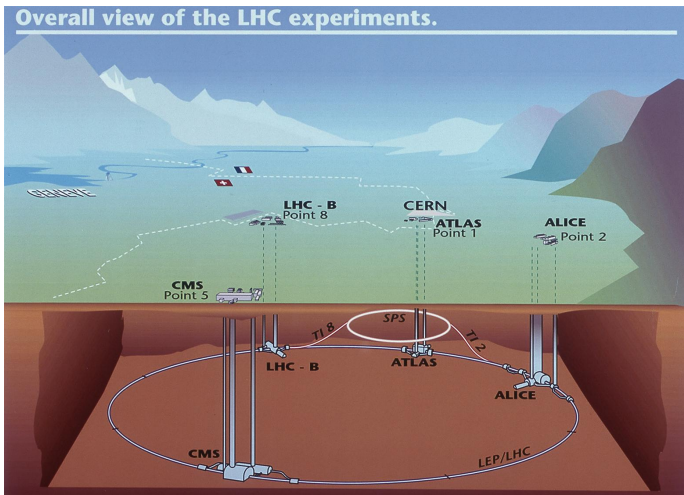


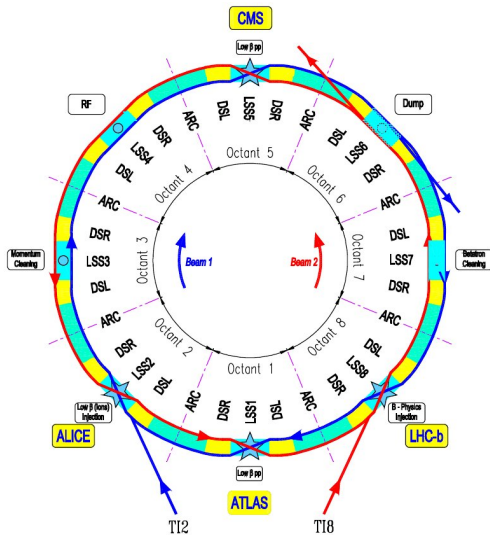
Vakuový systém urychlovače LHC



50 – 150 m pod zemí, délka 27 km home.web.cern.ch/topics/large-hadron-collider

LHC

- 8 - oblouků a 8 rovných částí
- sektor je část urychlovače mezi středy rovných úseků
- 7 TeV - energie protonů, spotřeba LHC celková 120 MW
- magnetické pole max. 8,33 T
- 11245 oběhů za 1 s
- supravodivé magnety z NbTi
- kryo-systém - 120 t He
- 700 MB/s dat ze všech experimentů
- náklady asi 3 miliardy EUR \sim 80 miliard Kč \sim 4,5 miliardy USD
- 1500 PC z ČR počítalo simulace pro uložení magnetu



