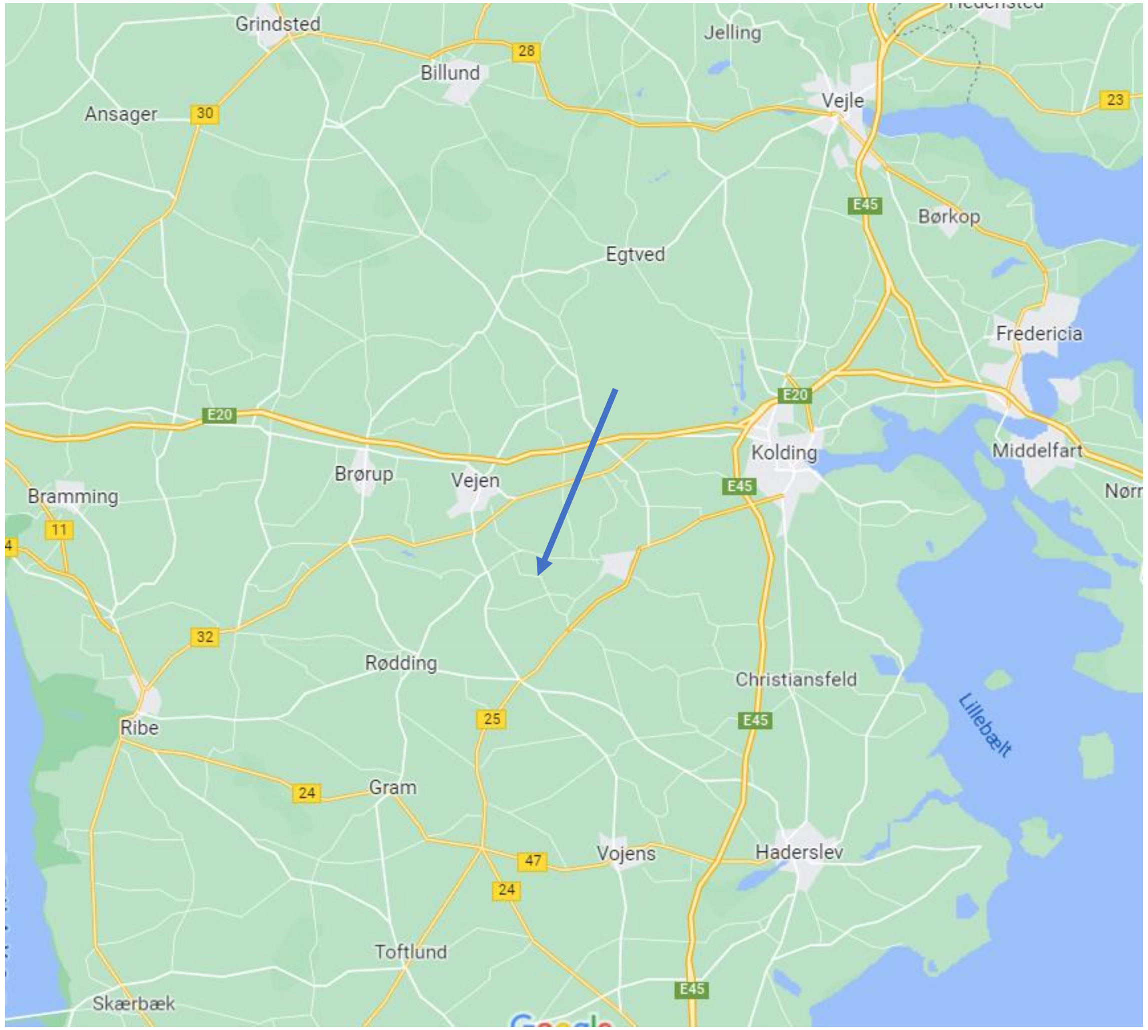
CERN

Simon Straarup

Maskinmester på CERN

- Jeg er 31 år
- Kommer fra Vejen omegn
- Bor i Gex, Frankrig
- Arbejder ved CERN's Large Magnet Facelility

- Mesterlære som Landbrugsmaskinmekaniker
- Adgangskursus på Maskinmesteruddannelsen
- Maskinmester



