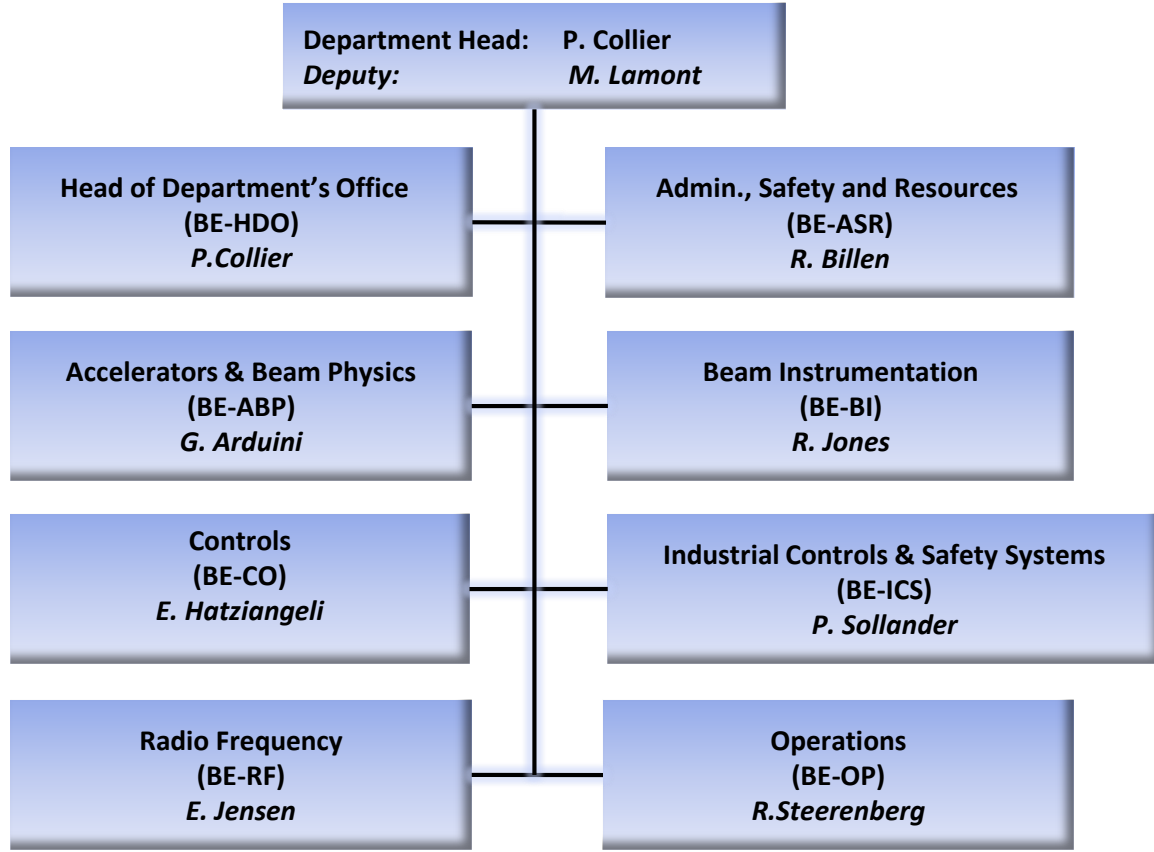




Beams Department

Paul Collier, Head of Beams, 19th March 2018



Activities

Operation/Exploitation:

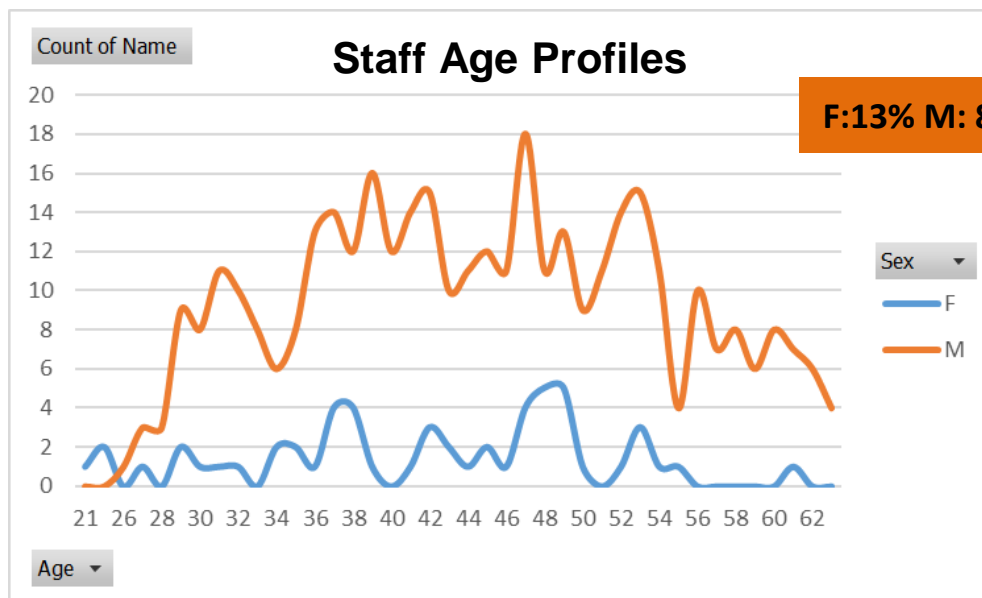
- **Machines,**
- **Technical Infrastructure**
- **Experimental Areas**
- **Site Access & Safety Systems**

Projects:

- **Consolidation**
- **Upgrades**
- **Approved Projects**

Studies:

- **New Facilities and machines**



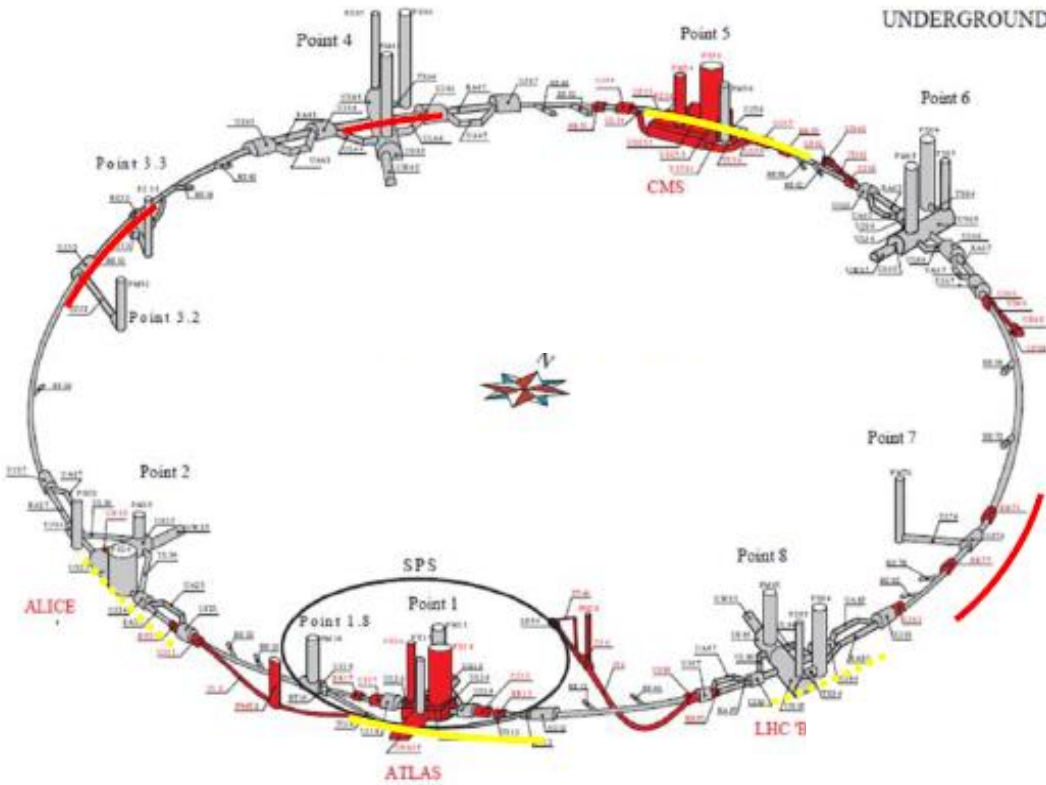
43 Nationalities

Primary Nationality	Number
AM	2
AT	17
AU	3
BE	20
BG	4
BY	1
CA	1
CH	51
CN	7
CY	3
CZ	4
DE	79
DK	10
ES	74
FI	11
FR	143
GB	75
GR	39
HU	10
IN	2
IR	4
IR	4
IT	112
JP	9
KR	1
LB	1
LK	1
MT	3
MX	5
NL	12
NO	12
PK	3
PL	47
PS	1
PT	12
RO	2
RS	1
RU	33
SE	13
SK	4
TR	11
UA	3
US	12

