

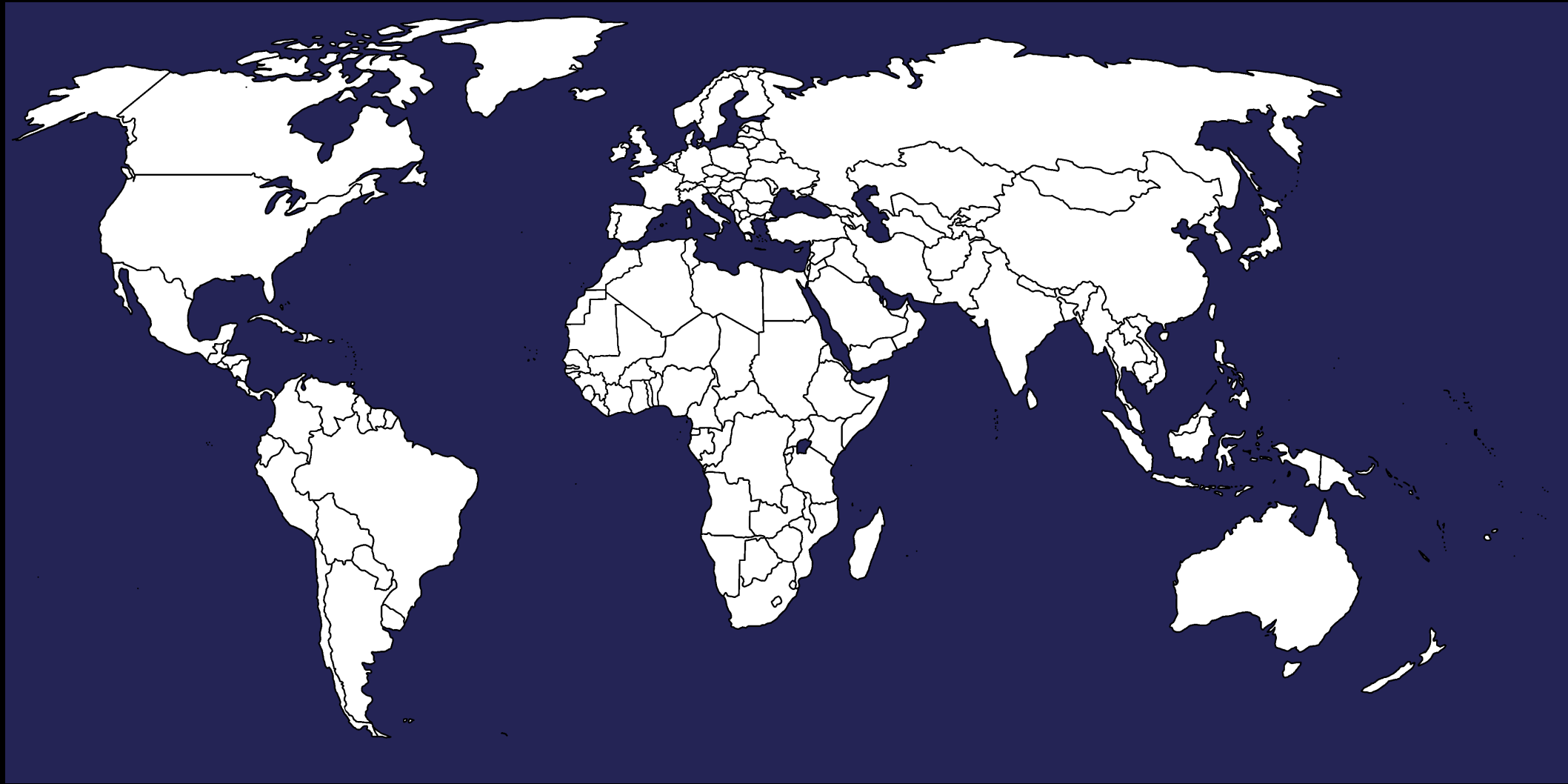
Utilisation de l'image et de la vidéo en physique des particules

