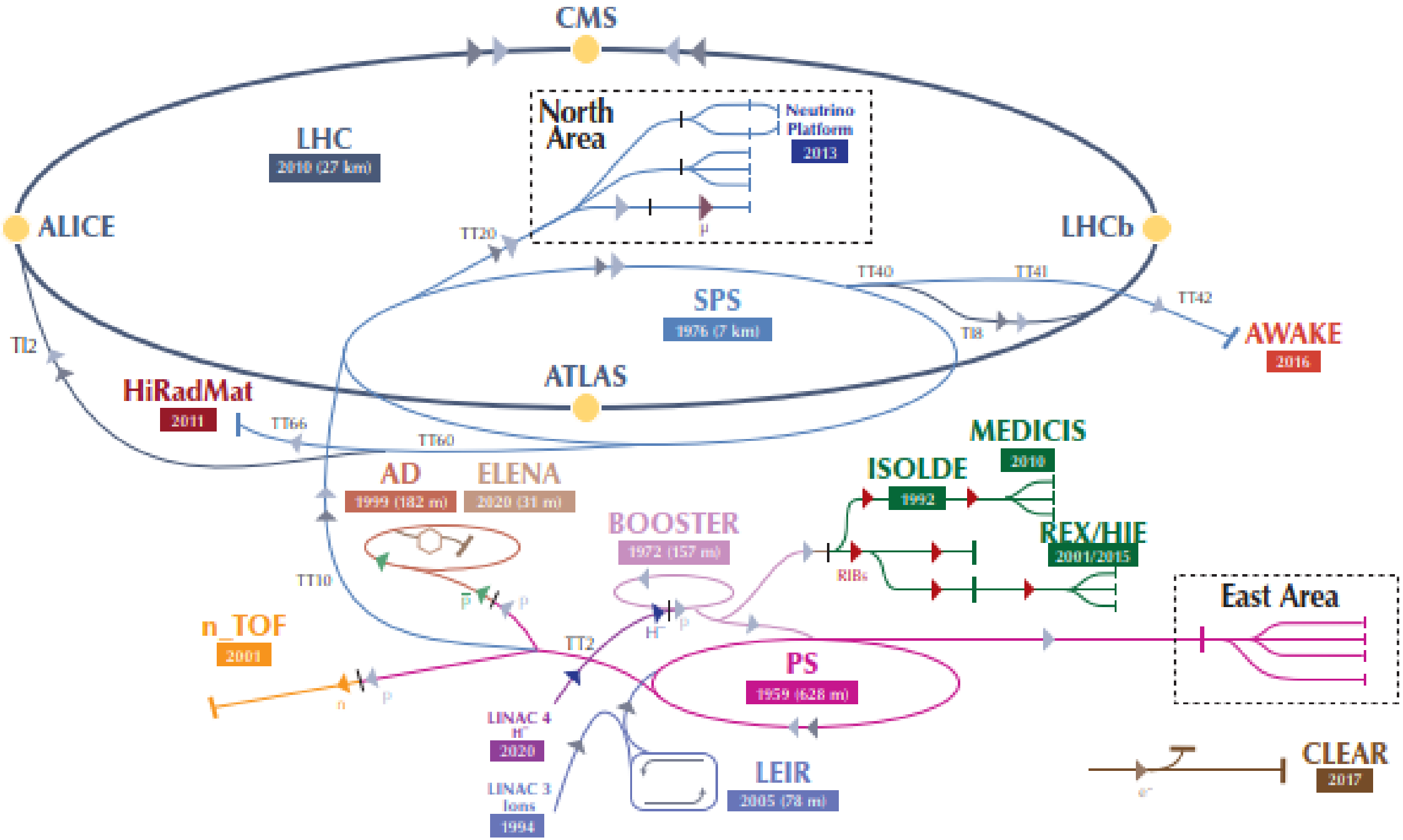
# Ein kurzer Blick in die Beschleunigerphysik