home.web.cern.ch/topics/large-hadron-collider

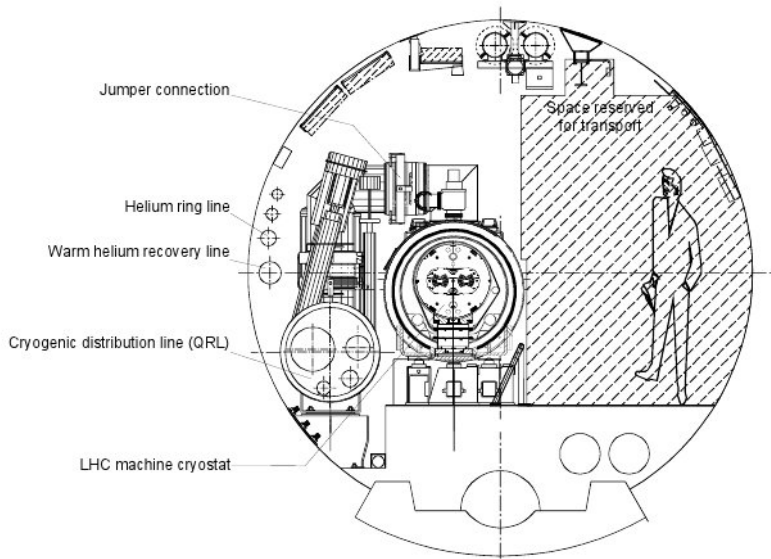
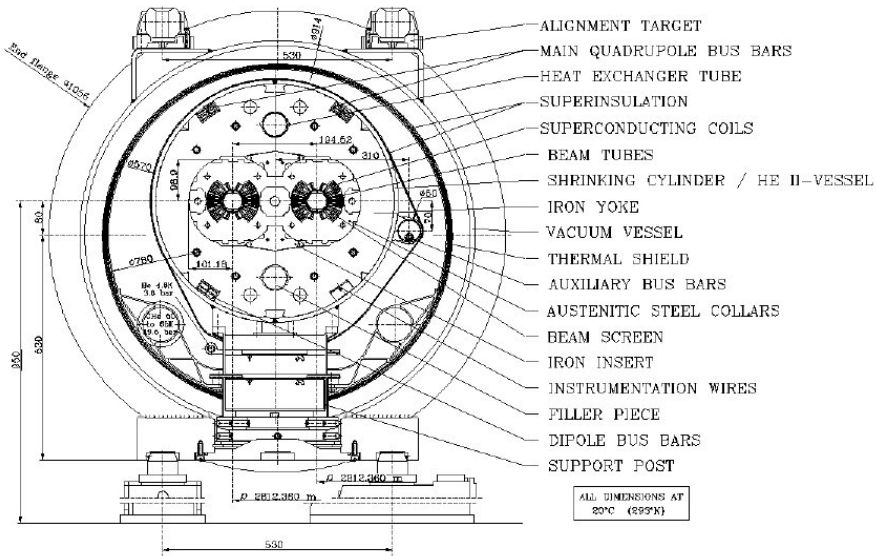


Figure 11.1: Transverse cross-section of the LHC tunnel

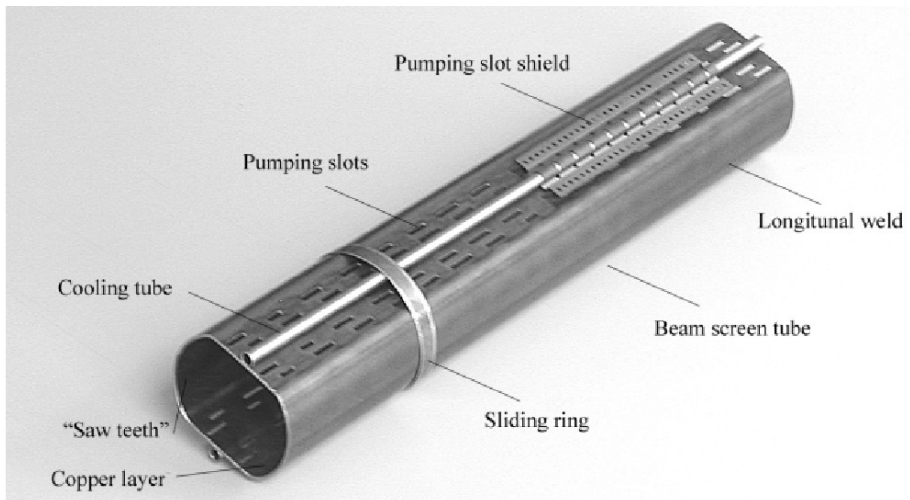


Vakuové systémy:

