

Why Are We Here?: Connecting the Micro and Macro

About CERN, Physics, and Innovation

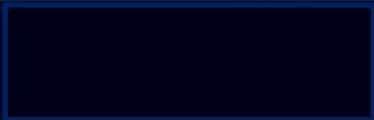
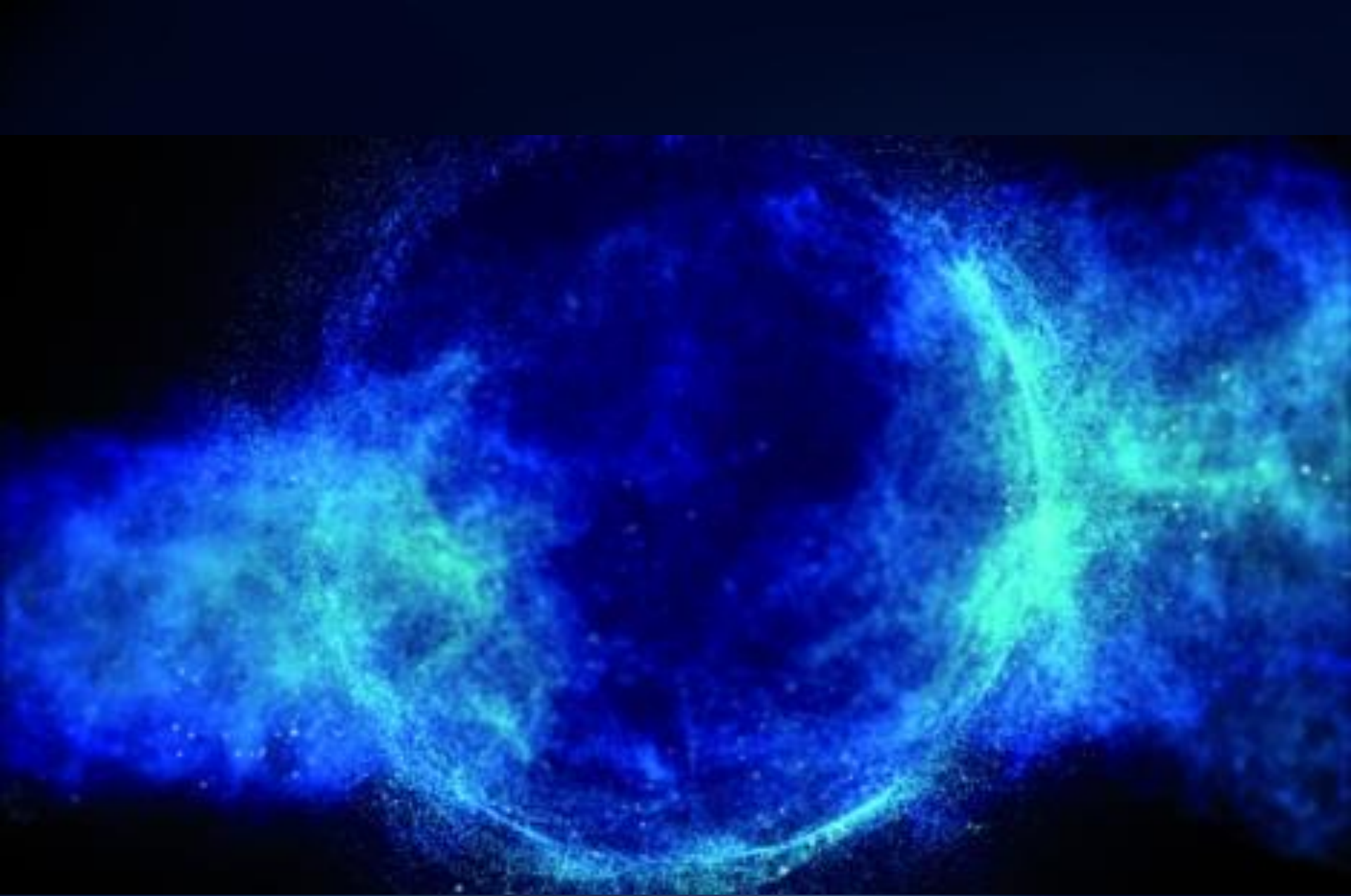
CBI-A3 November 7, 2023

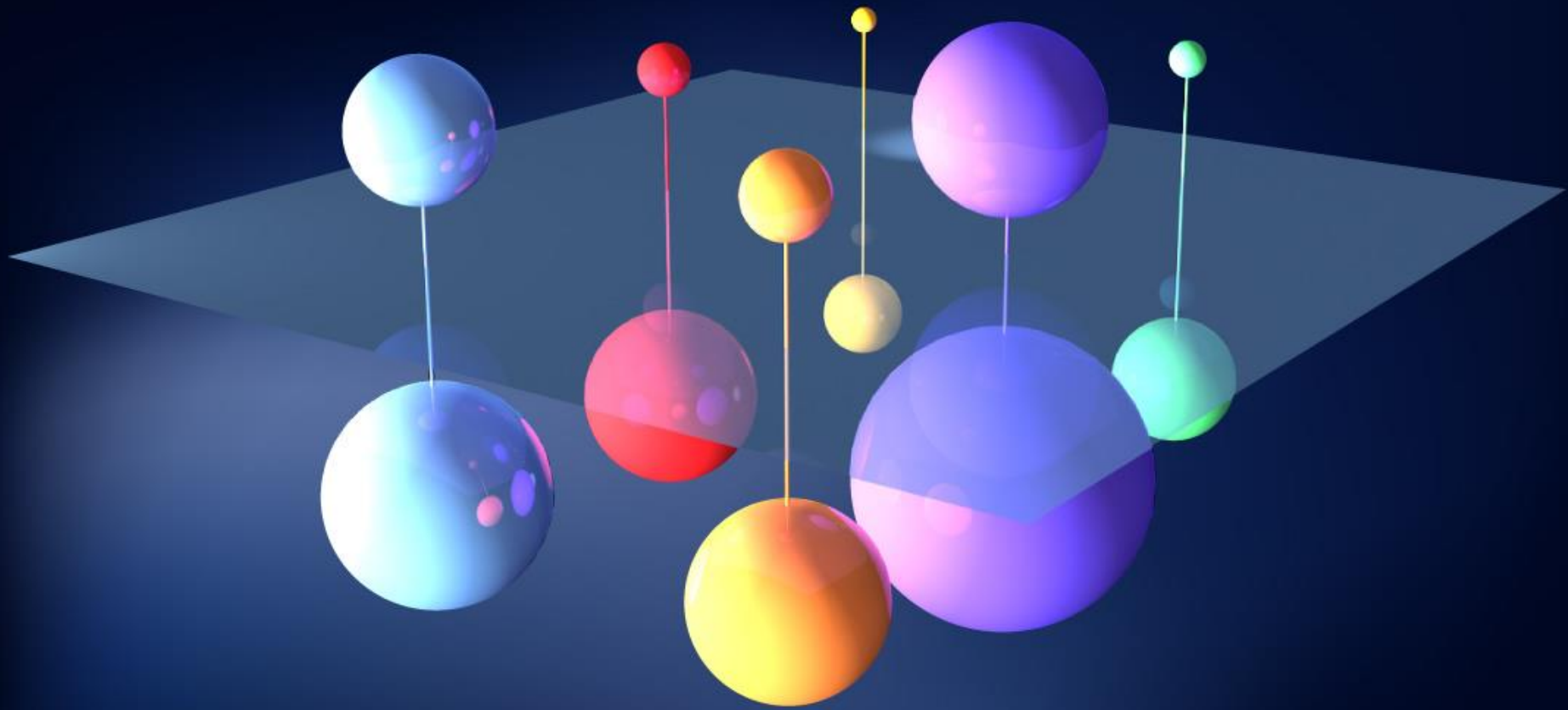
Markus Nordberg (CERN)

