



# Training in Vacuum Technology for JUAS 2013 Students

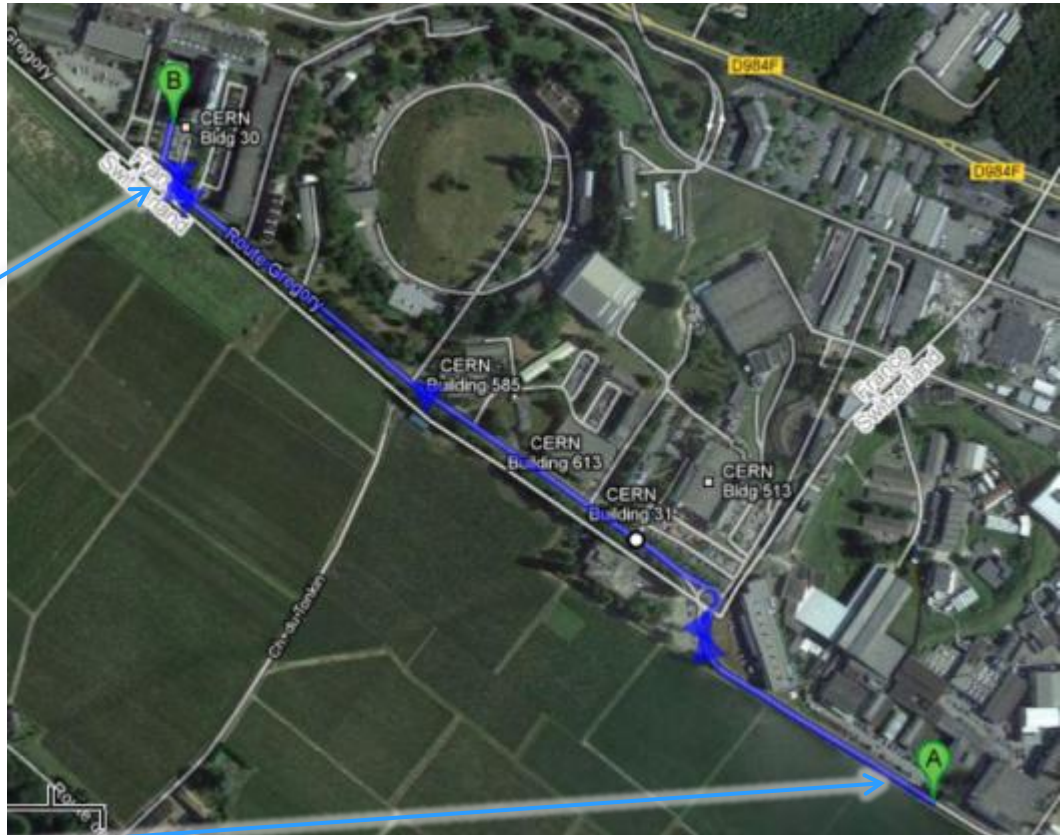
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1. Overview of the VSC group competences
2. Outgassing measurement and material assessment (B. 101-1)
3. Instrumentation: total pressure and gas analysis (B. 30-1)
4. LHC vacuum system and NEG pumps (B. 113-R)
5. Monitoring and control systems of the world longest beam circuit (B. 30-1)

