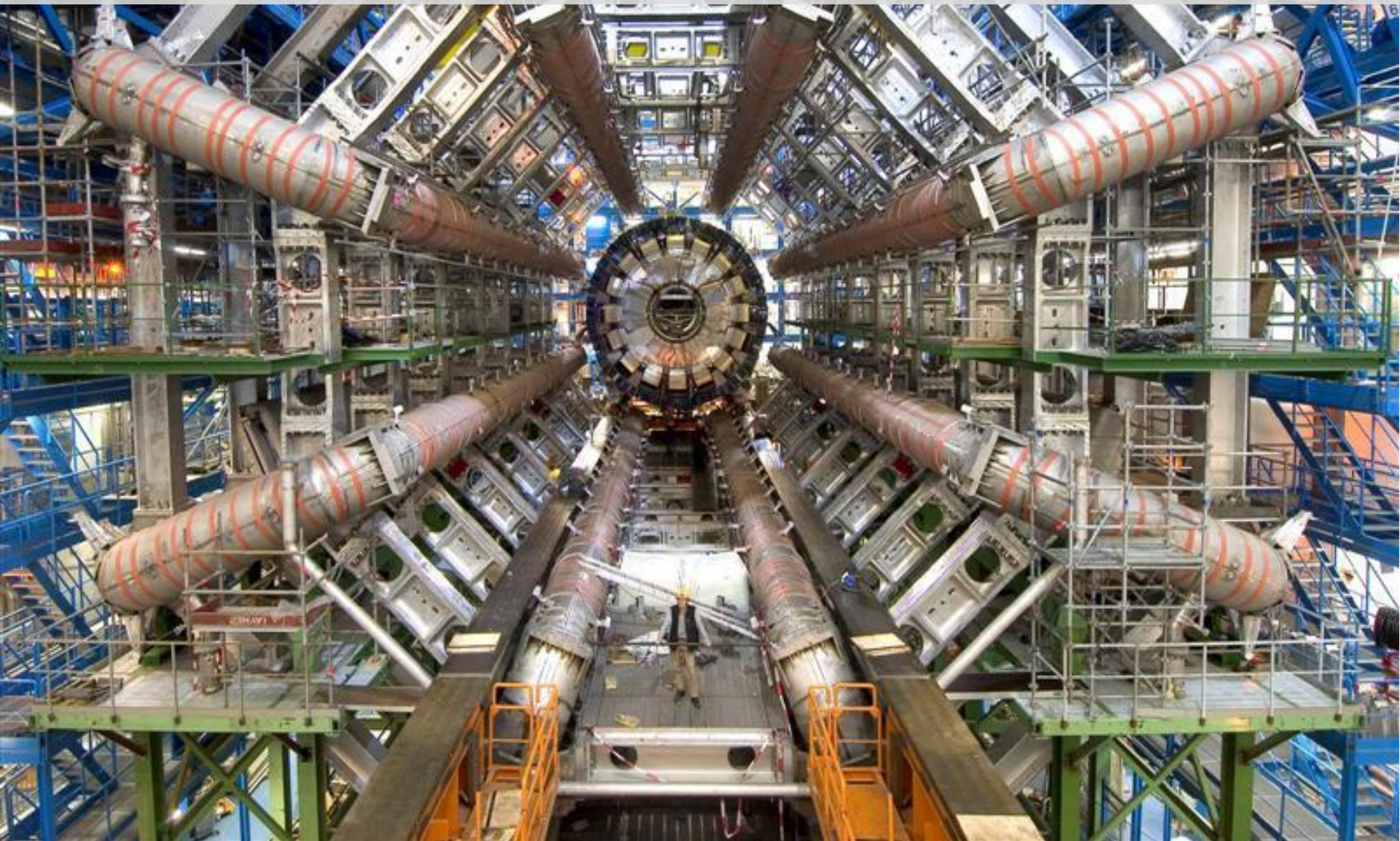
- Identification of particle type
 - Measurement of their energy

- **Using**

- Bubble Chamber, Wire Chamber
Spark Chamber
 - Scintillators
 - semi-conductors...