PollyMaggoo

Yann COADOU

Centre de physique des particules de Marseille

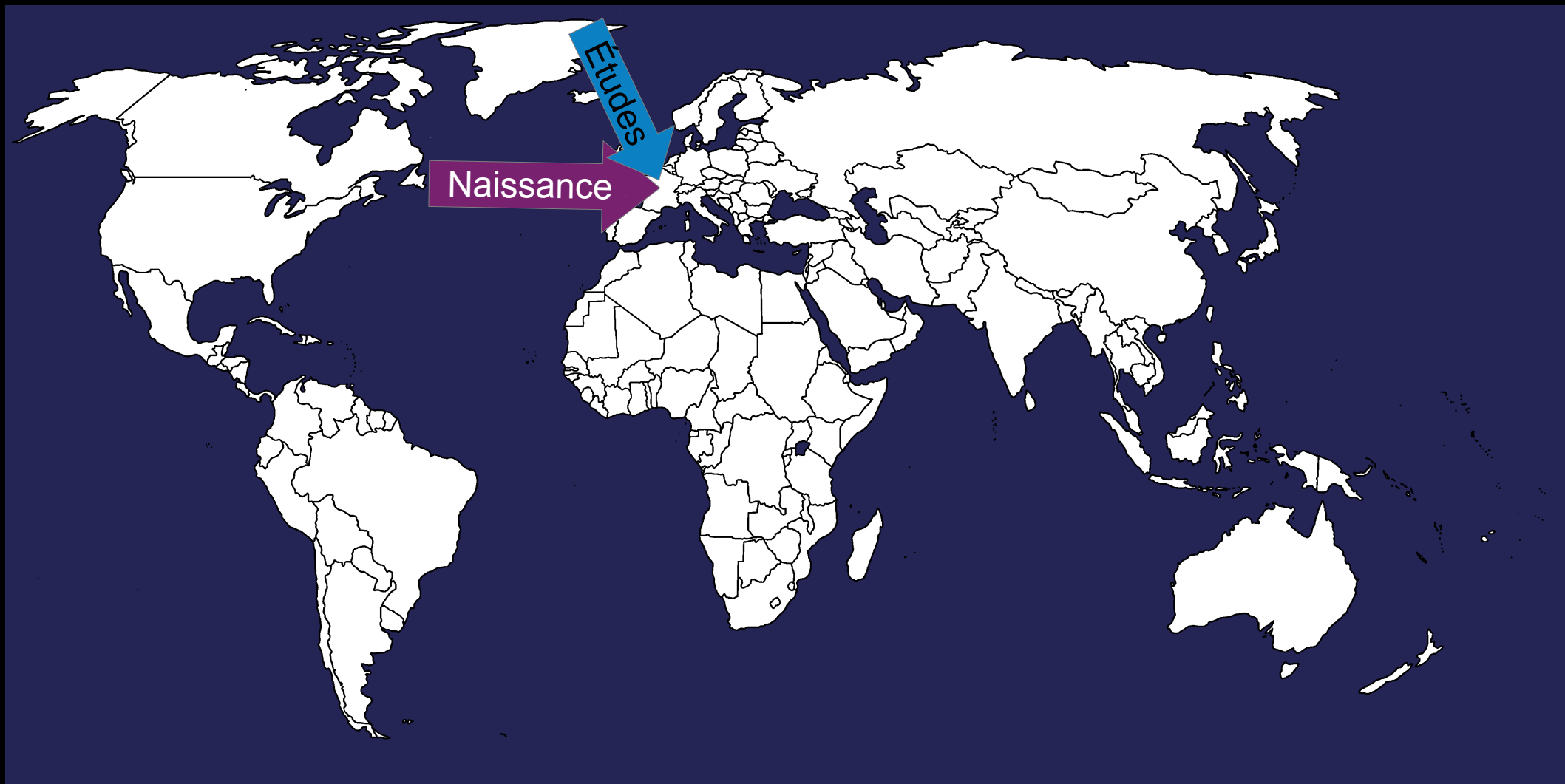
Mon parcours



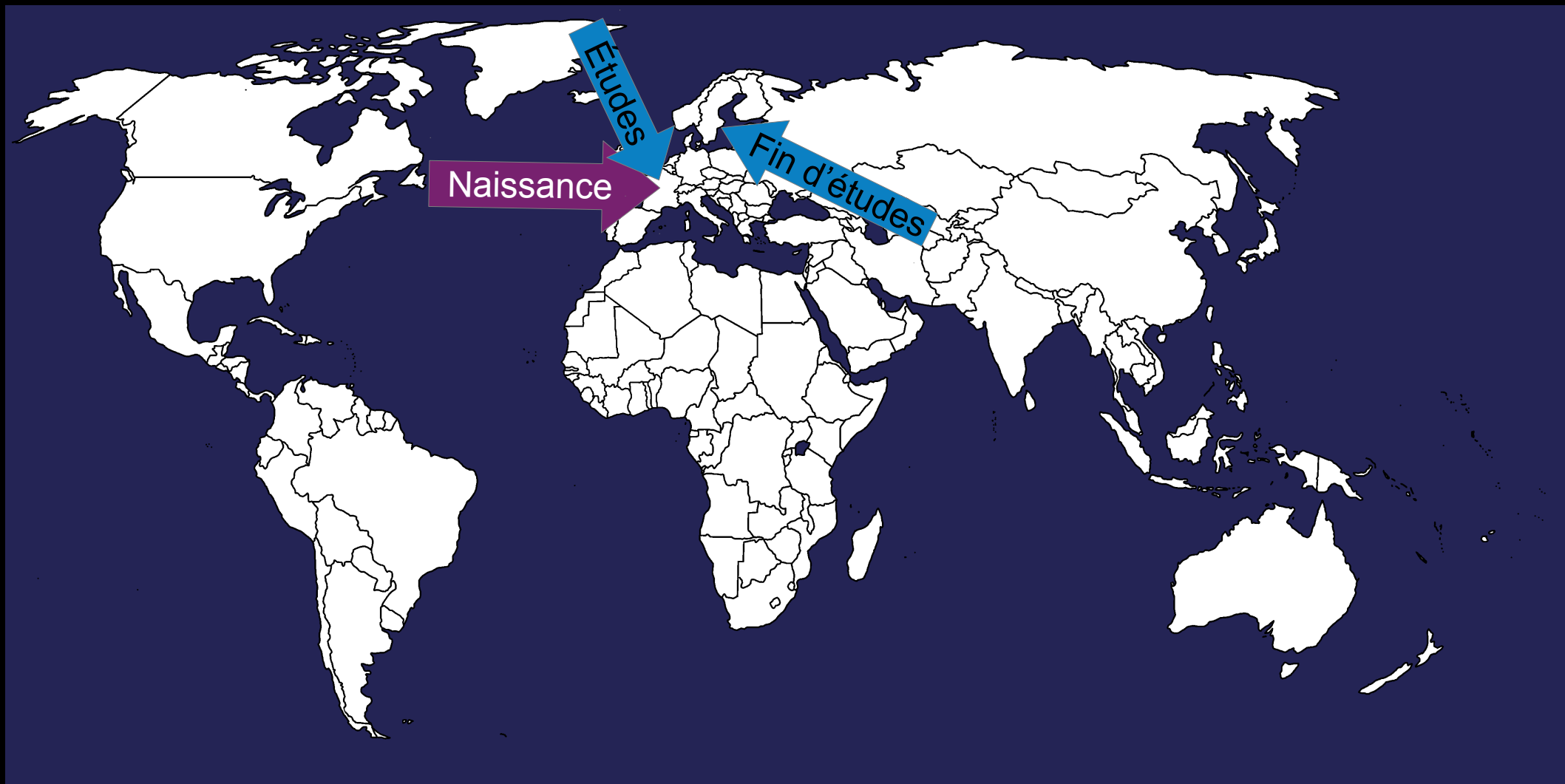
Mon parcours



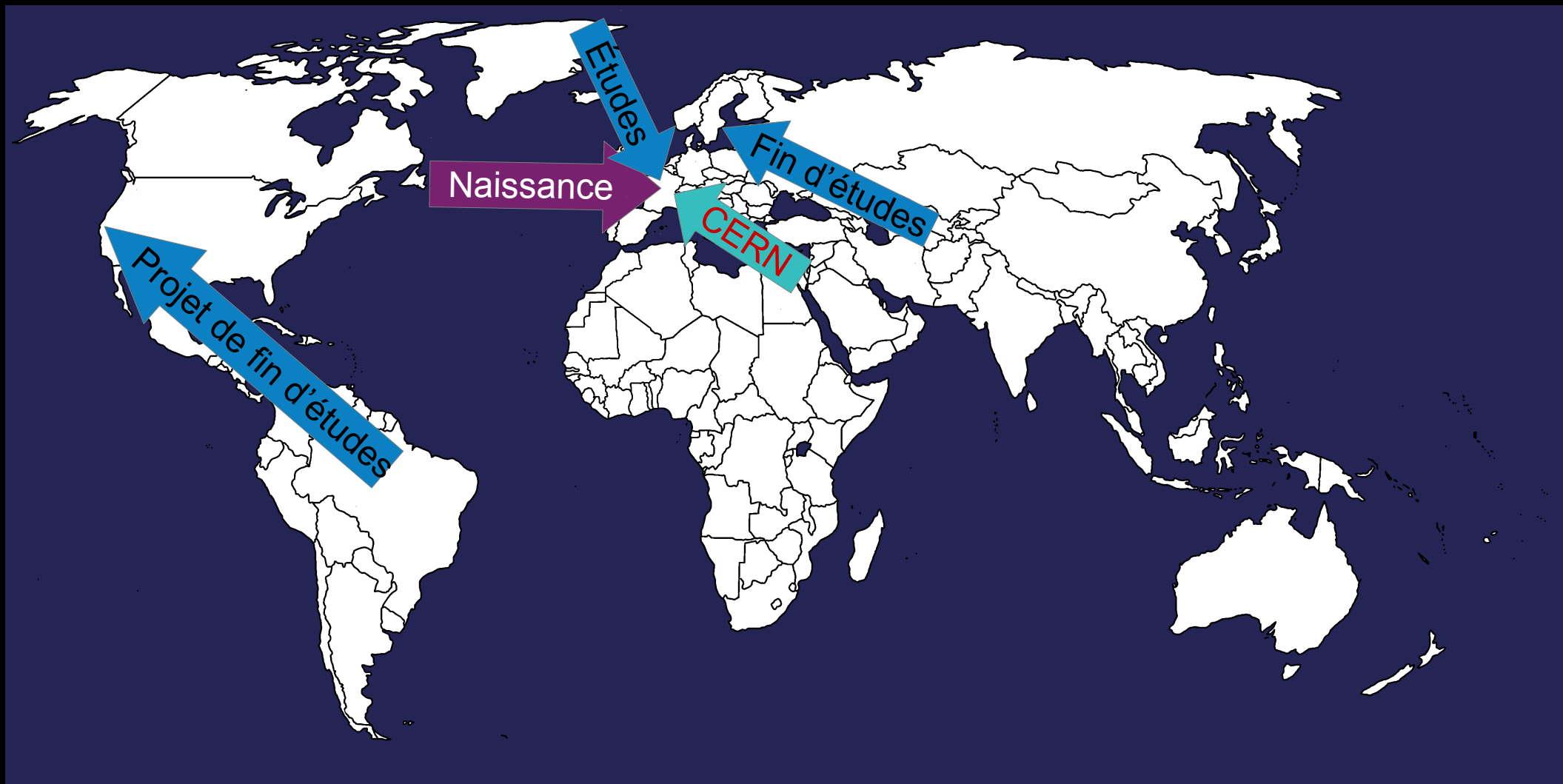
Mon parcours



Mon parcours



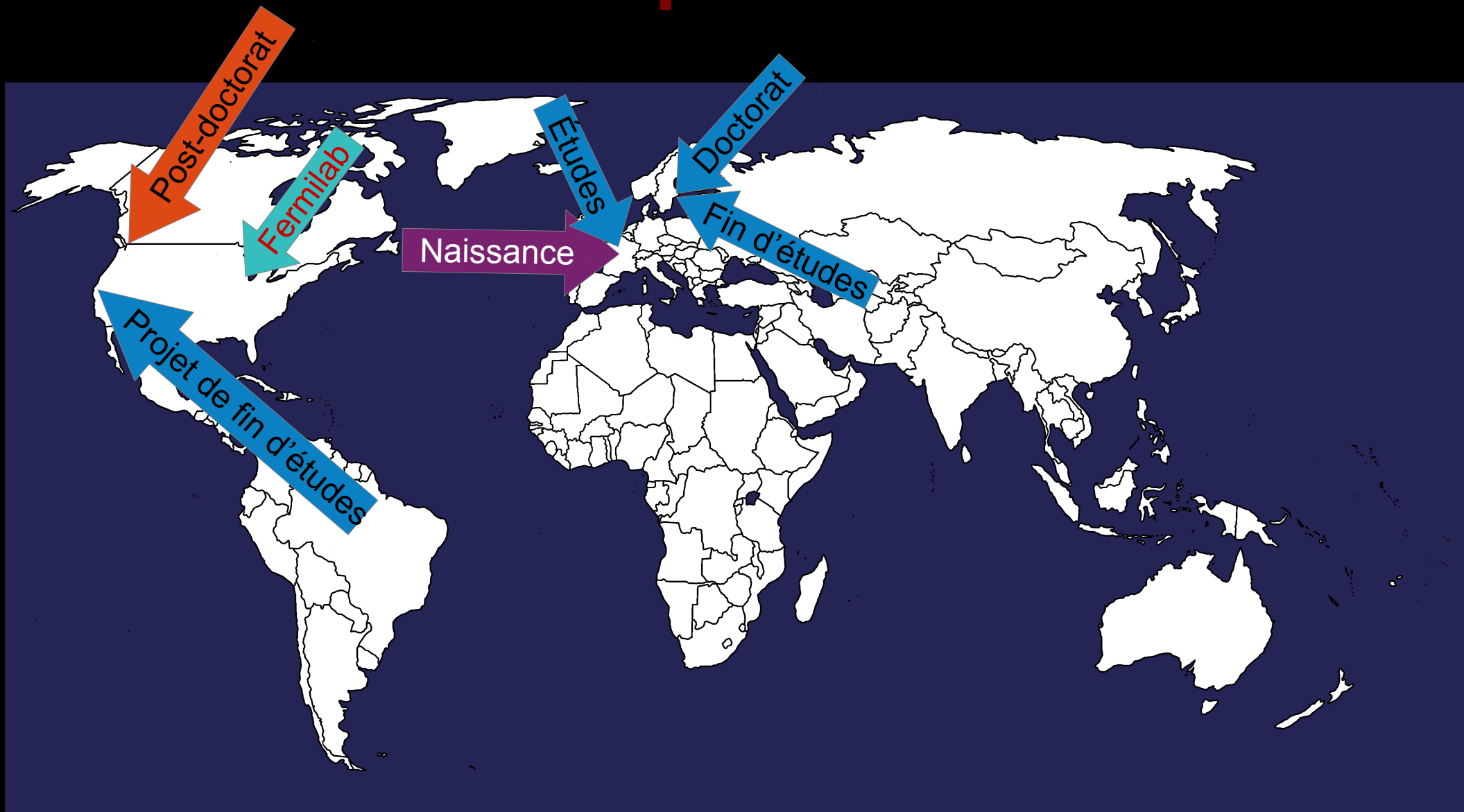
Mon parcours



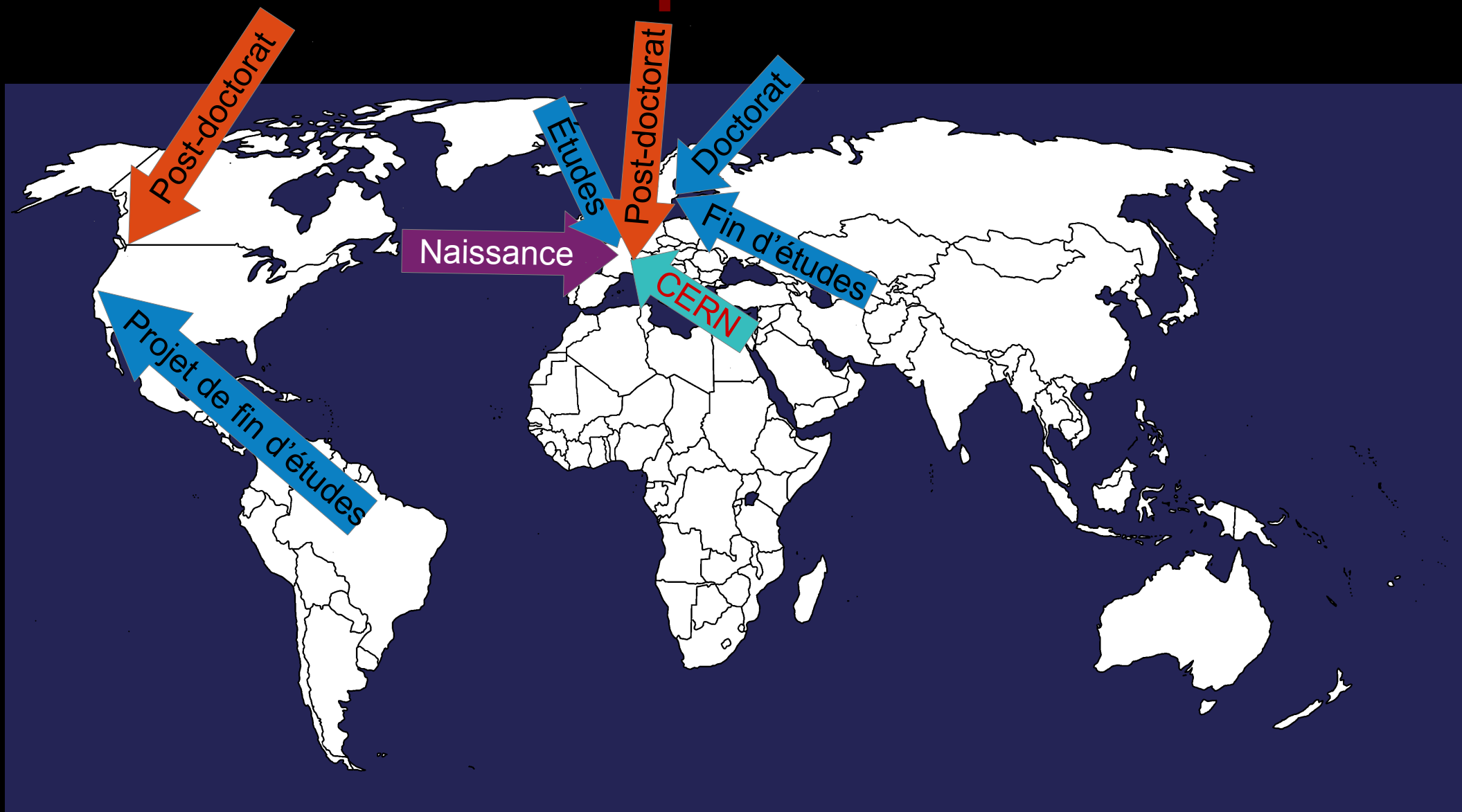
Mon parcours



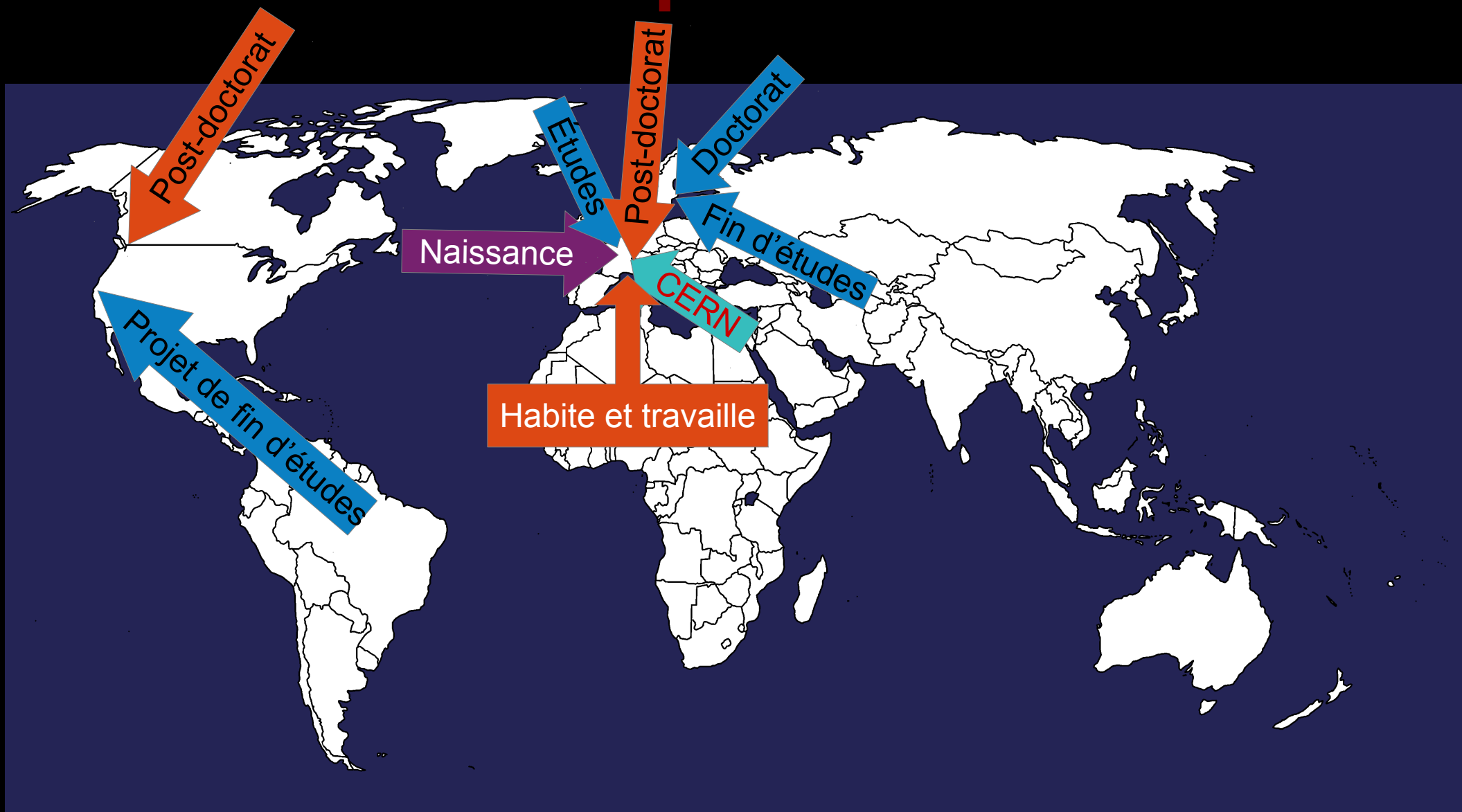
Mon parcours



Mon parcours



Mon parcours



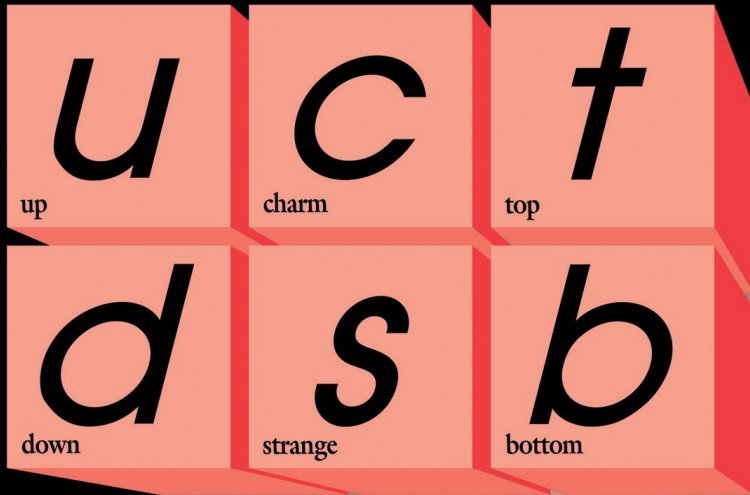


CENTRE DE PHYSIQUE DES
PARTICULES DE MARSEILLE

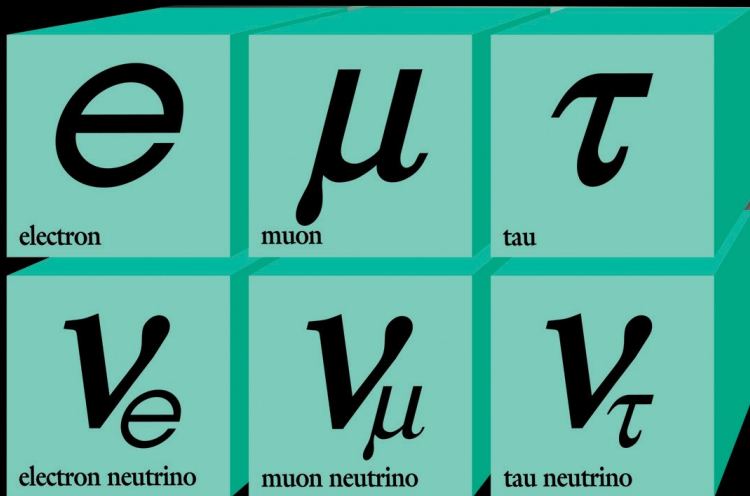
CPPM



Quarks



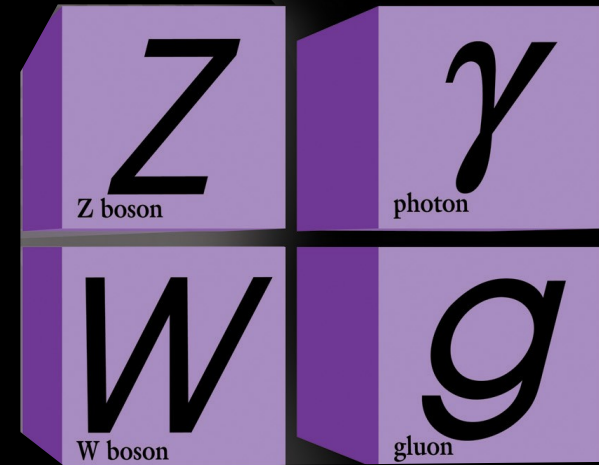
+ anti-matière



Leptons

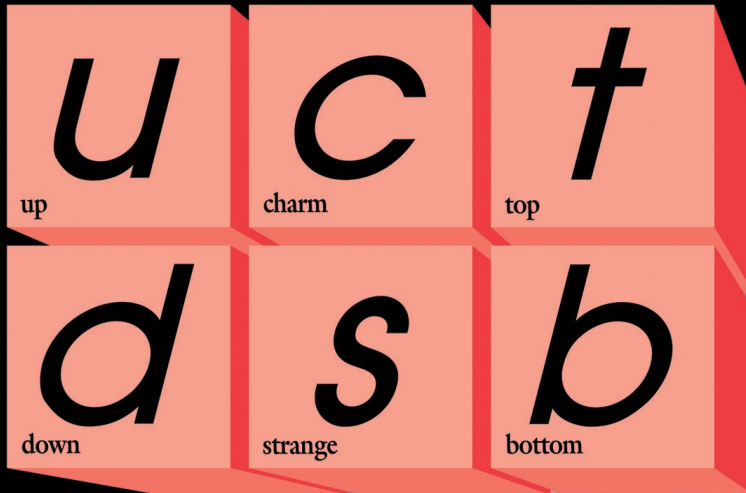
Le modèle standard

Forces

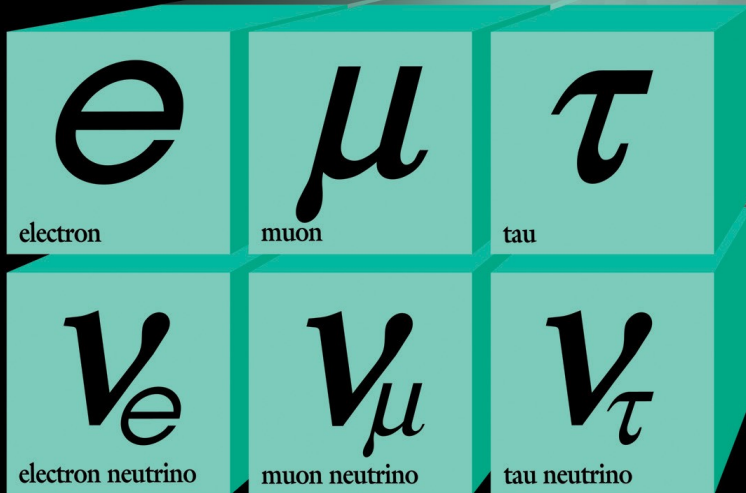


Quarks

Le modèle standard

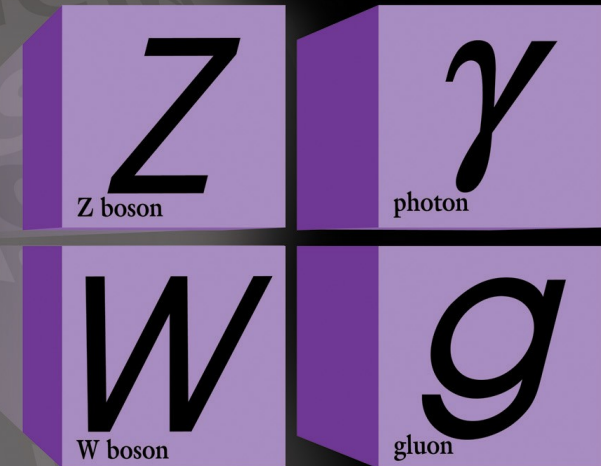


+ anti-matière

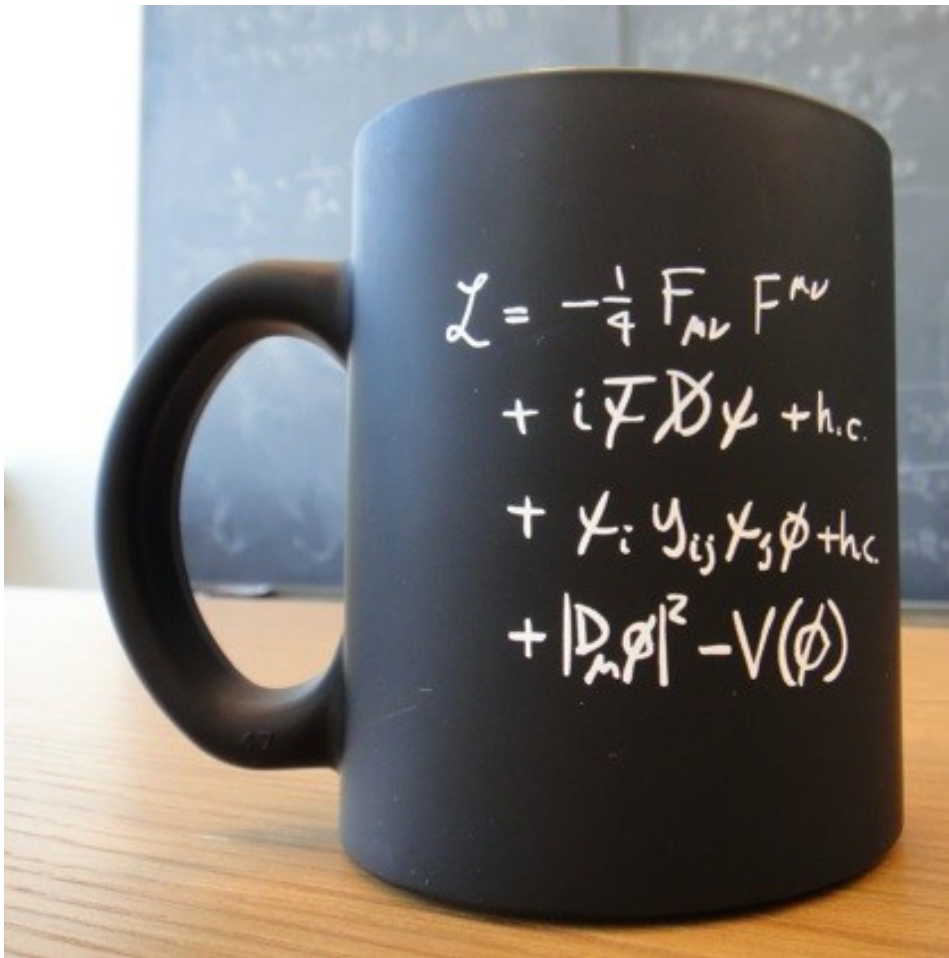


Leptons