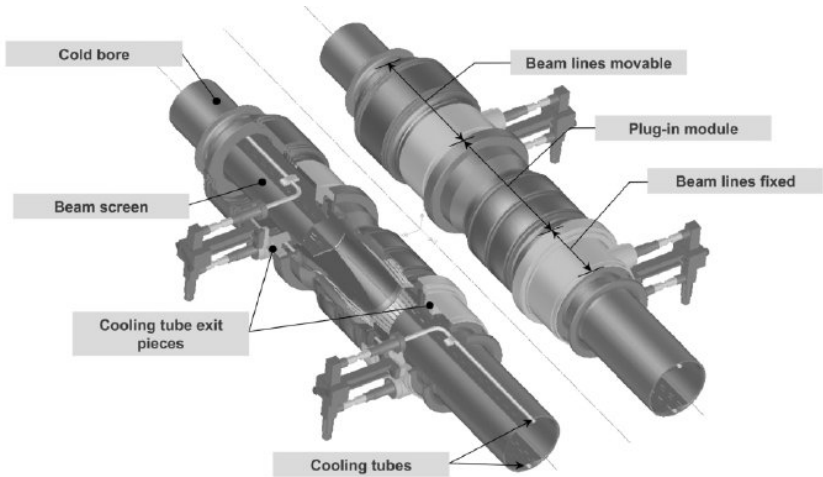
- kryomagnety - sektory s délkou 214 m, teplota 1,9 K
- He-rozvody - sektory s délkou 428 m
- urychlovač - různé délky sektorů, délka přibližně 2900 m,
 $10^{-8} - 10^{-9}$ Pa

| GAS | Nuclear scattering cross section(cm^2) | Gas density (m^{-3}) for a 100 hour lifetime | Pressure (Pa) at 5 K, for a 100 hour lifetime |
|----------------------|---|---|---|
| H_2 | $9.5 \cdot 10^{-26}$ | 9.810^{14} | 6.710^{-8} |
| He | $1.26 \cdot 10^{-25}$ | 7.410^{14} | 5.110^{-8} |
| CH_4 | $5.66 \cdot 10^{-25}$ | 1.610^{14} | 1.110^{-8} |
| H_2O | $5.65 \cdot 10^{-25}$ | 1.610^{14} | 1.110^{-8} |
| CO | $8.54 \cdot 10^{-25}$ | 1.110^{14} | 7.510^{-9} |
| CO_2 | $1.32 \cdot 10^{-24}$ | $7 \cdot 10^{13}$ | 4.910^{-9} |

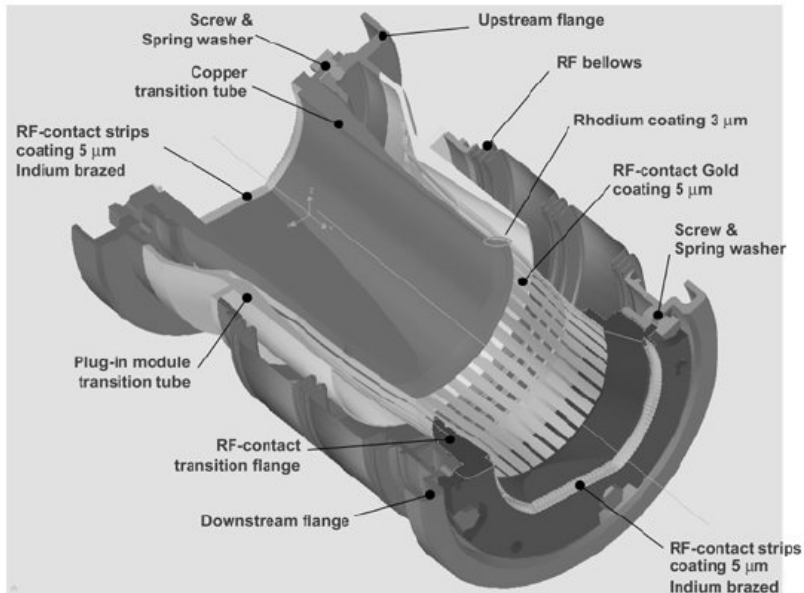
home.web.cern.ch/topics/large-hadron-collider



průměr asi 45 mm, 1 mm nerez ocel + $75 \mu\text{m}$ Cu, 5 – 20 K
home.web.cern.ch/topics/large-hadron-collider



elektrický odpor $0,1 \text{ m}\Omega$ home.web.cern.ch/topics/large-hadron-collider