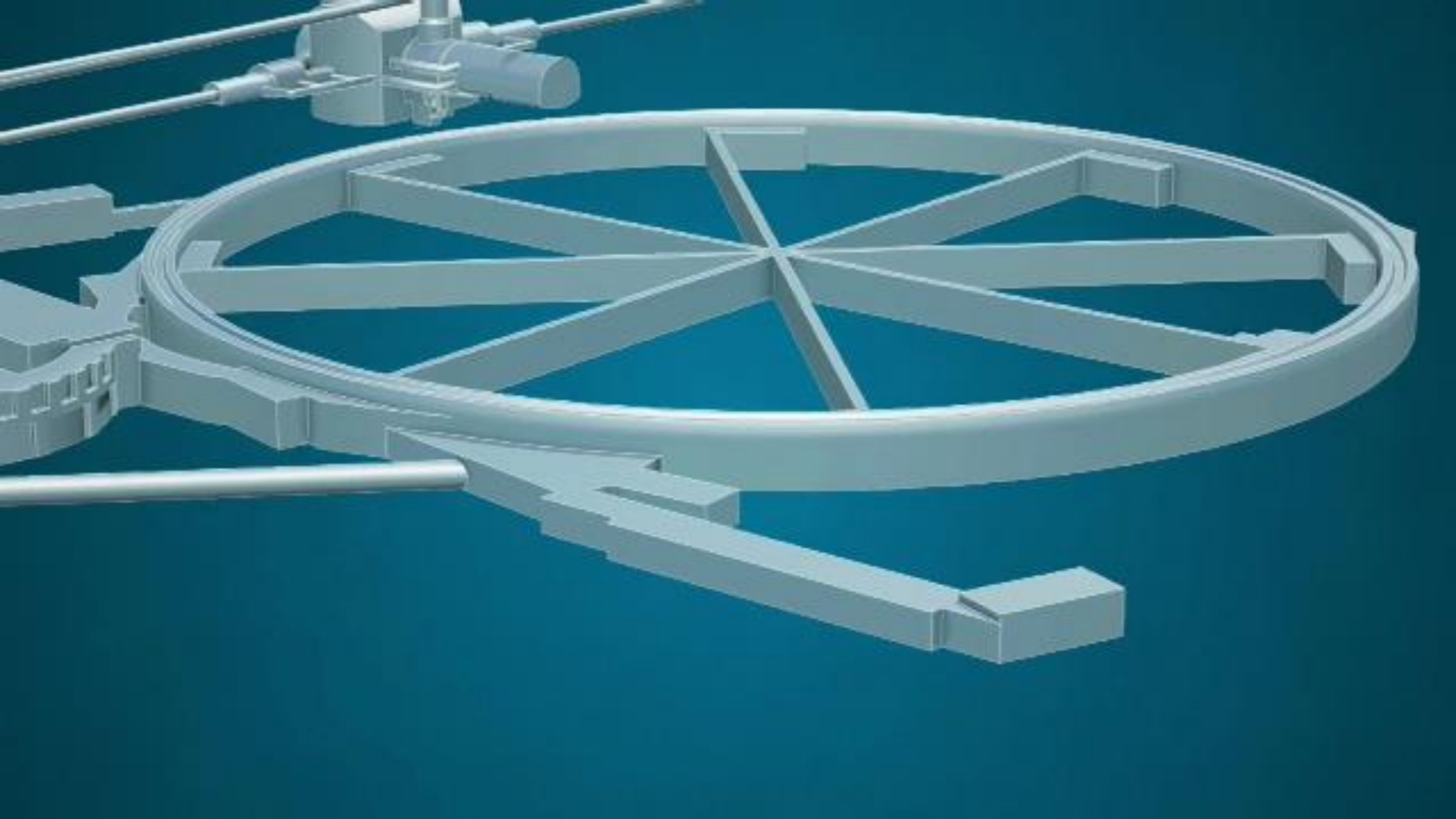
## Beschleuniger am CERN

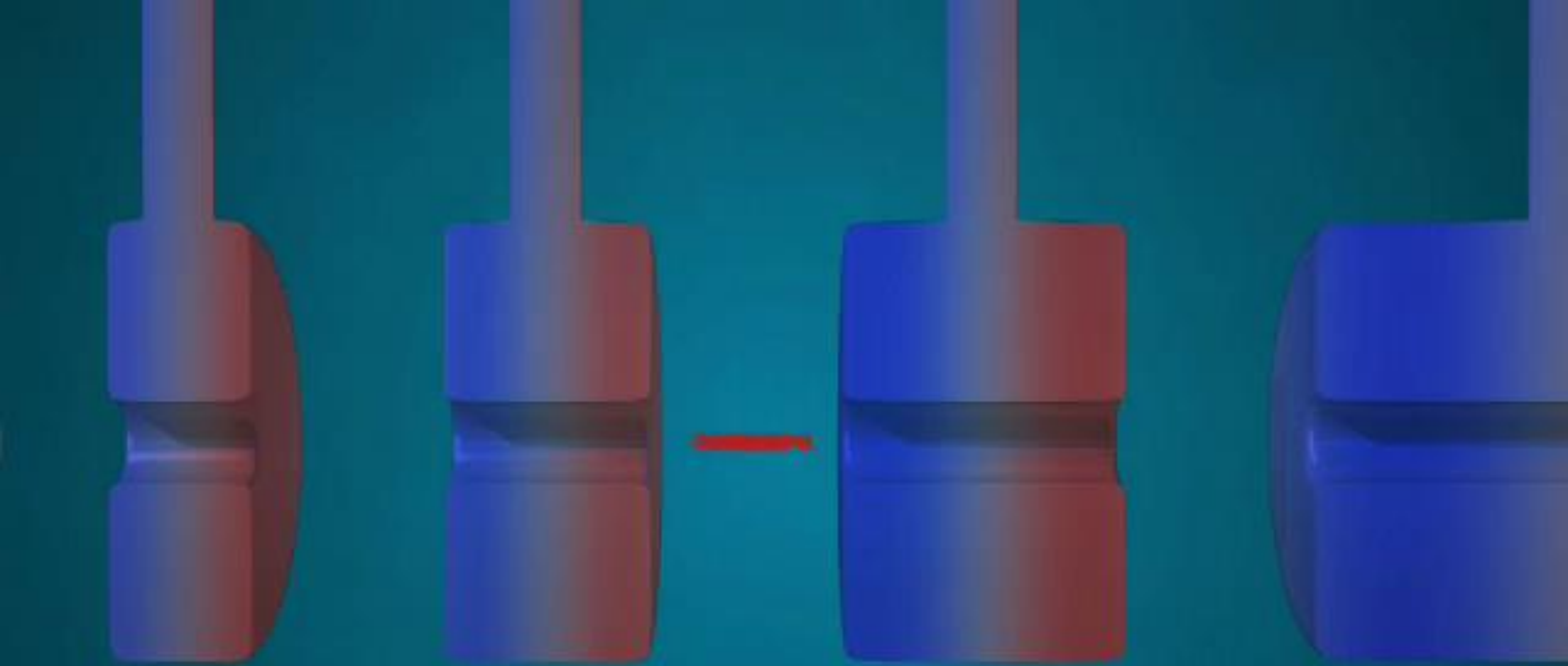
Dr. Sascha Marc Schmeling

# Überblick


CMS
LHC
2010 (27 km)
North Area
Neutrino Platform
2013
ALICE
LHCb
TT20
SPS
1976 (7 km)
TT40
TT41
TT42
TT8
AWAKE
2016
TI2
HiRadMat
2011
TT66
TT60
ATLAS
MEDICIS
2018
ISOLDE
1992
AD
1999 (182 m)
ELENA
2020 (31 m)
BOOSTER
1972 (157 m)
REX/HIE
2001/2015
RIBs
TT10
East Area
n_TOF
2001
TT2
PS
1959 (628 m)
LINAC 4
2020
LINAC 3
Ions
1994
LEIR
2005 (78 m)
CLEAR
2017