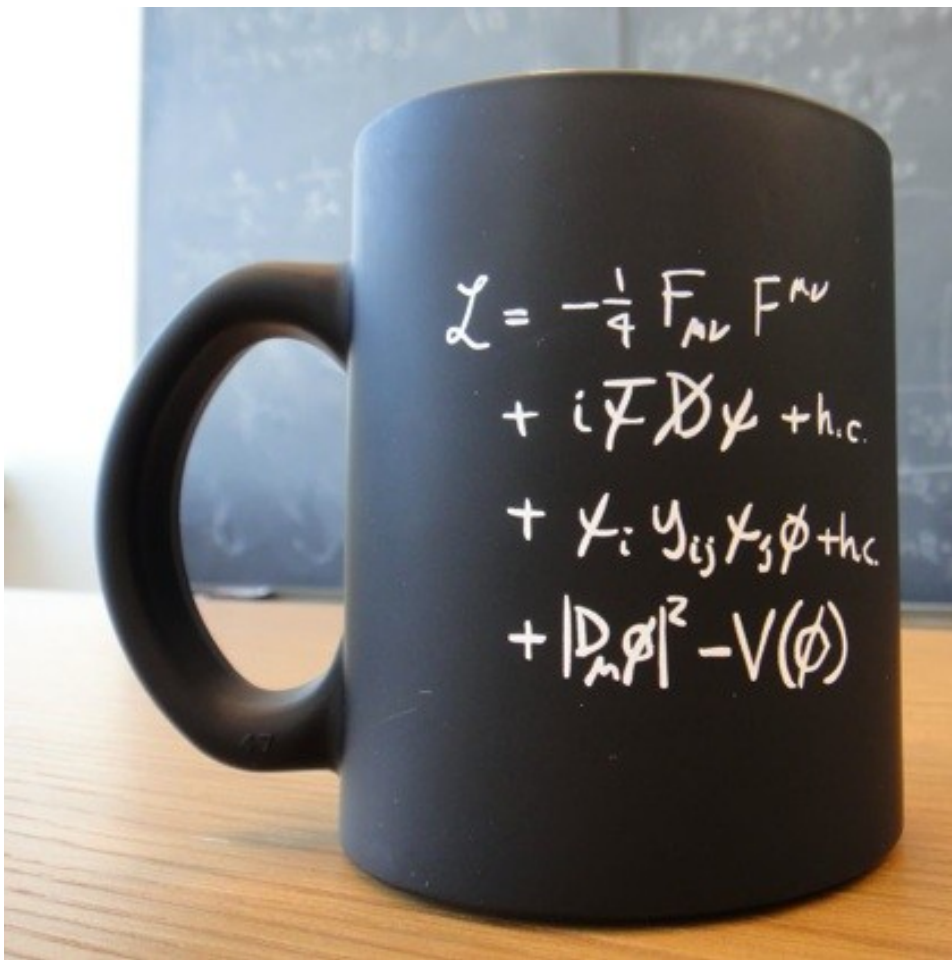
Forces



Le modèle standard

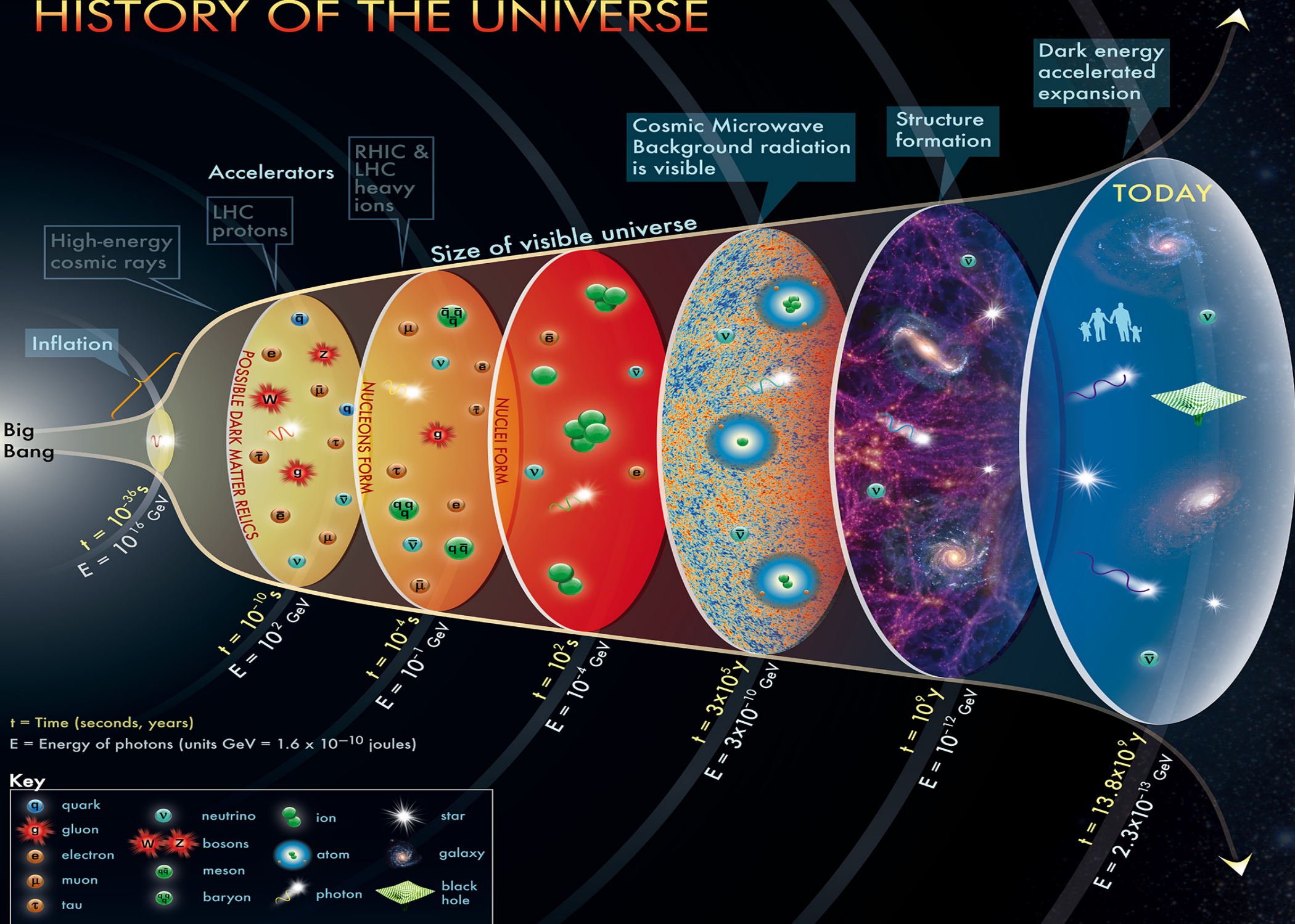


Le modèle standard



$$\begin{aligned}
 & -\frac{1}{2}\partial_\nu g_\mu^a \partial_\nu g_\mu^a - g_s f^{abc} \partial_\mu g_\nu^a g_\mu^b g_\nu^c - \frac{1}{4}g_s^2 f^{abc} f^{ade} g_\mu^b g_\nu^c g_\mu^d g_\nu^e + \\
 & \frac{1}{2}ig_s^2(\bar{q}_i^\sigma \gamma^\mu q_j^\sigma)g_\mu^a + \bar{G}^a \partial^2 G^a + g_s f^{abc} \partial_\mu \bar{G}^a G^b g_\mu^c - \partial_\nu W_\mu^+ \partial_\nu W_\mu^- - \\
 & M^2 W_\mu^+ W_\mu^- - \frac{1}{2}\partial_\nu Z_\mu^0 \partial_\nu Z_\mu^0 - \frac{1}{2c_w^2}M^2 Z_\mu^0 Z_\mu^0 - \frac{1}{2}\partial_\mu A_\nu \partial_\mu A_\nu - \\
 & \frac{1}{2}\partial_\mu \mathbf{H} \partial_\mu \mathbf{H} - \frac{1}{2}m_h^2 \mathbf{H}^2 - \partial_\mu \phi^+ \partial_\mu \phi^- - M^2 \phi^+ \phi^- - \frac{1}{2}\partial_\mu \phi^0 \partial_\mu \phi^0 - \\
