

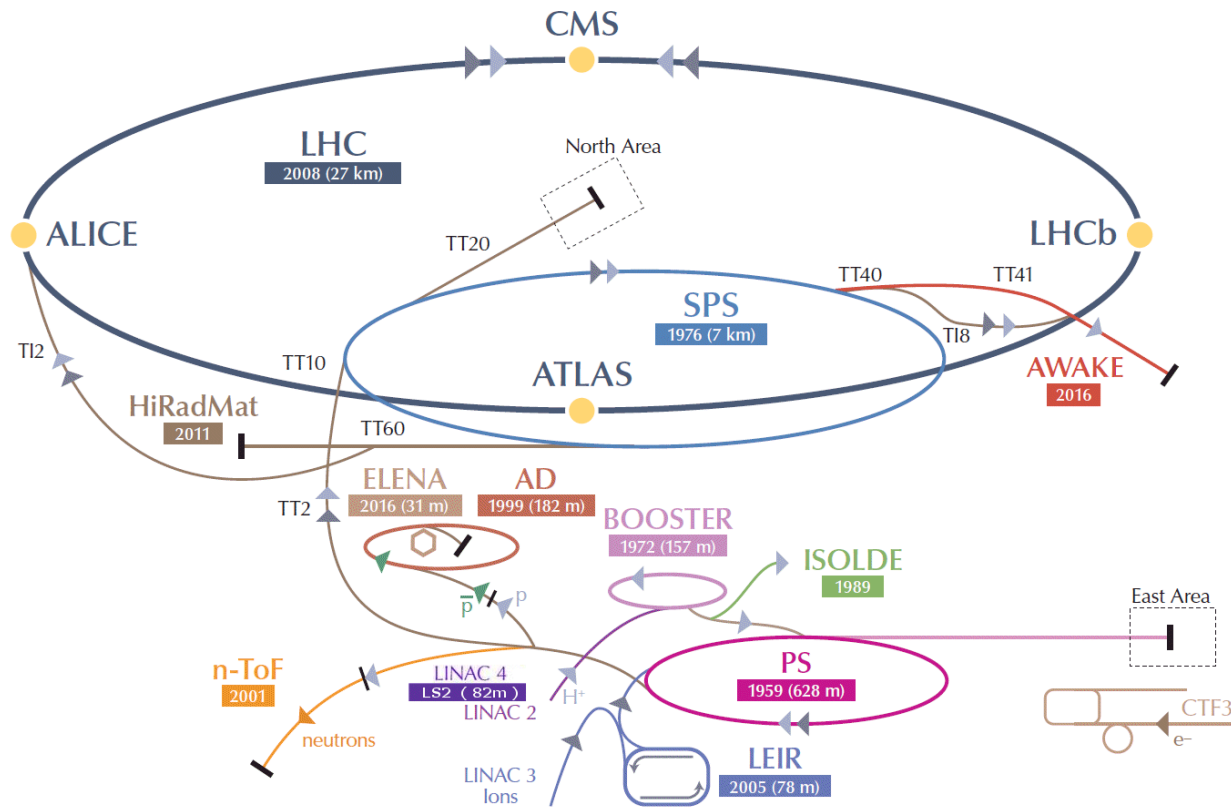
Practical Days Vacuum Systems

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CERN accelerators complex



▶ p (proton) ▶ ion ▶ neutrons ▶ \bar{p} (antiproton) ▶ electron ▶ \leftrightarrow proton/antiproton conversion