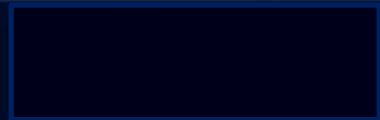


What is Wrong with this Picture?

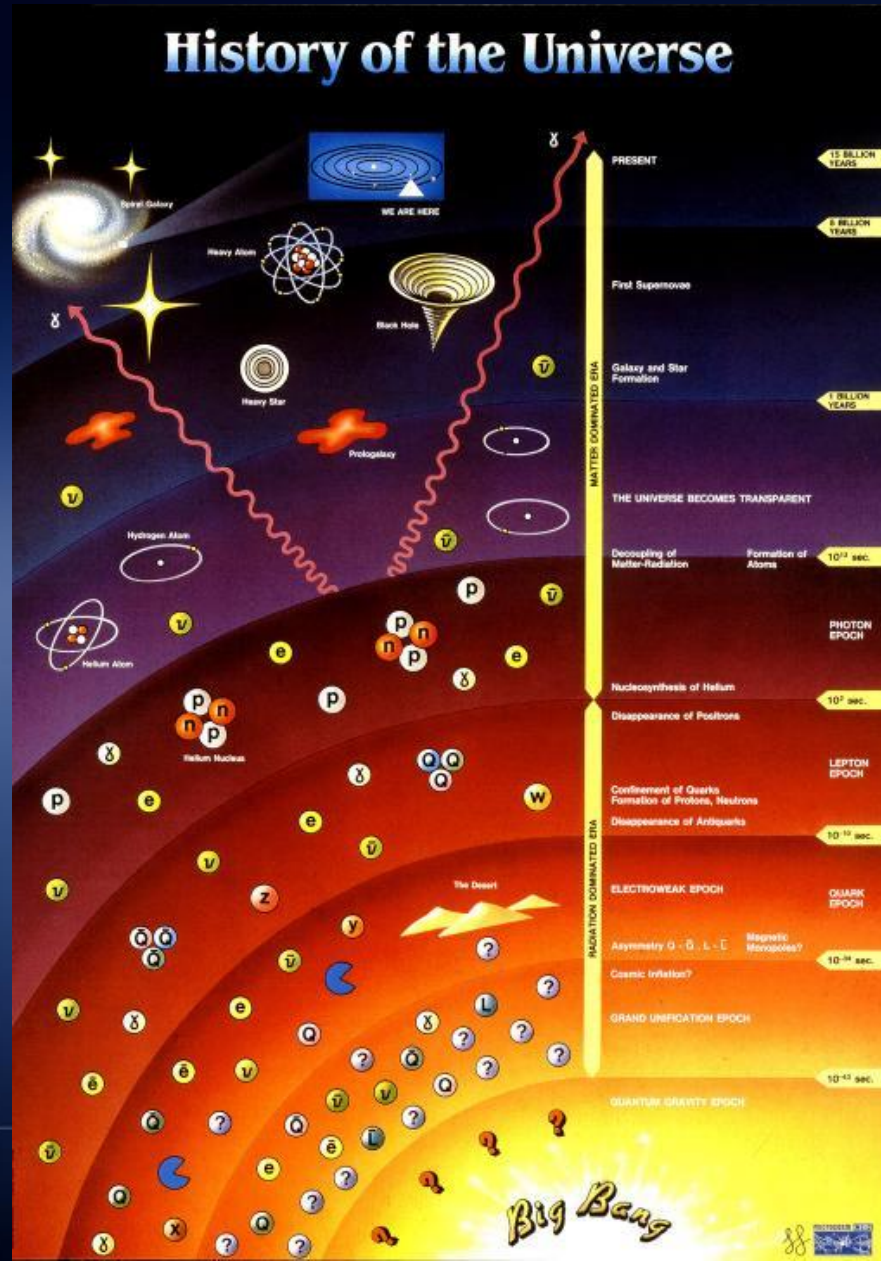






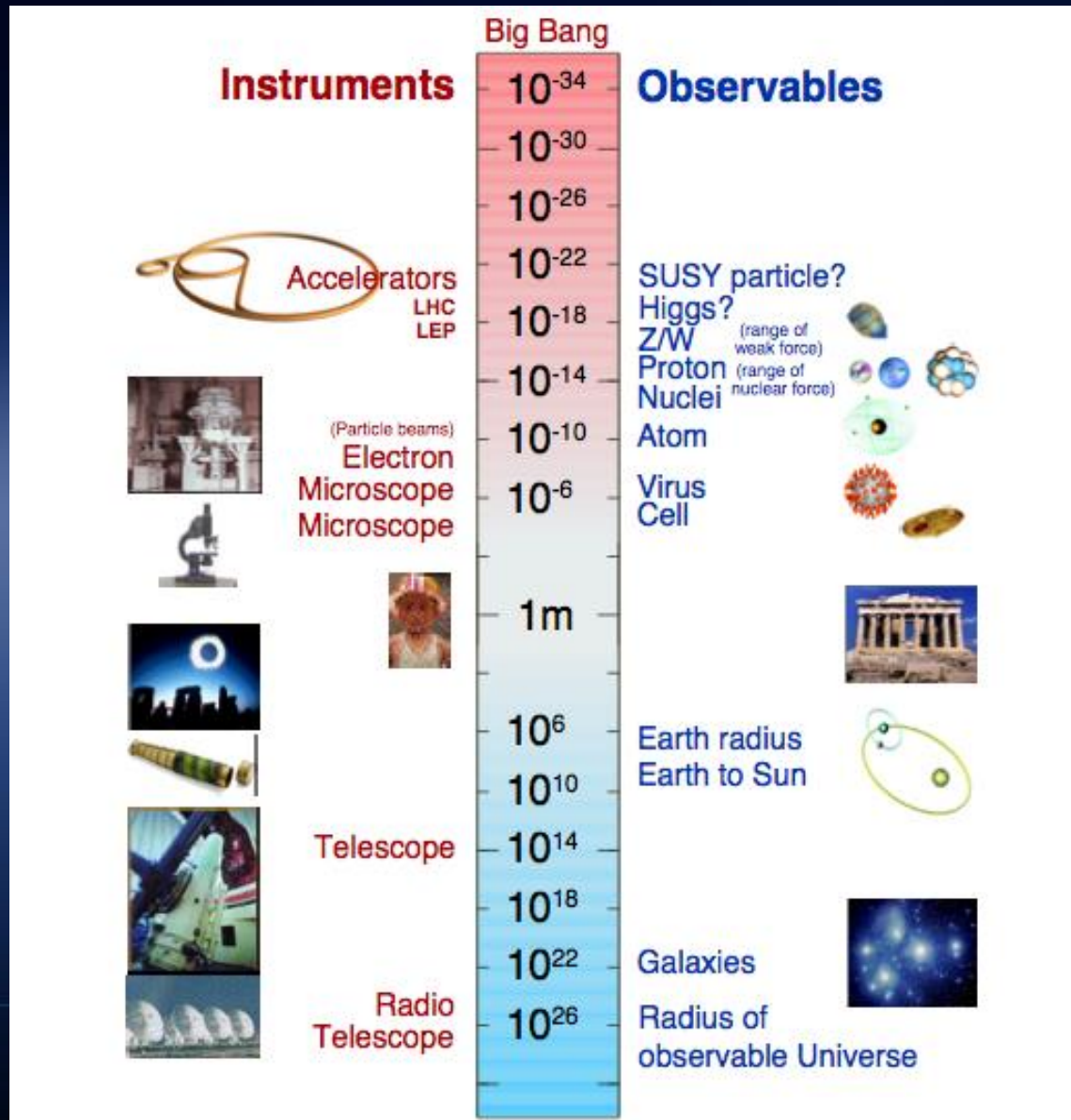


How does CERN Connect?

