FELIX

A full acceptance detector at the LHC

- Motivation
- FELIX at the LHC
- Detectors
- Physics with FELIX
- Status and Prospect

FELIX, the ultimate QCD detector...

....for high-energy hadron interaction

Focussed on QCD phenomena which are hard/impossibile to study using the other LHC experiments

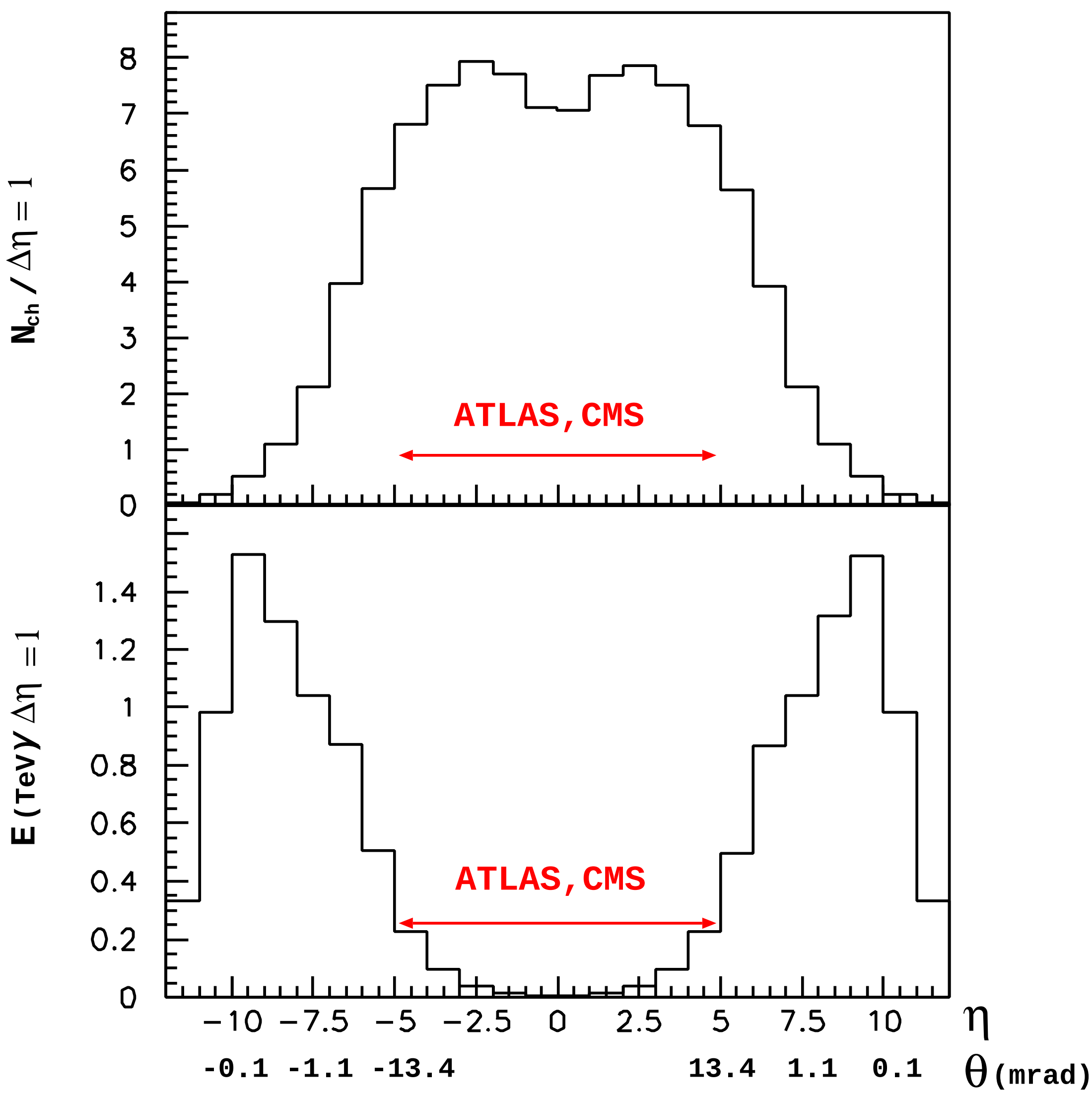
- 4π acceptance, down to zero degree, for charged and neutral particles
- particle identification via decays (K_s, Λ,Δ^+,...)
- electrons and muons
- pp, pA, $\gamma\gamma$ collisions