Baggrund

Min rejse til CERN

Folkeskole & 10. klasse

Landbrugsmaskinmekaniker

2010-2014

Entreprenør i fars biks

2014-2017

Selvstændig Entreprenør

2017-2022

Adgangskursus til Maskinmester-uddannelsen

2019-2019

Maskinmester-studerende

2019- 2022

Bachelorpraktik ved CERN

2022-2022

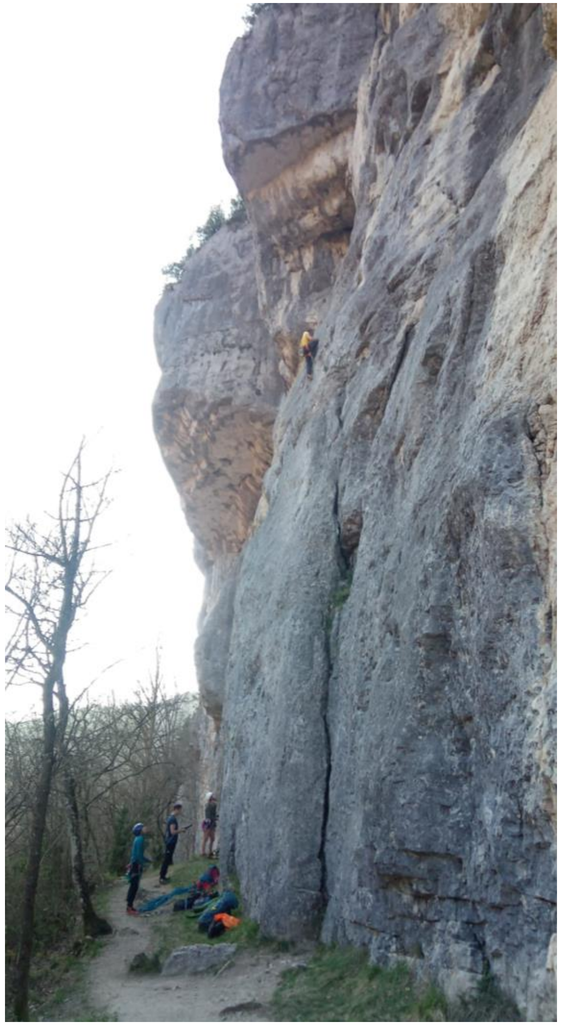
Mechanical Technical Engineer ved CERN

2022-nu

Fritid

Maskinmesterpraktikant på CERN

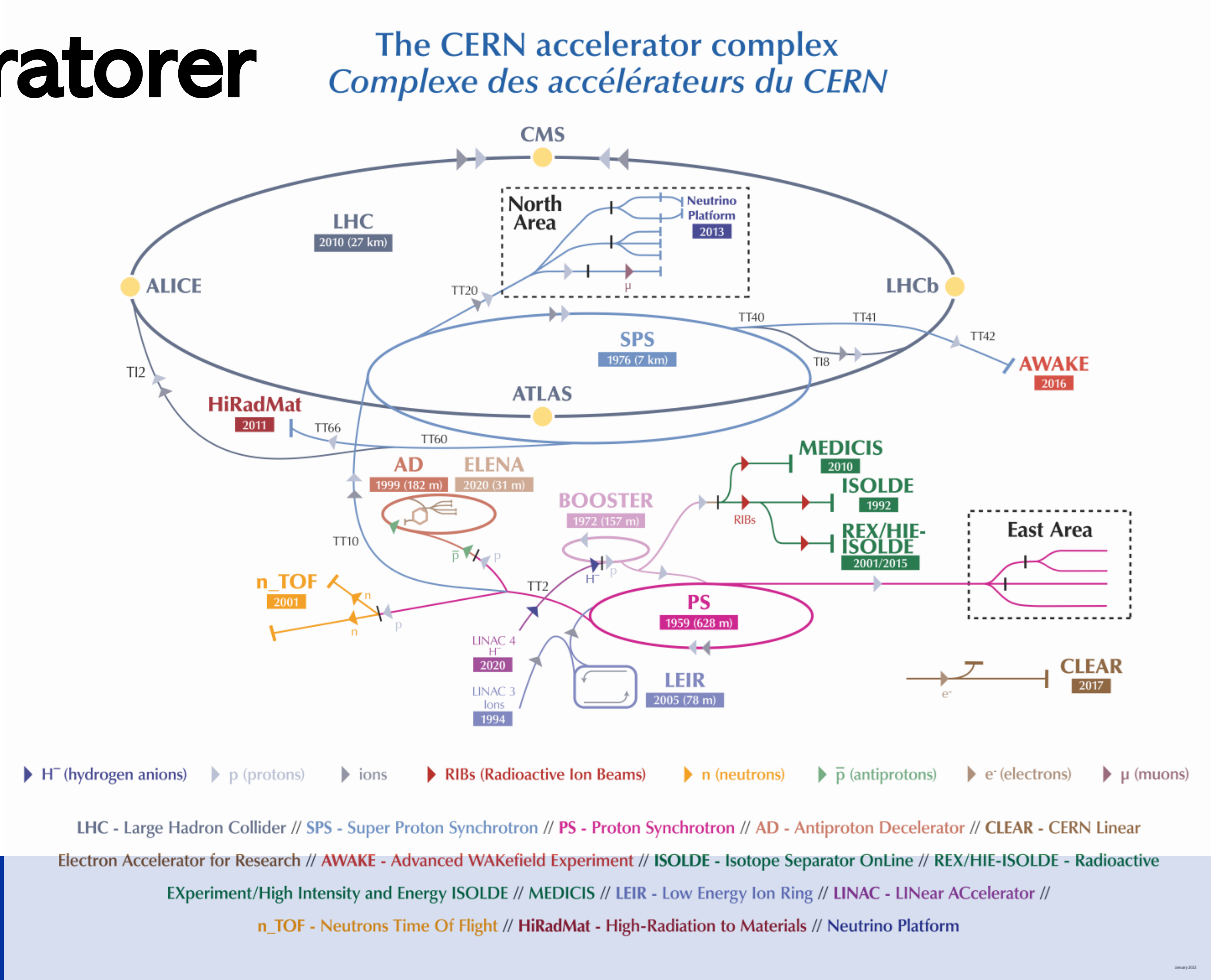
- Vandring
- Klatring
- Ski
- Genéve
- Lyón
- CERN-venner



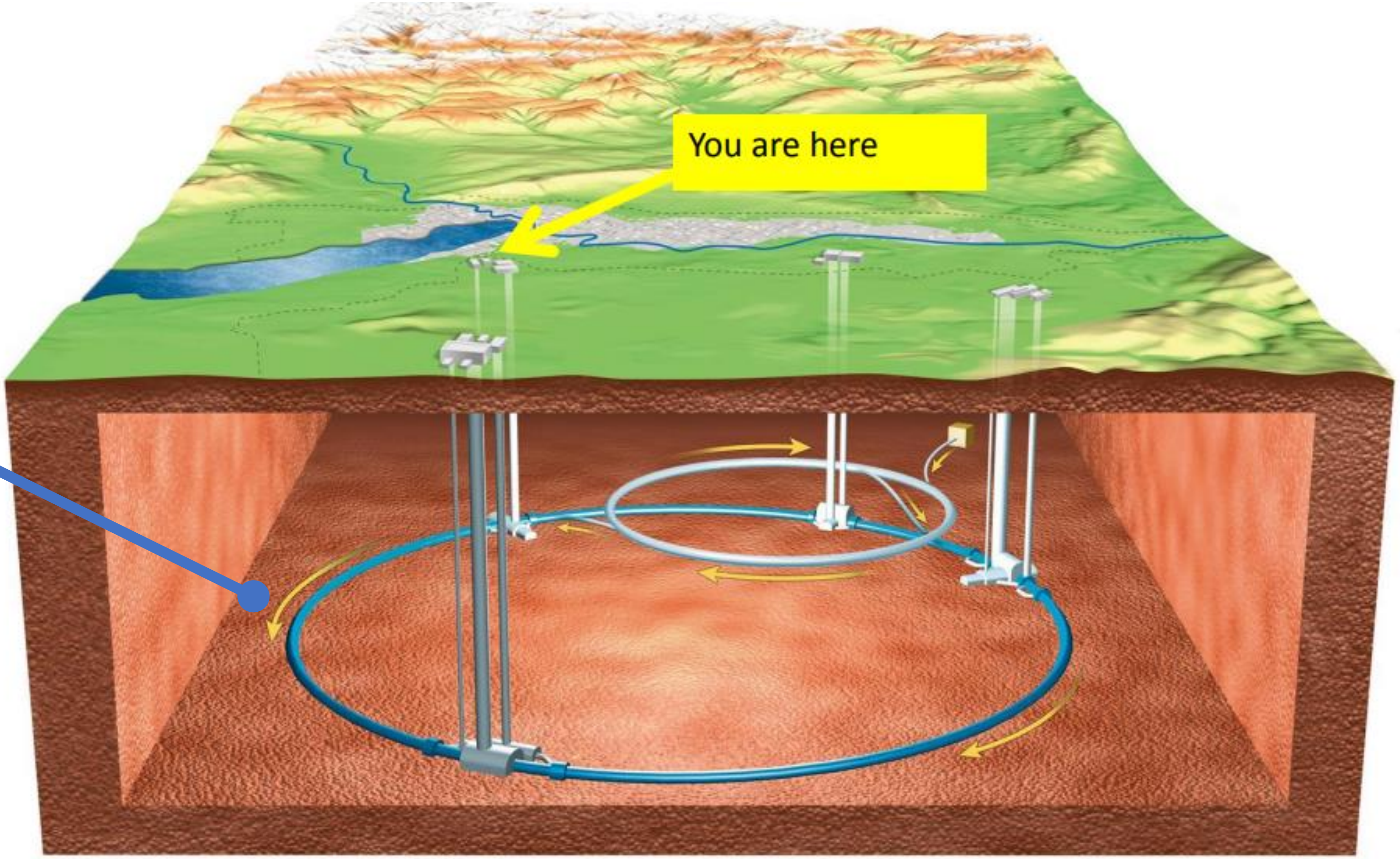
Coming up

- Acceleratorer ved CERN
- LHC'en
- Magnet – hvorfor bruger vi dem
- Superledende vs. Normalledende magneter
- Magnet design
- Hilumi
- Large Magnet Facility – Bygning 180