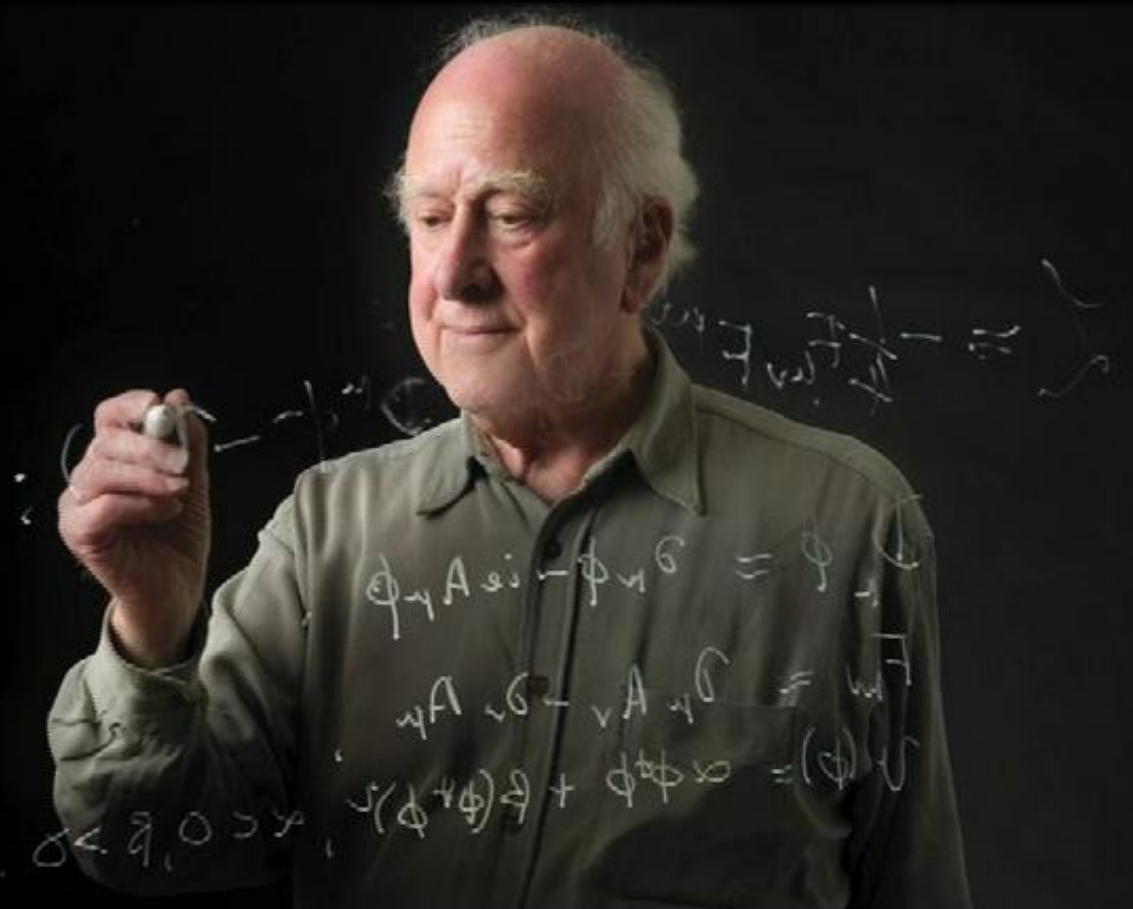


Size of things

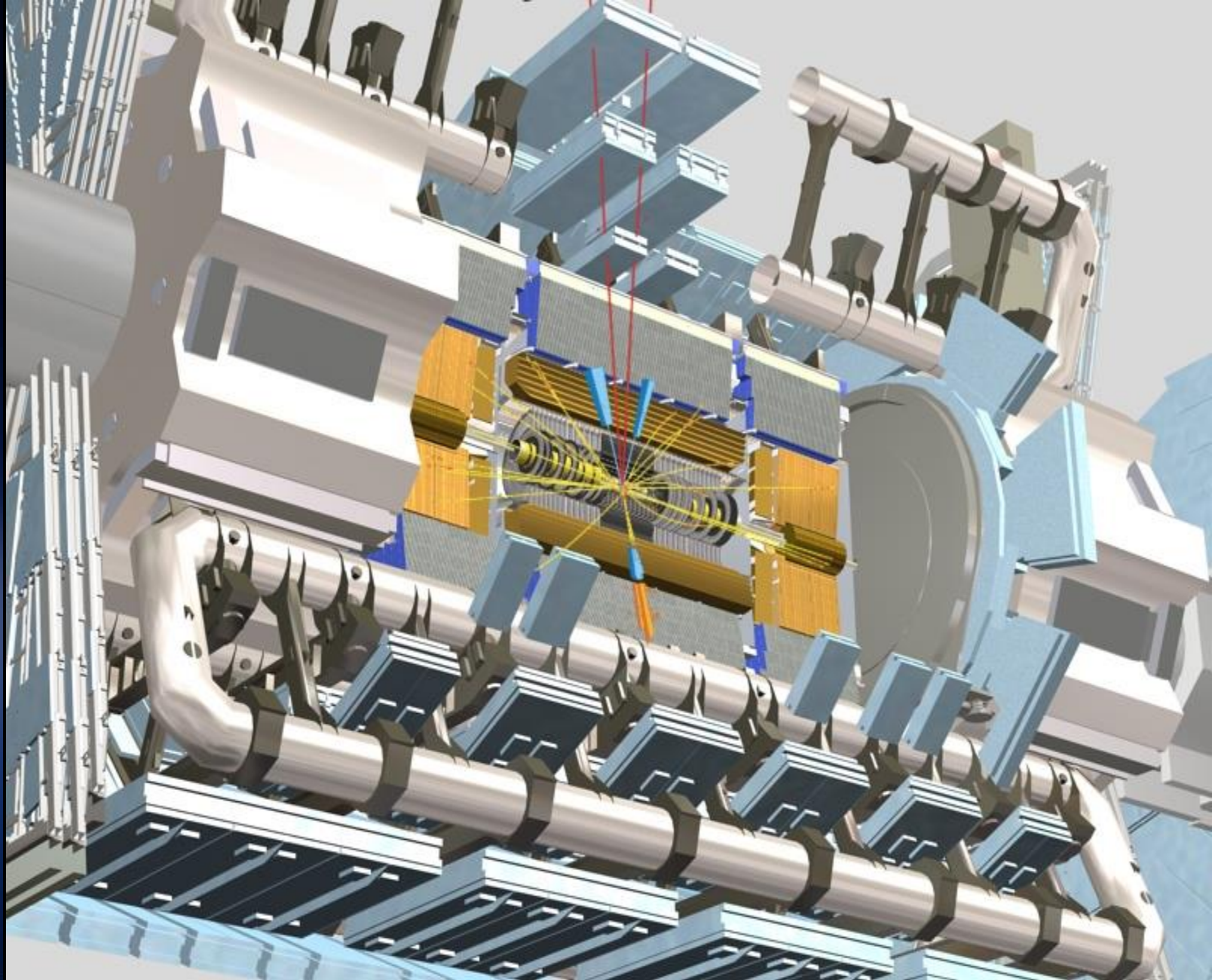