# The Circuit in the CERN's Meyrin Site

B. 30 and 113

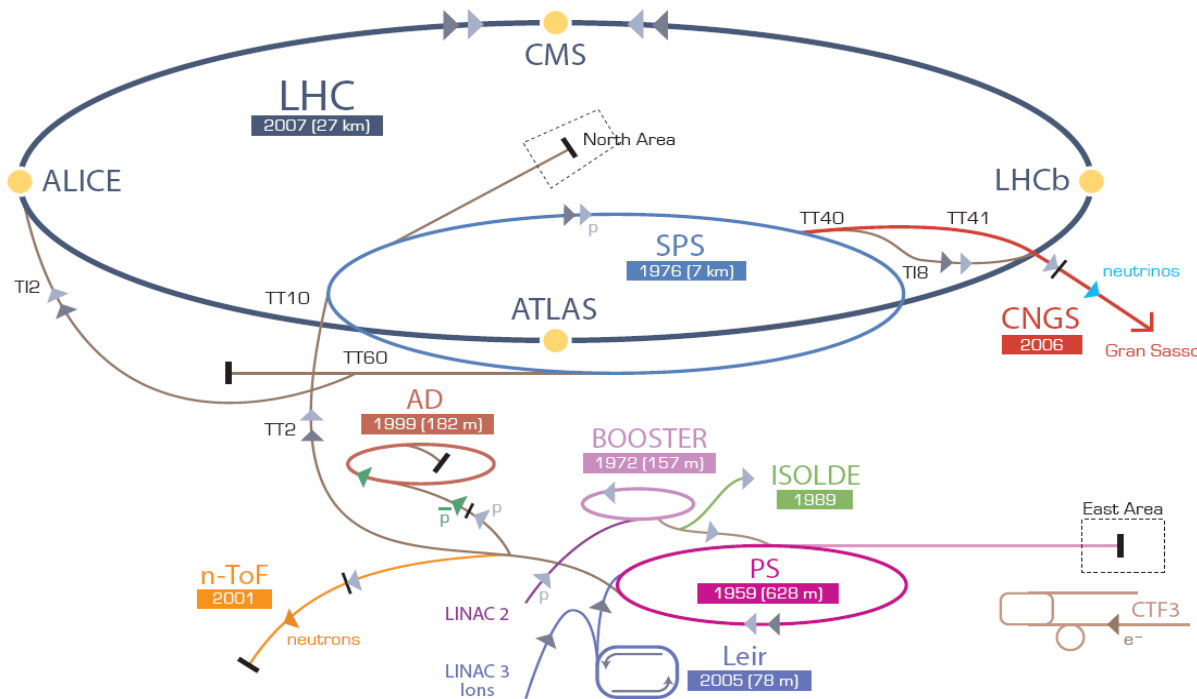


B. 101

1 Km from B. 30 to B. 101

# Overview of the VSC group competences

## CERN Accelerator Complex



▶ p [proton] ▶ ion ▶ neutrons ▶  $\bar{p}$  [antiproton] ▶  $\rightarrow$  proton/antiproton conversion ▶ neutrinos ▶ electron

LHC Large Hadron Collider SPS Super Proton Synchrotron PS Proton Synchrotron

AD Antiproton Decelerator CTF3 Clic Test Facility CNGS Cern Neutrinos to Gran Sasso ISOLDE Isotope Separator OnLine DEvice

LEIR Low Energy Ion Ring LINAC LINear ACcelerator n-ToF Neutrons Time Of Flight

In all places of the CERN accelerator complex there is only one common thing: **vacuum**