LHC EXPERIMENTS: ATLAS, as big as 5 floors building



CMS Experience: heavier than the Eiffel Tower



ALICE Experience: The ultrasensitive eye



LHCb Experience: the asymmetrical



CERN: People Working Together

■ Who Works At CERN

CERN employs approx. 2500 people
physicists, engineers, technicians
administrators, secretaries, etc.

Some 10,000 visiting scientists come to CERN for their research

representing 570 universities and over 60 nationalities

Students' first experience of an international laboratory

210 technical and doctoral students

150 summer students

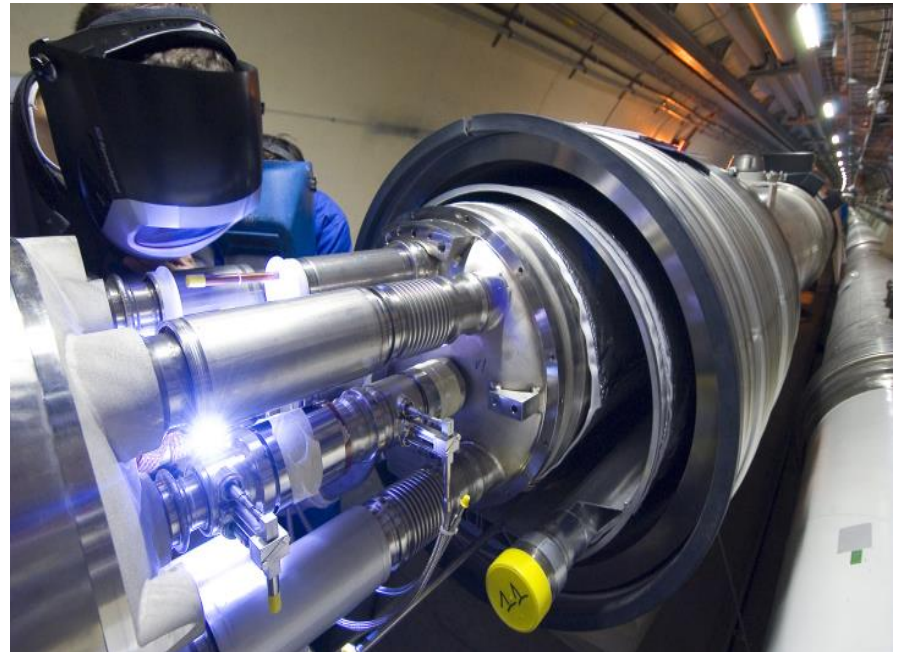
Work Environment

■ A unique work environment

- Forefront of technology and physics
- Multicultural and multidisciplinary teams
- Supervision by experts in their technical domain
- A dynamic environment with training opportunities
- An opportunity to make valuable & long-lasting contacts from all over Europe
- A bi-lingual organization (English and French)

■ Technology at CERN

- Computing/IT
- Vacuum & cryogenics
- Electronics
- Electricity
- Magnets
- Mechanics
- Material Science
- Radiofrequency
- Control Systems