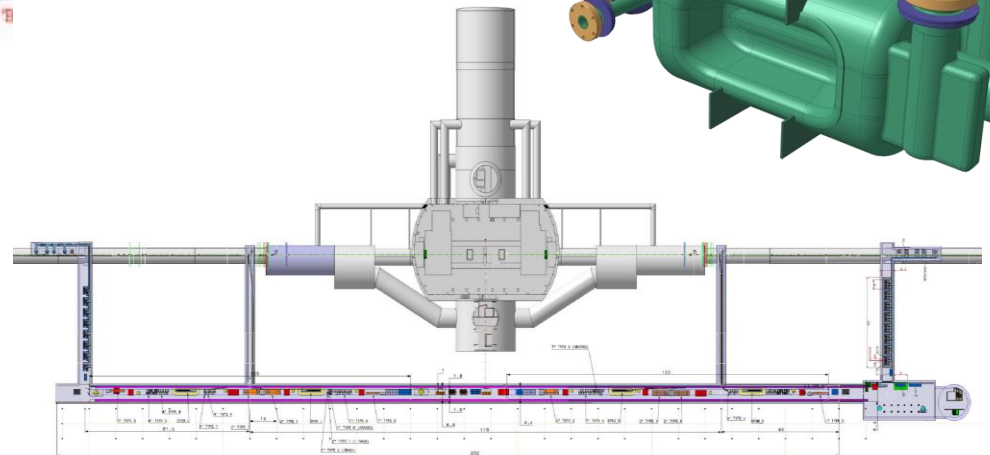
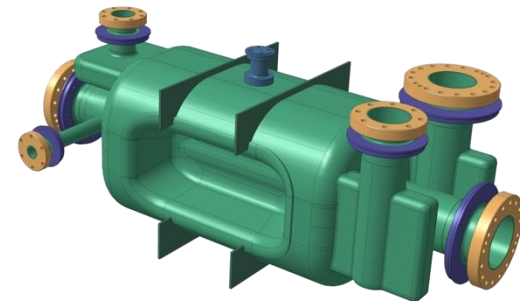
		%
Staff	428	50
Fellows & Trainees	142	16
Doctoral Students	54	6
Technical Students	48	6
Project Associates	40	5
Other Associates	149	17
Total	852	100

	Staff	%
Scientific and Engineering	234	55
Technical and Technical Engineering	182	42
Office and Admin	13	3
Total	428	100

+ 203 colleagues in Industrial support contracts
 + 64 colleagues in a partnership contract (ADAM)



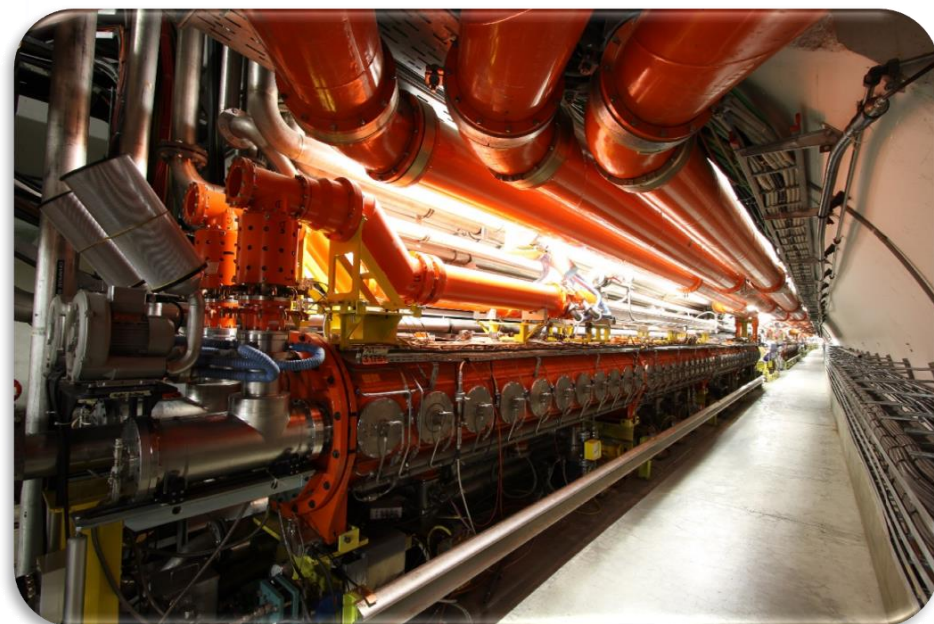
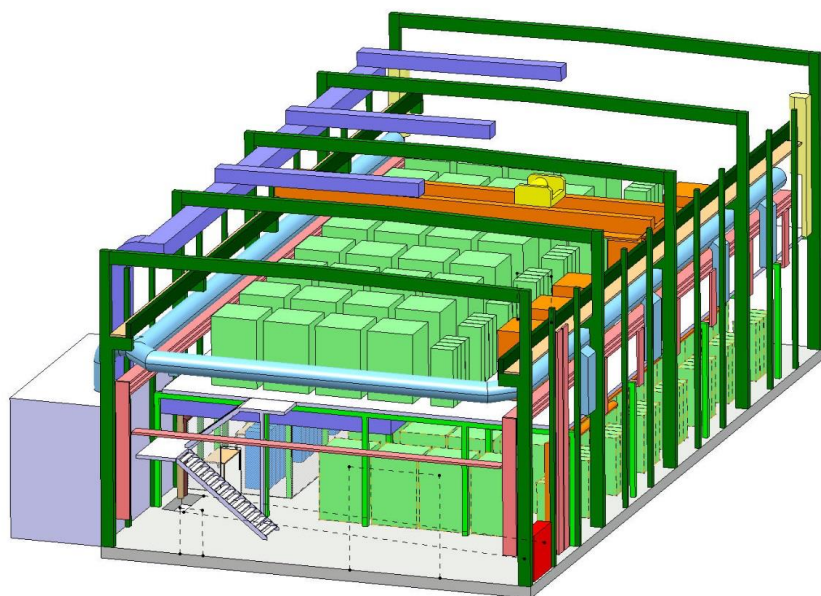
- New IR-quads Nb₃Sn (inner triplets)
- New 11 T Nb₃Sn (short) dipoles
- Collimation upgrade
- Cryogenics upgrade
- Crab Cavities
- Cold powering
- Machine protection
- Beam Instrumentation
- Controls



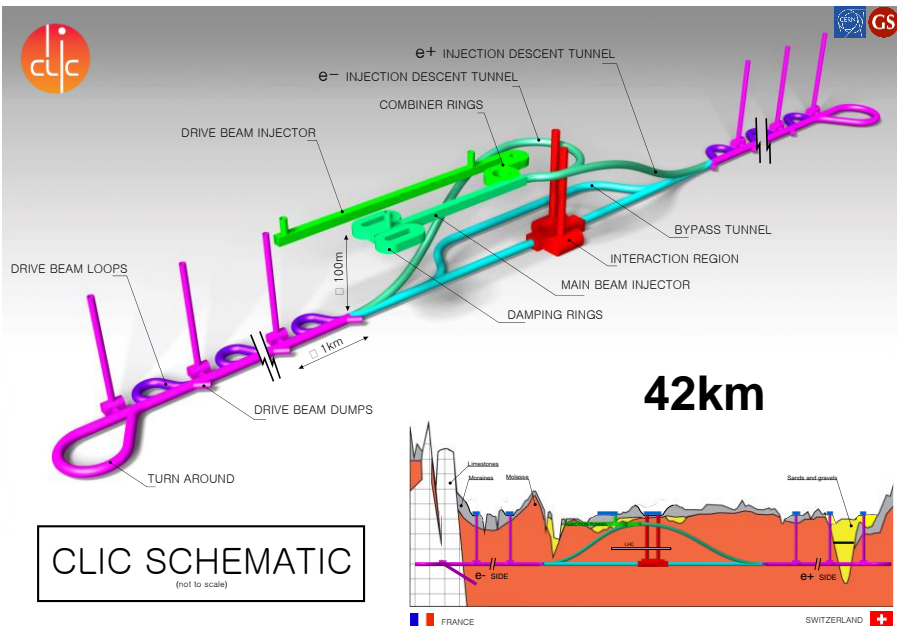
Aim to deliver 10x the LHC design - 3000 fb⁻¹

Total cost ~950MCHF

- Linac4** : Injection of H^- at 160 MeV into PSB
- PSB** : Increased Extraction energy from 1.4 to 2 GeV
- PS** : Higher Injection Energy
- SPS** : RF System upgrade



Aim to double the intensity per bunch delivered to the LHC.