How does CERN Measure?

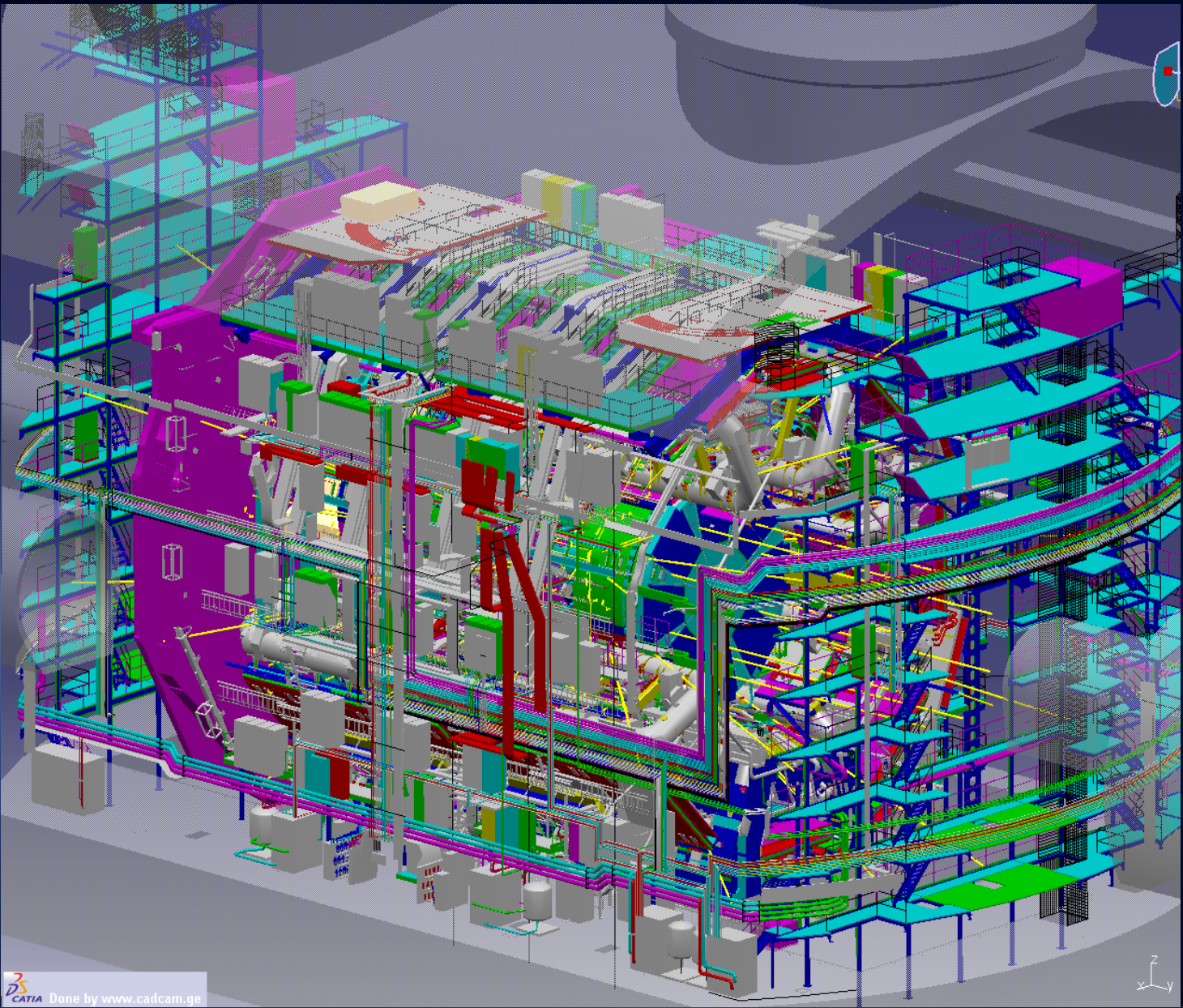


Where do we start?