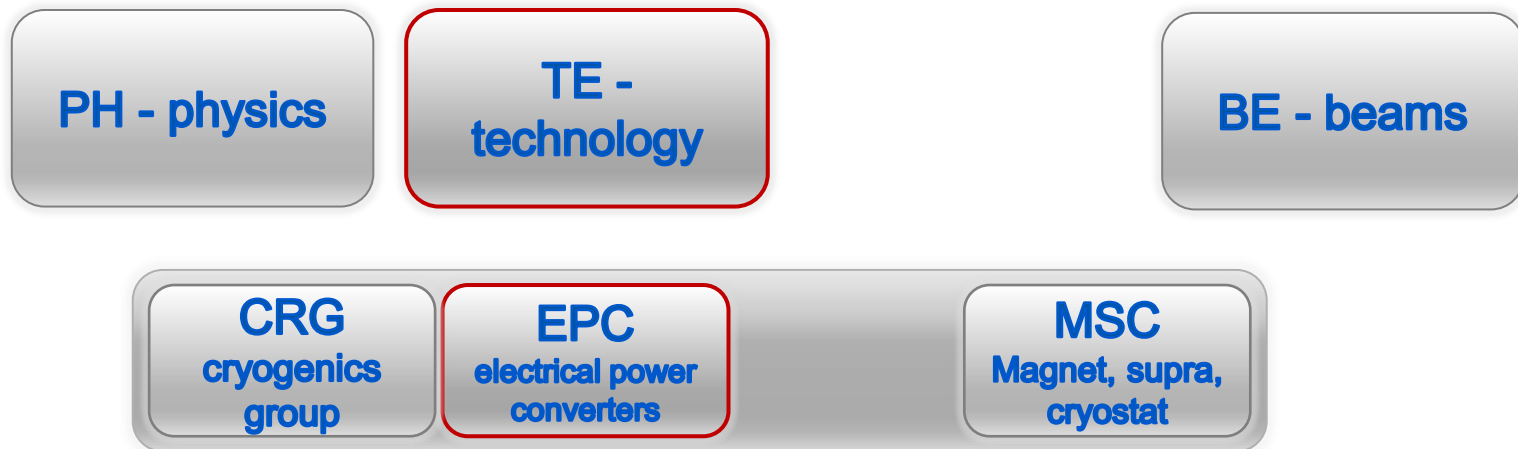
Electrical Power Converter

EPC Group @ CERN



TE-EPC Place In the organization

- **EPC inside TE (Technology Department)**



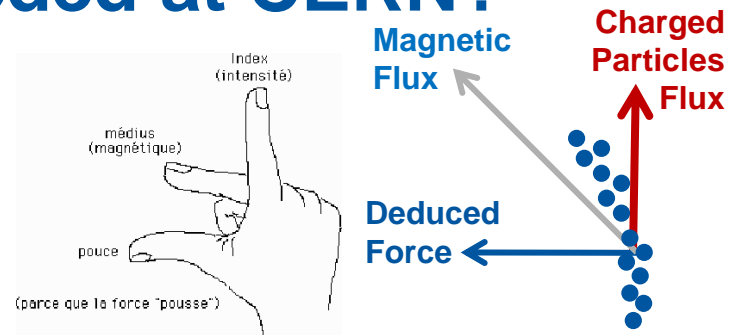
- **EPC Group is divided in 7 small (10 people) sections**
- **5 sections dedicated to Power Converter Design + 1 in charge of the high precision control**
- **A lot of Technical Staff working on the same domain, but on different scale (Watts to Megawatts)**

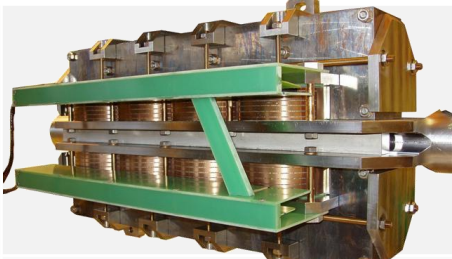



TE-EPC Mandate

■ Why a TE-EPC Group is needed at CERN?

All our accelerators are using magnetic field to curve and control beam trajectory, following the well known rule (Règle des 3 doigts)

Each magnet current is controlled with a Current Source Converter to allow a full control of the particles trajectory



Circuit Description	Magnet	Converter associated
I.Magnet = 600A This magnet is used for actually "watch" on screen the LHC beam, using Wiggler magnet type.		
I.Magnet = [60A..120A] This magnet is used to control LHC Beam Orbit. (Each LHC Beam must be stabilized in a 5cm beampipe on 27km, centered as much as possible)		

TE-EPC In figures

- A young group (40 yr average) of 70 people
- > 3000 Power Converters in operation
- From watts to MegaWatts
- Design & Operate converters



TE-EPC: Skills we look for

■ Needs for TE-EPC ?

- Higher Technical Diploma in electricity, electronics or equivalent
- Young or experienced electronic technician
- Measurement and develop skills in electrical domains
- Ability to work in a large environment, which implies to work in several sites, or offices or laboratories in CERN complex
- Ability to take responsibilities on working equipments in operation
- Good level of English is valuable (or undertaking to acquire it rapidly)
- People who want to participate to the operation of the LHC and other systems in a stand-by Service / Piquet (outside of normal CERN working hours, including we, nights, and public holidays)
- Autonomy is a must when working at CERN

■ A lot of internal trainings available to develop your skills

- Design orientated Softwares: Labview, Schematic editor, simulators, Autocad...
- Electromagnetic Compatibility courses, VHDL design...
- Communication courses...