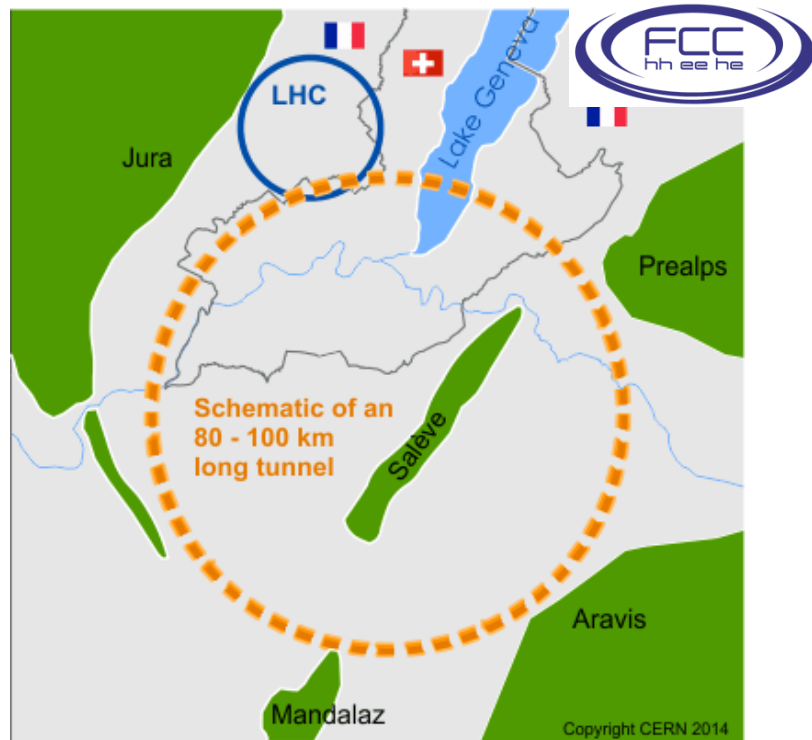


- ✓ Staged Energy up to 3TeV – a ‘discovery’ machine
- ✓ Based on Room Temperature RF Technology producing 100MV/m
- ✓ Uses a novel ‘twin-beam’ system
- ✓ International collaboration on R&D and Studies
- ✓ Site specific studies undertaken at CERN
- ✓ Very challenging technologies – TDR_{lite} by 2018

100 km tunnel infrastructure in the Geneva area

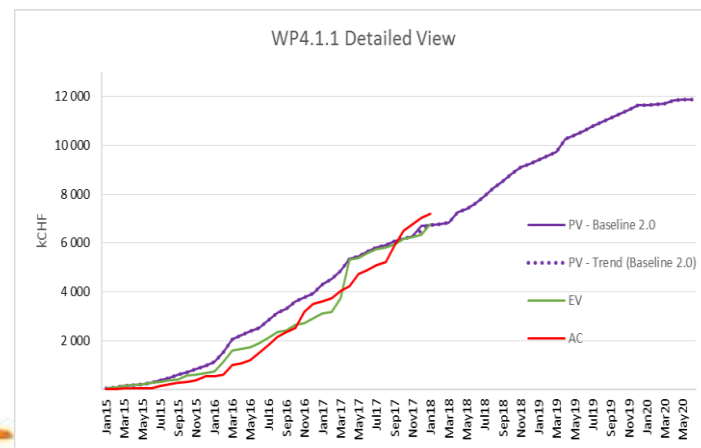
- design driven by hadron-hadron collider
 - 100 TeV centre of mass collisions
 - 16 Tesla Nb₃Sn magnets
- e⁺-e⁻ operation at:
 - 45GeV (Z), 80GeV (W), 120GeV (H) & 175GeV(T)

Conceptual Design Report and Cost Review by End of 2018



The ASR group is responsible for:

- The overall management and planning of departmental resources
- Safety in the Beams Department and safety during operation of all beam facilities at CERN



Group Leader
Ronny Billen



ILO Forum



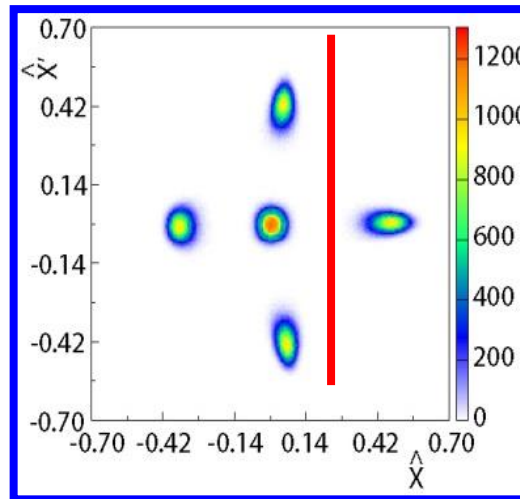
- Accelerator Physics & beam dynamics studies over the complete CERN accelerator complex with the aim of improving accelerator performance.
- Providing operational support for the exploitation of the complex.
- Operation, maintenance and development of hadron sources and Linacs,
- Development and maintenance of accelerator physics computer codes
- Beam and machine parameters and beam dynamics studies for the LHC and Injector Upgrades
- Studies for future accelerators, New Acceleration Techniques and Medical Accelerators.
- Teaching accelerator physics in international schools