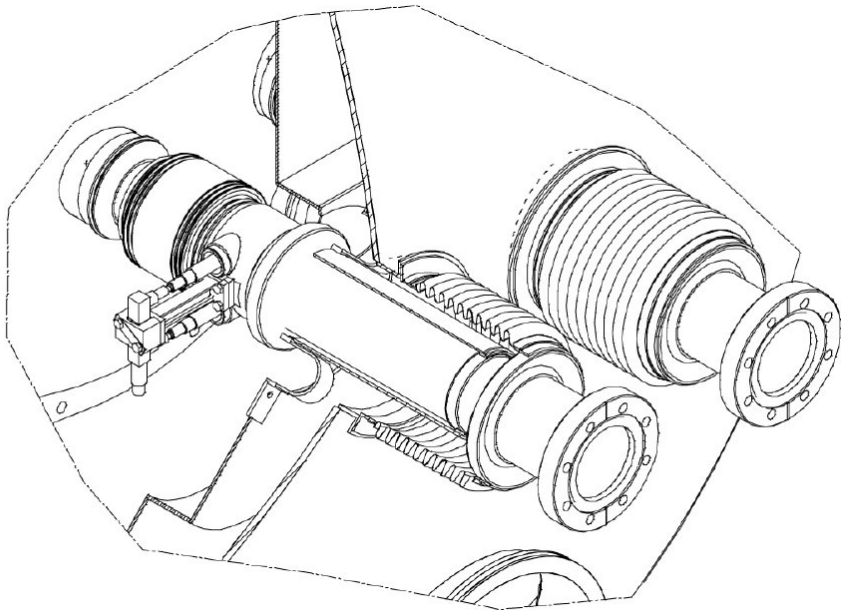


Figure 12.7: Details of a cold-to-warm transition

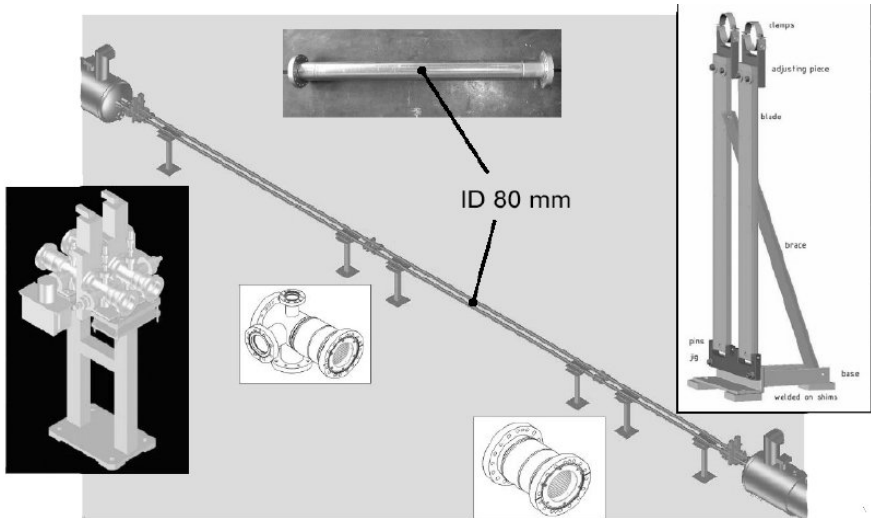


Figure 12.8: Standard layout of the RT beam vacuum system between two cryostats.