Manpower: TE-EPC & Missions

■ TE-EPC Typical technician missions

- Power Converter operation, maintenance design, upgrade
- Participate to consolidation programs
- Piquet Operation (LHC)
- Card tester Design
- Visit [te-epc-lpc website](http://te-epc-lpc)

te-epc-lpc google search



Example: Technician At CERN?

■ In which day to day environment?

Computing in Office

- Email, Report, Meeting
- Remote Control and diagnose
- Schematic & Design
- Project Follow-Up
- Documentation, Note d'Operation, how to, guide...

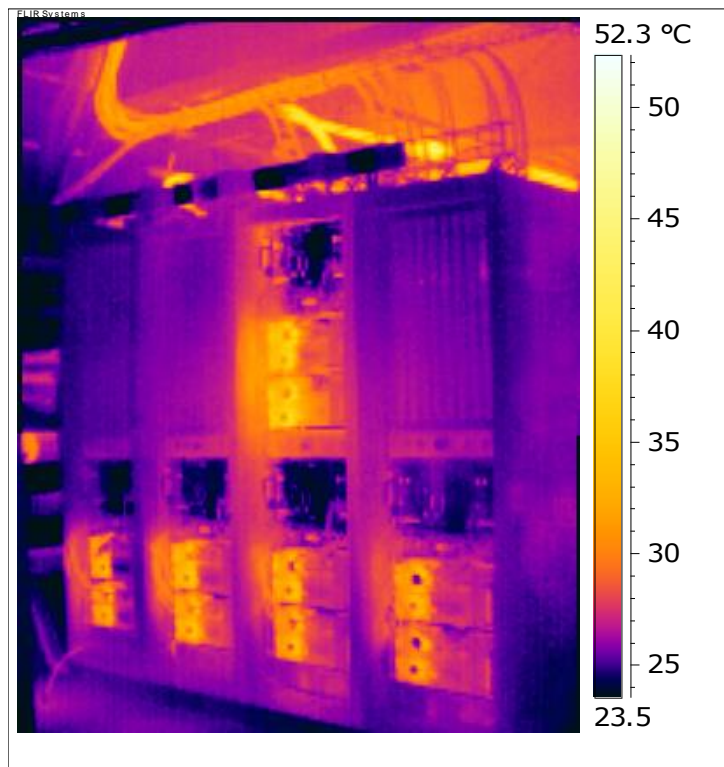


Test & development in Power Test Hall



Domain of Competence

- **Multi-Discipline**
 - Thermal, EMC, Control, Power Electro-mechanical, Magnetic Topology, design, Reliability...



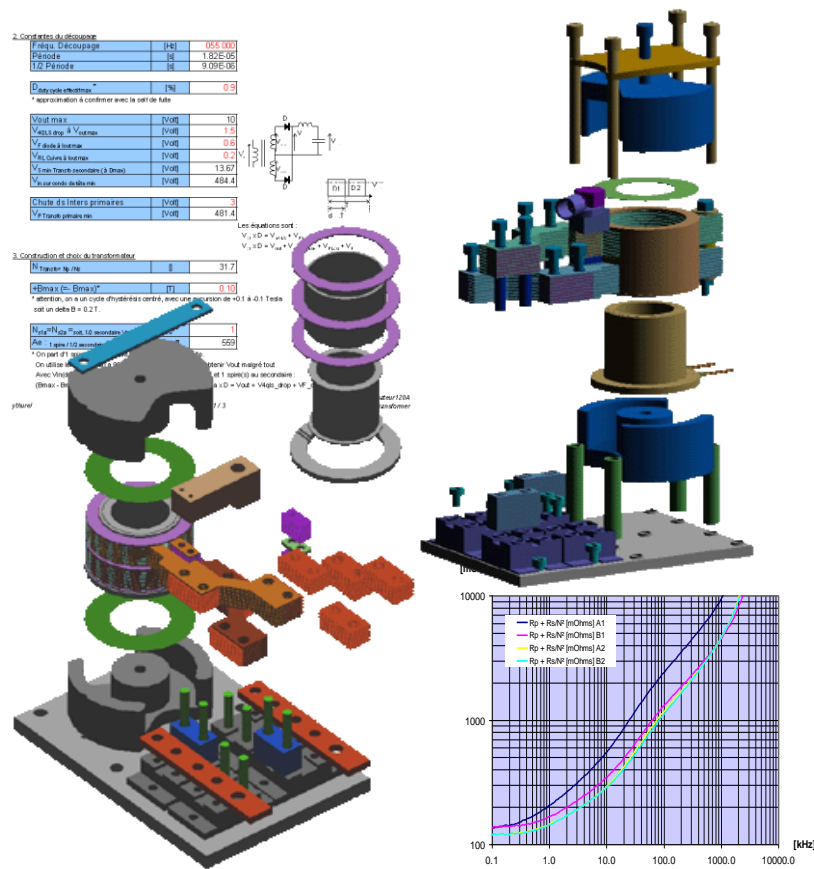
Our daily Job (1/3)