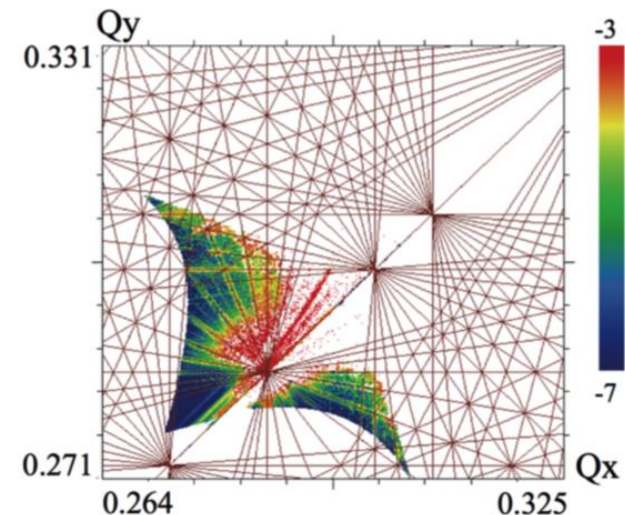
750 MHz RFQ



Group Leader
Gianluigi Arduini



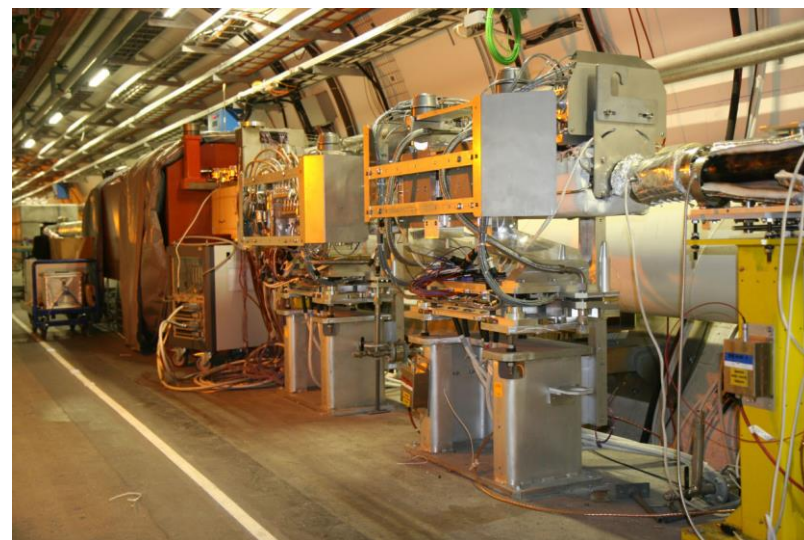
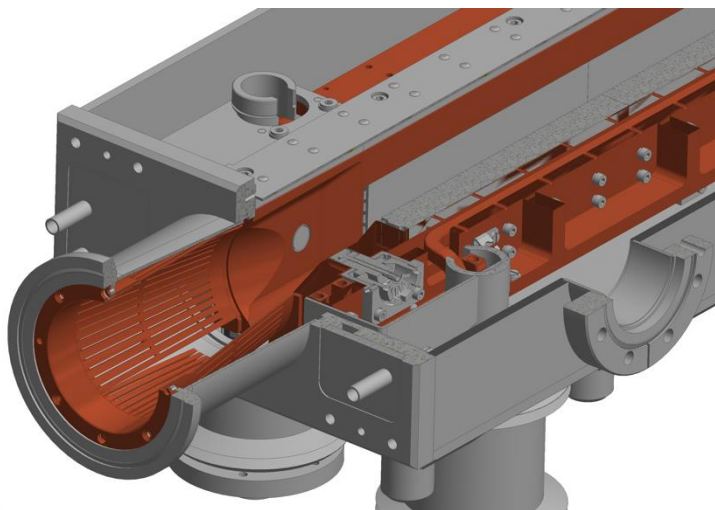
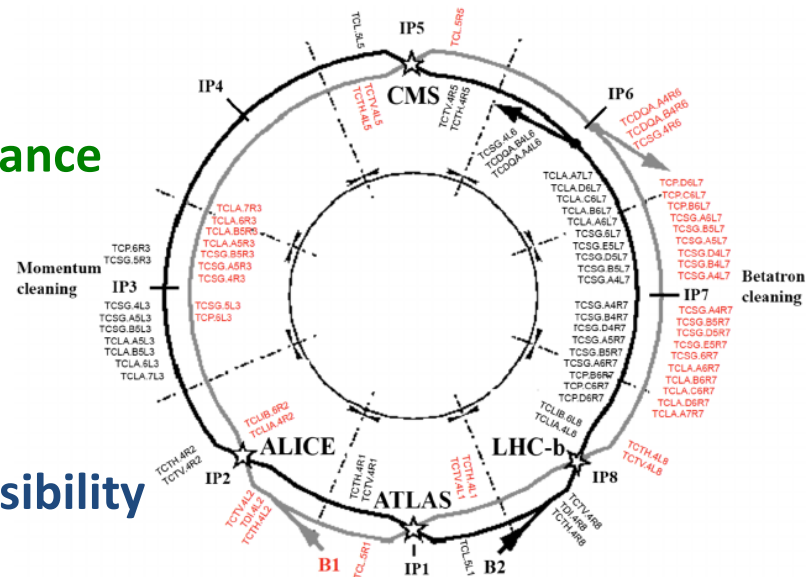
PS Multi-turn Extraction Scheme



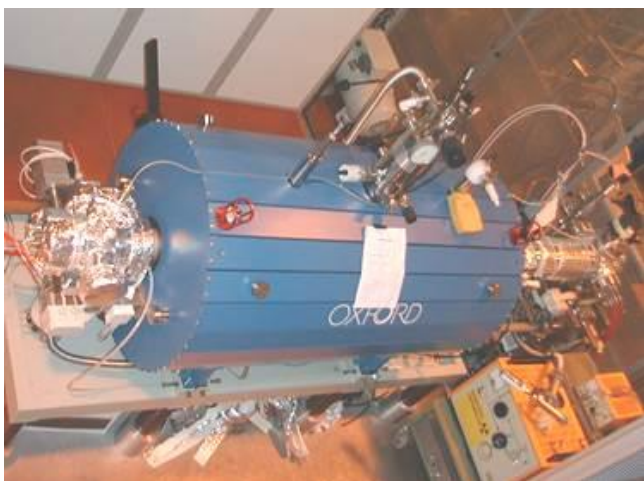
Uncompensated Beam-Beam Footprint in HL-LHC

Leadership of the HL-(LHC) Collimation

- Definition of the requirements and performance
- Specification of the elements
- High level software
- Operation of the whole system
- (Most of) The hardware is under the responsibility of the EN department



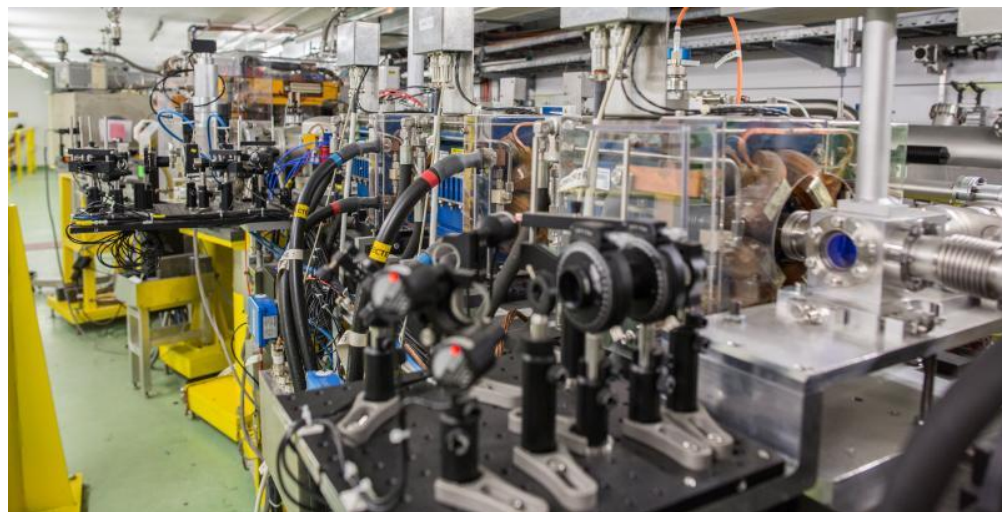
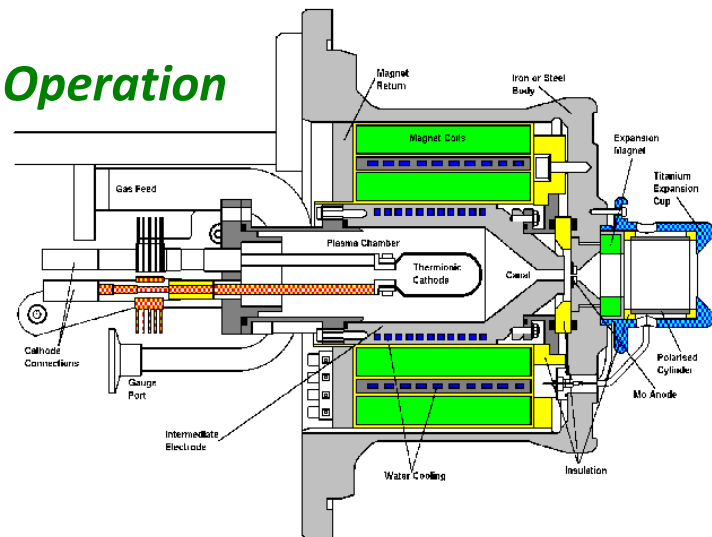
Development, Construction and Operation of all particle sources at CERN



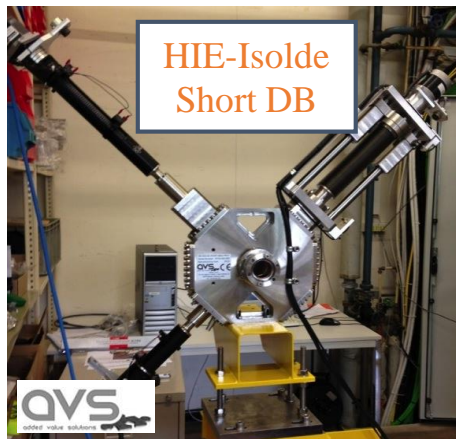
EBIS Charge Breeder at Isolde

Construction and Operation of the low-energy electron test beam facility (CLEAR)

Mainly small orders



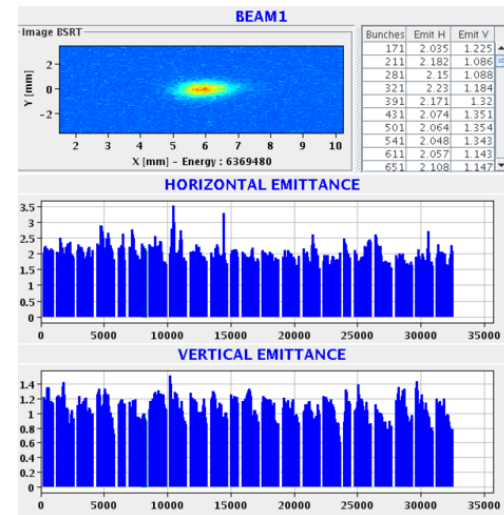
- Responsible for designing, building and maintaining the instruments that allow observation of the particle beams and the measurement of related parameters for all CERN accelerators and transfer lines.
- It is also engaged in research and development to improve existing detection techniques and explore new avenues to allow further optimization of the current machines and to meet the challenges associated with future accelerators.
- Activities include: accelerator physics, detector technology, custom built electronics, mechanical and vacuum engineering for detector housings and software engineering.