**128 Km** long vacuum system: the longest in the world.

**All vacuum degrees and all vacuum technologies** are employed at CERN

# Overview of the VSC group competences

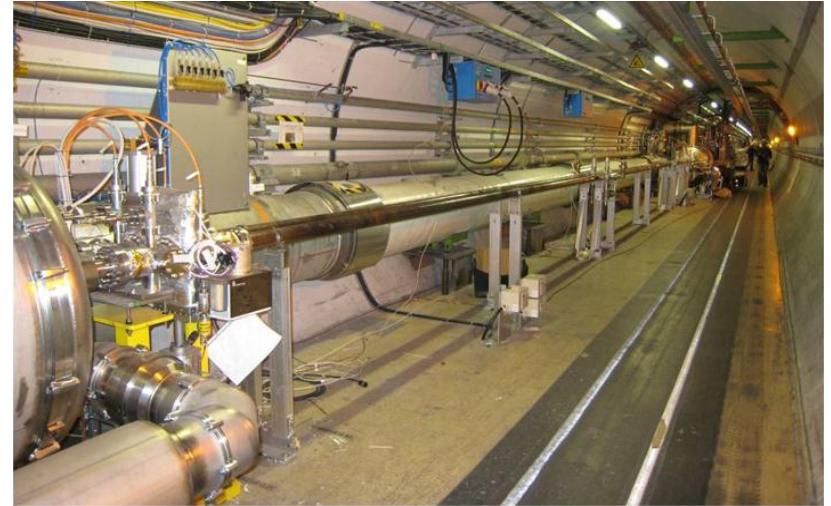
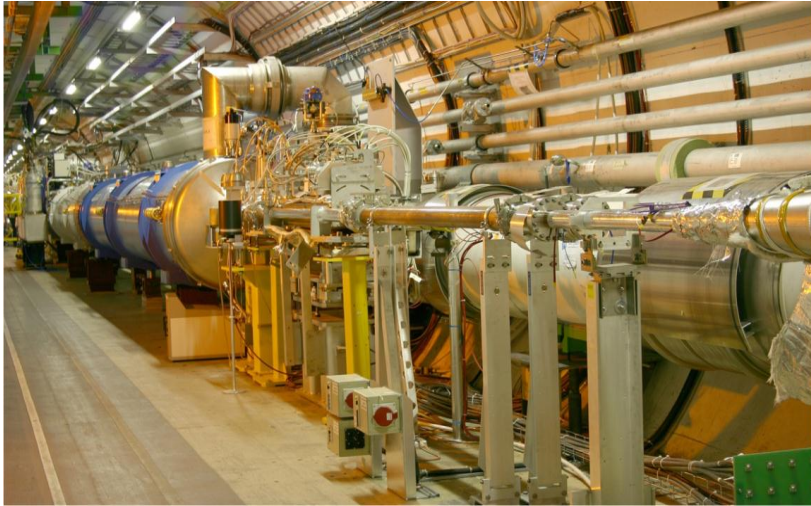
Machine	Type	Year	Energy	Bakeout	Pressure (Pa)	Length	Particles	
<b>Linac, Booster, ISOLDE, PS, n-TOF and AD Complex</b>						<b>2.6 km !</b>		
LINAC 2	linac	1978	50 MeV	Ion pumps	$10^{-7}$	40 m	p	
ISOLDE	electrostatic	1992	60 keV	-	$10^{-4}$	150 m	ions: 700 isotopes and 70 (92) elements	
REX-ISOLDE	linac	2001	3 MeV/u	partly	$10^{-5} - 10^{-10}$	20 m		
LINAC 3	linac	1994	4.2 MeV/u	Ion pumps	$10^{-7}$	30 m	ions	
LEIR	accumulator	1982/2005	72 MeV/u	complete	$10^{-10}$	78 m	pbar, ions	
PSB	synchrotron	1972	1-1.4 GeV	Ion pumps	$10^{-7}$	157 m	P, ions	
PS	synchrotron	1959	28 GeV	Ion pumps	$10^{-7}$	628 m	P, ions	
AD	decelerator	?	100 MeV	complete	$10^{-8}$	188 m	pbar	
CTF3 complex	linac/ring	2004-09		partly	$10^{-8}$	300 m	e	
PS to SPS TL	Transfer line	1976	26 GeV	-	$10^{-6}$	~1.3 km	P, ions	
<b>SPS Complex</b>						<b>15.7 km !</b>		
SPS	synchrotron	1976	450 GeV	Extractions	$10^{-7}$	7 km	p, ions	
SPS North Area	Transfer line	1976		-	$10^{-6} - 10^{-7}$	~1.2 km		
SPS West Area	Transfer line	1976		-		~1.4 km		
SPS to LHC T12/8 Line	Transfer line	2004/2006		-		2 x 2.7 km		
CNGS Proton Line	Transfer line	2005		-		~730 m		
<b>LHC Accelerator</b>						<b>~109 km !</b>		
LHC Arcs (Beam x2, Magnets & QRL insul.)	collider	2007	2 x 7 TeV	-	$< 10^{-8}$	2 x (2 x 25 km)	p, ions	
LSS RT separated beams				complete		2 x 3.2 km		
LSS RT recombination				complete		~ 570 m		
Experimental areas				complete		~ 180 m		
Beam Dump Lines TD62/68	Transfer line	2006	7 TeV	-	$10^{-6}$	2 x 720 m		
						<b>High Vacuum</b>	~20 km	<b>~128 km !</b>
						<b>UHV w/wo NEG</b>	~ 57.5 km	
						<b>Insulation vacuum</b>	~ 50 km	

**2850** ion pumps, **450** turbomolecular pumps, **325** Ti sublimation pumps,...  
**6 Km** of NEG coated beam pipes, **2750** pressure gauges, **40** leak detectors  
and **100** RGAs, **1930** roughing valves and **510** gate sector valves