 & \frac{1}{2c_w^2}M\phi^0 \phi^0 - \beta_h[\frac{2M^2}{g^2} + \frac{2M}{g}\mathbf{H} + \frac{1}{2}(\mathbf{H}^2 + \phi^0 \phi^0 + 2\phi^+ \phi^-)] + \frac{2M^4}{g^2}\alpha_h - \\
 & igc_w[\partial_\nu Z_\mu^0(W_\mu^+ W_\nu^- - W_\nu^+ W_\mu^-) - Z_\nu^0(W_\mu^+ \partial_\nu W_\mu^- - W_\mu^- \partial_\nu W_\mu^+) + \\
 & Z_\mu^0(W_\nu^+ \partial_\nu W_\mu^- - W_\nu^- \partial_\nu W_\mu^+)] - ig s_w[\partial_\nu A_\mu(W_\mu^+ W_\nu^- - W_\nu^+ W_\mu^-) - \\
 & A_\nu(W_\mu^+ \partial_\nu W_\mu^- - W_\mu^- \partial_\nu W_\mu^+) + A_\mu(W_\nu^+ \partial_\nu W_\mu^- - W_\nu^- \partial_\nu W_\mu^+)] - \\
 & \frac{1}{2}g^2 W_\mu^+ W_\mu^- W_\nu^+ W_\nu^- + \frac{1}{2}g^2 W_\mu^+ W_\nu^- W_\mu^+ W_\nu^- + g^2 c_w^2(Z_\mu^0 W_\mu^+ Z_\nu^0 W_\nu^- - \\
 & Z_\mu^0 Z_\nu^0 W_\mu^+ W_\nu^-) + g^2 s_w^2(A_\mu W_\mu^+ A_\nu W_\nu^- - A_\mu A_\nu W_\mu^+ W_\nu^-) + \\
 & g^2 s_w c_w[A_\mu Z_\nu^0(W_\mu^+ W_\nu^- - W_\nu^+ W_\mu^-) - 2A_\mu Z_\mu^0 W_\nu^+ W_\nu^-] - g\alpha[\mathbf{H}^3 + \\