Group Leader
Rhodri Jones



AD Cryogenic Current Comparator



Many different systems using a variety of techniques and technology spread around all of the CERN accelerators and Experimental areas:

Beam Position, Beam Profile, Beam Intensity, Beam Structure, Beam Loss

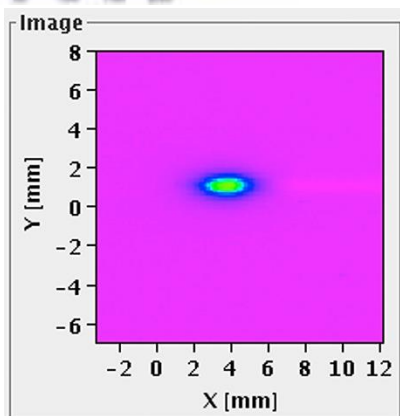
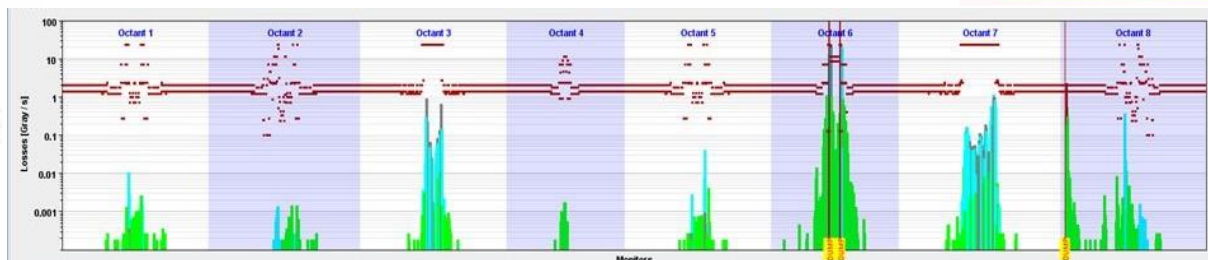
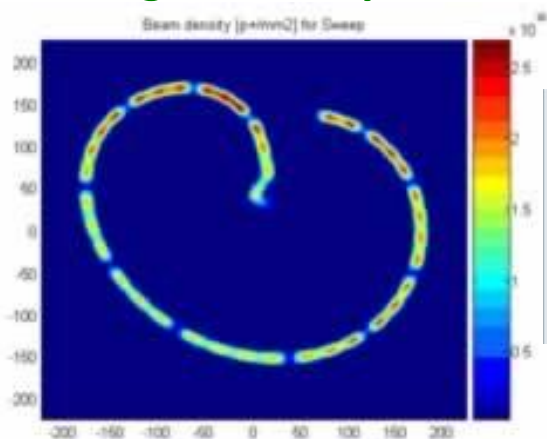
Common requirements:

Mechanics, UHV, Motorization, High Voltage, Optics, Special Materials, Specialized detectors



Combination of specialized electronics designs and some off the shelf systems – for example:

- High speed acquisition, signal treatment and transmission
- (Rad-Hard) Camera systems with digitizers
- Significant processing and concentration often needed



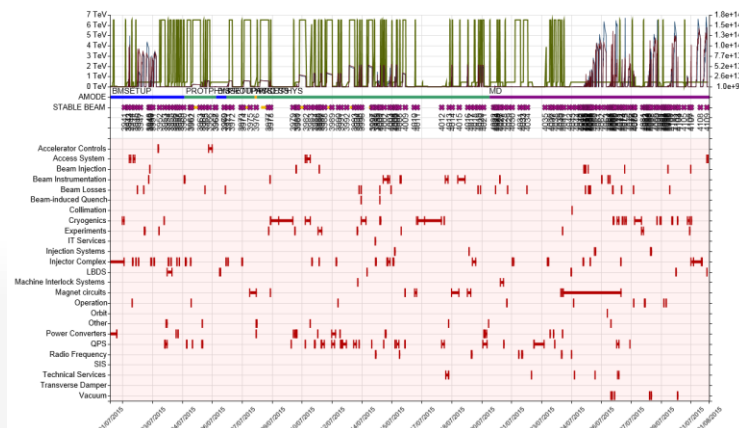
LIU	2018
Mechanics production and installation for operational BWS (16 devices)	MME vac tank order Various small orders
Acquisition electronics and cables for wire-scanners	Small orders
Control electronics for wire-scanners	Production in 2 nd half of 2018
Mechanical commercial components for BWS	
New SEM Grid (transfer line PSB-PS)	Small orders
Upgrade SPS Orbit Acquisition Electronics	Part of a large order for LHC
Provide fibre optic infrastructure LS2	
LEIR Instrumentation Injection Line BPM	Small orders

Consolidation	2018
AD beam instrumentation	Spare FMC for VXS BPM system
AD Cryogenic Current Comparator	
LHC BLM rad hard electronics	ASIC development in LS2
LHC Consolidation of WS Electronics	Orders as part of LIU WS project
Consolidation of standard LHC BPM system	Small orders
Consolidation of standard LHC BLM system	Large order
Interlock BPM system	Small orders
Mechanical Spares for Critical LHC systems	New BSRT windows being finalised

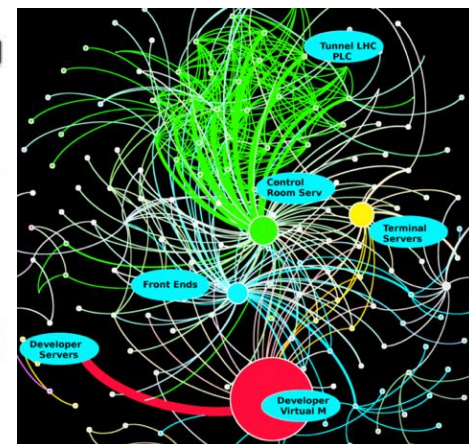
- Responsible for the controls infrastructure for all CERN accelerators, transfer lines and experimental areas
- Covers from embedded front end controllers up to the applications software
- Provides standardised hardware and software services and frameworks as well as timing distribution, signal observation, alarms, surveillance, logging and data management
- Also provides desktop support to the department as well as security policy and electronic instrument repair and calibration



Open Hardware



Accelerator Fault Tracking

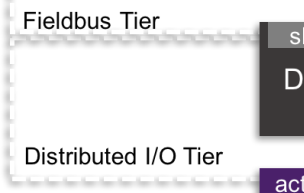
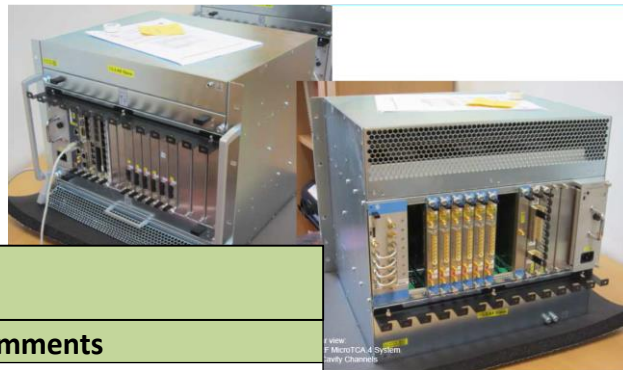


TN-GPN network traffic & dependencies



Group Leader
Eugenia Hatziangeli

Both COTS and 'in-house' card development using the Open Hardware repository and license framework