- **Reception Tests**
 - Contract follow-up, Technical Specification
- **Support to operation**
 - Fault finding
- **Electronic Design**
 - Elaboration of a Cahier des Charges
 - Looking for adequate topology
 - Designing it



- **Pure Electronic Design**

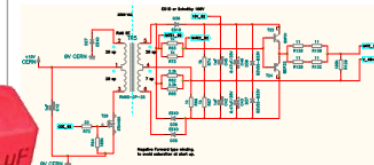
High Frequency Transformer



Phase Shifted Inverter Card

2. ELECTRICAL SCHEMATICS

2.1 POWER DRIVER

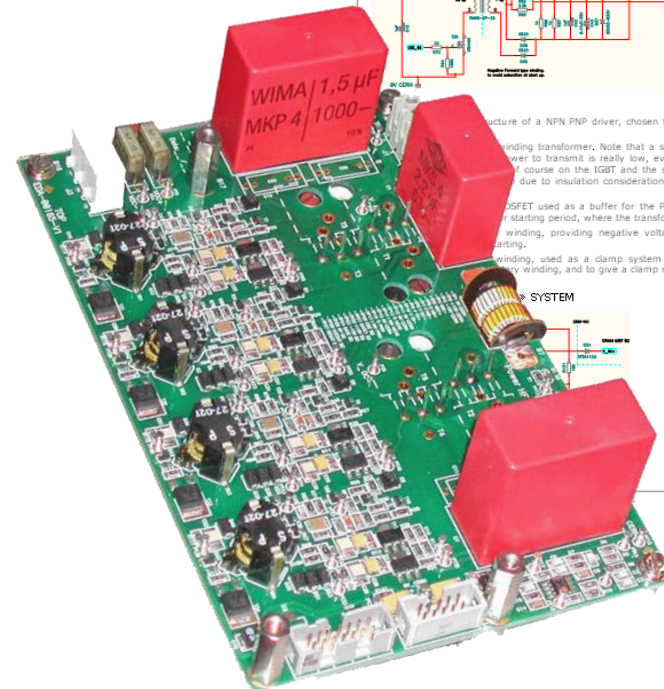


structure of a NPN PNP driver, chosen for its relative simplicity, and its winding transformer. Note that a smaller could have been chosen, as the power to transmit is really low, even with a big IGBT (less than 2 W). Of course on the IGBT and the switching frequency). The choice is due to insulation considerations. (2 sections winding available

OSFET used as a buffer for the PWM gate coming in. It is more starting period, where the transformer normally saturates a bit. winding, providing negative voltage so that de-magnetization is

winding, used as a clamp system to avoid oscillation across the primary winding, and to give a clamp reset voltage in abnormal case.