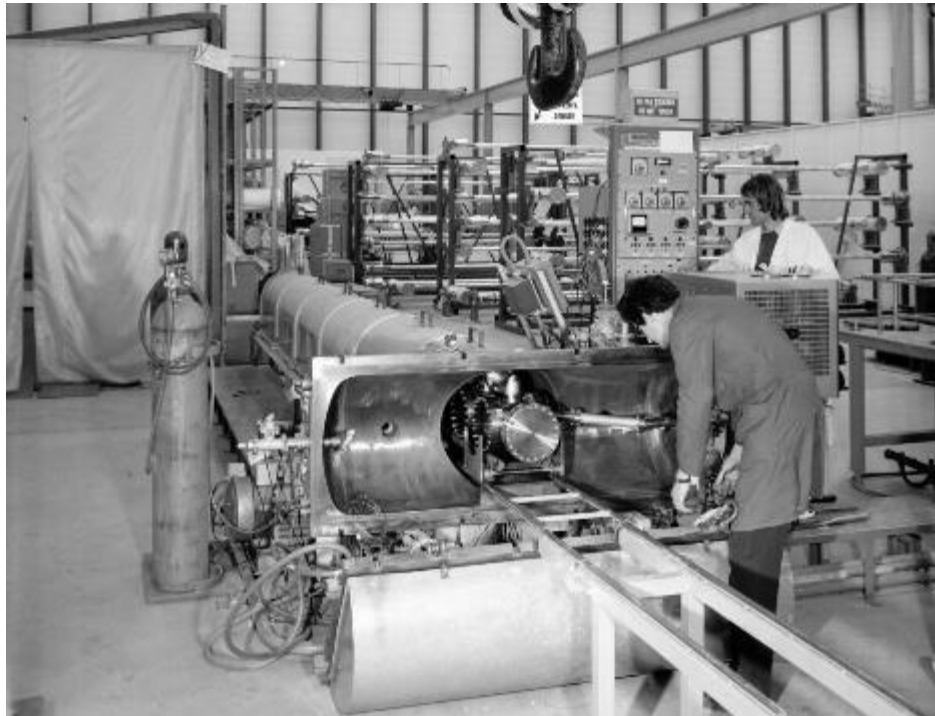
CERN vacuum systems

Machine	Type	Year	Energy	Bakeout	Pressure (Pa)	Length	Particles	
Linac, Booster, ISOLDE, PS, n-TOF and AD Complex						2.6 km !		
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	
SPS Complex						15.7 km !		
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		
LHC Accelerator						~109 km !		
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		
						High Vacuum	~20 km	~128 km !
						UHV w/wo NEG	~ 57.5 km	
						Insulation vacuum	~ 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

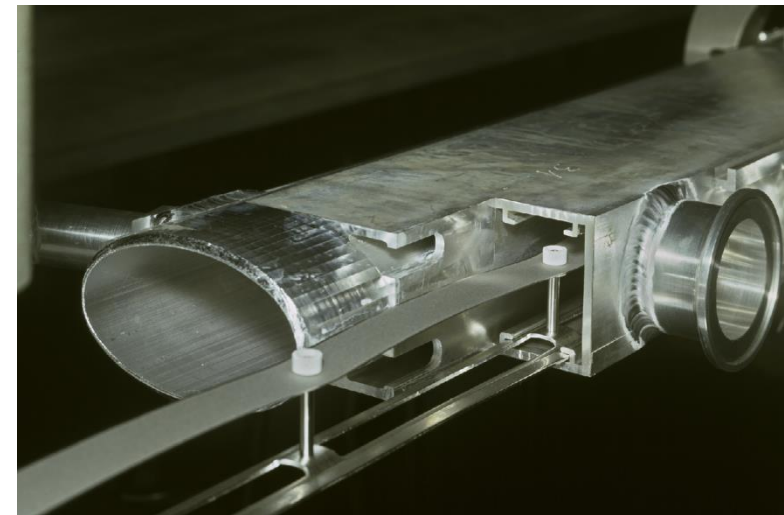
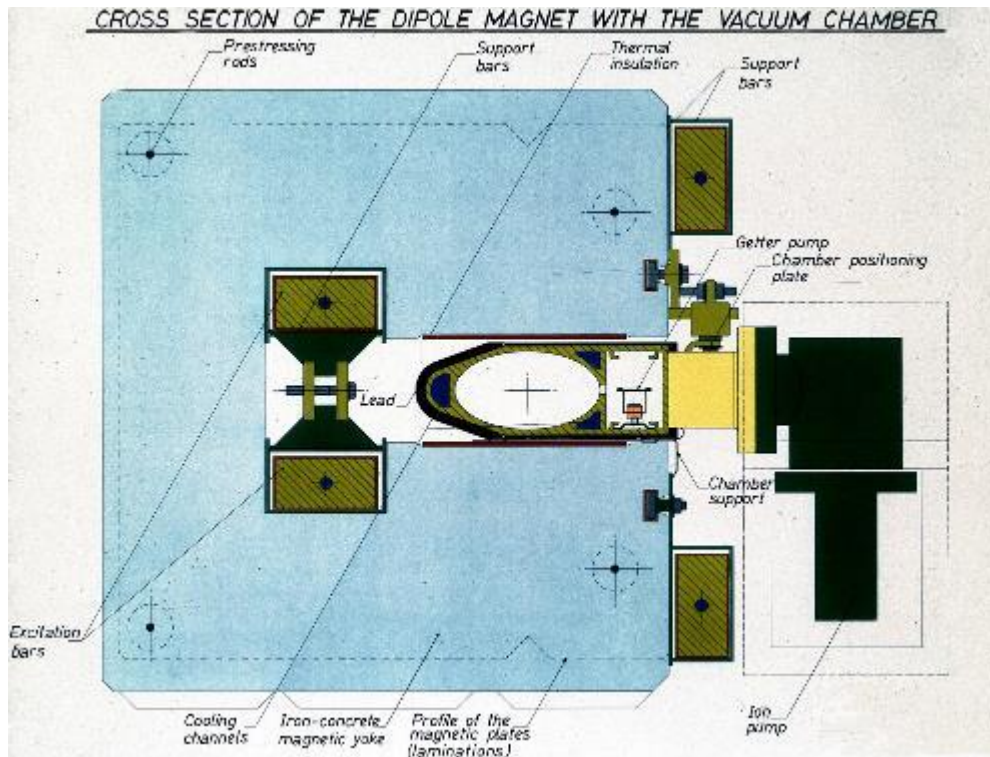
Intersecting Storage Rings

- Discovery of :
 - Vacuum stability and pressure runaway
 - Beam induced multipacting (electron cloud)
- Developments of laboratory studies and cleaning methods