Typical Orders	
2018 Order	Comments
White Rabbit Switches	Will split between 2 companies
VME modules	Likely to be 5 different orders
VME Crates	contract over 5 years
MENA25 CPU platform	contract over 2 years
Various Electronic cards	8 separate orders
Back End Servers	Part of the general IT contract

ME and now easily μ TCA

Standards

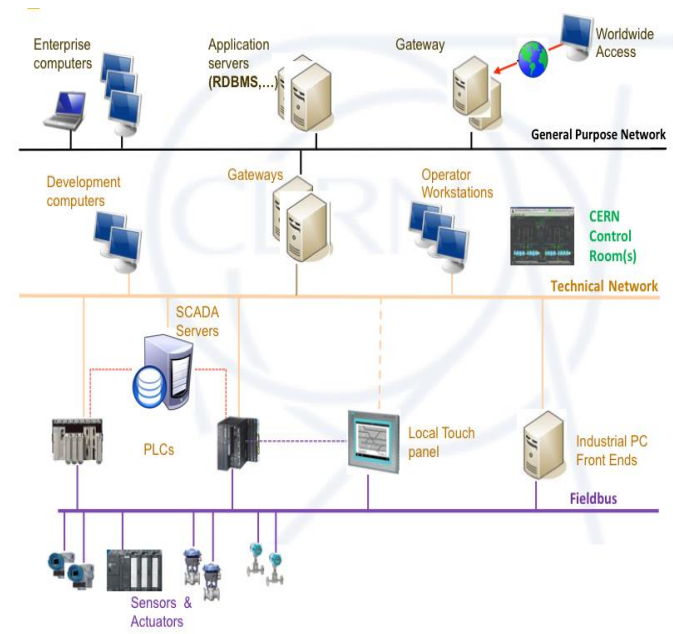
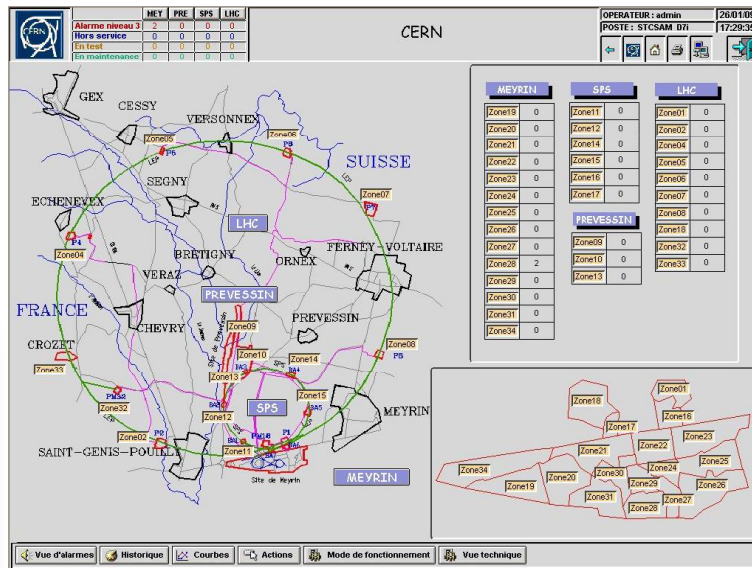


Servers now part of the IT contract



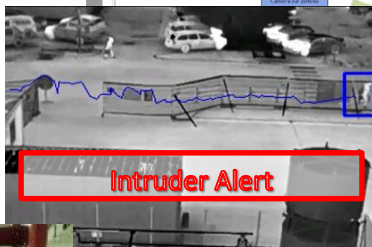
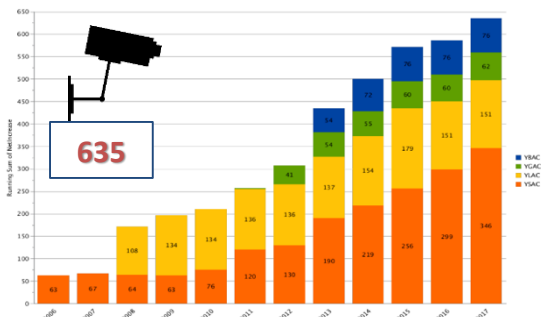
+ Custom cards for specific needs

- Design, implement, install, maintain and support
 - ✓ CERN's safety and access control systems (site and machines)
 - ✓ Industrial control systems for experiments, technical infrastructure, accelerator interlocks and other equipment
- Evaluate, select and support related tools and technologies
- Provide the necessary tools, frameworks and interfaces to integrate these systems in the CERN environment

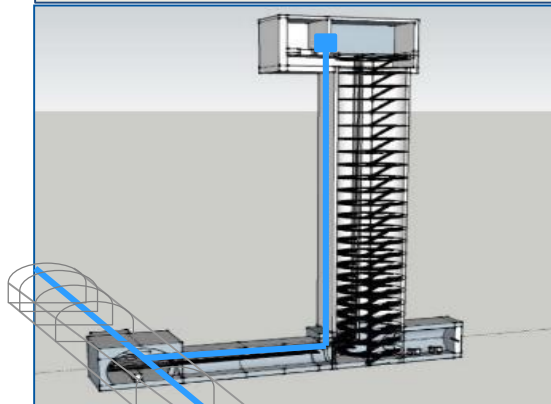


Group Leader
Peter Sollander

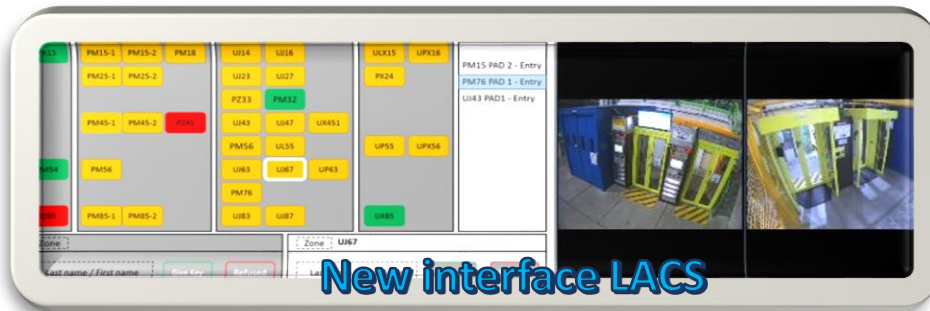
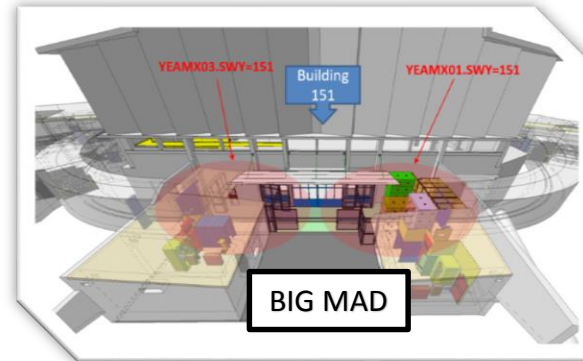
AC-YSAC-006C: Inventaire Cameras



SPS Ring line



Several large Contracts adjudicated at last FC
More to come ...