Acceleratorer Anlæg

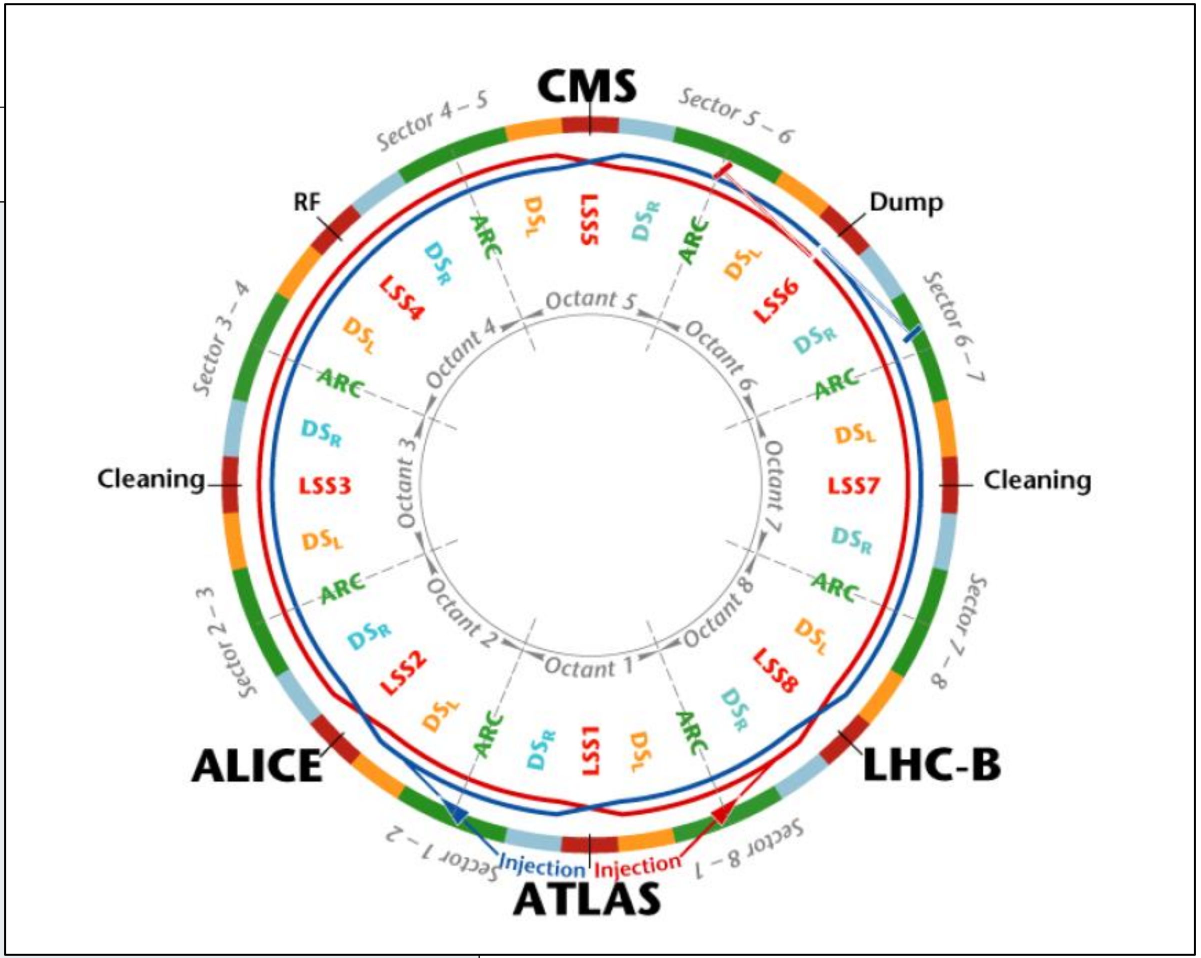


LHC facts



LHC facts

Quantity	Number
Circumference	26 659 m
Dipole operating temperature	1.9 K (-271.3°C)
Number of magnets	9593
Number of main dipoles	1232
Number of main quadrupoles	392
Number of RF cavities	8 per beam
Nominal energy, protons	6.5 TeV
Nominal energy, ions	2.56 TeV/u (energy per nucleon)
Nominal energy, protons collisions	13 TeV
No. of bunches per proton beam	2808
No. of protons per bunch (at start)	1.2×10^{11}
Number of turns per second	11245
Number of collisions per second	1 billion



Magnetvideen

Electro-magnetic field accelerates particles

$$\vec{F} = e\vec{E}$$

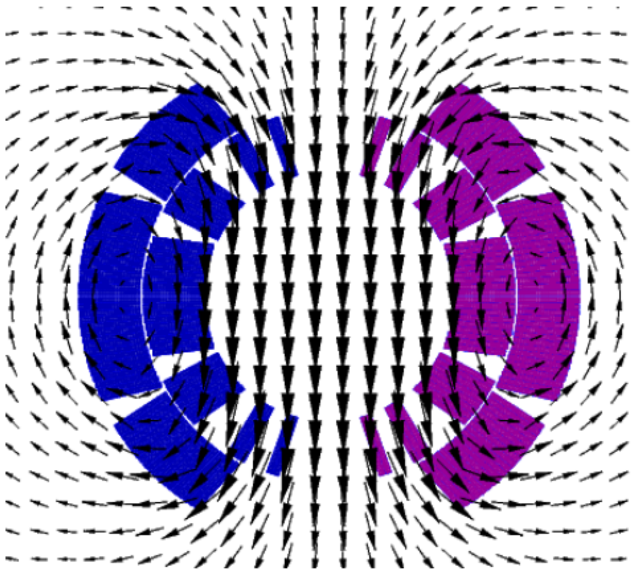
Magnetic field steers the

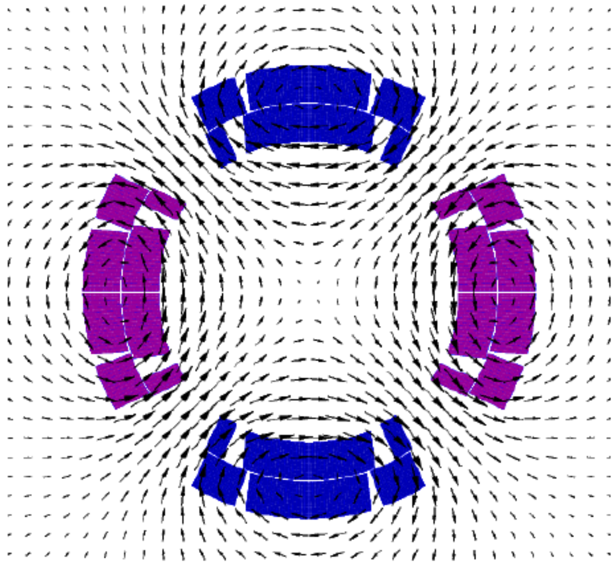
$$\vec{F} = e\vec{v} \times \vec{B}$$

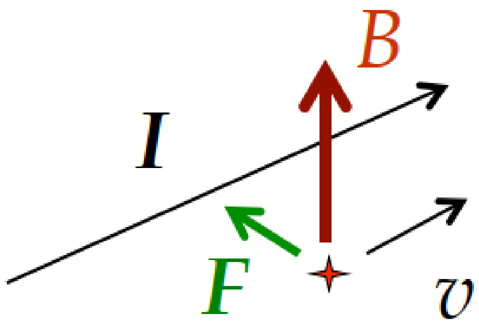
Brug højre hånd

How do we keep the particles in a cycle? MAGNETS!