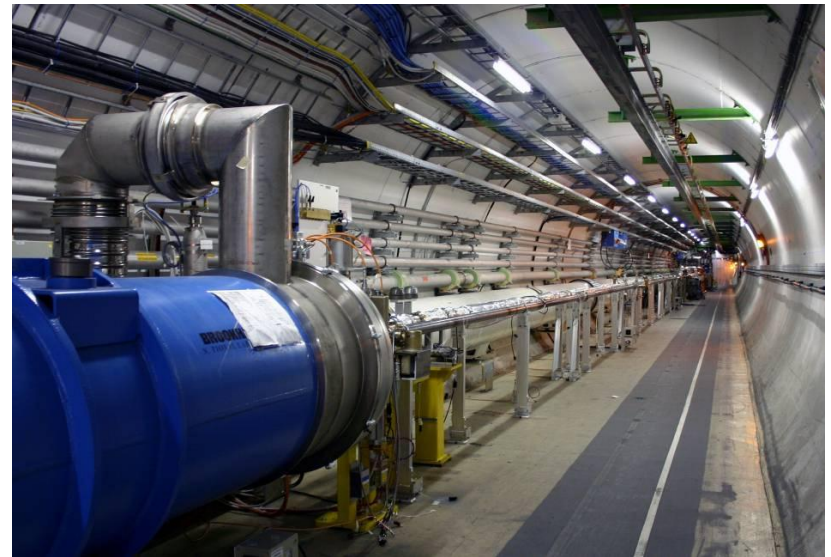
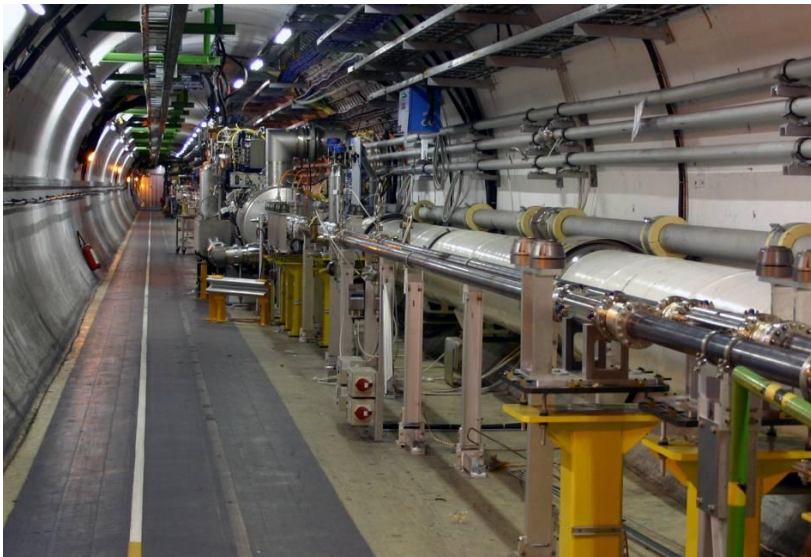
And the numbers are continuously increasing...