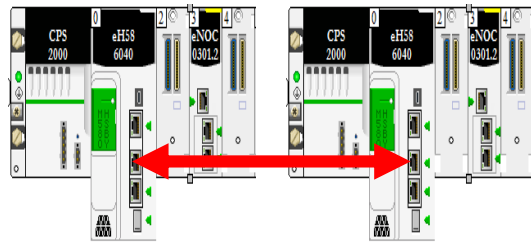
New interface LACS



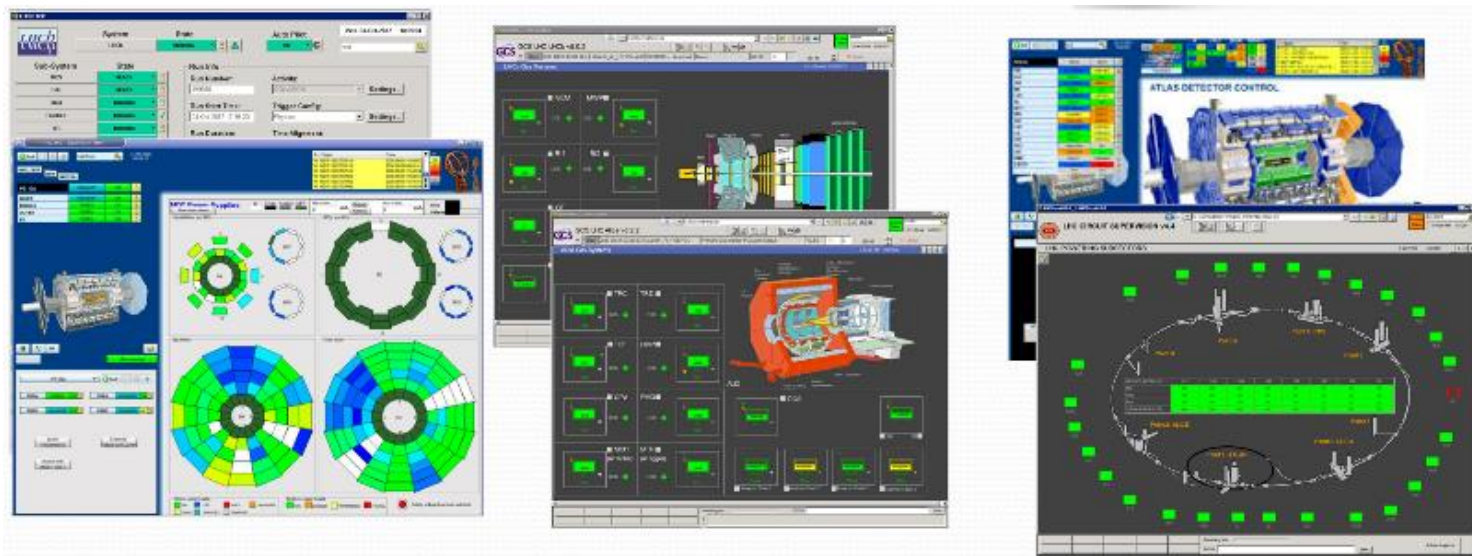
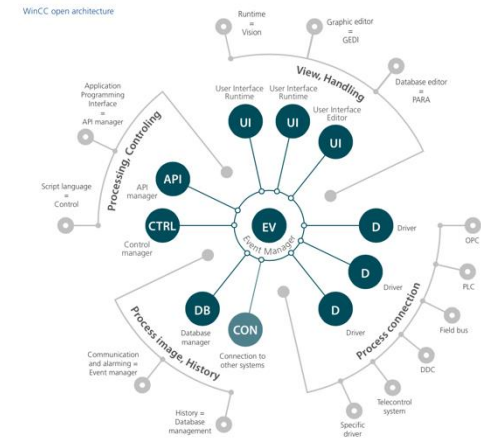
ICS : Safety System Contracts



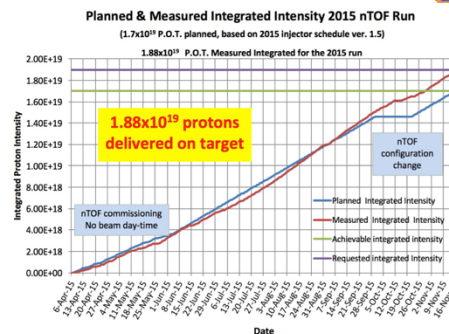
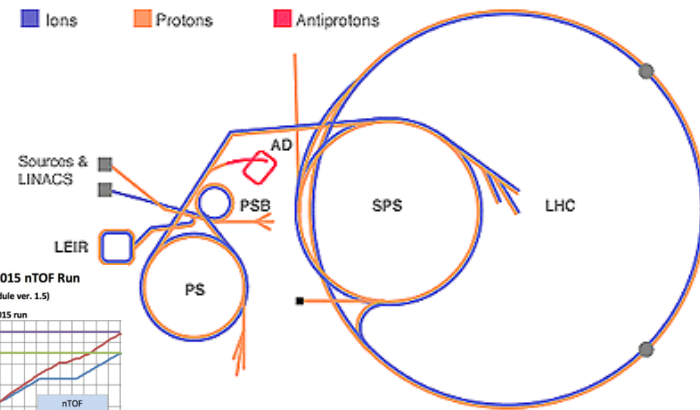
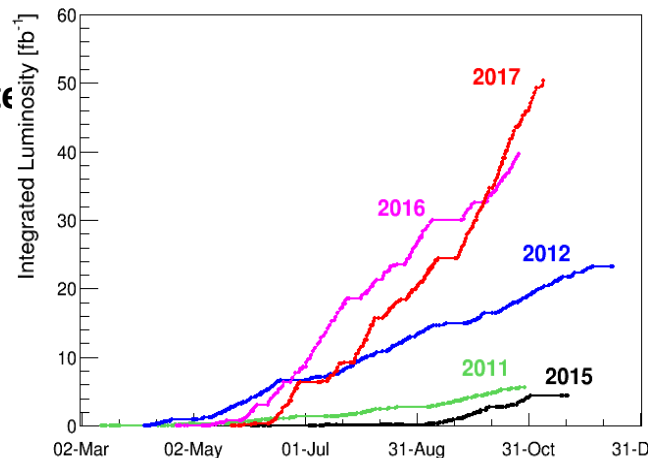
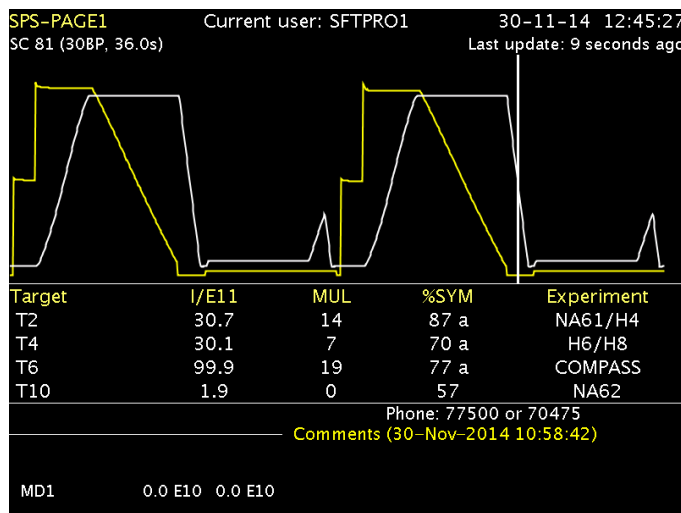
Provides facilities, hardware, frameworks and support across CERN – machines and Experiments



Blanket contracts for PLC's
 Large development infrastructure
 Strong links with OpenLab

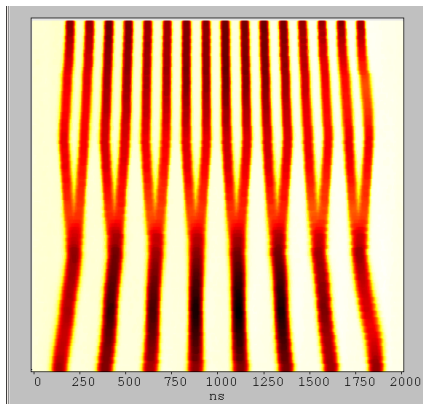


- Responsible for the co-ordination & operation of all CERN accelerators and experimental areas including safety and access in the installations
- Monitoring of the technical infrastructure for the whole CERN site
- Wide range of additional activities including machine studies, application software, operational procedures & statistics

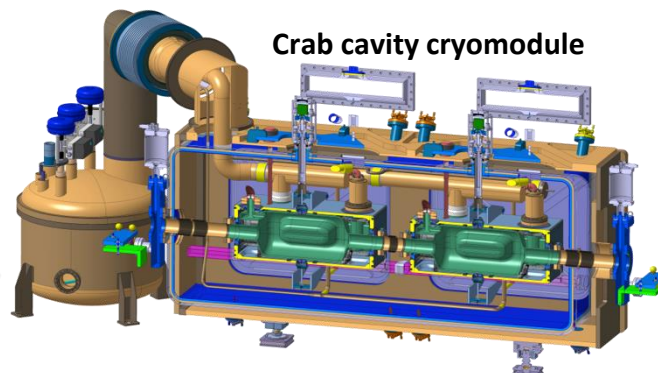


Group Leader
 Rende Steerenberg

- Responsible for the accelerating and damping systems for all accelerators at CERN, including:
 - Operation, maintenance and upgrades of these systems in all existing machines
 - Design and construction for new approved machines ;
 - Research & development and design studies for future machines
- RF parameters and longitudinal dynamics in present and future accelerators