- Dipole magnets provide a constant field, to be increased with time to follow the particle acceleration, steering (bends) the particles in ≈ circular orbit
- Quadrupole magnets keep the particles in the orbit, providing a linear force that keep them focused acting as a spring. They provide a field
  - Equal to zero in the center
  - Increasing linearly with the radius

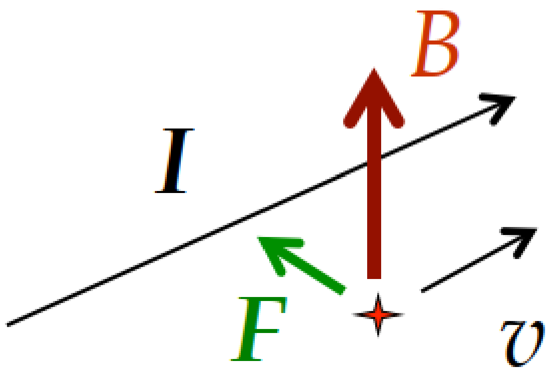


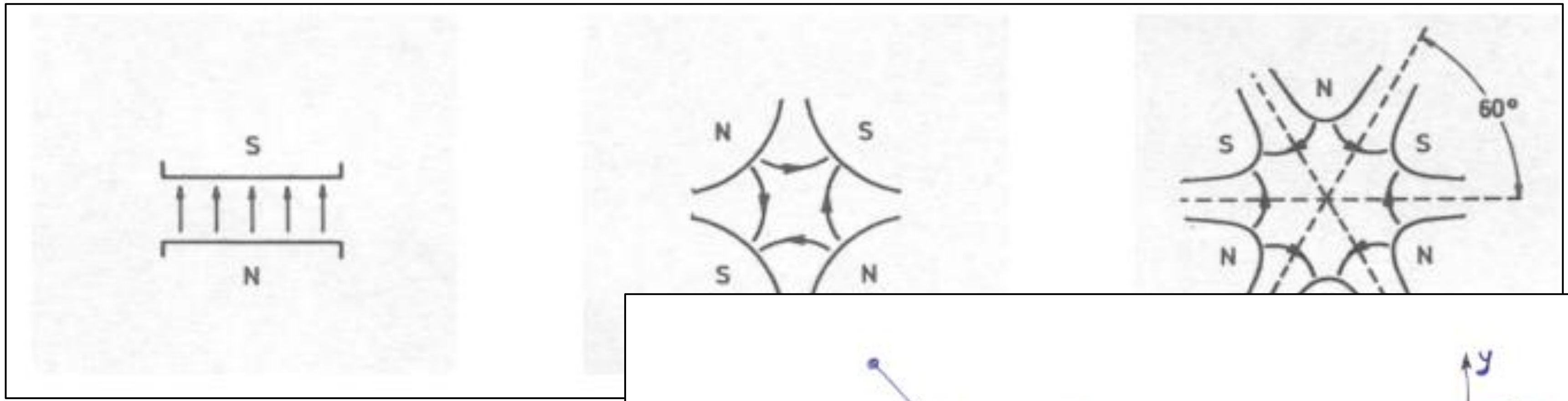


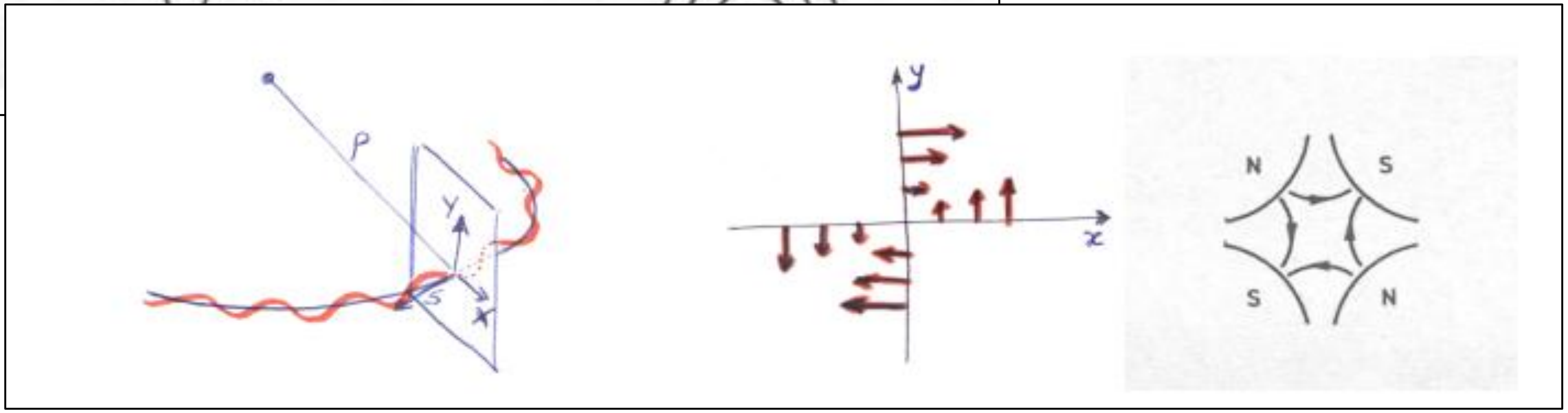


Magnetviden

Brug højre hånd

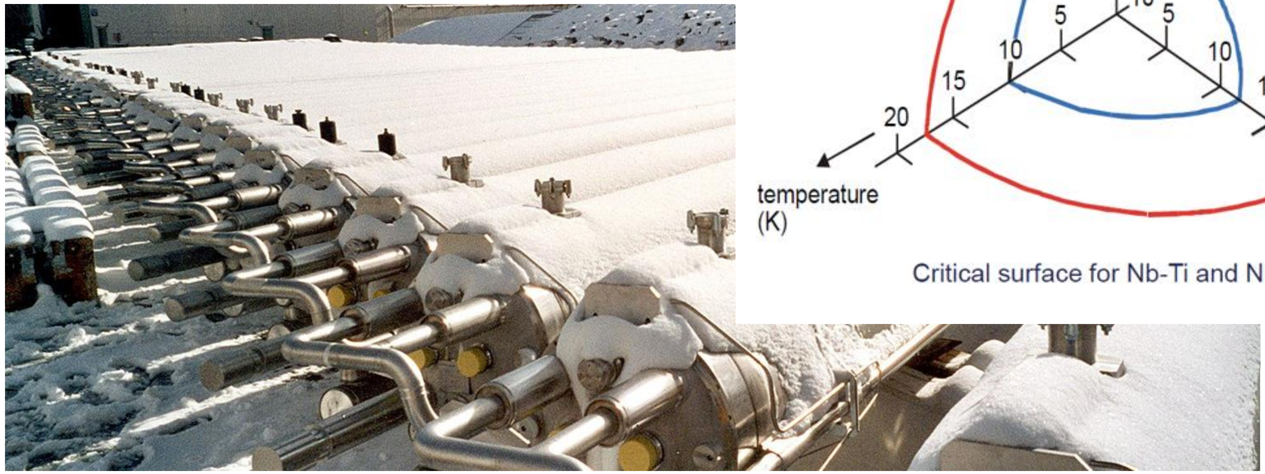


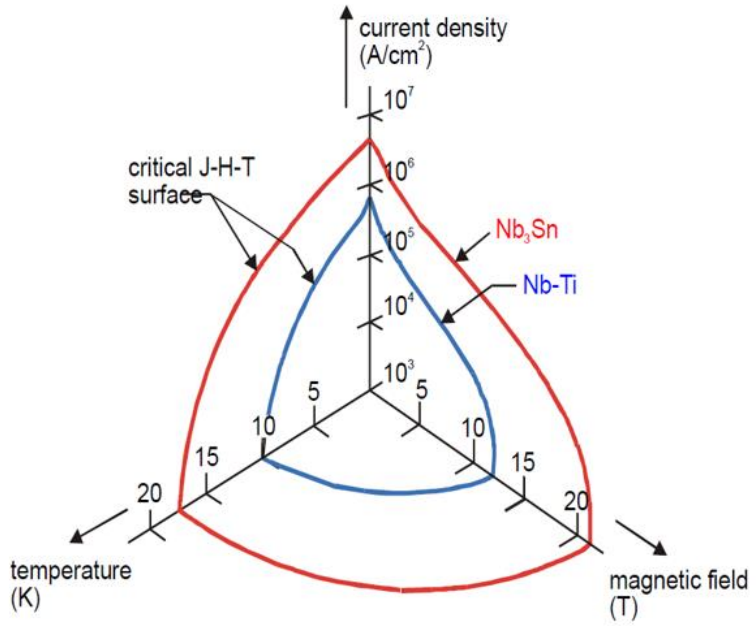