# Overview of the VSC group competences

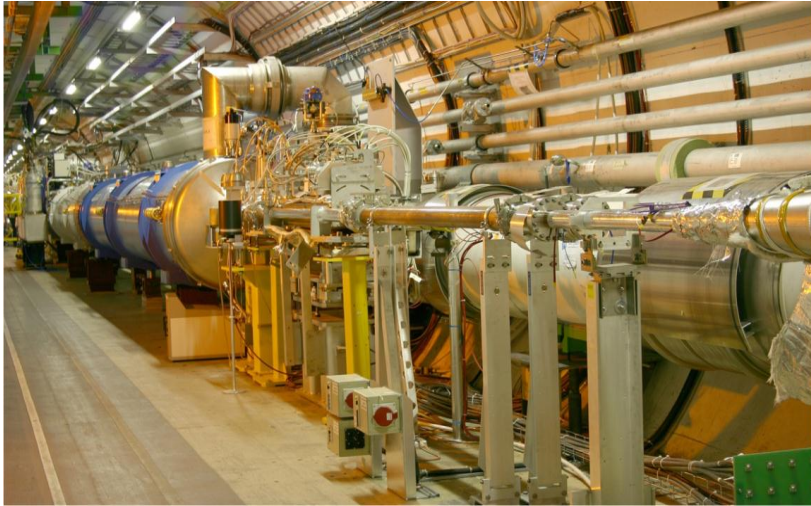


LHC

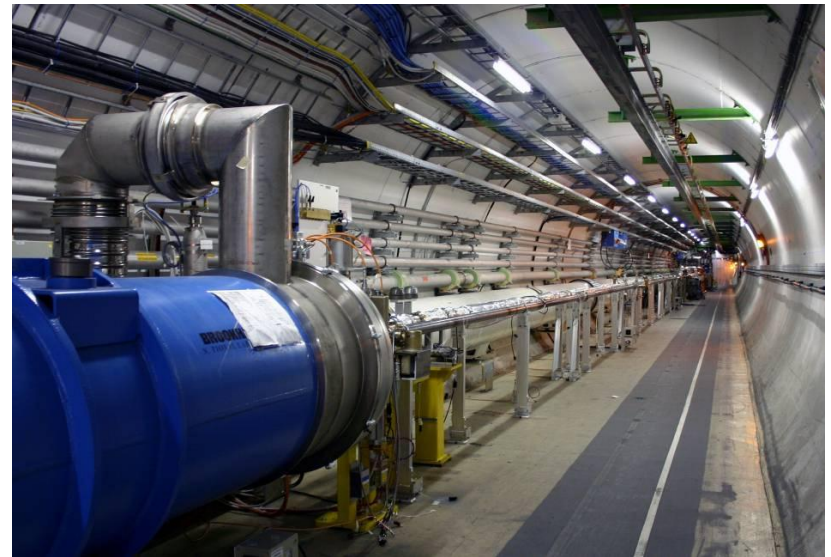
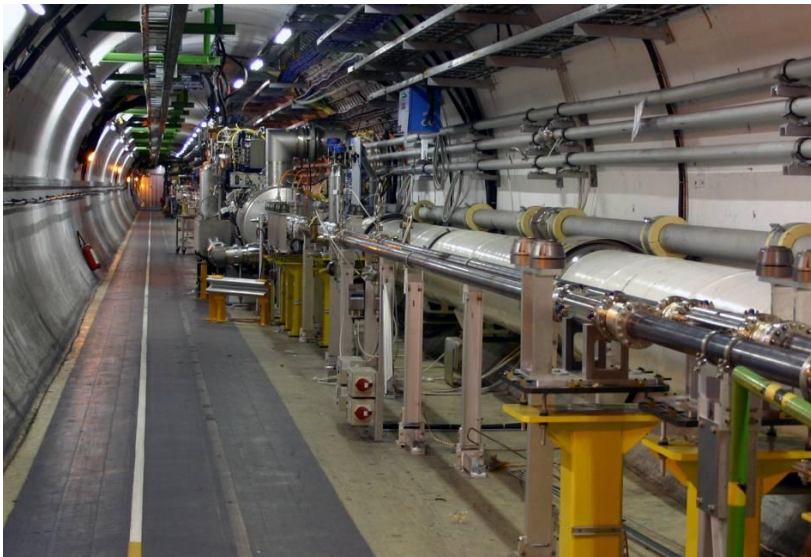
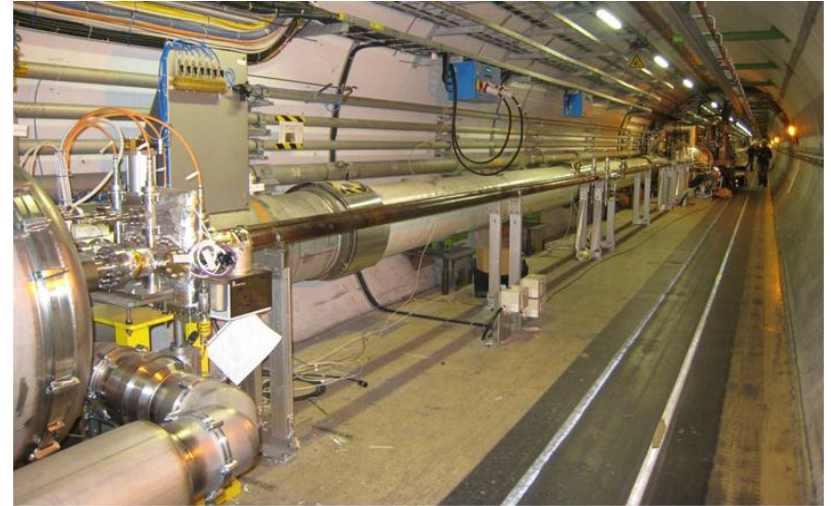