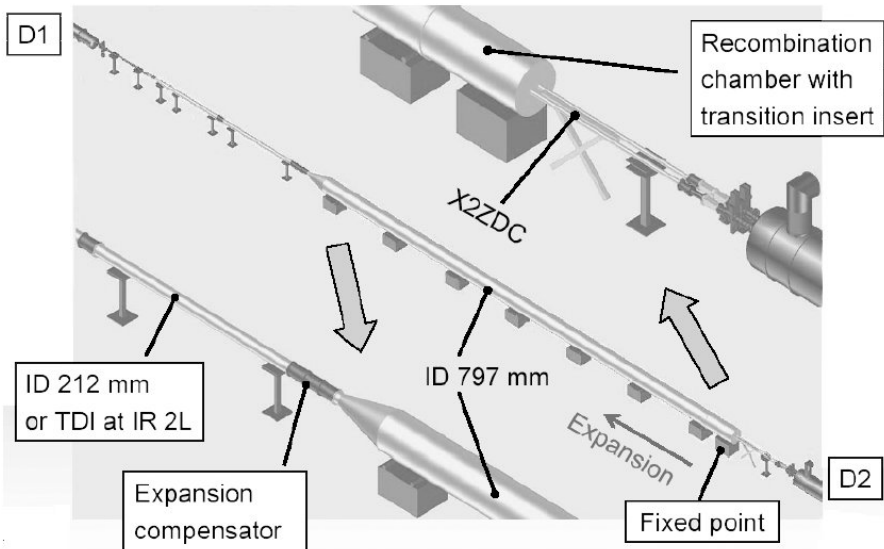


Figure 12.10: Layout of the RT beam vacuum system at right of IR point 2

- mobilní čerpací stanice
- trubice urychlovače - kryogenní vývěva
- části na pokojové teplotě - NEG getr - TiZrV, iontové vývěvy asi po 28 m
- manometry v každém sektoru - 1x Pirani, 2x ionizační se studenou katodou, 1x ionizační se žhavenou katodou
- analyzátor plynu (hmotový spektrometr) na mobilní čerpací jednotce + další manometry