Magneter

- Superledende magneter
- Normalledende magneter
- Permanente magneter

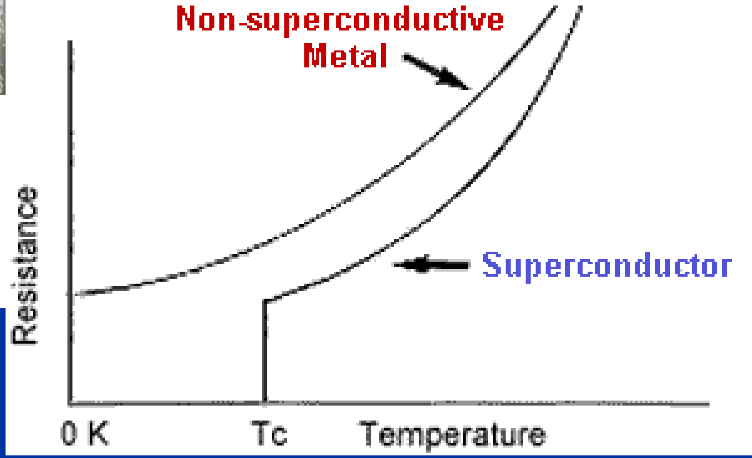




Critical surface for Nb-Ti and Nb_3Sn

SPS main bending.
2.0 T, 5.8 kA

LHC main bending.
8.3 T, 12 kA, 1.9 K

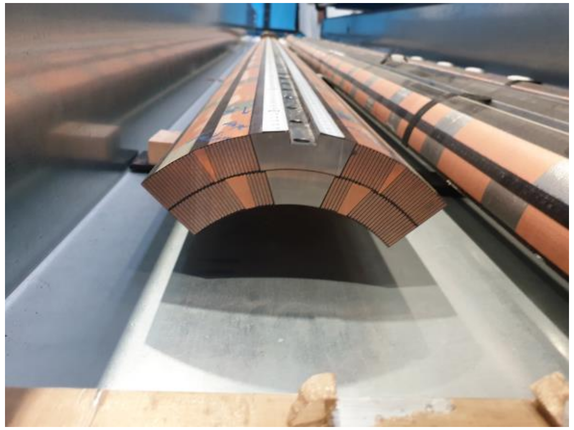


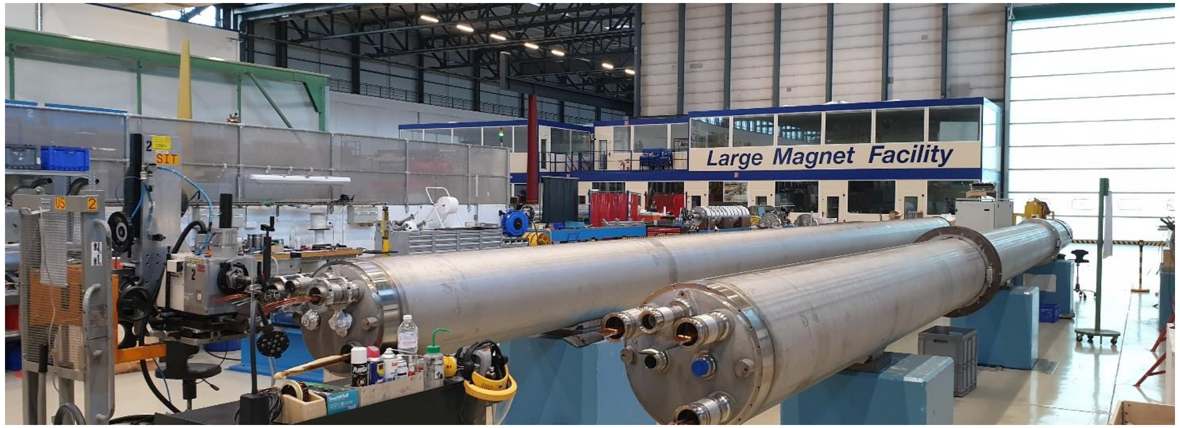
Magnetviden

- Der er 1232 Dipoles magneter i LHC
- Der er 476 Quadropoles magneter i LHC
- Dipolerne er ~15 m.
- Dipolerne har et Sagitta på 9,143 mm.
- Magneterne køles ned til 1,9K ≈ -271,3°C

Large Magnet Facility

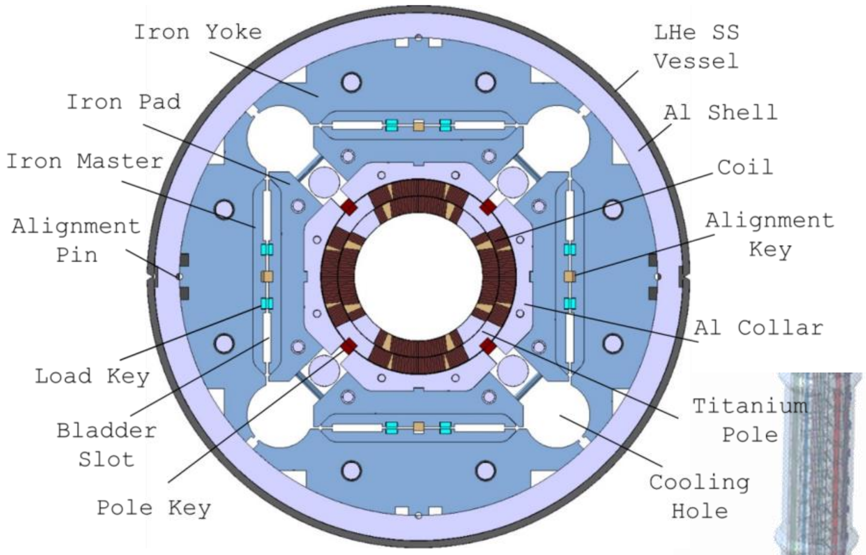
Hvad laver LMF?