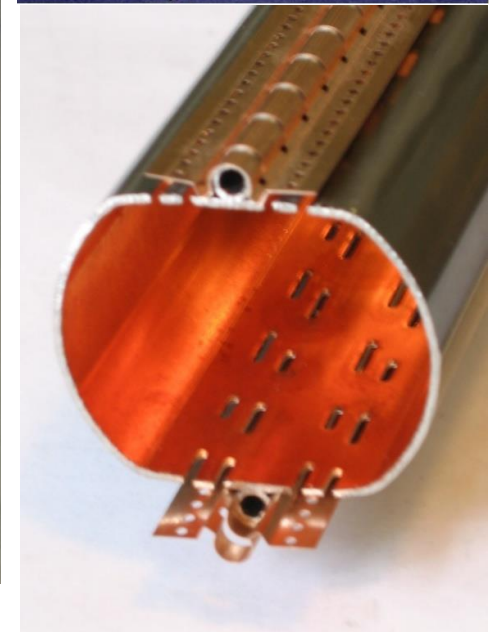
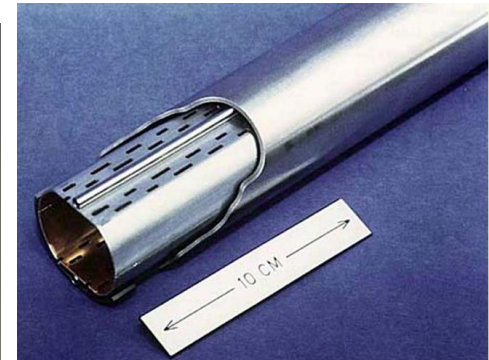
Large Electron Positron Collider

- **Synchrotron radiation** in LEP:
 - From 6 to 660 keV critical energy
 - Gas desorption studies
- Innovative pumping system
 - Antechamber with NEG pumping strip
 - Water cooled and lead shielded



Large Hardon Collider

- Cold bore (CB) at 1.9 K which ensures leak tightness
- Beam screen (BS) at 5-20 K which intercepts thermal loads and acts as a screen



Vacuum, Surface and Coatings group

Design, construction, operation, maintenance and upgrade of high & ultra-high vacuum systems for Accelerators and Detectors.

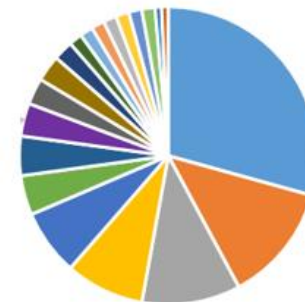
- Expertise and support on thin-walled vacuum chambers, windows and bellows compensation systems
- Expertise in vacuum sealing and leak-tightness technology
- Expertise in dynamic vacuum phenomena
- Management of the industrial support contract for vacuum work in accelerators
- Expertise in vacuum control systems, vacuum interlocks and monitoring tools

Coatings, surfaces treatments, surface and chemical analysis for Accelerators and Detectors. Expertise and support in the fields of:

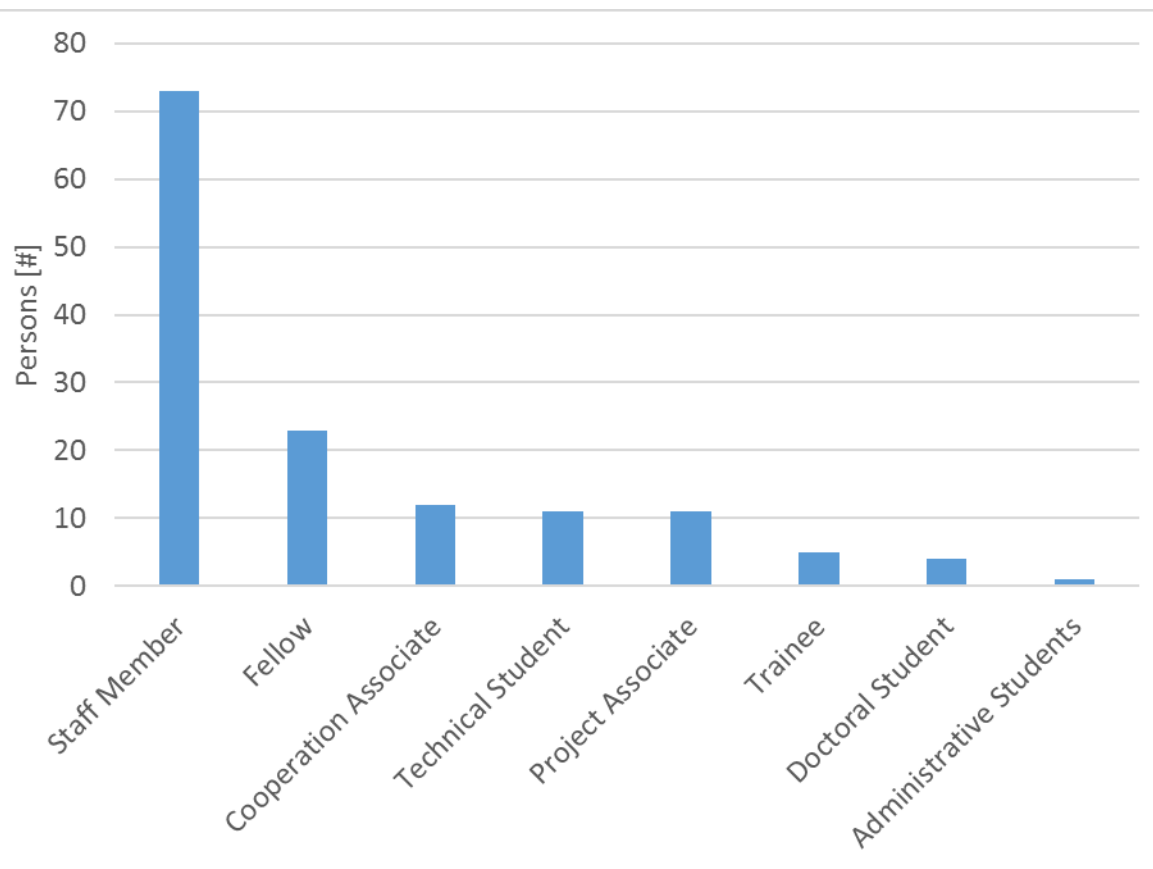
- Coatings, electroplating and surface cleaning techniques
- UHV characterization and of material and surfaces
- Degassing analysis and treatments