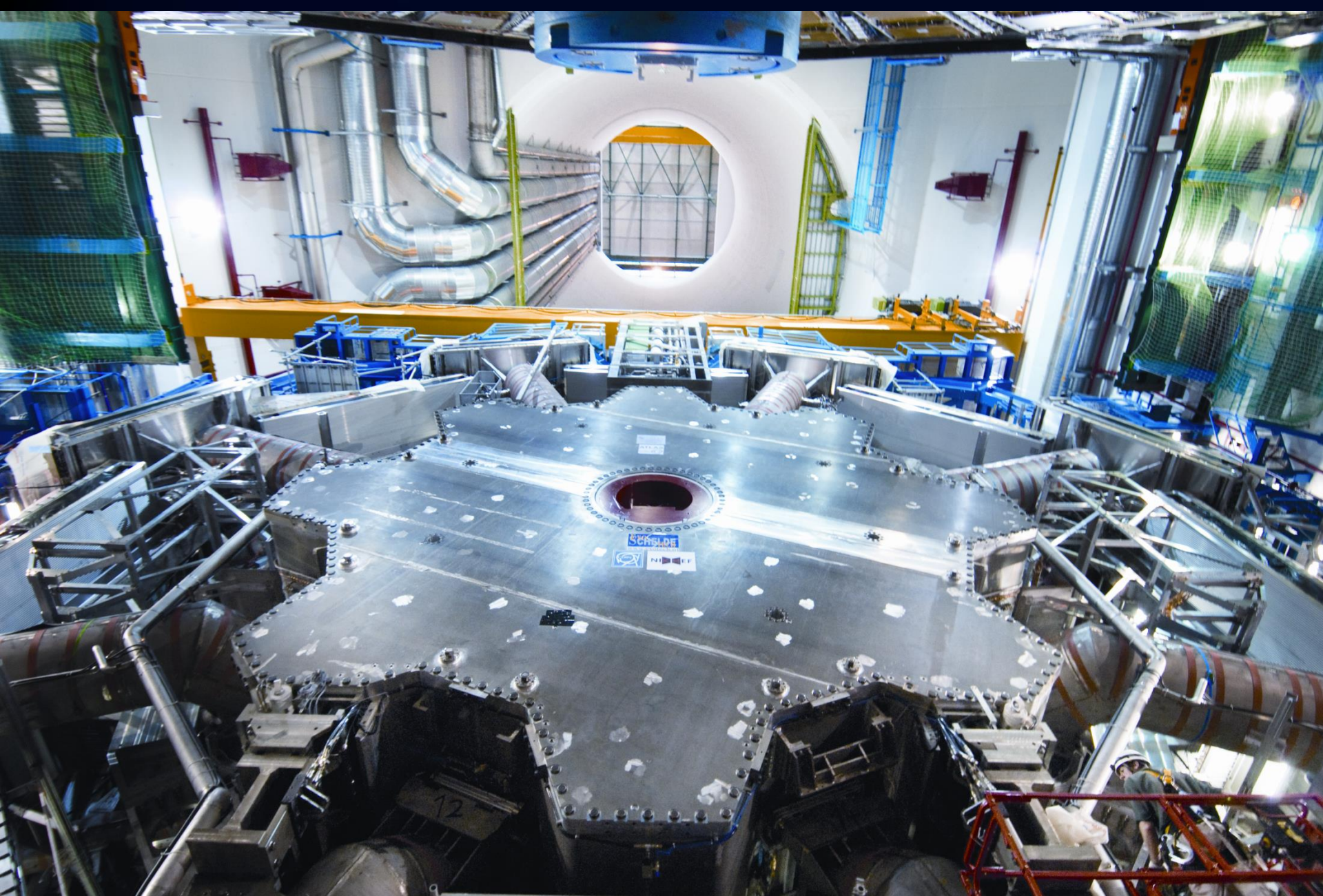






DS
CATIA Done by www.cadcam.ge

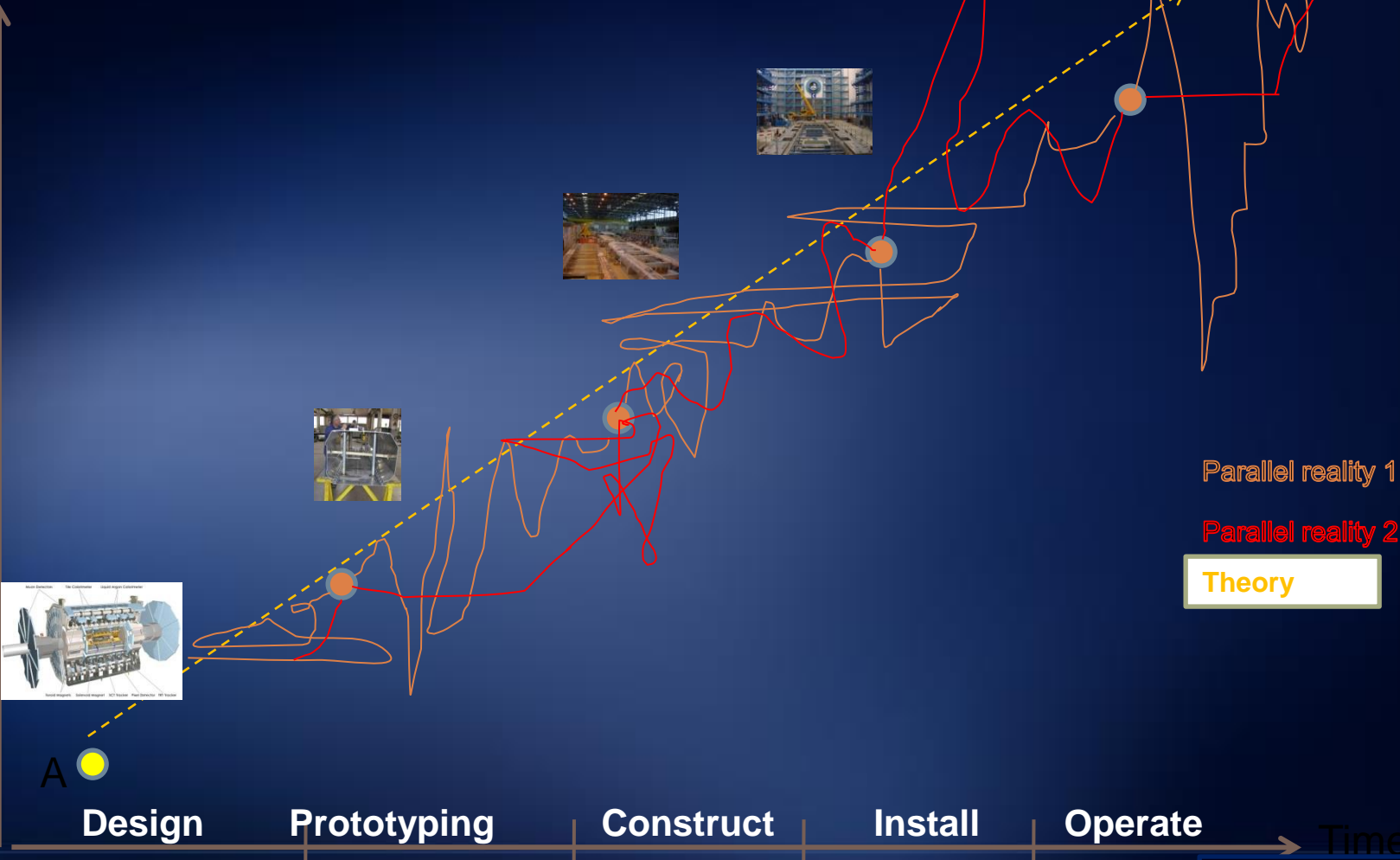




Implementing Strategy is Not Linear



Progress



Parallel reality 1

Parallel reality 2

Theory

A

B

Design

Prototyping

Construct

Install

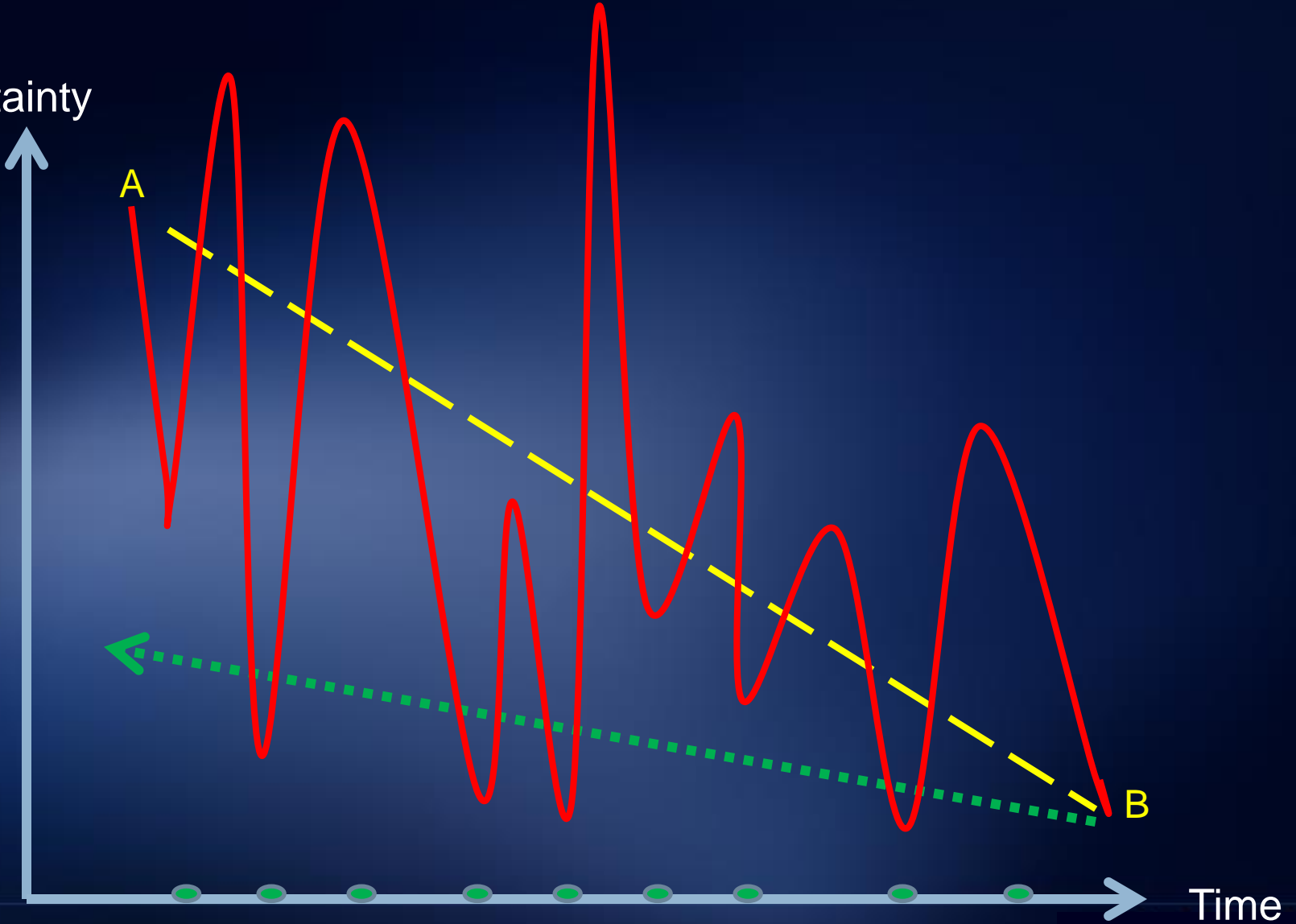
Operate

Time



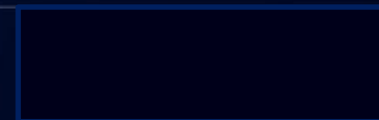
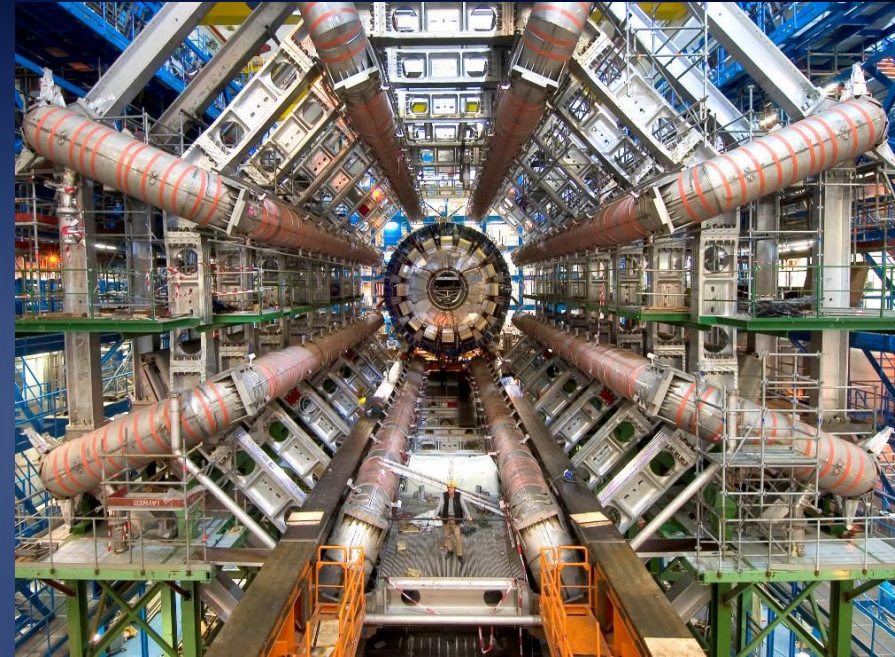
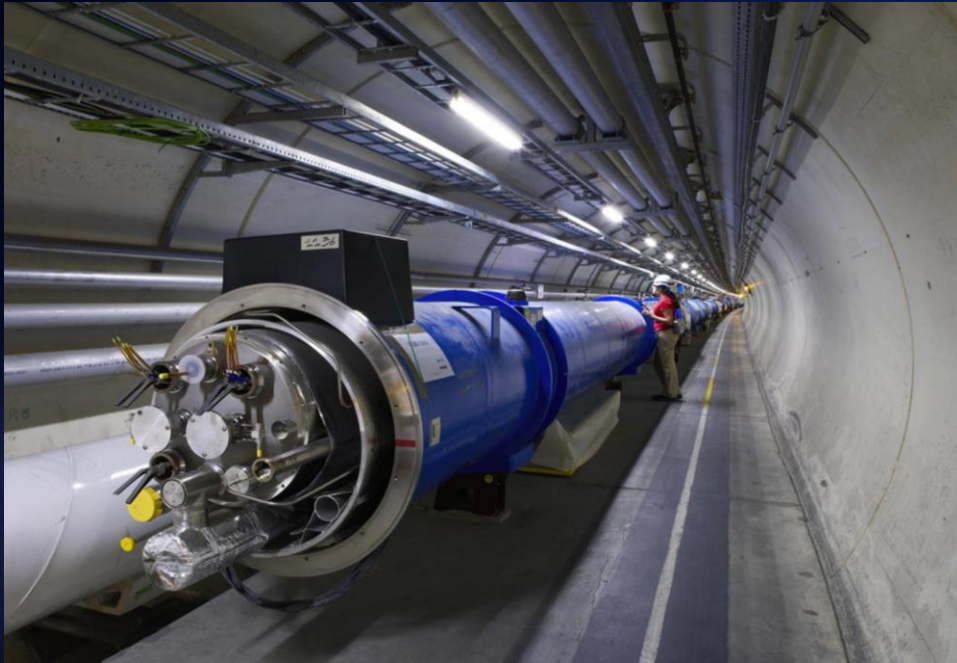
Absorbing vs. Reducing Uncertainty

Uncertainty

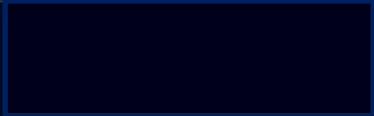


Time

Seeing the Micro needs the Macro (scopes)







CERN was founded 1954: 12 European States Today: 23 Member States

- ~ 2676 staff, 783 Fellows
- ~ 1700 other paid personnel
- ~ 11 200 users
- Budget (2022) ~1200 MCHF

- **23 Member States:** Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.
- **9 Associate Members:** Croatia, Cyprus, Estonia, India, Lithuania, Pakistan, Slovenia, Turkiye, Ukraine.
- **6 Observers to Council:** Japan, the Russian Federation, the United States of America, Turkey, the European Commission and Unesco





Charged-particle multiplicities in pp interactions at $\sqrt{s} = 900$ GeV measured with the ATLAS detector at the LHC $\star\star$

ATLAS Collaboration