The FELIX program will lead to a big step forward in understanding high-energy QCD and the hadron structure

Complete studies of forward physics at hadron colliders have never been done:
neither the ISR, nor the SPS, nor the Tevatron have been instrumented with a real full acceptance detector

Particle- and Energy- Flow at the LHC ($\sqrt{s}$=14 TeV)

Inelastic and diffractive events



$$\eta = -\ln \mathrm{tg}\Theta/2 \qquad y = \tanh^{-1} p_L/E$$

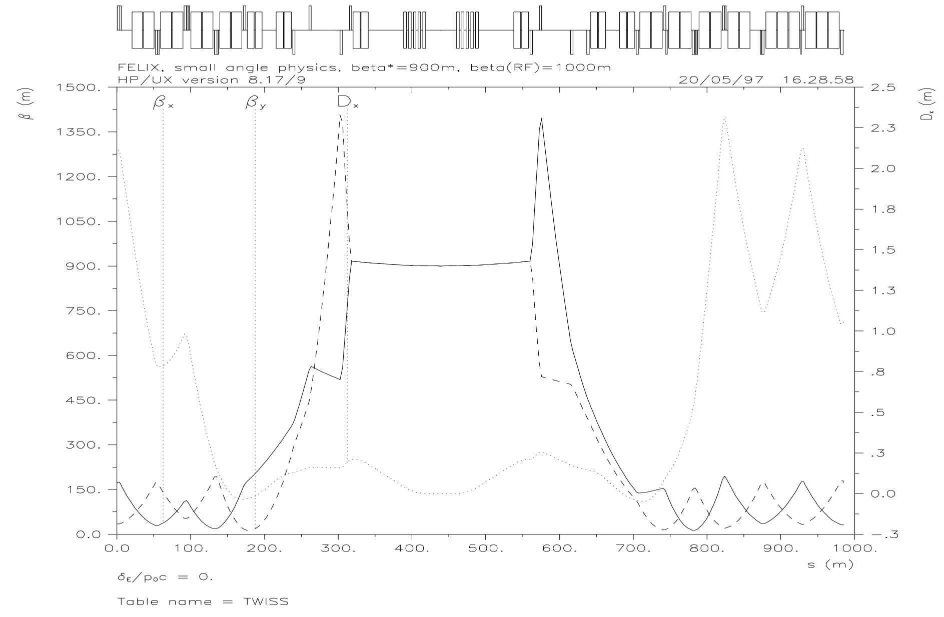
$$E = m_\perp \cosh y \sim \frac{m_\perp}{2} e^y \ \text{ for } \ y \gg 1 \qquad m_\perp^2 = p_t^2 + m^2$$

Fraction of total energy flow seen by:

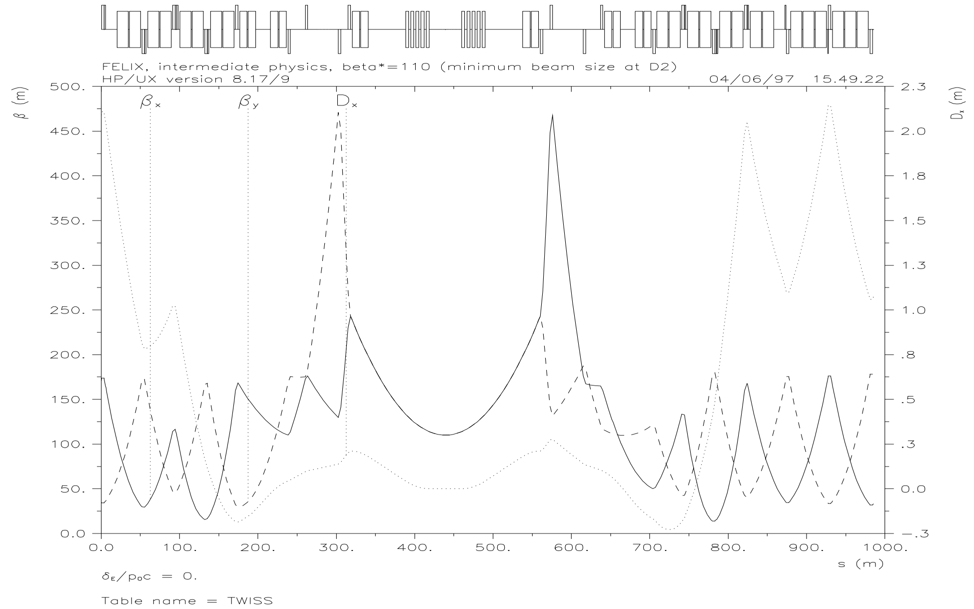
- ATLAS, CMS $\sim$ 10%
- FELIX $\sim$ 100%