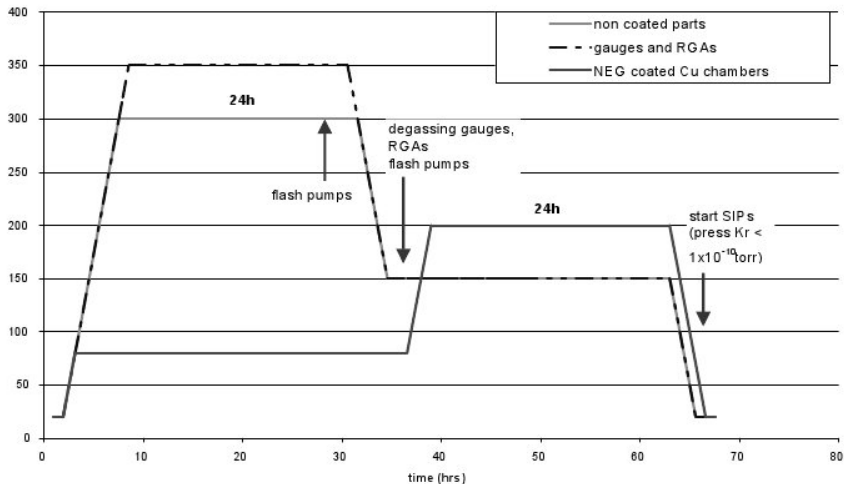


Figure 12.13: Proposed bake-out cycle with NEG activation

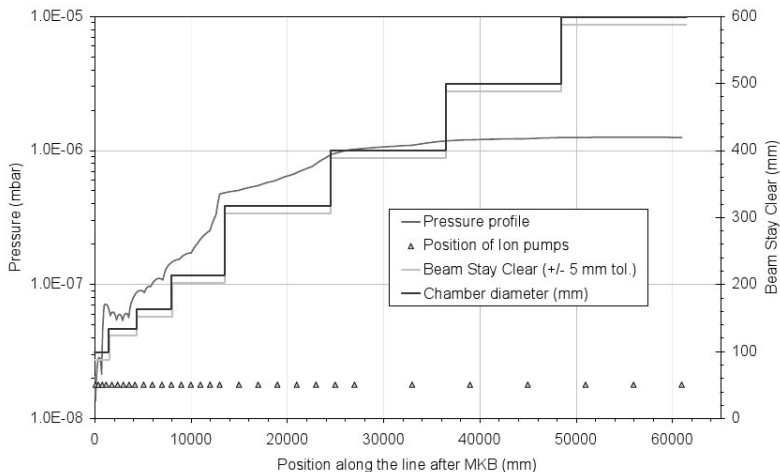


Figure 12.15: Pressure profile, distribution of ion pumps, vacuum chamber diameters and beam stay clear along the beam dump line starting downstream of the diluters (MKB) down to the dump (TDE).

Table 12.3: Main characteristics of the insulation vacuum sectors

| | Cryomagnet | QRL |
|--------------------------|-------------------|------------|
| Volume (m ³) | 80 | 85 |
| Length (m) | 214 | 428 |
| MLI (m ² /m) | 200 | 140 |
| Sectors per arc | 14 | 7 |

home.web.cern.ch/topics/large-hadron-colliderVakuum pro kryomagnety a He rozvody.