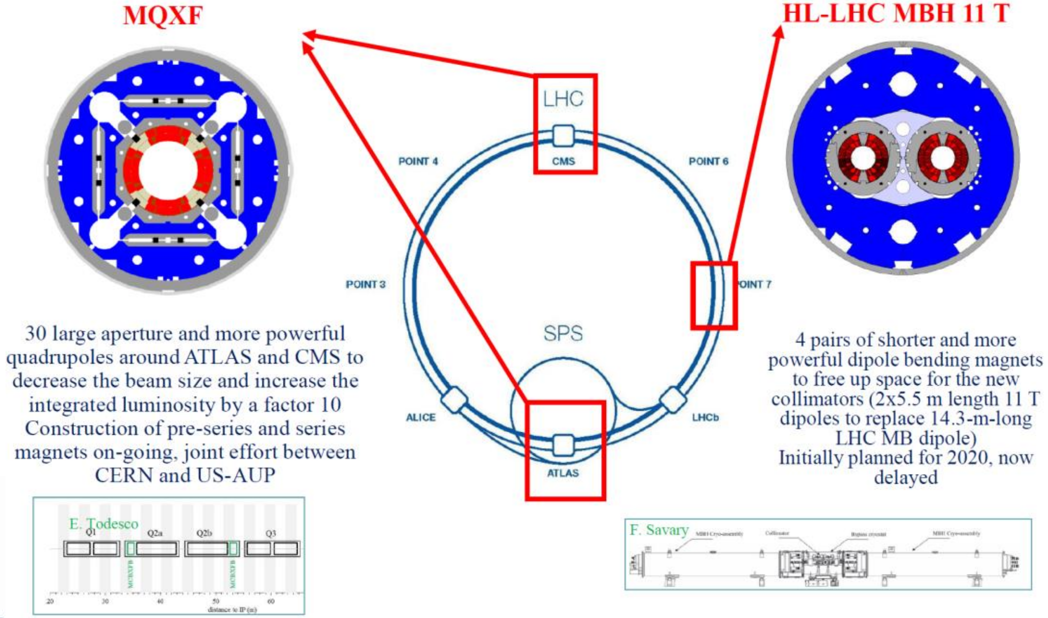




Hvad laver vi nu - HiLumi

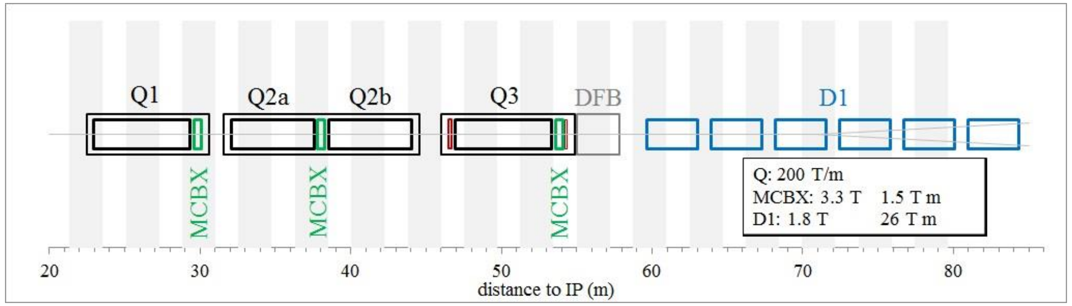
Udskifter triplet magneter

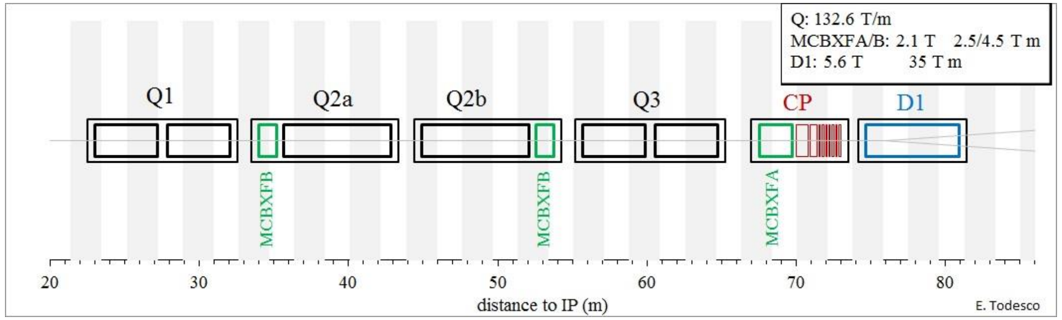


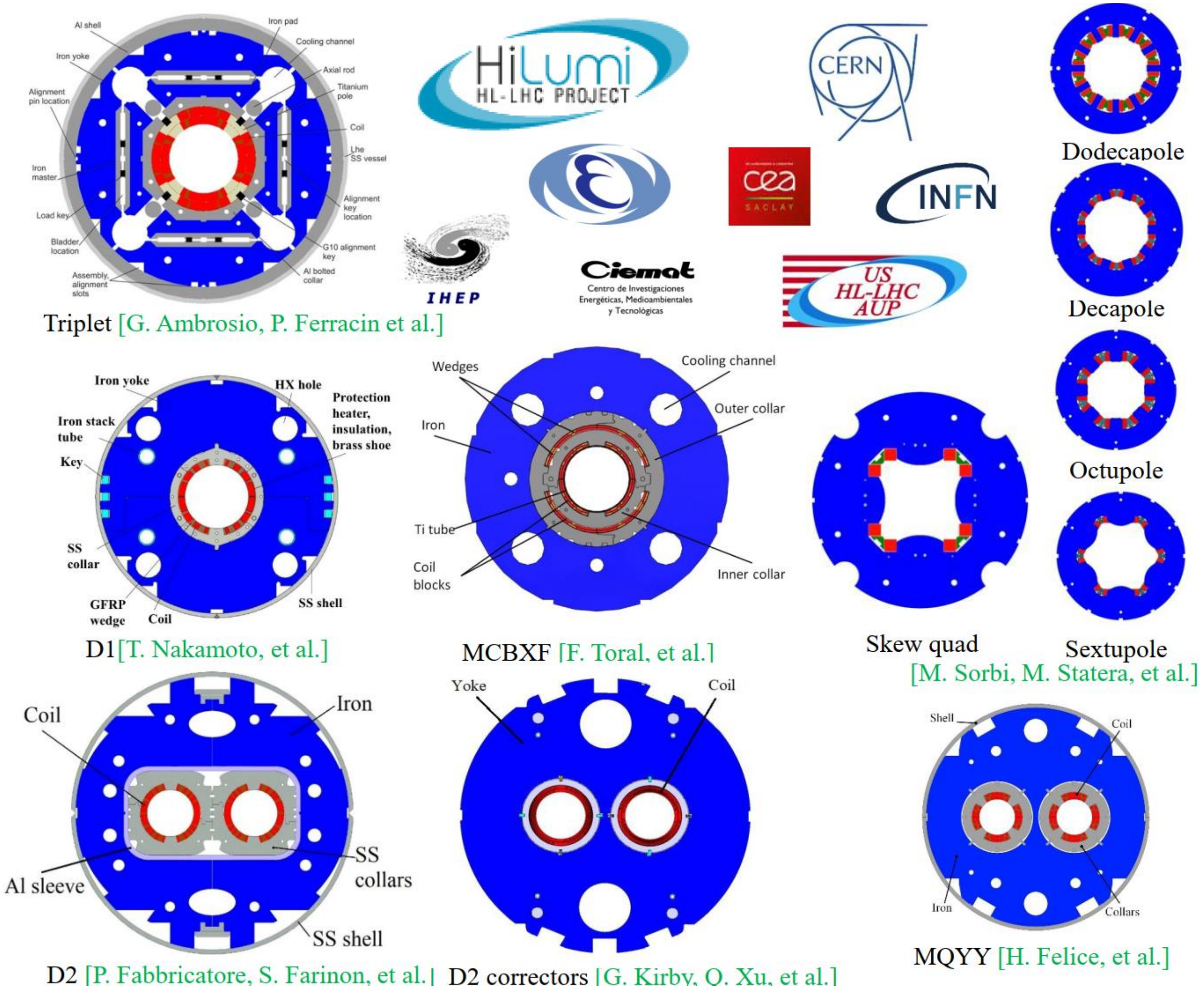


HiLumi

Det er et globalt samarbejde



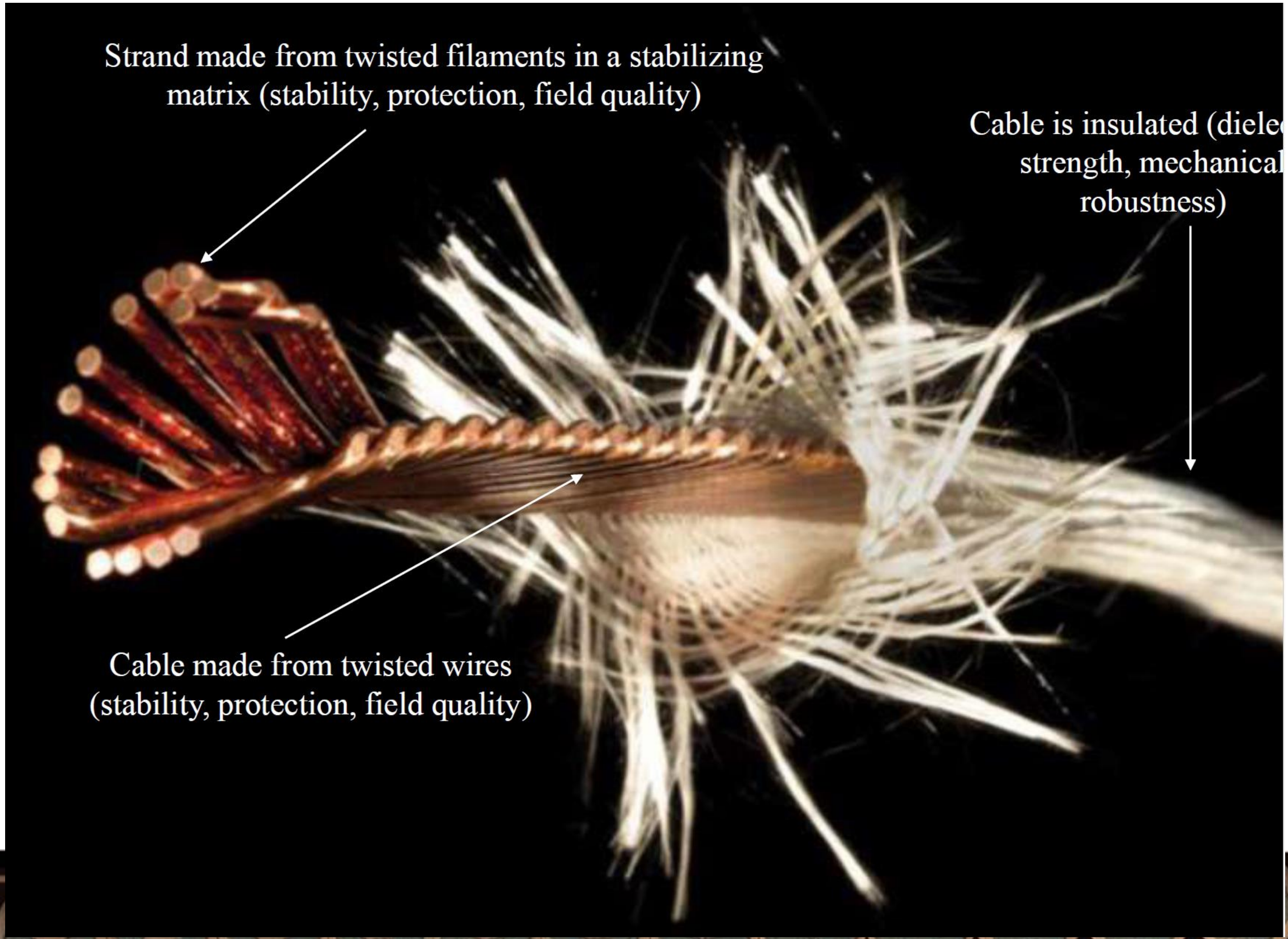




HiLumi

Nye materialer giver nye udfordringer