# Overview of the VSC group competences



LHC





# Overview of the VSC group competences

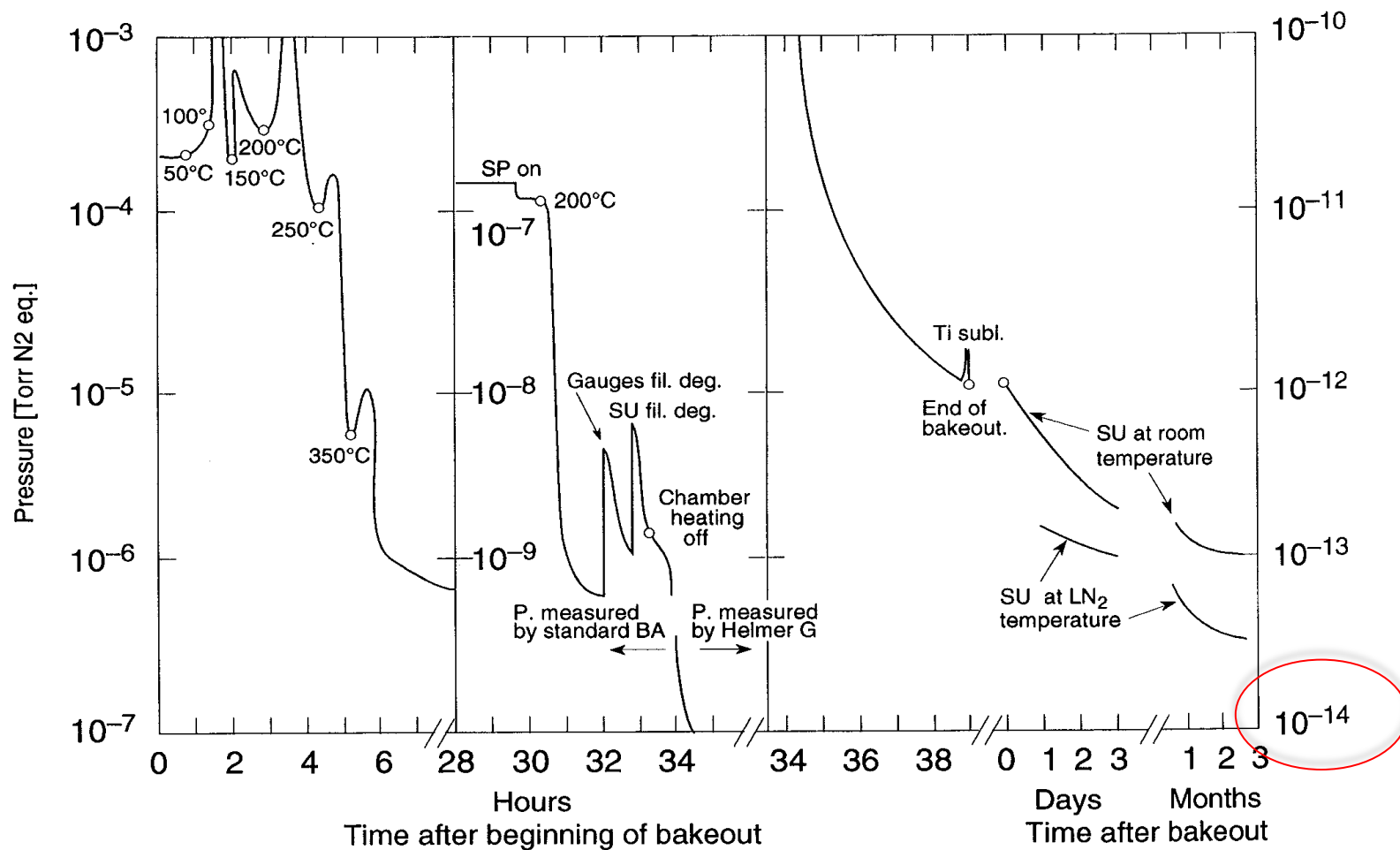
Vacuum technicians installing part of the beam pipe support system