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ABSTRACT

The first measurements from proton–proton collisions recorded with the ATLAS detector at the LHC are presented. Data were collected in December 2009 using a minimum-bias trigger during collisions at a centre-of-mass energy of 900 GeV. The charged-particle multiplicity, its dependence on transverse momentum and pseudorapidity, and the relationship between mean transverse momentum and charged-particle multiplicity are measured for events with at least one charged particle in the kinematic region $|\eta| < 2.5$ and $p_T > 500$ MeV. The measurements are compared to Monte Carlo models of proton–proton collisions and to results from other experiments at the same centre-of-mass energy. The charged-particle multiplicity per event and unit of pseudorapidity at $\eta = 0$ is measured to be 1.333 ± 0.003 (stat. ± 0.040 (sys.)), which is 5–15% higher than the Monte Carlo models predict.

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1. Introduction

Inclusive charged-particle distributions have been measured in pp and $p\bar{p}$ collisions at a range of different centre-of-mass energy [1]. Many of these measurements have been used to constrain phenomenological models of soft-hadronic interactions and to properties at higher centre-of-mass energies. Most of the previous charged-particle multiplicity measurements were obtained by selection data with a double-arm coincidence trigger, thus removing large fractions of diffractive events. The data were then further corrected the remaining single-diffractive component. This selection is referred to as non-single-diffractive (NSD). In some cases, despite as inelastic non-diffractive, the residual double-diffractive component was also subtracted. The selection of NSD or inelastic non-diffractive charged-particle spectra involves model-dependent corrections for the diffractive components and for effects of the trigger selection with no charged particles within the acceptance of the detector. The measurement presented in this Letter implements a diffractive strategy, which uses a single-arm trigger overlapping with the acceptance of the tracking volume. Results are presented as inclusive distributions, with minimal model-dependence, by requiring one charged particle within the acceptance of the measurement. This Letter reports on a measurement of primary charged particles with a momentum component transverse to the beam direction.