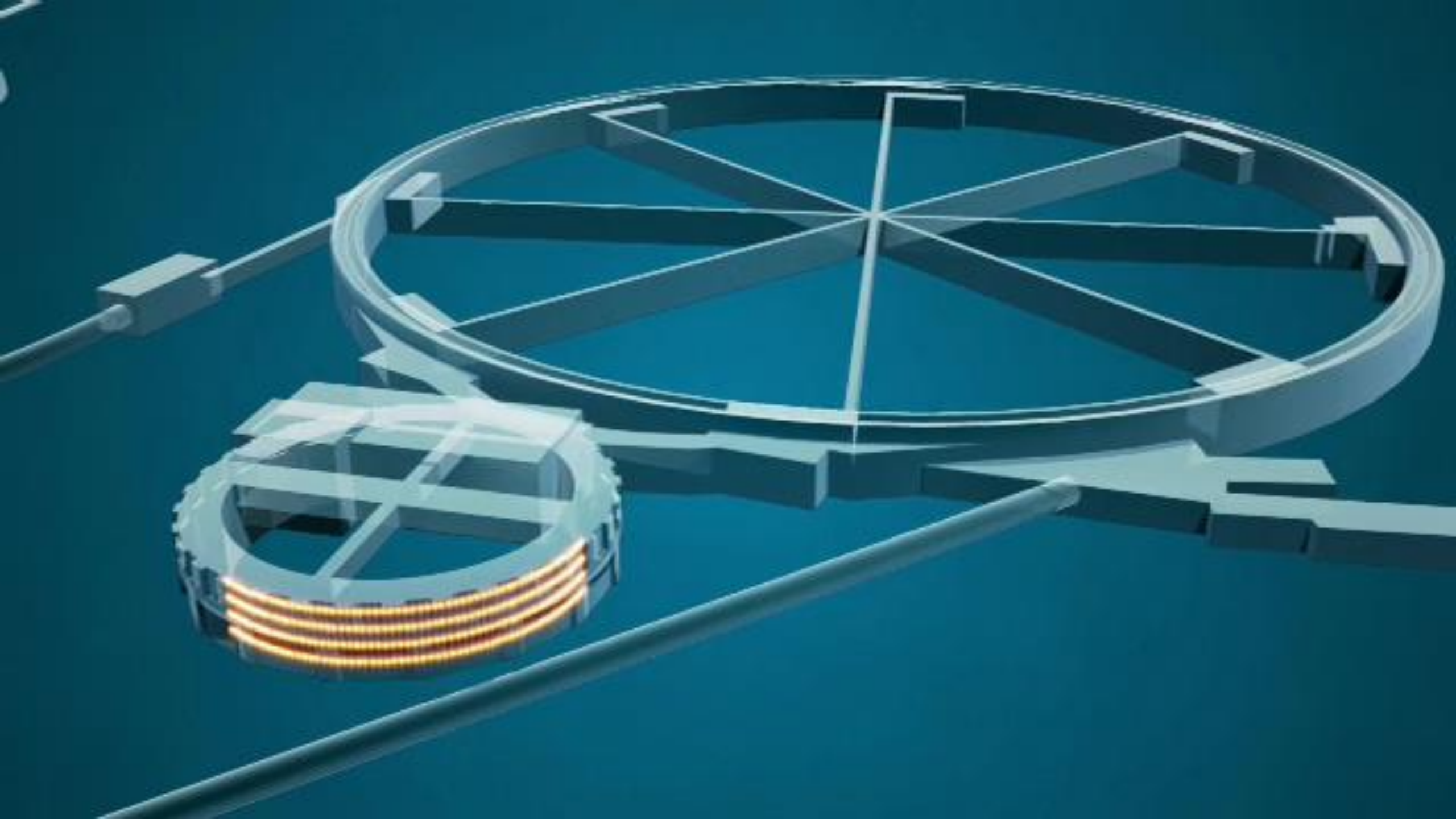

CERN
LHC
[ Large Hadron Collider ]