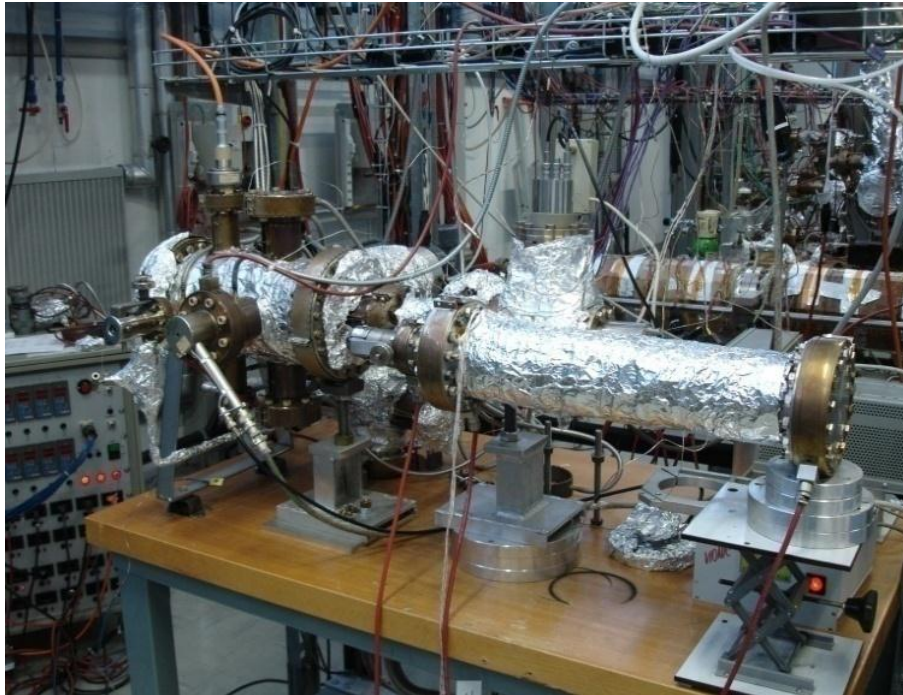


# Overview of the VSC group competences

## Lowest pressure ever measured at room temperature



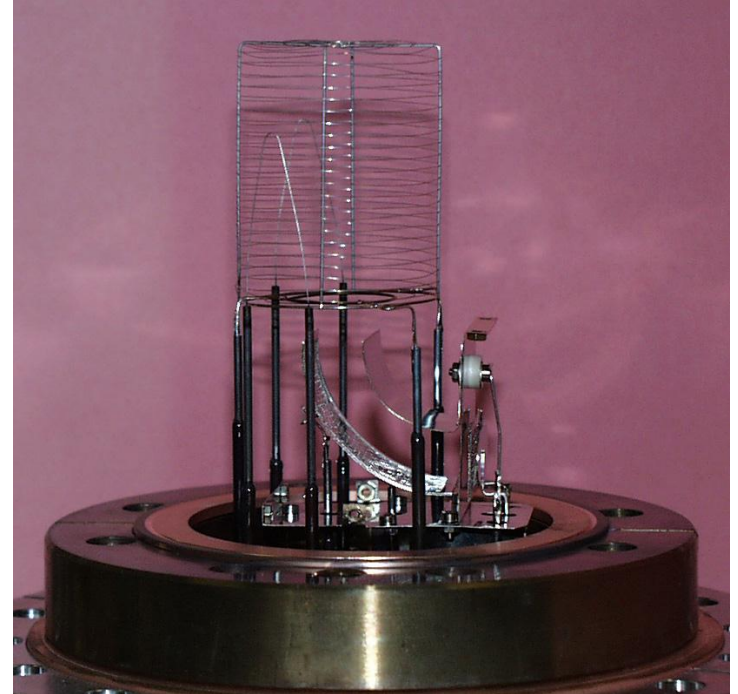
# Outgassing measurement and material assessment



- Thermal and particle induced outgassing
- Gas permeation in polymers and metals
- Assessment of vacuum components
- Thin film coatings for the reduction of material outgassing