 & \mathbf{H}\phi^0 \phi^0 + 2\mathbf{H}\phi^+ \phi^-] - \frac{1}{8}g^2 \alpha_h[\mathbf{H}^4 + (\phi^0)^4 + 4(\phi^+ \phi^-)^2 + \\
 & 4(\phi^0)^2 \phi^+ \phi^- + 4\mathbf{H}^2 \phi^+ \phi^- + 2(\phi^0)^2 \mathbf{H}^2] - gMW_\mu^+ W_\mu^- \mathbf{H} - \\
 & \frac{1}{2}g\frac{M}{c_w^2}Z_\mu^0 Z_\mu^0 \mathbf{H} - \frac{1}{2}ig[W_\mu^+(\phi^0 \partial_\mu \phi^- - \phi^- \partial_\mu \phi^0) - W_\mu^-(\phi^0 \partial_\mu \phi^+ - \\
 & \phi^+ \partial_\mu \phi^0)] + \frac{1}{2}g[W_\mu^+(\mathbf{H} \partial_\mu \phi^- - \phi^- \partial_\mu \mathbf{H}) - W_\mu^-(\mathbf{H} \partial_\mu \phi^+ - \phi^+ \partial_\mu \mathbf{H})] + \\
 & \frac{1}{2}g\frac{1}{c_w}(Z_\mu^0(\mathbf{H} \partial_\mu \phi^0 - \phi^0 \partial_\mu \mathbf{H}) - ig\frac{s_w^2}{c_w}M Z_\mu^0(W_\mu^+ \phi^- - W_\mu^- \phi^+) + \\
 & ig s_w M A_\mu(W_\mu^+ \phi^- - W_\mu^- \phi^+) - ig\frac{1-2c_w^2}{2c_w}Z_\mu^0(\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) + \\