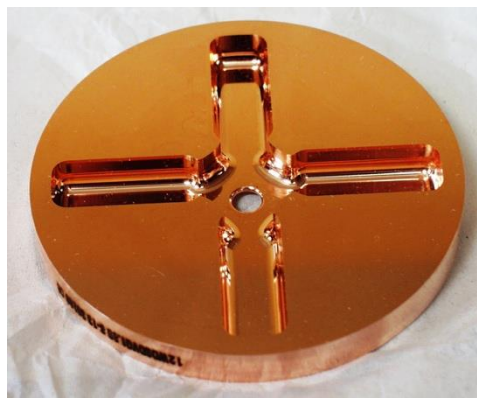
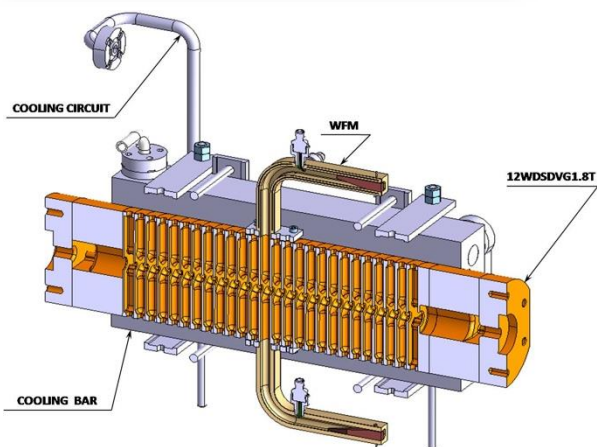
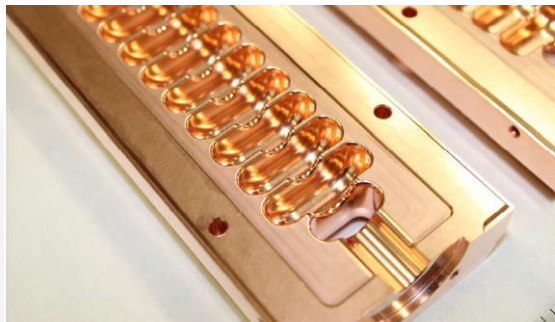
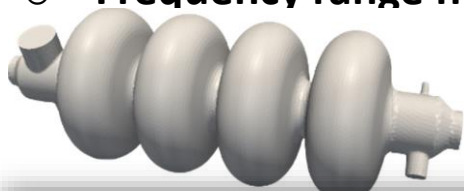


Group Leader
Erk Jensen



Precision Mechanical Engineering

- Specialized materials and treatments
- Both SC-RF and Warm Structures
- Frequency range from few MHz to 12 GHz



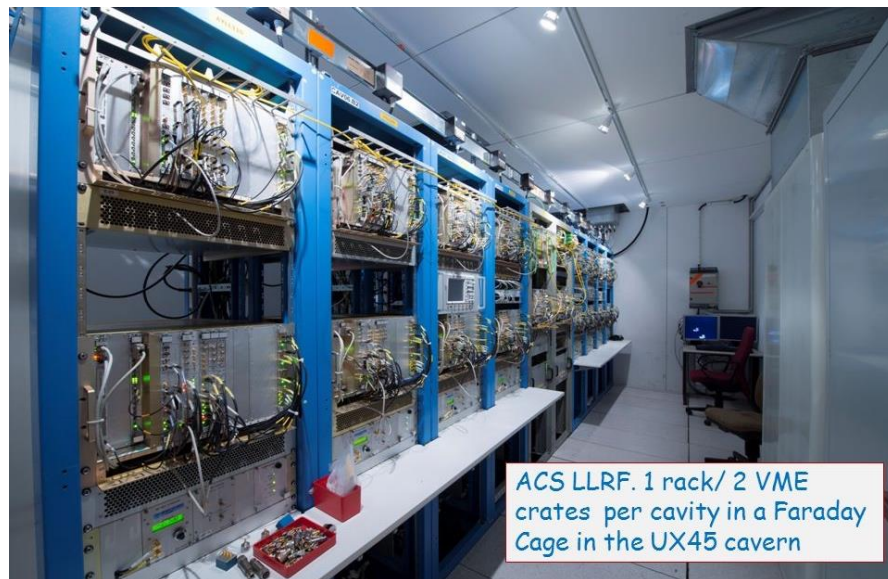
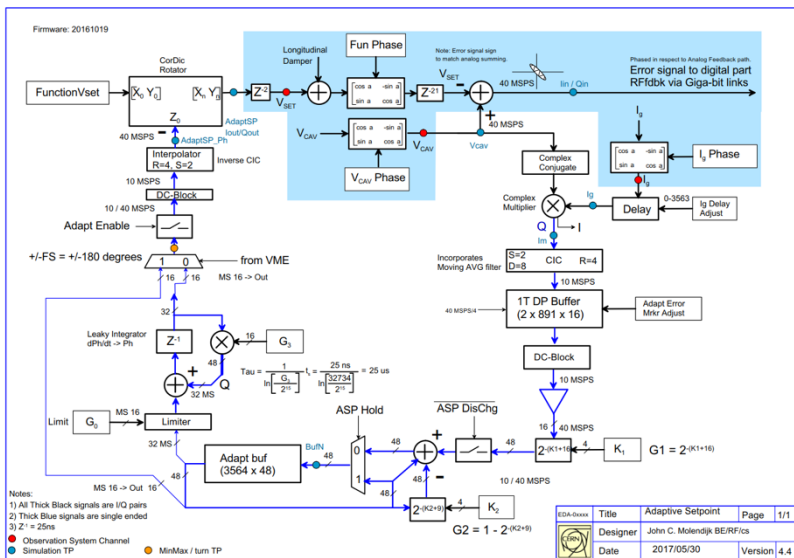
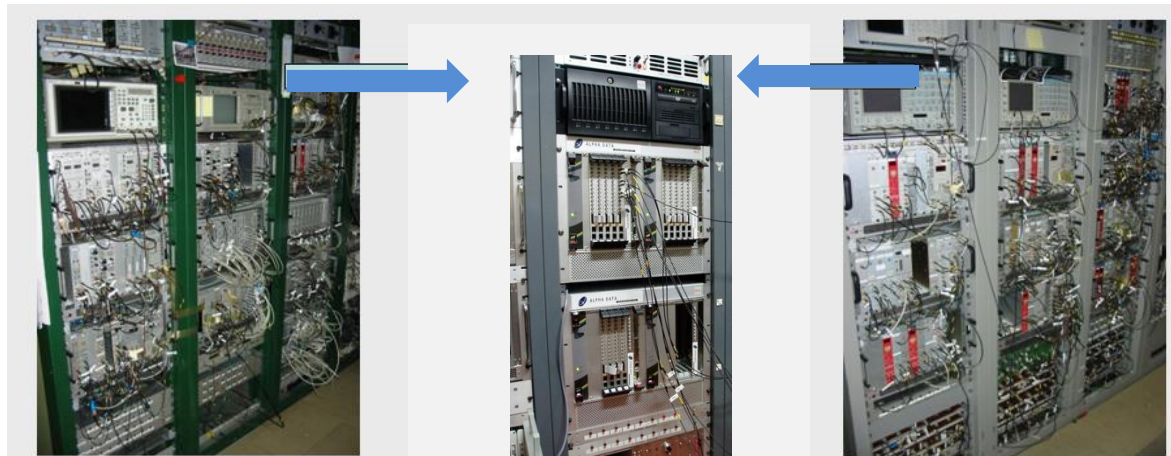


Based on:
Tetrodes, IoT, Klystron, Solid State
Several big supply/maintenance contracts



Traditionally Analog, now progressively digitized

- FPGA Programming
- Many Specialized cards
- But a lot of COTS too
- Moving from VME to μ TCA



BE Covers a lot of technologies and works a lot with industrial and institute partners

- Design of accelerators (beam Physics) and operation
- Specialized electronics design and batch fabrication
- COTS systems including VME and μ TCA based front end computers
- Centralized controls infrastructure – generally COTS
- Mechanical Engineering – precision manufacturing
- Industrial Control Systems
- Safety infrastructure (fire detection, oxygen deficiency etc.)
- Site Surveillance and access control including video surveillance
- Controlled areas access control including individual recognition systems



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