β function and dispersion

- β^{*}=900 m



- β^{*}=110 m



Luminosity

beam particles	$\sqrt{s}$/nucleon (TeV)	$\sqrt{s}$ (TeV)	$\mathcal{L}$ (cm^{-2} sec^{-1})	β^* (m)	bunchstruct (nsec)	Run time (s/year)
$p\,p$	14	14	10^{29}	900	25	10^7
			10^{29-30}	110, 900	25	
			10^{31-32}	23, 110	25	
$Pb\,Pb$	5.5	1148	10^{26}	23	25, 125	10^6
$Ca\,Ca$	7	280	$4 \cdot 10^{30}$	23	25	10^5-10^6
$p\,Pb$	8.8	126	10^{30}	23	25, 125	10^5
$p\,Ca$	9.9	88	10^{31}	23	25	10^5

- LHC starts in 2005 :

  $\mathcal{L} = 10^{30} - 10^{33}$ cm^{-2} sec^{-1}

  $I = \frac{1}{10} I_0$, $\varepsilon = \frac{1}{4}\varepsilon_0$

- β^*=900 m

  elastic scattering, σ_{tot}, min. bias

  $\mathcal{L} = 10^{27} - 10^{30}$ cm^{-2}sec^{-1}

- β^*=110 m, 23 m

  full program of FELIX

  $\mathcal{L} = 10^{31} - 10^{32}$ cm^{-2} sec^{-1}

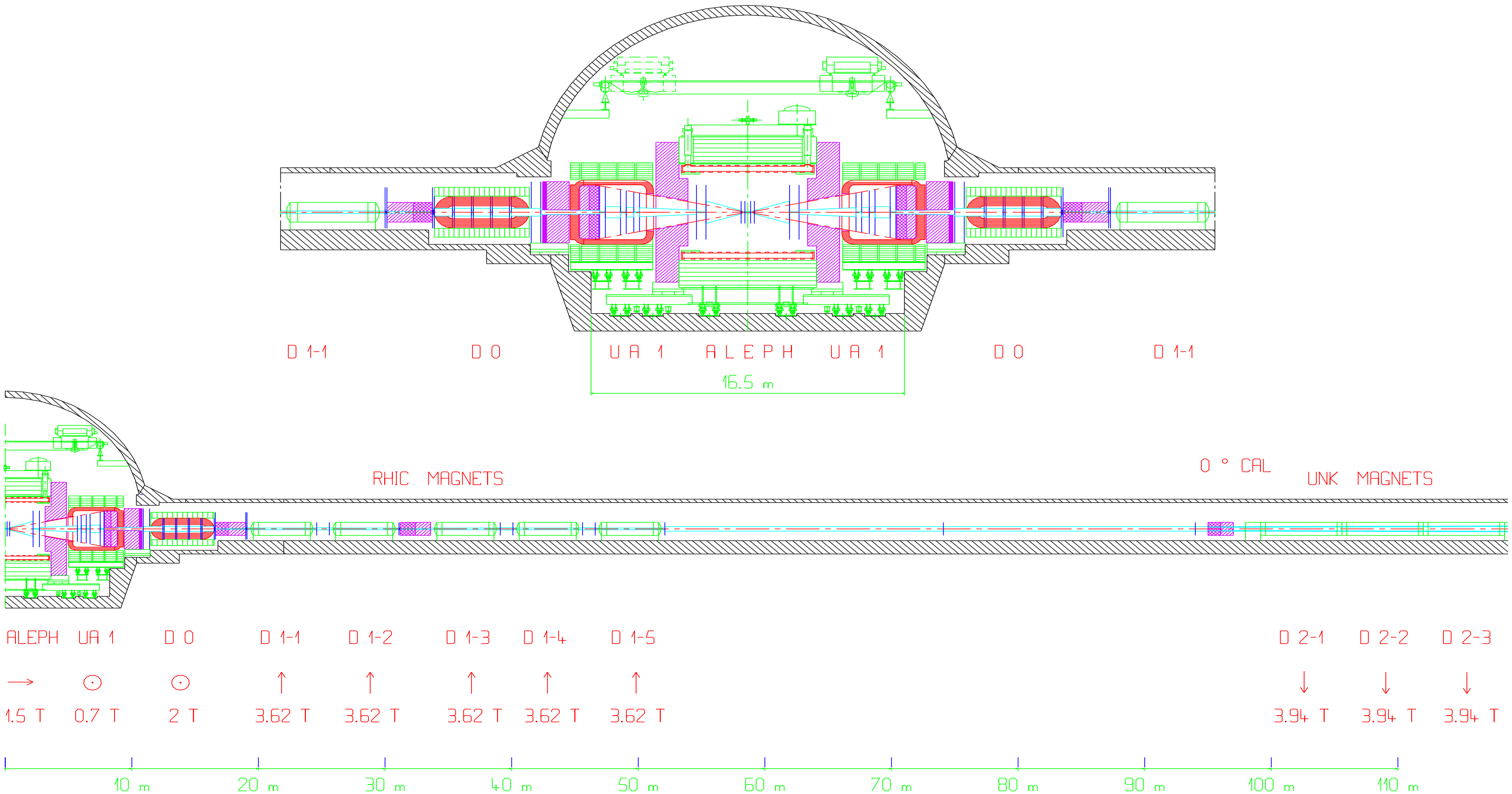
Basic Design Idea

- Full acceptance in phase space on both arms
- Diffractive proton measurements on both sides
- Measurements of elastically scattered protons
- The magnetic architecture of the experiment should be integrated into the design of the LHC machine lattice
- Multiple magnet spectrometer with overlapping acceptances. Define tracks in the previous magnet and improve their momentum resolution in the following one. High momentum forward charged particles are bent out of the beam and their momenta are measured with detectors close to the beams

Basic Design Idea

- Measurements of photons reasonably uniform over the complete phase space
- Full calorimetry (with gamma detection) requires coordinated interplay with tracking and zero degree calorimeter between the beams
- Muon identification in the forward arms
- Cost minimization by the use of existing magnets (ALEPH solenoid and UA1 magnet) and exploitation of stageability
- Optimal use of Intersection Region IP4, including caverns and infrastructure at minimal cost.