Vacuum, Surface and Coatings group

Design, construction, installation and operation of the CERN vacuum systems



FR IT ES PT PL CH RU NL GR GB
BE NO SE CZ FI HU DE DK BY AT



Several collaborators from different countries and institutes

TE-VSC organisation

Group management

+ 5 sections:

Vacuum studies and measurements

Beam vacuum operation

Design, logistics & methods

Interlock, controls & monitoring

Surface, chemistry & coatings

Vacuum, Surfaces & Coatings group

Group Management:
 P. Chiggiato (Group Leader), P. Crubbank (Deputy Group Leader), P. Chou (Group Secretary), G. Bédère (Group Coordinator), M. Basso (Admin Support), G. Rodriguez (Project Assistant), G. Loret (Deputy TE-MCO).

Section Leaders:
 V. Baglin (Vacuum Studies and Measurements), U. Bragazzi (Beam Vacuum Operation), C. Garion (Design, Logistics & Methods), P. Gomes (Interlocks, Controls & Monitoring), M. Tabori (Surface, Chemistry & Coatings).

Staff Members: A grid of 50+ staff members, each with a photo and name, organized into the five sections.

Students & Collaborators: A list of individuals with their names, affiliations, and dates of involvement, organized into the five sections.

12-07-2018



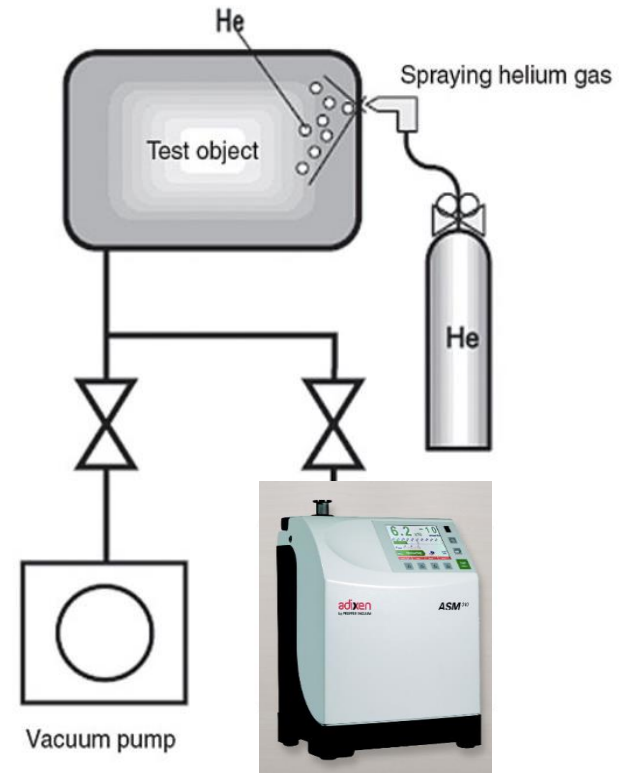
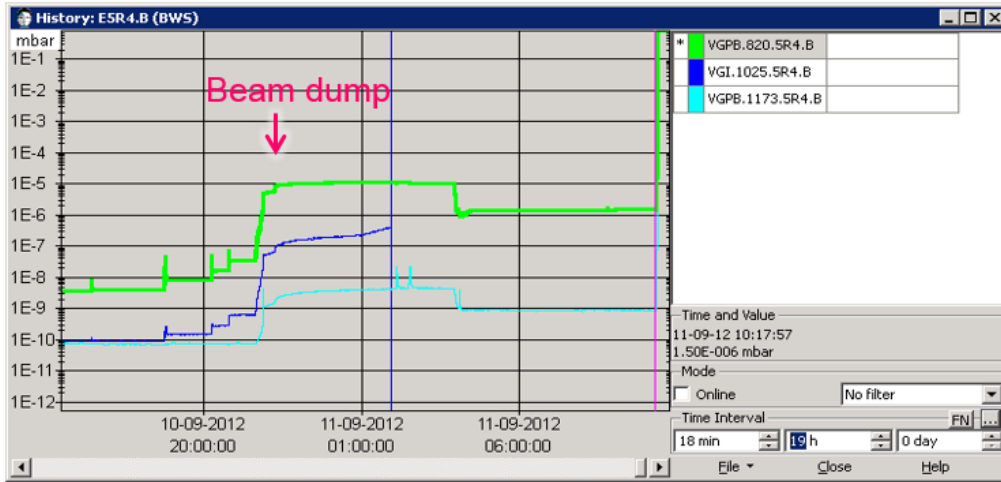
Laboratory activities: pump down