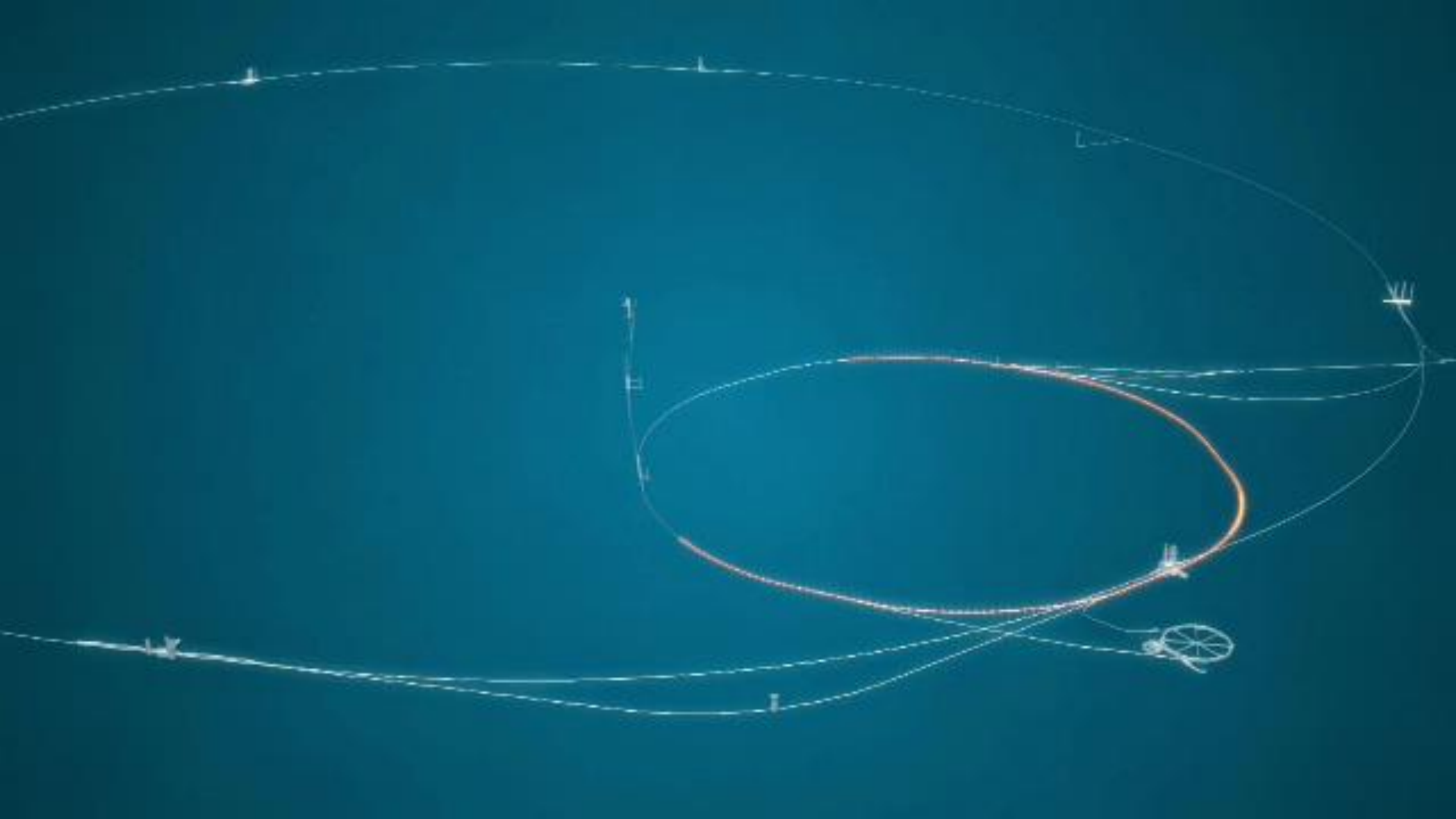


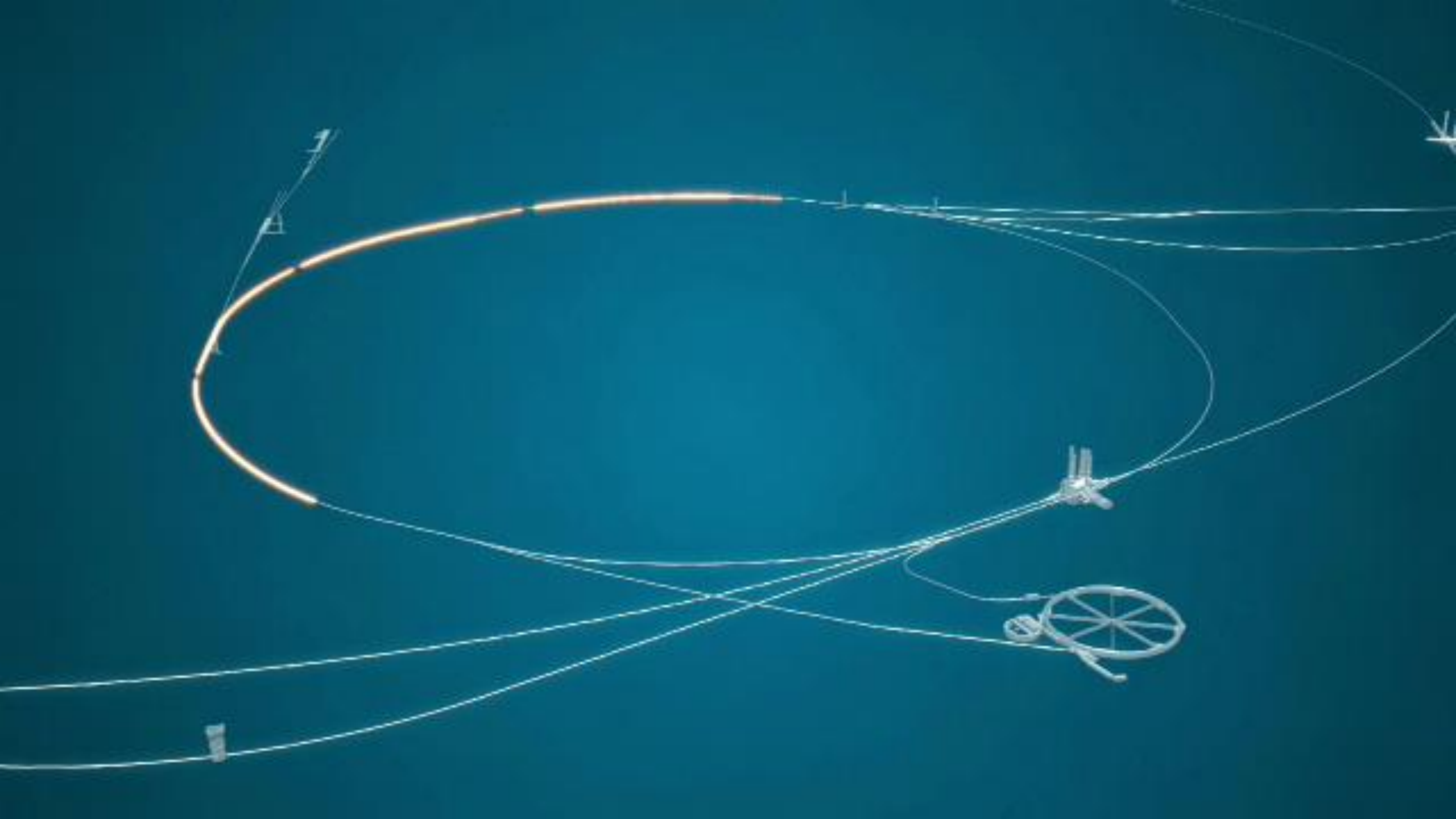


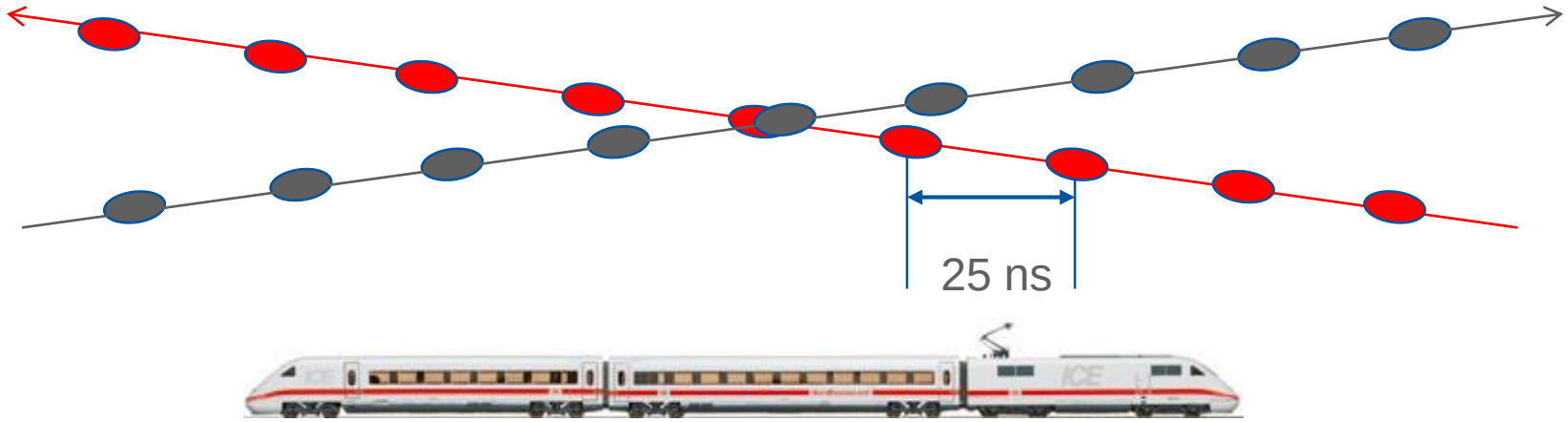
# Wire-scanner for beam diagnostics

## Fil volant pour diagnostic de faisceau







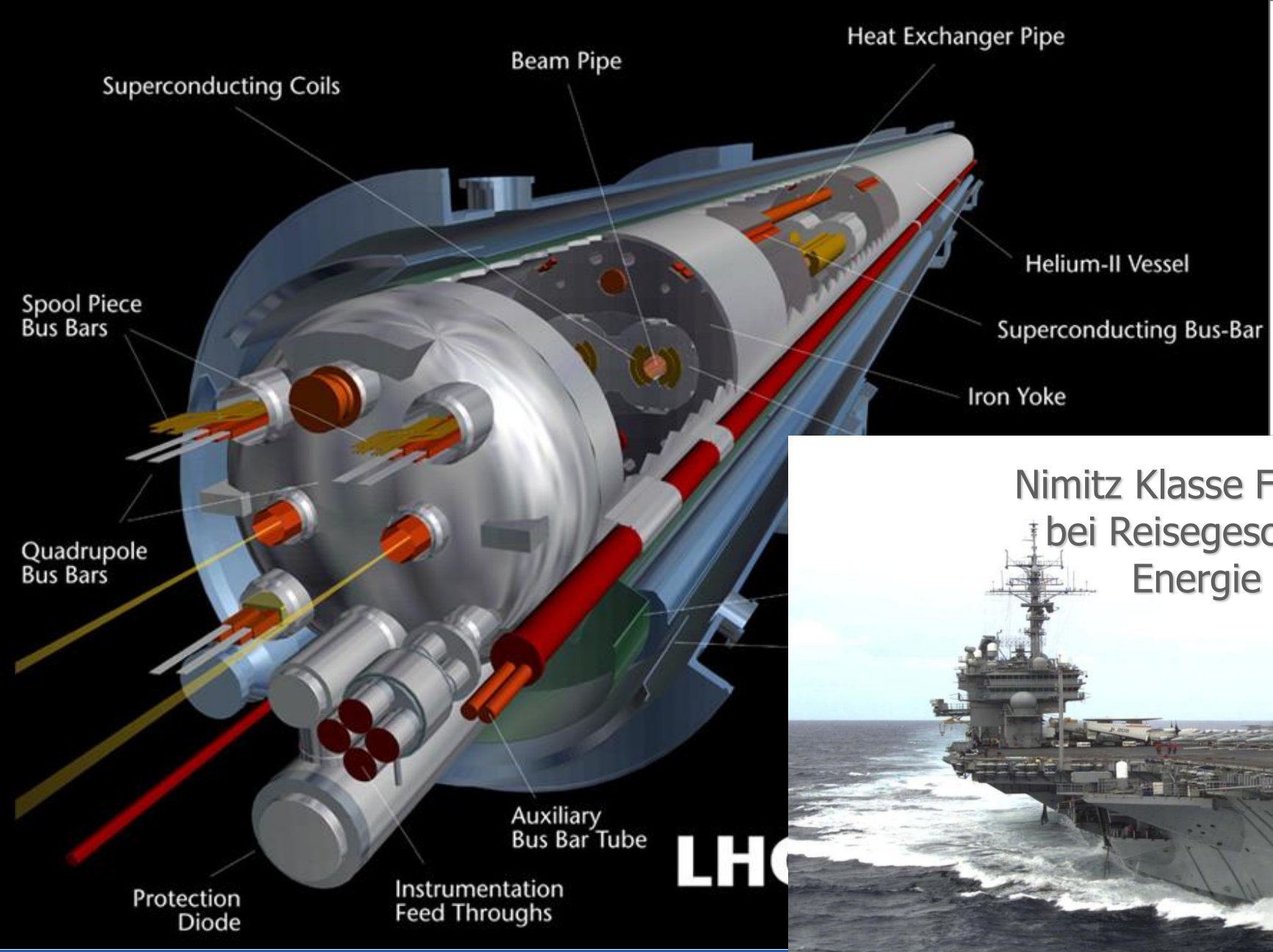



Strahlenergie = Protonenenergie • Anzahl der Protonen pro Wolke • Anzahl der Wolken

| | |
|---|---|
| Protonenenergie: | 7 TeV |
| **bei höchster Intensität:** | |
| Anzahl der Protonen je Wolke: | $1.05 \bullet 10^{11}$ |
| Anzahl der Wolken pro Richtung: | 2808 |

**Strahlenergie (pro Richtung): 346 MegaJoule**

# LHC – Strahlenergie




$$E_{Dipol} = 0.5 \bullet L_{Dipol} \bullet I^2_{Dipol}$$

gespeicherte Energie
in einem Dipol: 7.6 MJ

**Gesamt für alle 1232 Dipole im LHC: 9.4 GJ**

Nimitz Klasse Flugzeugträger (90000 t)
bei Reisegeschwindigkeit von 20 kn
Energie = ½ $mv^2$ ~ 10GJ