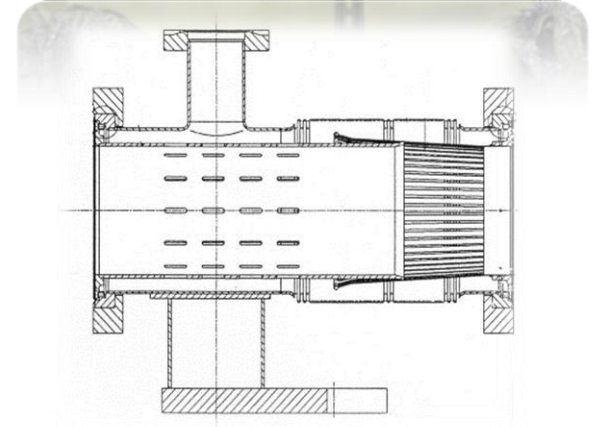
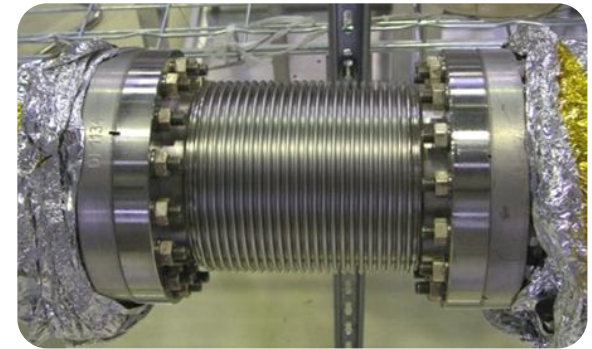
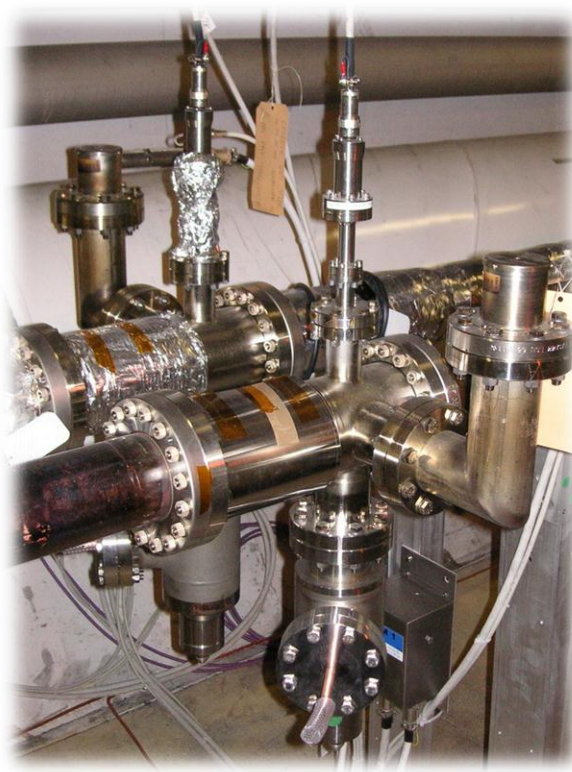


# Instrumentation: total pressure & gas analysis



- Pressure measurement by gas ionization
- Quadrupole gas analyzers and partial pressure measurement
- The training lab
- Calibration of instrumentation

# LHC vacuum system and NEG pumps



- Thin film coating for the LHC
- LHC vacuum components
- The LHC collimators and their vacuum system
- Bakeout and NEG activation



# Monitoring and control systems



[TE-VSC Piquet and Vacuum Monitoring Room sharepoint](#)

**[vmr2011-03-22T09\\_56\\_23.xml](#)** has been added

[Modify my alert settings](#) | [View vmr2011-03-22T09\\_56\\_23.xml](#) | [View Monitoring and piquet report](#) | [Mobile View](#)

<b>Title:</b>	vmr2011-03-22T09_56_23.xml
<b>Author:</b>	Jan Hansen
<b>Date:</b>	22/03/2011
<b>Piquet 1:</b>	Jan Hansen
<b>Piquet 2:</b>	Henrik Vestergard
<b>VMR Staff:</b>	None
<b>Report type:</b>	Monitoring report (Daily)
<b>Duration:</b>	1.5 h
<b>BV LHC:</b>	NO action
<b>IV LHC:</b>	Action
<b>SPS:</b>	NO action
<b>PS:</b>	Action
<b>Booster:</b>	NO action
<b>LINAC:</b>	NO action
<b>AD:</b>	NO action

- The vacuum control logic
- Interlocks and protection
- Participation in the daily monitoring
- The basis of PVSS

Monitoring and piquet report

Author: Jan Hansen Date: 22/03/2011

Summary of observations and interventions

Piquet 1	Piquet 2	VMR Staff
Report type	Duration	Status
Monitoring report (Daily)	1.5 h	OK

Affected machine

Beam V.LHC	Top V.LHC	SPS	PS	Booster	LINAC	AD	Other
OK	OK	OK	OK	OK	OK	OK	OK

Detailed description

LHC Insulation vacuum  
 Oxygenic vapour no new events  
 Group file: Compared to reference (Block loader) no LHC sample size (1.1.2011), no difference detected  
 On gas and pumping group status  
 100% Gas and 100% Pumping  
 This group was recovered yesterday at 20:40 but dropped out again at 20:42 in monitor mode

no other operations  
 VMR Staff: Control room operator J.Hansen  
 LHC Report: Group 100 OK (2011-03-22T09:56:23) mode "GROUP"

**We are looking forward to  
sharing our work with you at  
CERN !**





[www.cern.ch](http://www.cern.ch)