- Pump down of a vacuum system:
 - start pumping
 - open roughing valve
 - expected pump down curve

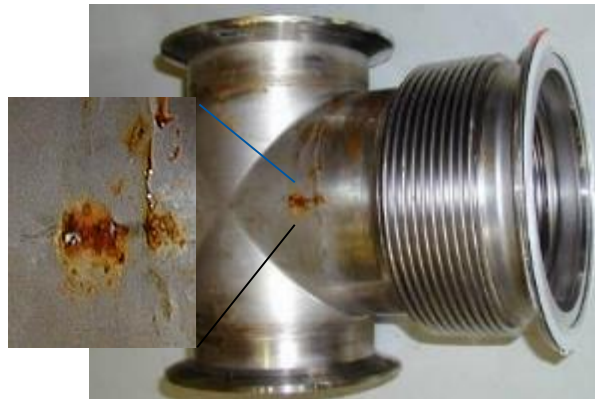
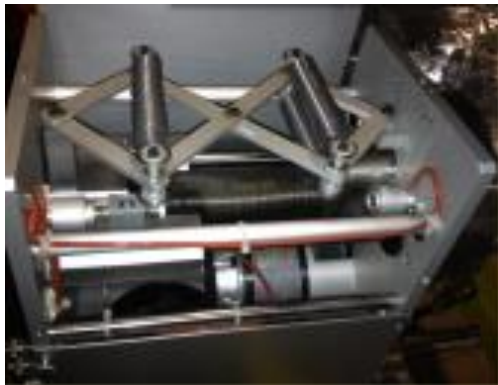


Laboratory activities: leak detection

- How to locate / identify leaks in a vacuum system ?