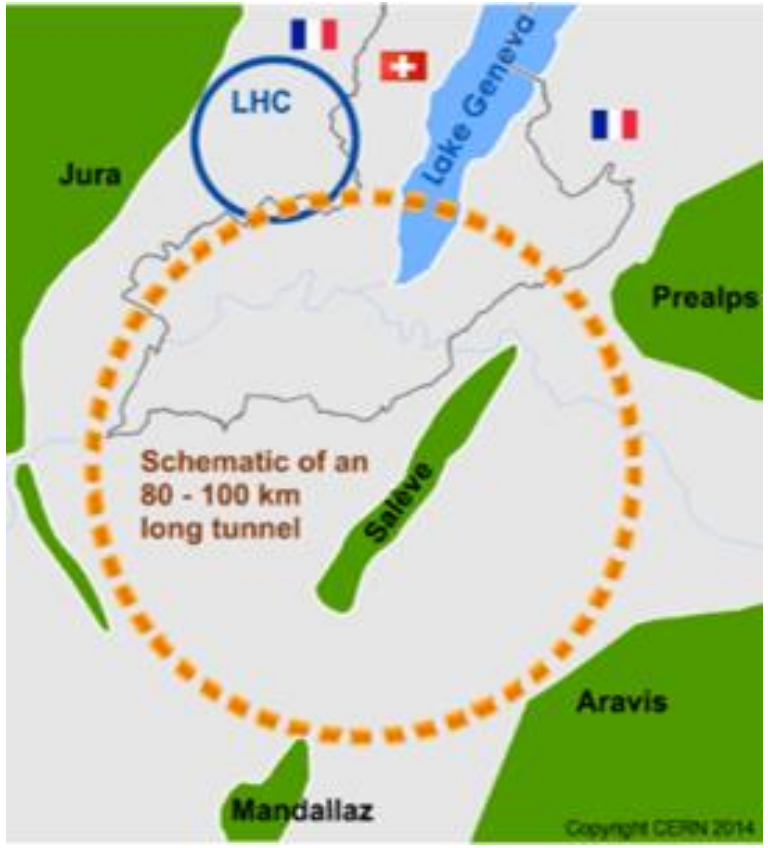
# LHC Dipol

Zukünftige Beschleuniger

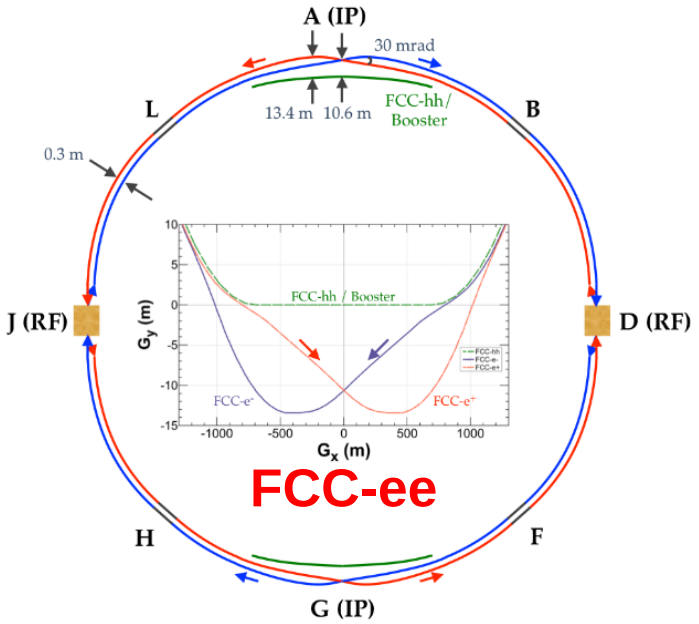
# Ideen, Studien und Konzepte

# The FCC Integrated Programme
# Inspired by successful LEP – LHC Programmes at CERN

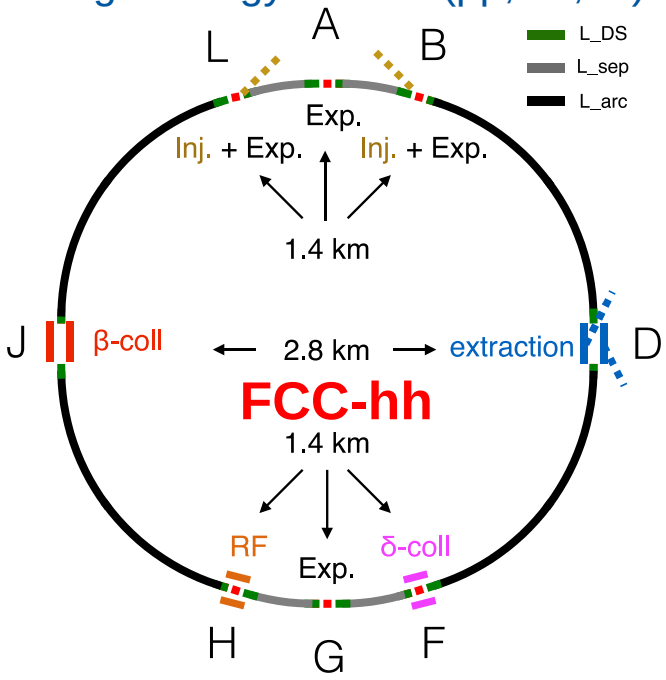
Complementary physics, common civil engineering and technical infrastructures, building on and reusing CERN's existing infrastructure, FCC integrated project allows seamless continuation of HEP after HL-LHC