 & ig s_w A_\mu(\phi^+ \partial_\mu \phi^- - \phi^- \partial_\mu \phi^+) - \frac{1}{4}g^2 W_\mu^+ W_\mu^- [\mathbf{H}^2 + (\phi^0)^2 + 2\phi^+ \phi^-] - \\
 & \frac{1}{4}g^2 \frac{1}{c_w}Z_\mu^0 Z_\mu^0 [\mathbf{H}^2 + (\phi^0)^2 + 2(2s_w^2 - 1)^2 \phi^+ \phi^-] - \frac{1}{2}g^2 \frac{s_w^2}{c_w}Z_\mu^0 \phi^0(W_\mu^+ \phi^- + \\
 & W_\mu^- \phi^+) - \frac{1}{2}ig^2 \frac{s_w^2}{c_w}Z_\mu^0 \mathbf{H}(W_\mu^+ \phi^- - W_\mu^- \phi^+) + \frac{1}{2}g^2 s_w A_\mu \phi^0(W_\mu^+ \phi^- + \\
 & W_\mu^- \phi^+) + \frac{1}{2}ig^2 s_w A_\mu \mathbf{H}(W_\mu^+ \phi^- - W_\mu^- \phi^+) - g^2 \frac{s_w}{c_w}(2c_w^2 - 1)Z_\mu^0 A_\mu \phi^+ \phi^- - \\
 & g^1 s_w^2 A_\mu A_\mu \phi^+ \phi^- - \bar{e}^\lambda(\gamma \partial + m_e^\lambda)e^\lambda - \bar{\nu}^\lambda \gamma \partial \nu^\lambda - \bar{u}_j^\lambda(\gamma \partial + m_u^\lambda)u_j^\lambda - \\