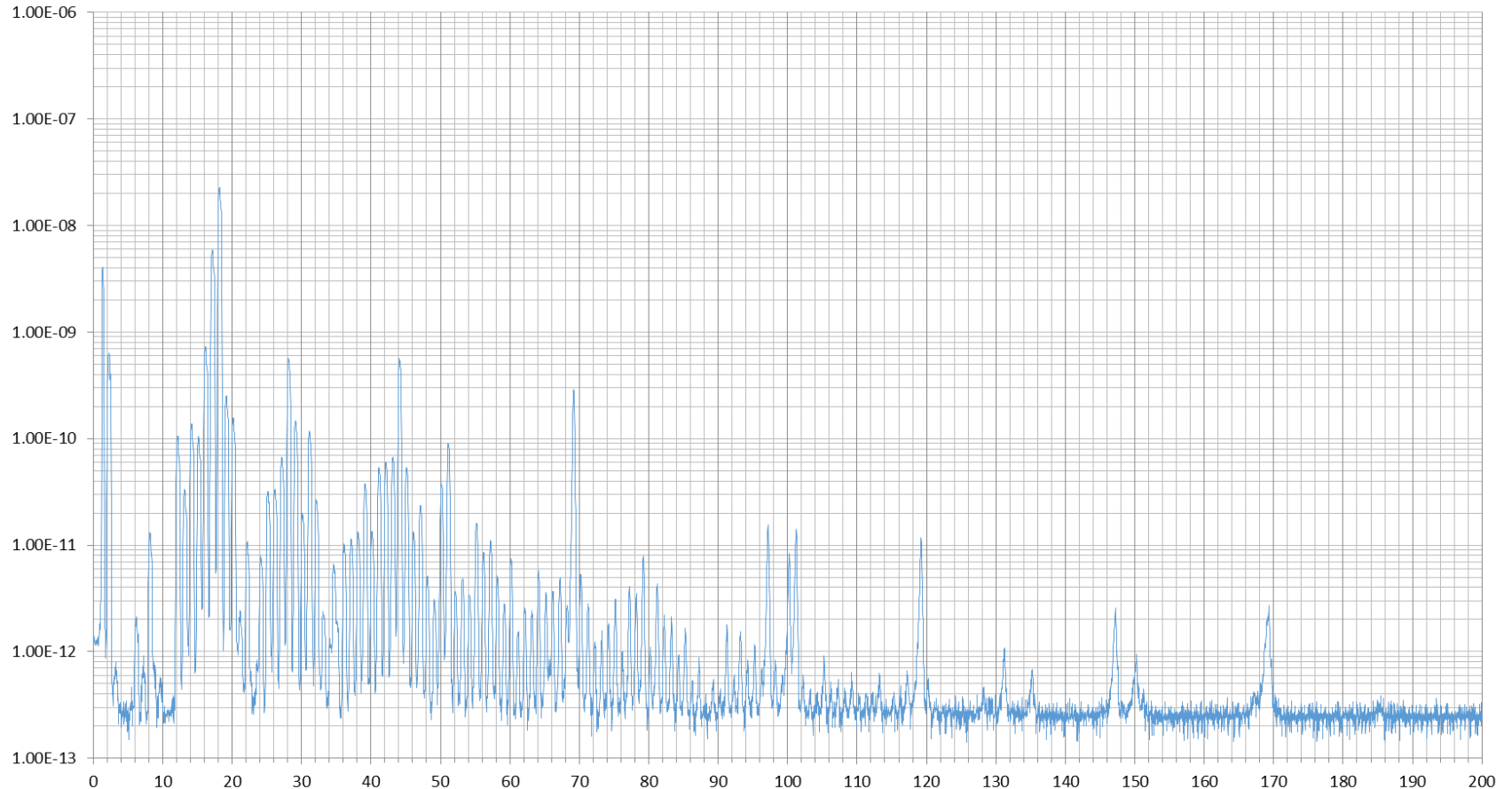


He leak detector



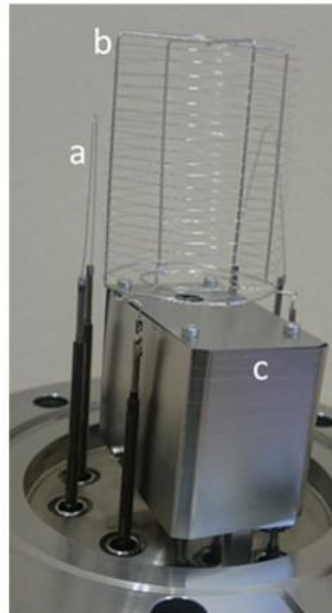
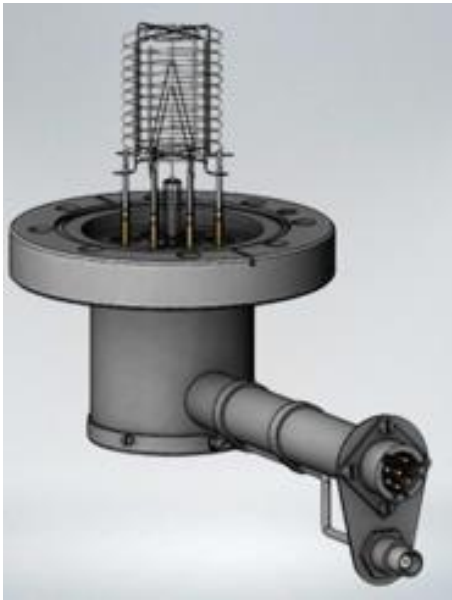
Laboratory activities: gas analysis

- is my residual gas reasonable ?
- Estimation of the partial pressure



Laboratory activities: vacuum gauge

- Vacuum gauges descriptions
- Vacuum gauge calibration



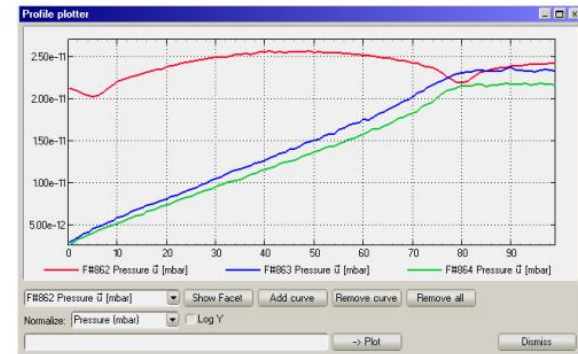
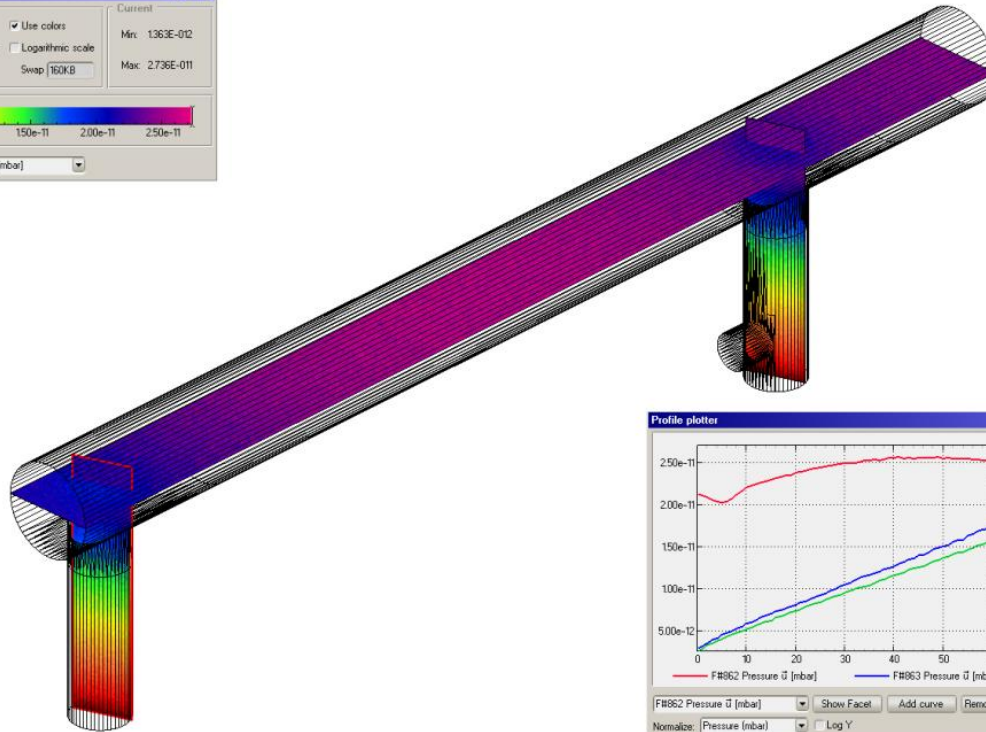
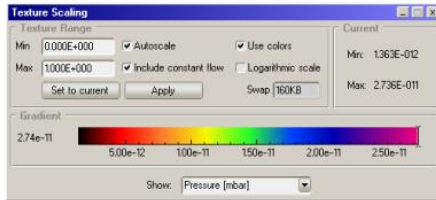
Laboratory activities: pumping speed measurement