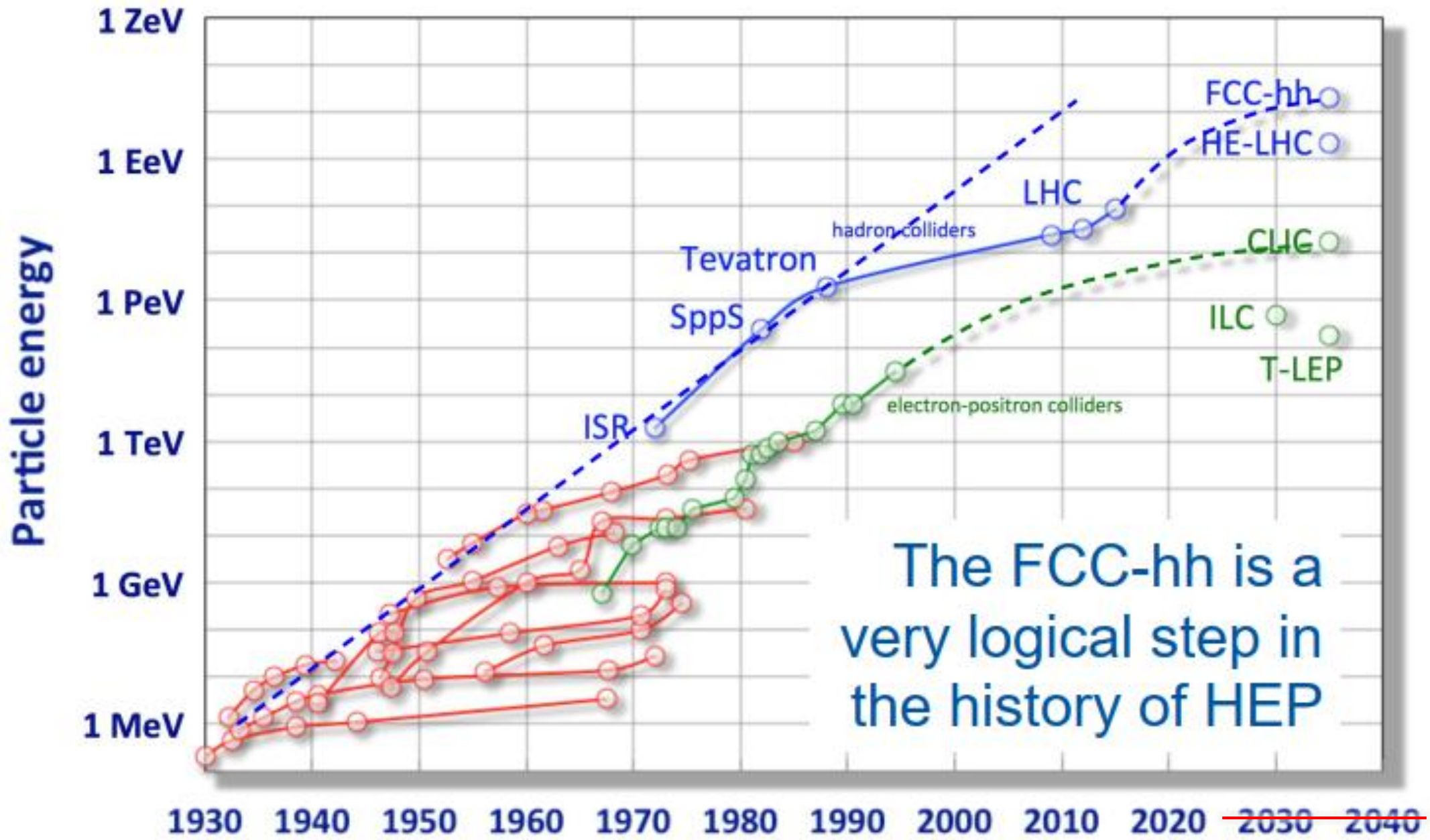

**Phase 1 : FCC-ee**
**electron – positron Collider**
Higgs, Z, W, ttbar Factory at highest lumi




**Phase 2 : FCC-hh**
**proton – proton Collider**
High-energy frontier (pp,ion,eh)



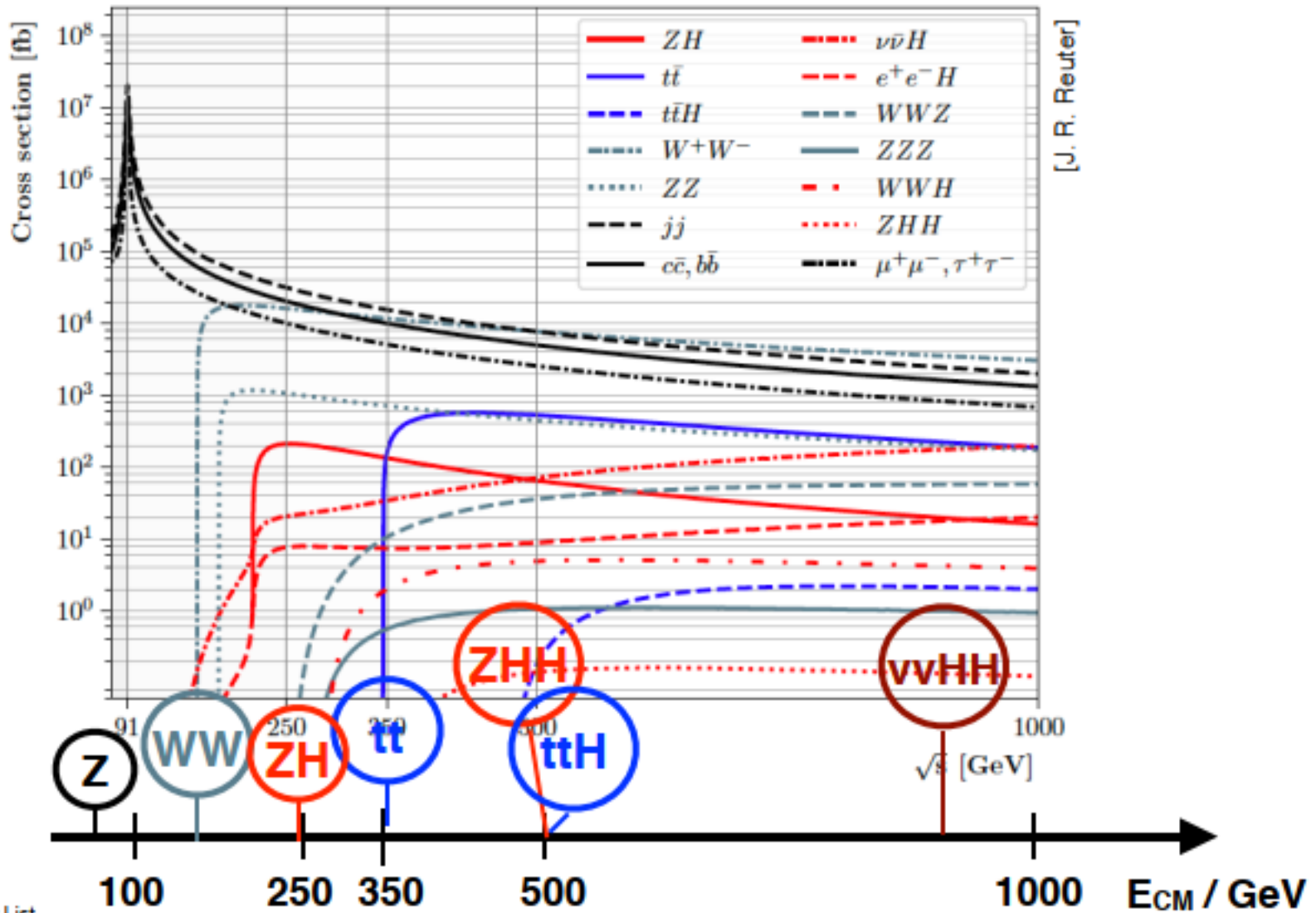

2020 - 2040 | 2040 - 2055 | 2060 - 2090




# Livingston Plot

# Particle production thresholds in e+e- collisions

## Production rates vs collision energy



# There are several proposed Higgs factories

## Each have their advantages


### Circular e+e- Colliders

- FCCee, CEPC
- length 250 GeV: ~100km
- high luminosity & power efficiency at **low energies**
- **multiple interaction regions**
- very clean: little beamstrahlung etc