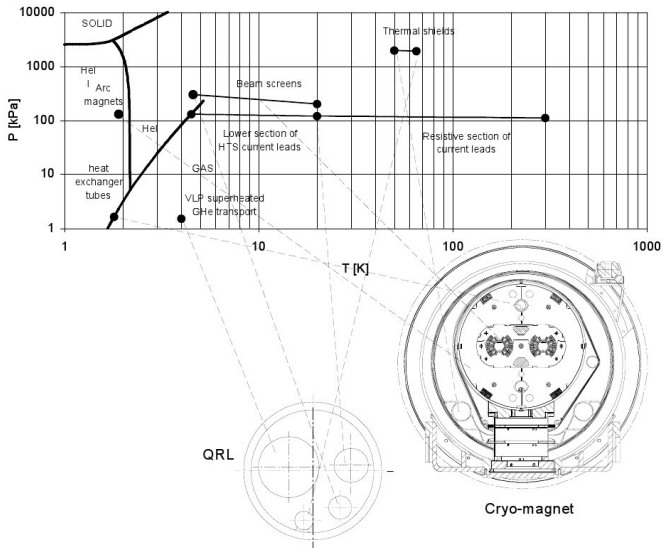


Figure 11.4 Thermodynamic states of helium in the LHC cryogenic system

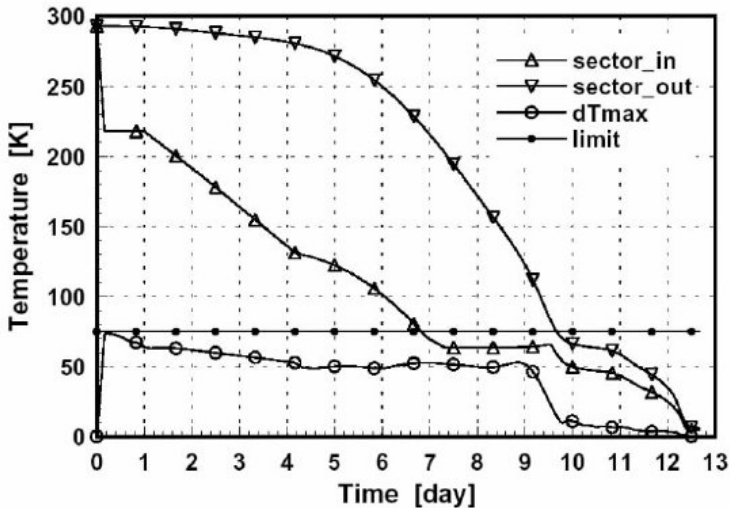


Figure 11.12: Normal cool-down from 300 K to 4.5 K of LHC sectors

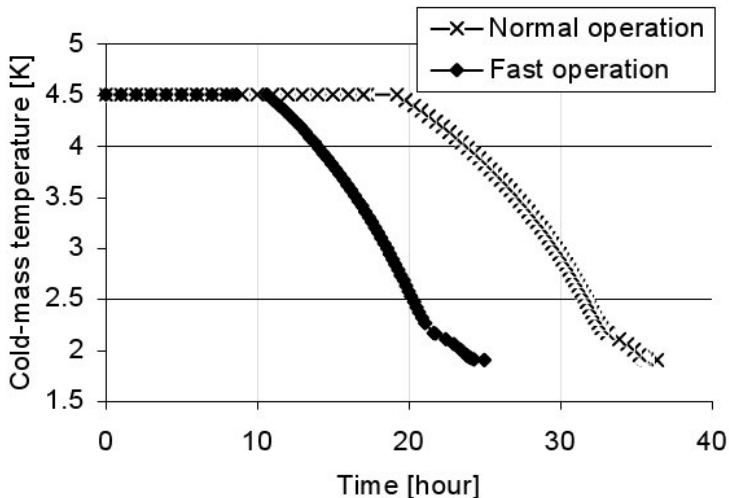
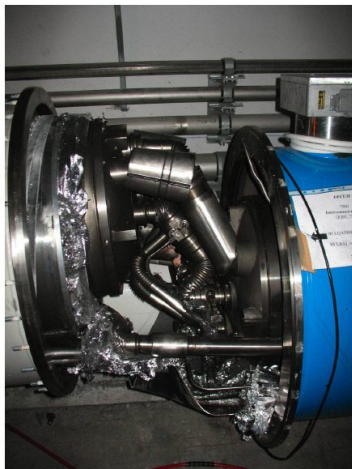


Figure 11.13: Magnet filling and cool-down down from 4.5 K to 1.9 K

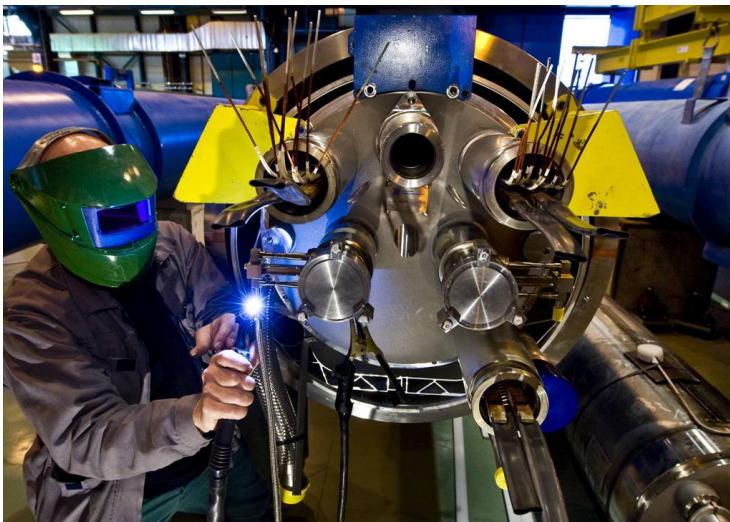
Nehoda na LHC

- 19.9.2008
- vadné propojení mezi dvěma magnety, sektor 3-4
- při zvyšování proudu magnetem na hodnotu 8,7 kA, provozní proud 9,3 kA
- rekonstrukce asi 700 m urychlovače
- ztráta asi 6 t He



1

¹www.osel.cz/index.php?clanek=4144



2

www.osel.cz/index.php?clanek=4144

Odkazy na www

- <http://lhc.web.cern.ch/lhc/>
- <http://www.osel.cz/index.php?clanek=4144>
- <http://www.czechnationalteam.cz>