- Pumping speed measurement



Design of vacuum systems

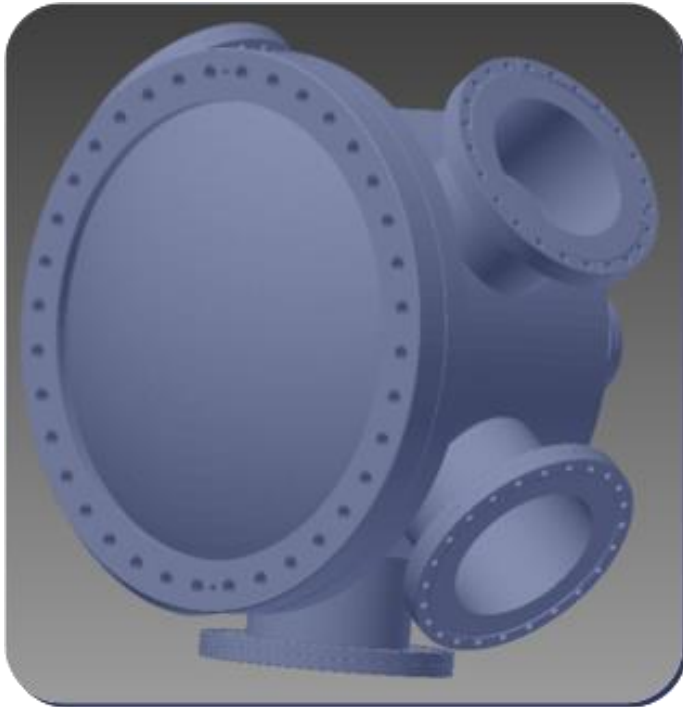
- A test particle Monte-Carlo code for molecular flow
- <http://molflow.web.cern.ch/>
- R. Kersevan – M. Ady



A simple accelerator part with a pumping port

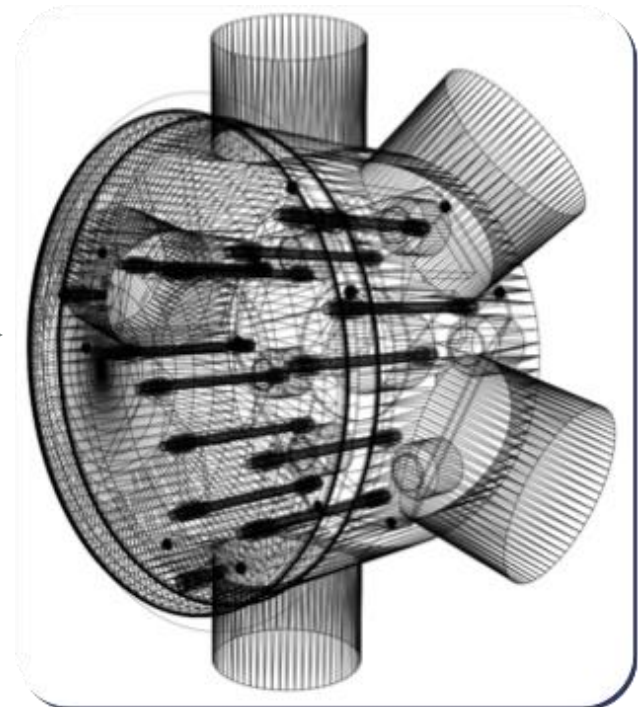
Step 1: creating geometry

CAD



STL format

Molflow+



Step 2: adding physics

Molflow+ 2.6.39 64-bit (Feb 22 2017) [simple_geo.zip]

File Selection Tools Facet Vertex View Test Time

Profile plotter

V:228 F:139 Dim(5,4,18) Area:216.18

3D Viewer settings

- Rules
- Normals
- Lines
- Leaks
- Hits
- Volume
- Texture
- Vertices
- Indices

Selected Facet (3 selected)

Particles in

Desorption: ...