### Long-term vision: re-use of tunnel for pp collider

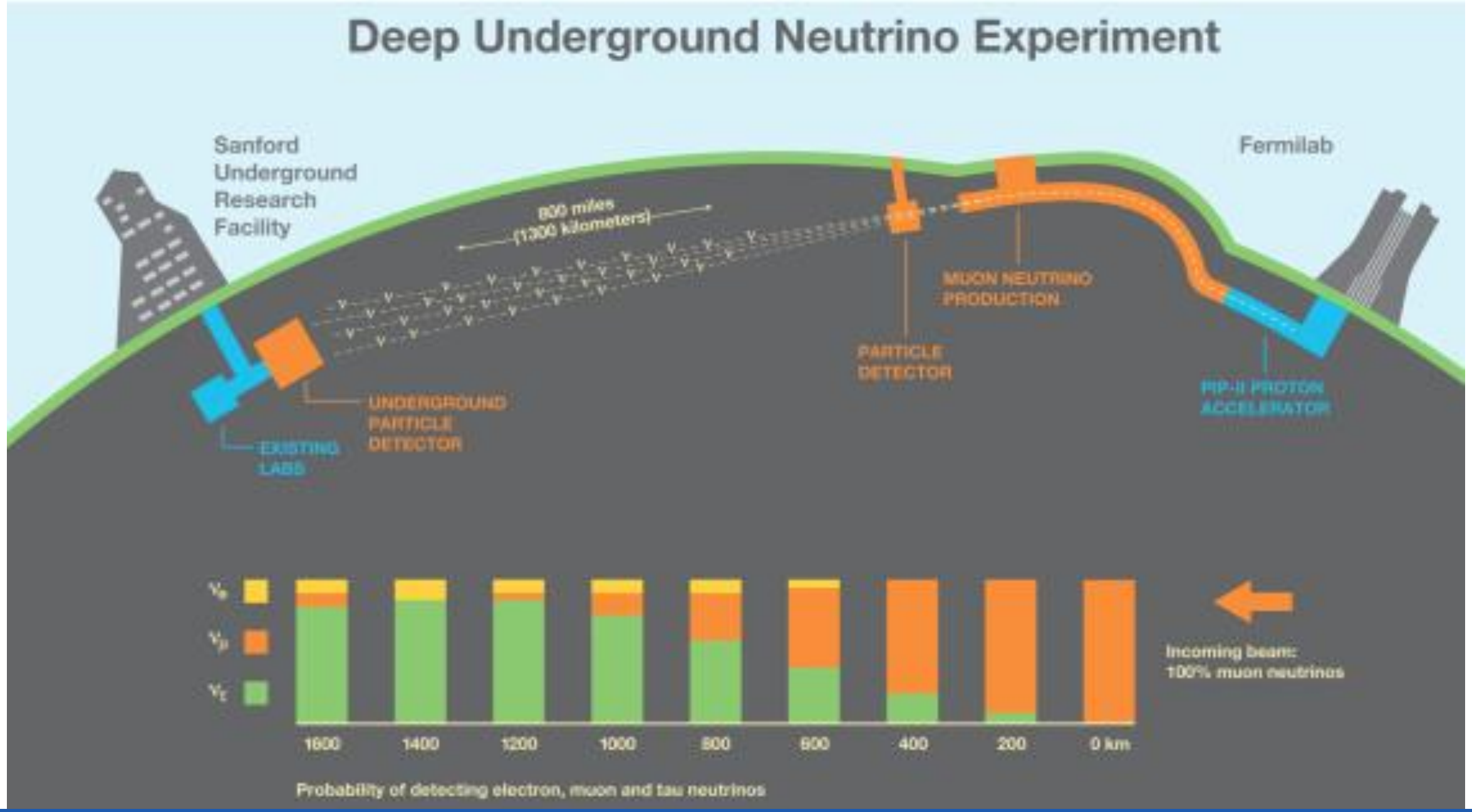
- to measure eg Higgs self-coupling, top Yukawa incl CP properties, search for new particles
- **to explore uncharted territory at highest energies**
- **driving HTSC magnet R&D**

### Linear Colliders

- ILC, CLIC
- length 250 GeV: ~10…20 km
- high luminosity & power efficiency at **high energies**
- **spin-polarised beam(s)**

### Long-term vision: energy extendability

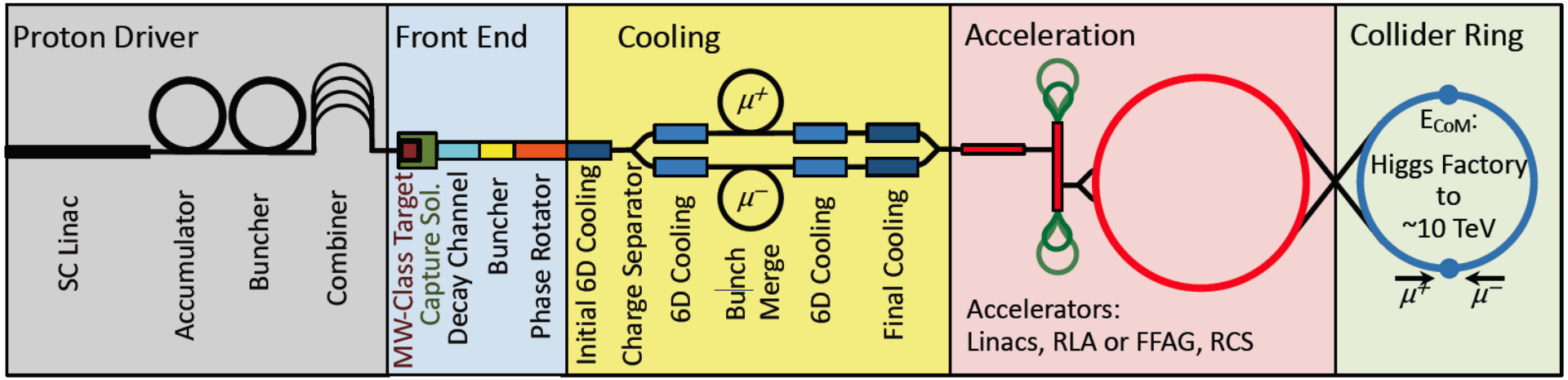
- to measure eg top axial-vector couplings, Higgs self-coupling, top Yukawa incl CP properties, search for new particles
- by increasing length
- **or by replacing accelerating structures with advanced technologies**




# Neutrinophysik

# Proton-driven Muon Collider Concept (MAP)

From the MAP collaboration: Proton-driven source (M. Palmer et al.)




Short, intense proton bunches to produce hadronic showers

Pions decay into muons that can be captured

Muon are captured, bunched and then cooled

Acceleration to collision energy

Collision

No CDR exists, no fully integrated baseline
No cost estimate
Need to extend to higher energies (10+ TeV)
But did not find something that does not work