- Nb-Ti
- **Nb_3Sn**



HiLumi

Typical operational conditions (0.85 mm diameter strand)

by P. Ferracin

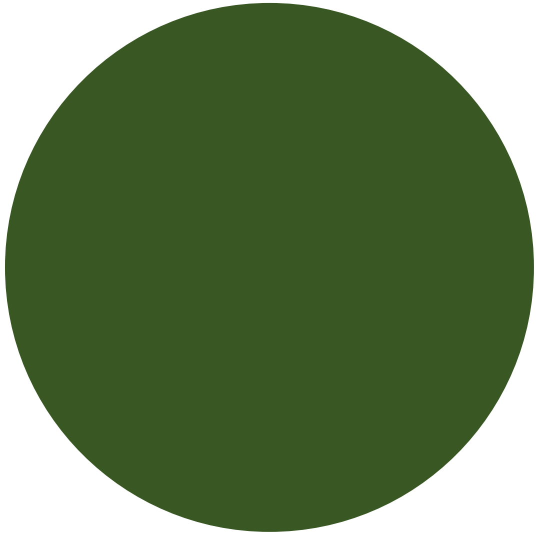
Cu	Nb-Ti	Nb_3Sn
$J_e \sim 5$ A/mm^2	$J_e \sim 600$-700 A/mm^2	$J_e \sim 600$-700 A/mm^2
$I \sim 3$ A	$I \sim 300$-400 A	$I \sim 300$-400 A
$B = 2$ T	$B = 8$-9 T	$B = 12$-13 T