Outgassing (mbar¹/s): ...

Outg/area(mbar¹/s/cm²): ...

Particles out

Sticking factor: ...

Pumping Speed (l/s): ...

Sides: 1 Sided

Opacity: 1

Temperature (°K): 293.15

Sum Area (cm²): 13.90576475

Profile: None

<< Adv Details... Coord... Apply

Shortcuts

Simulation

<< Sim Resume Reset

Auto update scene Update

Hits 182.76 Mhit (3.2 Mhit/s)

Des. 2.02 Mdes (34.9 Kdes/s)

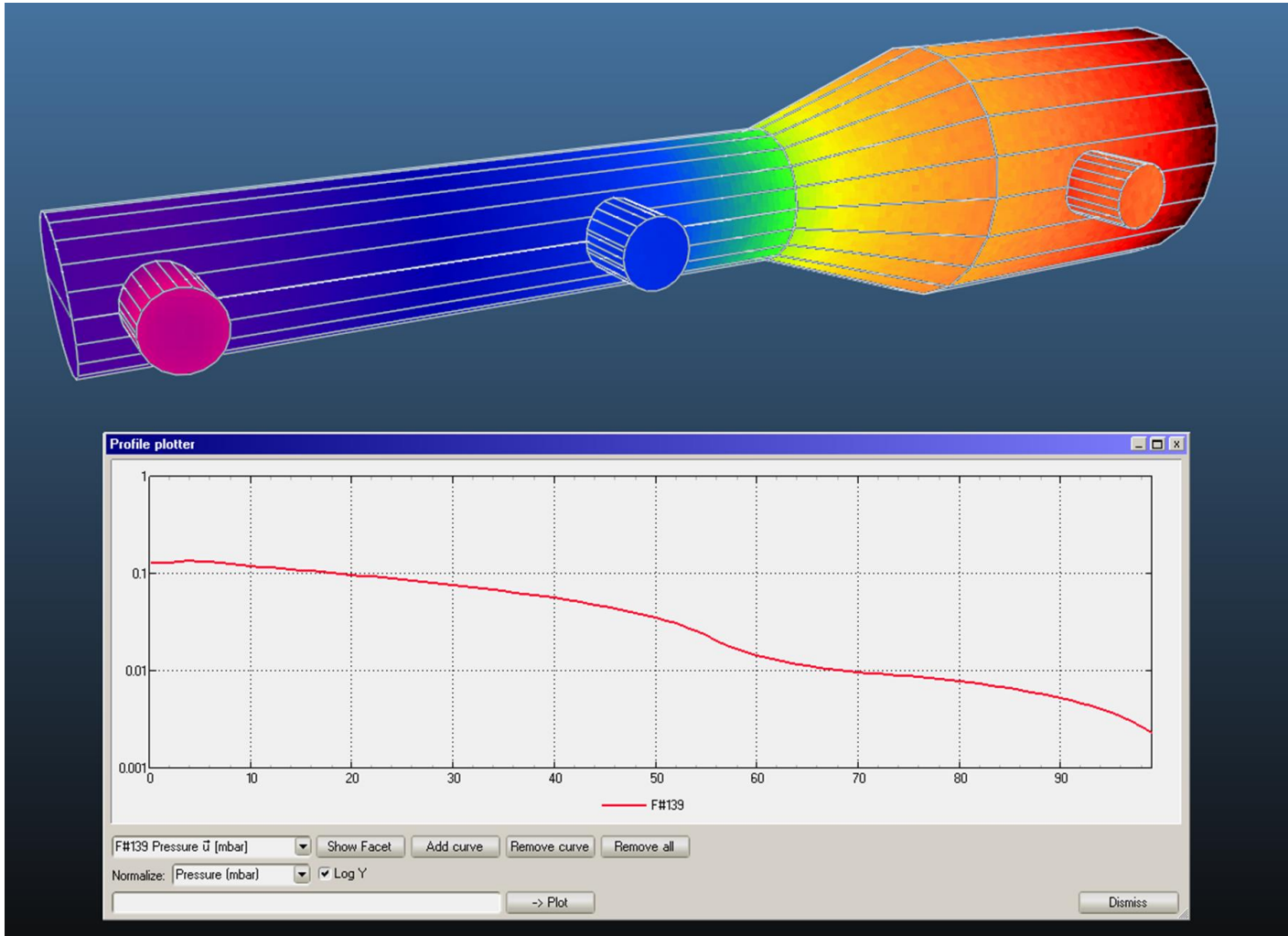
Leaks None

Time Stopped: 00:00:58

#	Hits	Des	Abs
67	6261377	0	0
68	6280336	0	0
69	6294972	0	0

Trans. Prob. Divide by 0

Step 3: simulation and results



100k molecules

**You are welcome to join our group
for the practical days !**



Thank you for your attention !!!