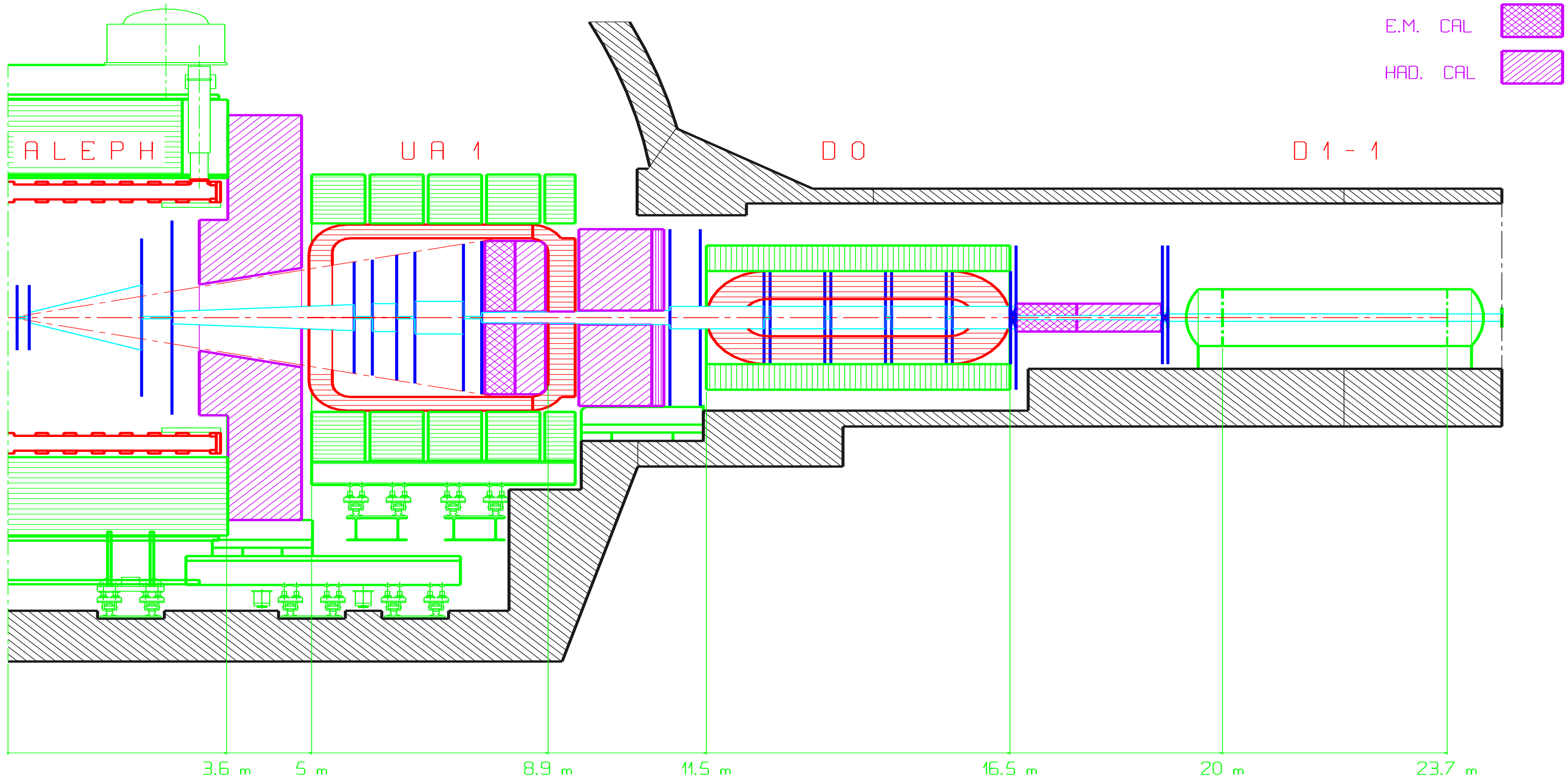
FELIX, CENTRAL & FORWARD



FELIX

A full acceptance detector at the LHC

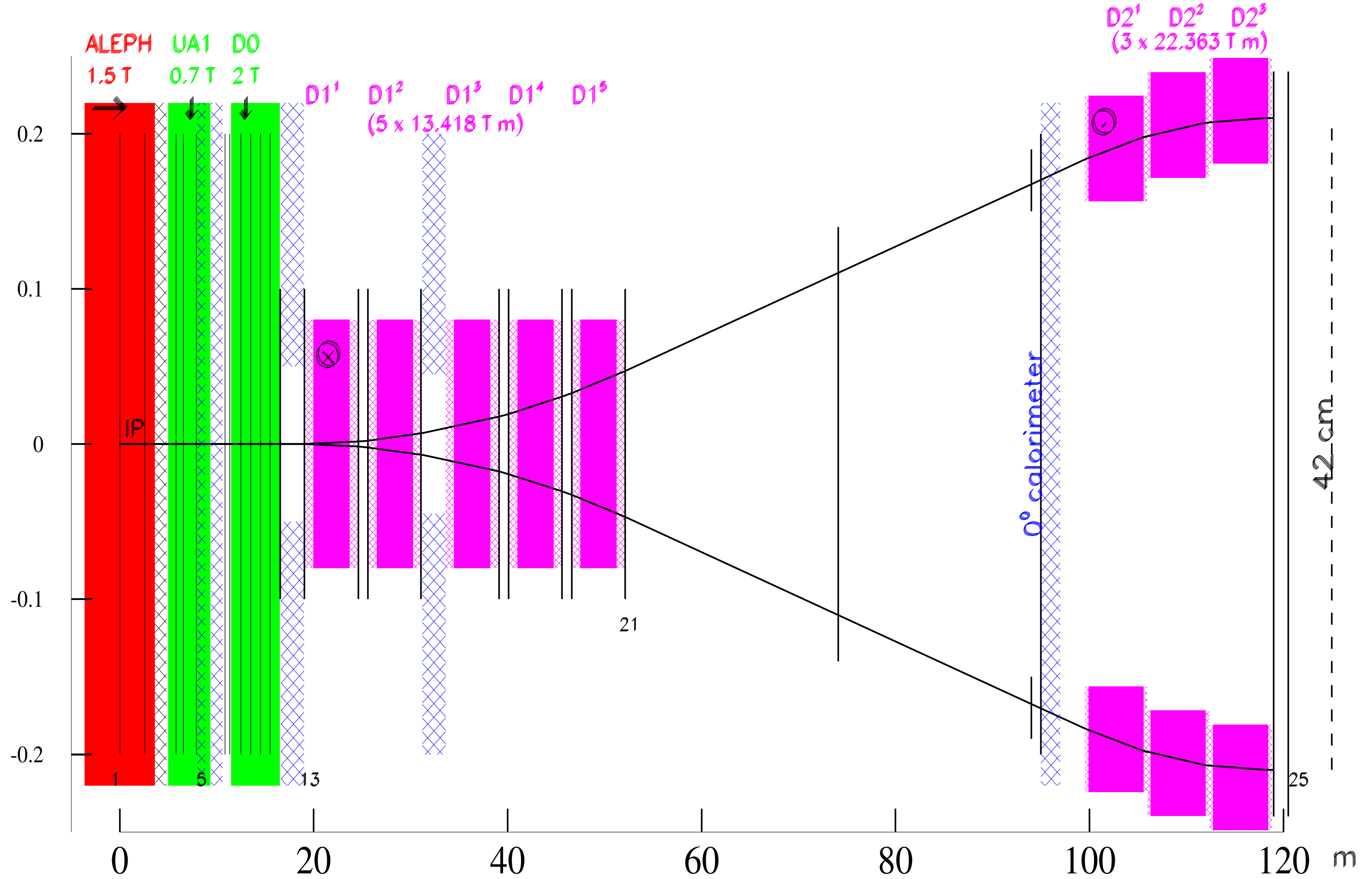
FELIX FORWARD



FELIX

A full acceptance detector at the LHC

FELIX set-up



ALEPH
1.5 T
UA1
0.7 T
D0
2 T
D1¹ D1² D1³ D1⁴ D1⁵
(5 x 13.418 T m)
D2¹ D2² D2³
(3 x 22.363 T m)
IP
0° calorimeter
42 cm
0.2
0.1
0
-0.1
-0.2
1
5
13
21
25
0
20
40
60
80
100
120
m

Tracking close to the beams