 & \bar{d}_j^\lambda(\gamma \partial + m_d^\lambda)d_j^\lambda + ig s_w A_\mu [-(\bar{e}^\lambda \gamma^\mu e^\lambda) + \frac{2}{3}(\bar{u}_j^\lambda \gamma^\mu u_j^\lambda) - \frac{1}{3}(\bar{d}_j^\lambda \gamma^\mu d_j^\lambda)] + \\
 & \frac{ig}{4c_w}Z_\mu^0[(\bar{\nu}^\lambda \gamma^\mu(1 + \gamma^5)\nu^\lambda) + (\bar{e}^\lambda \gamma^\mu(4s_w^2 - 1 - \gamma^5)e^\lambda) + (\bar{u}_j^\lambda \gamma^\mu(\frac{4}{3}s_w^2 - \\
 & 1 - \gamma^5)u_j^\lambda) + (\bar{d}_j^\lambda \gamma^\mu(1 - \frac{8}{3}s_w^2 - \gamma^5)d_j^\lambda)] + \frac{ig}{2\sqrt{2}}W_\mu^+[(\bar{\nu}^\lambda \gamma^\mu(1 + \gamma^5)e^\lambda) + \\
 & (\bar{u}_j^\lambda \gamma^\mu(1 + \gamma^5)C_{\lambda\kappa}d_j^\kappa)] + \frac{ig}{2\sqrt{2}}W_\mu^-[(\bar{e}^\lambda \gamma^\mu(1 + \gamma^5)\nu^\lambda) + (\bar{d}_j^\kappa C_{\lambda\kappa}^\dagger \gamma^\mu(1 + \\
 & \gamma^5)u_j^\lambda)] + \frac{ig}{2\sqrt{2}}\frac{m_e^\lambda}{M}[-\phi^+(\bar{\nu}^\lambda(1 - \gamma^5)e^\lambda) + \phi^-(\bar{e}^\lambda(1 + \gamma^5)\nu^\lambda)] - \\