HiLumi

Typical operational conditions (0.85 mm diameter strand)

by P. Ferracin

Cu

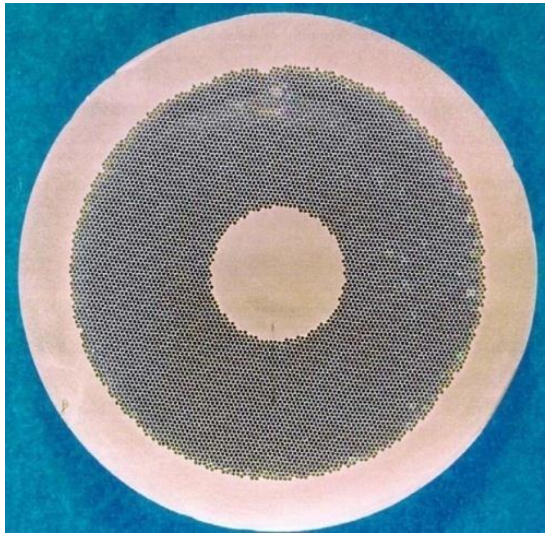


J_e ~ 5 A/mm²

I ~ 3 A

B = 2 T

Nb-Ti

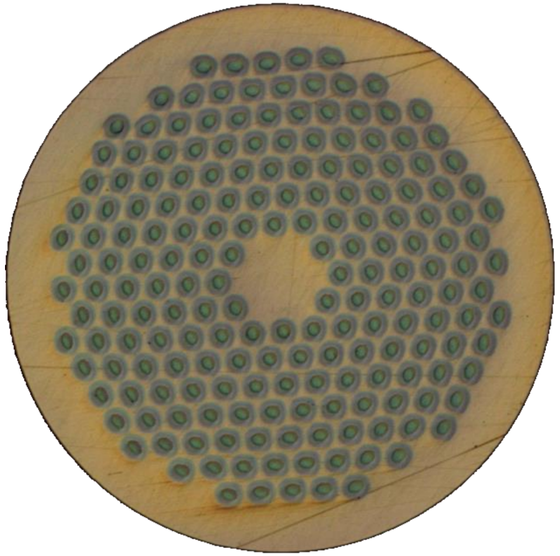


J_e ~ 600-700 A/mm²

I ~ 300-400 A

B = 8-9 T

Nb_3Sn



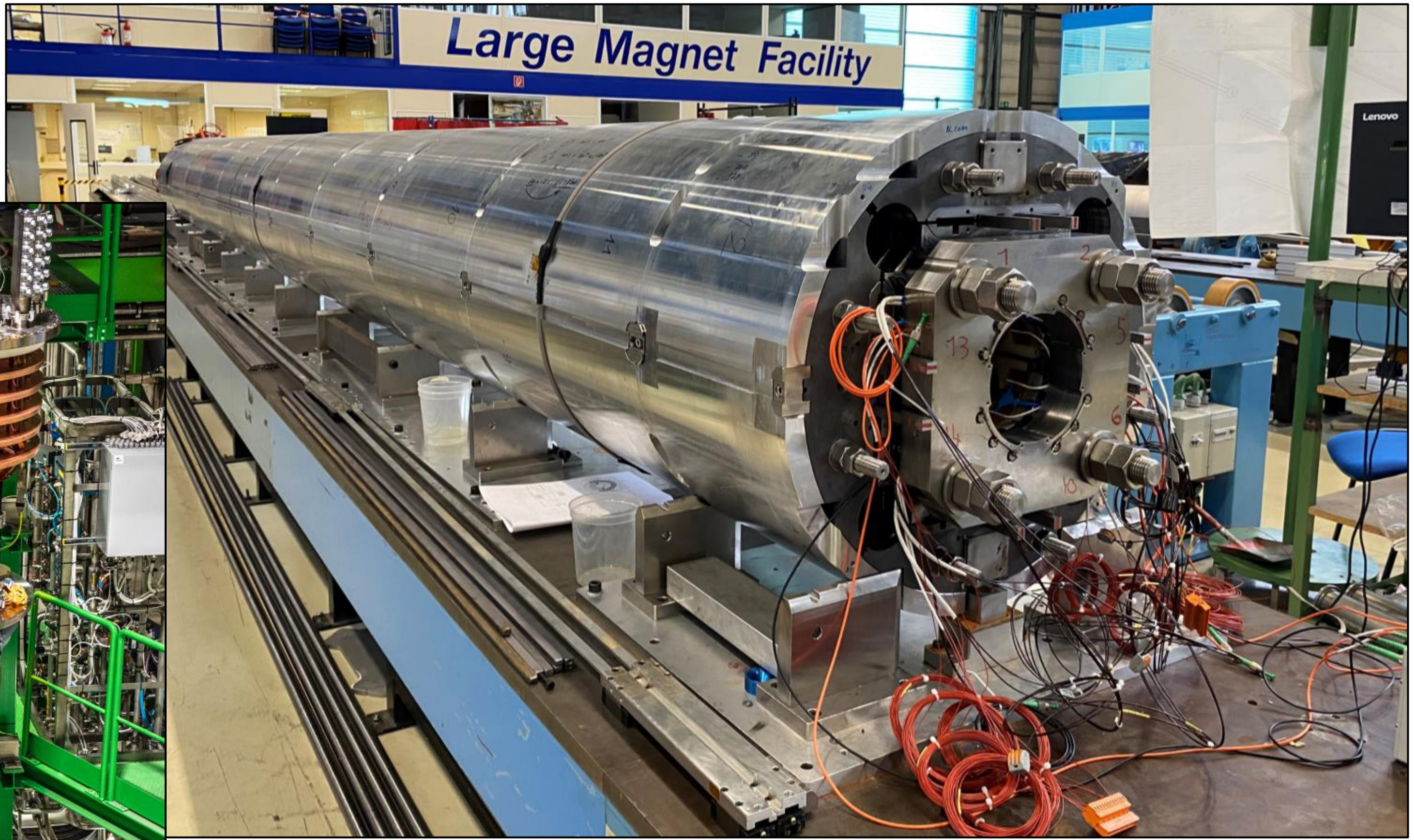
J_e ~ 600-700 A/mm²

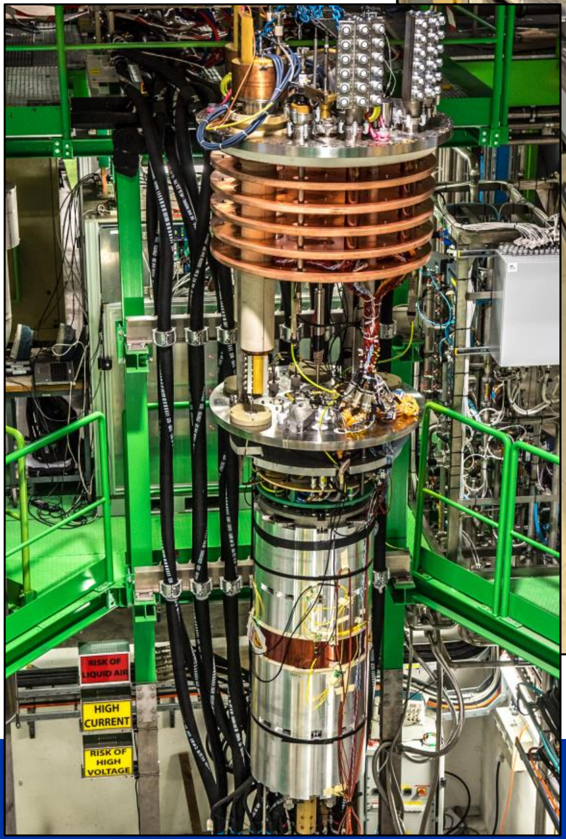
I ~ 300-400 A

B = 12-13 T

HiLumi

MQXFB/S magneter





HiLumi

Vi ses i bygning 180

Aka :

The Large Magnet Facility

by S. Izquierdo Bermudez