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ATLAS Collaboration / Physics Letters B 688 (2010) 21–42

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32

ATLAS Collaboration / Physics Letters B 688 (2010) 21–42

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32

ATLAS Collaboration / Physics Letters B 688 (2010) 21–42

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36

ATLAS Collaboration / Physics Letters B 688 (2010) 21–42

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40

ATLAS Collaboration / Physics Letters B 688 (2010) 21–42

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ATLAS Collaboration / Physics Letters B 688 (2010) 21–42

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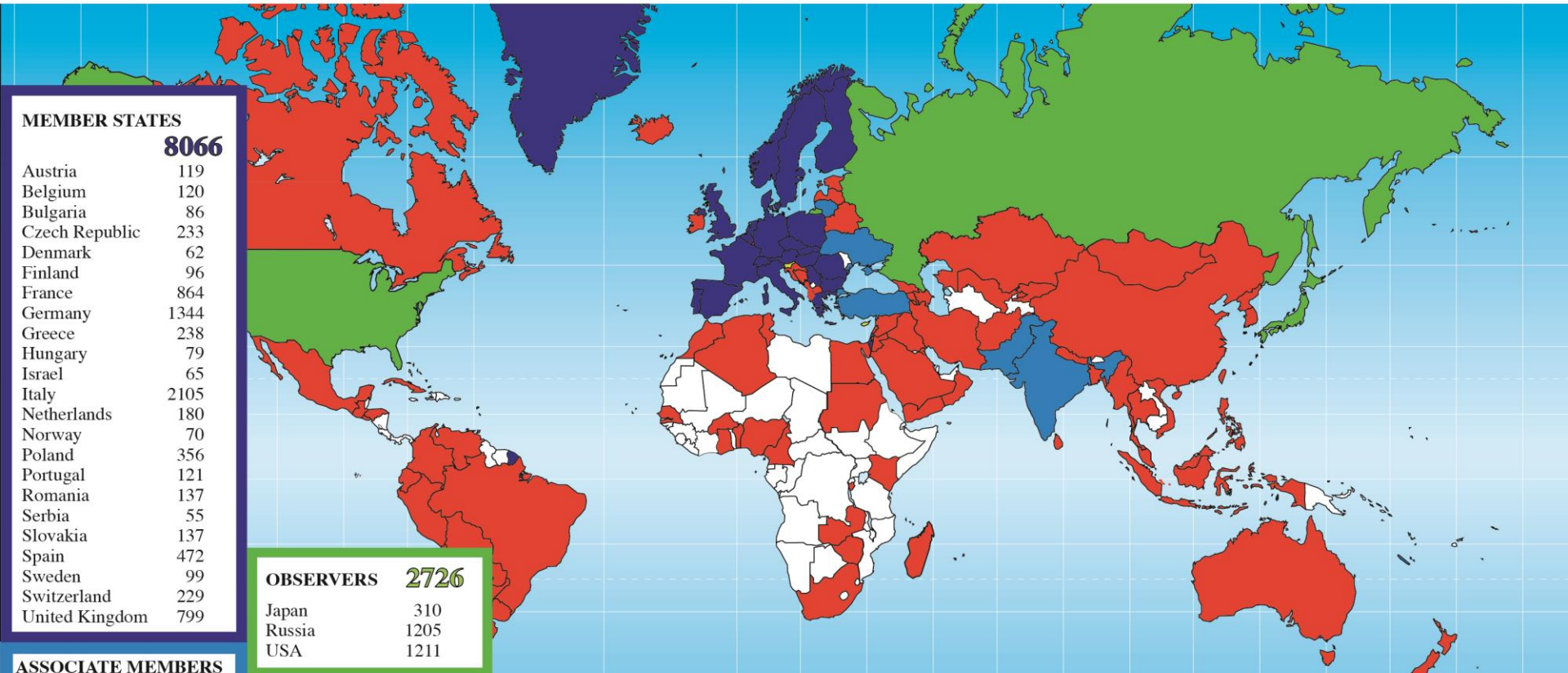
ATLAS Collaboration / Physics Letters B 688 (2010) 21–42

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A Global Reach

Distribution of All CERN Users by Nationality as of mid-April 2019



MEMBER STATES **8066**

Austria	119
Belgium	120
Bulgaria	86
Czech Republic	233
Denmark	62
Finland	96
France	864
Germany	1344
Greece	238
Hungary	79
Israel	65
Italy	2105
Netherlands	180
Norway	70
Poland	356
Portugal	121
Romania	137
Serbia	55
Slovakia	137
Spain	472
Sweden	99
Switzerland	229
United Kingdom	799

OBSERVERS **2726**

Japan	310
Russia	1205
USA	1211

ASSOCIATE MEMBERS **778**

India	387
Lithuania	39
Pakistan	71
Turkey	165
Ukraine	116

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP **59**

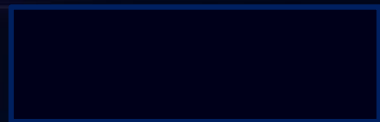
Cyprus	26
Slovenia	33

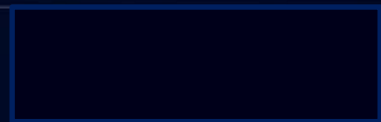
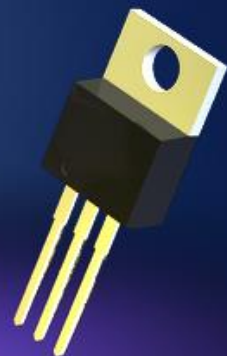
OTHERS **1999**

Albania	4	Bolivia	3	Ecuador	10	Iraq	1	Malta	9	Palestine	7	Sudan	1
Argentina	26	Bosnia & Herzegovina	3	Egypt	27	Ireland	13	Mexico	85	Paraguay	1	Syria	1
Armenia	22	Brazil	127	El Salvador	1	Jordan	2	Mongolia	2	Peru	6	Taiwan	56
Australia	36	Burkina Faso	1	Estonia	15	Kazakhstan	10	Montenegro	11	Philippines	3	Thailand	26
Azerbaijan	10	Burundi	1	Georgia	51	Kenya	1	Morocco	24	Saint Kitts and Nevis	1	Tunisia	4
Bahrain	1	Cameroon	1	Ghana	1	Korea	183	Myanmar	2	San Marino	1	Uruguay	1
Bangladesh	8	Canada	170	Guatemala	1	Kyrgyzstan	1	Nepal	7	San Marino	1	Uzbekistan	3
Belarus	45	Chile	21	Hong Kong	1	Latvia	4	New Zealand	5	Saudi Arabia	4	Venezuela	9
Benin	1	China	576	Honduras	1	Lebanon	27	Nigeria	4	Senegal	4	Viet Nam	11
		Colombia	44	Iceland	4	Luxembourg	4	North Korea	4	Singapore	5	Zambia	1
		Croatia	50	Indonesia	11	Madagascar	1	North Macedonia	3	South Africa	56	Zimbabwe	2
		Cuba	16	Iran	58	Malaysia	22	Oman	3	Sri Lanka	10		

(How) Do We Manage This?

1. Vision
2. Commitment
3. Tolerance







What do you see differently?