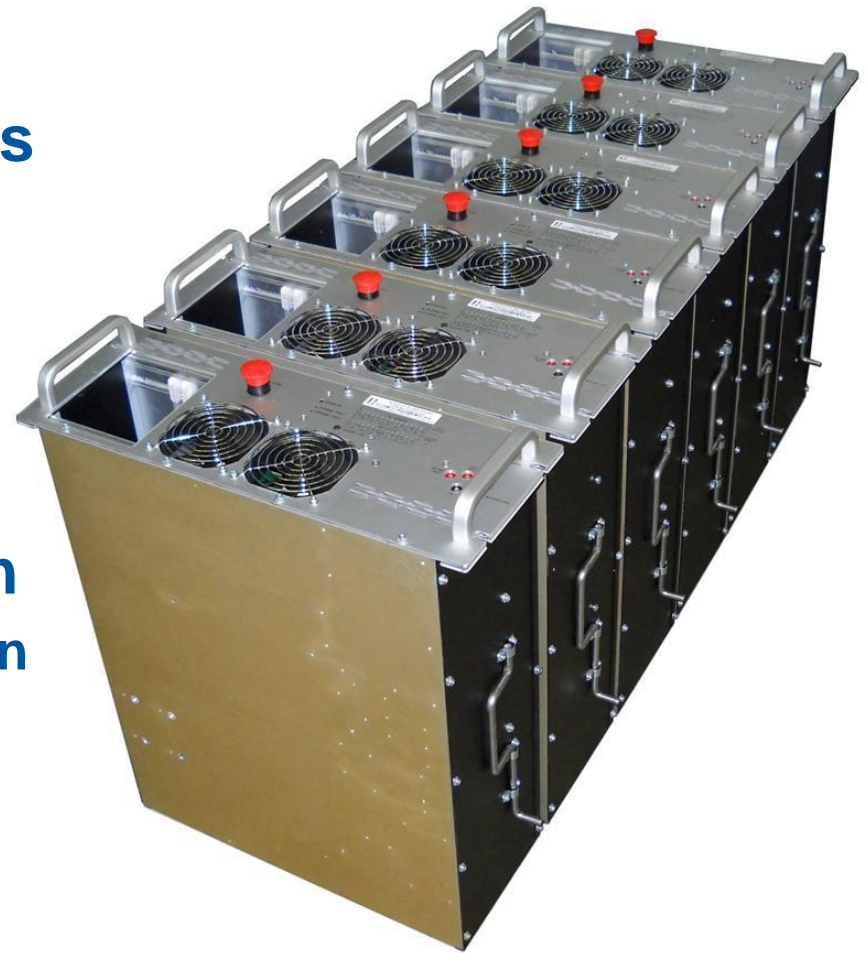
→ SYSTEM



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Our daily Job (3/3)

- **Power Converter Design**
 - From schematics to hardware
- **Usually very specific needs**
 - 4 Quadrant Power converter
 - High frequencies control loop
 - Ultra low noise
- **Up to several hundreds units, following production**
 - Reliability and lifetime concern
 - Maintenance, repair, remote diagnosis from any place in the world



TE-EPC: People Missions

■ Typical missions for TE-EPC Staff?

Design

New project or consolidation programs are always an opportunity to design new Power Converters, new Concepts to better match with accelerator machine needs

Operation

A large part of technical people from group TE-EPC joins Stand-by Service and is then operating on various equipment to allow a high availability of accelerator machine.

Equipment Responsible

Each technical people in TE-EPC is responsible of some equipments, and has to ensure the viability of the equipment: documentation up to date, consolidation program, repair, spare parts...

Tests

A lot of tests are always susceptible to be conducted: design phase or Operation phase, when trying to better understand issues.

What Next: How to apply?

■ Interested? How to apply to a post?

<http://jobs.web.cern.ch/> (Professionals > Electricity)

CERN Accelerating science

Careers at CERN

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Job Search Results

[Electronics / Electrical Technician](#)
Publication Date: 20/02/2014
Are you a technician who is passionate about power electronics? Do you have a first experience in developing electronic cards in such a domain? This is an opportunity for you to contribute to the improvement of CERN's complex installations! Take part!

[PS Accelerator operation Technical Engineer](#)
Publication Date: 17/02/2014
Are you qualified in physics, computing, electronics, electricity or electro-mechanics? Do you have a first experience in a technical or scientific environment? Take your career to an exciting new level by joining the team of operators who run the Proton Synchrotron (PS) of CERN's accelerator complex. CERN. Take part!

[PS Accelerator Operation Technician](#)
Publication Date: 17/02/2014
Are you qualified in physics, computing, electronics, electricity or electro-mechanics? Do you have a first experience in a technical or scientific environment? Take your career to an exciting new level by joining the team of operators who run the Proton Synchrotron (PS) of CERN's accelerator complex. CERN. Take part!