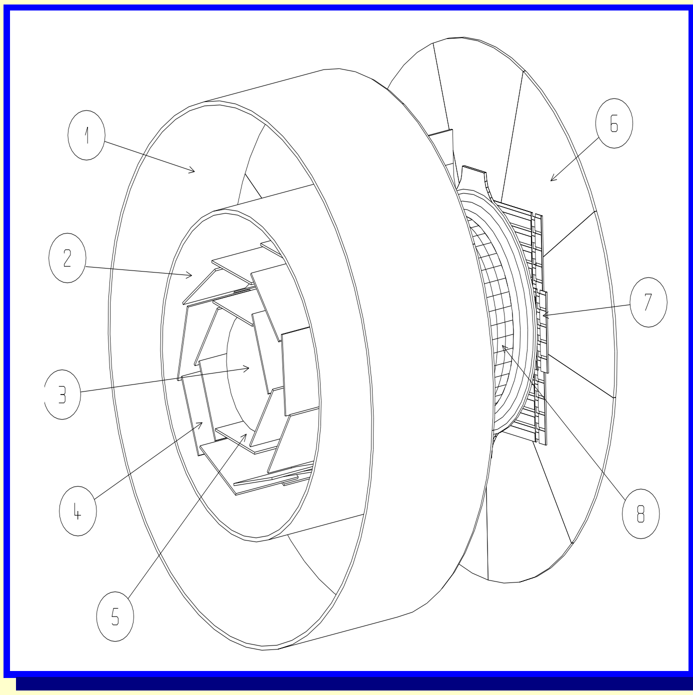
- microvertex detectors covers η= 0 - 2
- fixed detectors in ALEPH, UA1 and D0 magnets, approaching the beams to r=2 cm
- detectors in Roman pots, approaching the beam to the 10σ envelope

Tracking technologies used:

- pixel detectors close to the beam (50μm x 300μm)
- Si strip detectors in Roman pots
- Gas Electron Multiplier (GEM) chambers
- micro-time projection chamber (TPC)
- scintillating fibres detectors

Microvertex detector

- two barrels of Si pixel detectors (r=4.9, 7.9 cm)
- two barrels of GEM chambers (r=12.2, 20 cm)
- standard tracking station (z=15-30 cm) with two Si-planes and a μTPC



1) cylindrical GEM chamber r=20 cm
2) cylindrical GEM chamber r=12.2 cm
3) r=4.7 beampipe
4) Si barrel r=7.9 cm
5) Si barrel r=4.9 cm
6) annular GEM chamber z=31.75 cm
7) Si detector plane z=31.5 cm
8) μ TPC.