[SPS Accelerator operation technician](#)
Publication Date: 17/02/2014
Are you qualified in physics, computing, electronics, electricity or electro-mechanics? Do you have a first experience in a technical or scientific environment? Take your career to an exciting new level by joining the team of operators who run the Super Proton Synchrotron (SPS) of CERN's accelerator complex. Take part!

feedback

Job Search

Career Level: Professionals
Job Category: Electricity
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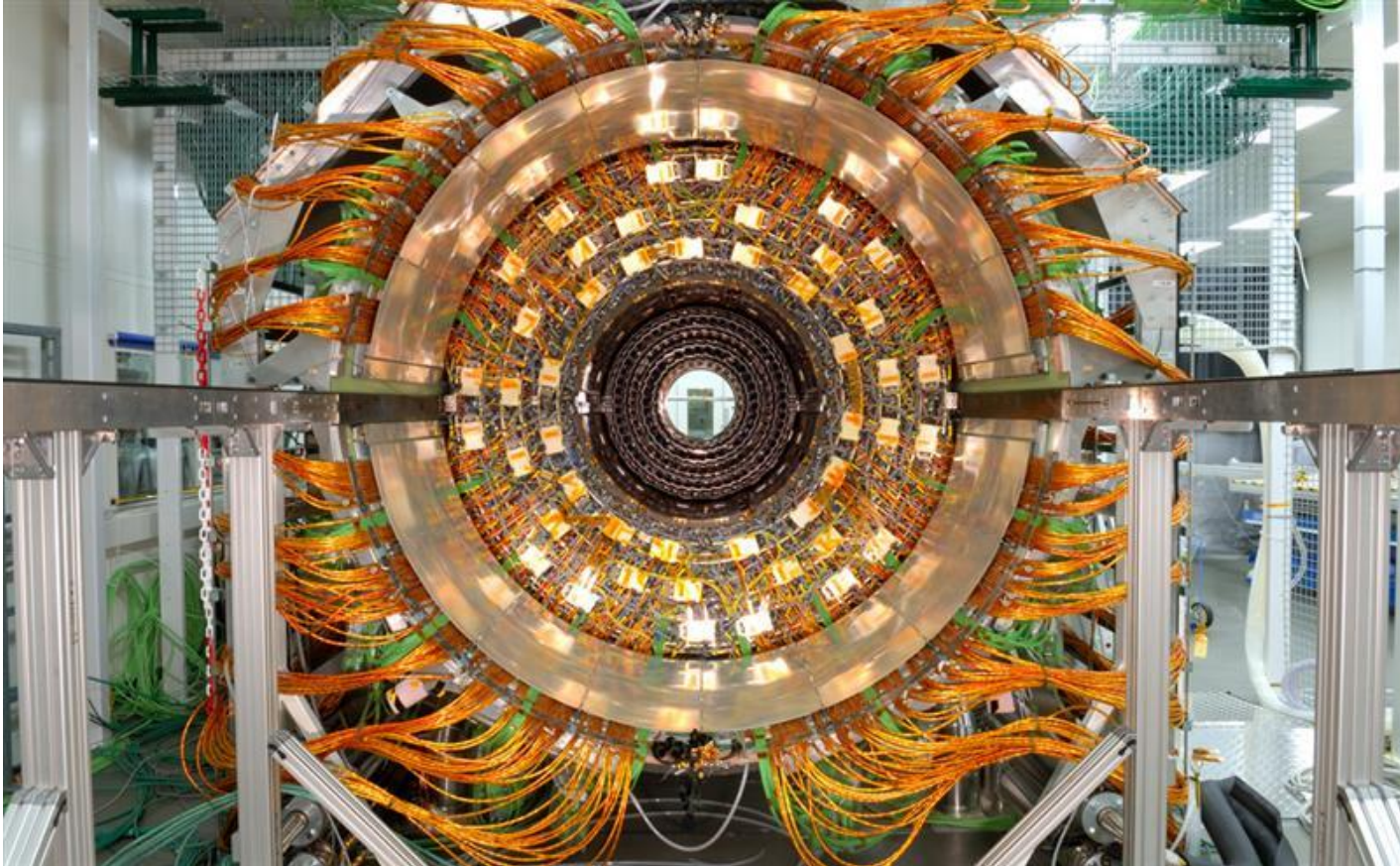
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Conclusion

Thank you for your attention
Anything you want to know? Please Ask



See you at CERN www.cern.ch