 & \frac{g}{2}\frac{m_u^\lambda}{M}[\mathbf{H}(\bar{e}^\lambda e^\lambda) + i\phi^0(\bar{e}^\lambda \gamma^5 e^\lambda)] + \frac{ig}{2M\sqrt{2}}\phi^+[-m_d^\kappa(\bar{u}_j^\lambda C_{\lambda\kappa}(1 - \gamma^5)d_j^\kappa) + \\
 & m_u^\lambda(\bar{u}_j^\lambda C_{\lambda\kappa}(1 + \gamma^5)d_j^\kappa) + \frac{ig}{2M\sqrt{2}}\phi^-[m_d^\lambda(\bar{d}_j^\kappa C_{\lambda\kappa}^\dagger(1 + \gamma^5)u_j^\kappa) - m_u^\kappa(\bar{d}_j^\kappa C_{\lambda\kappa}^\dagger(1 - \\
 & \gamma^5)u_j^\kappa) - \frac{g}{2}\frac{m_u^\lambda}{M}\mathbf{H}(\bar{u}_j^\lambda u_j^\lambda) - \frac{g}{2}\frac{m_d^\lambda}{M}\mathbf{H}(\bar{d}_j^\lambda d_j^\lambda) + \frac{ig}{2}\frac{m_u^\lambda}{M}\phi^0(\bar{u}_j^\lambda \gamma^5 u_j^\lambda) - \\
 & \frac{ig}{2}\frac{m_d^\lambda}{M}\phi^0(\bar{d}_j^\lambda \gamma^5 d_j^\lambda) + \bar{X}^+(\partial^2 - M^2)X^+ + \bar{X}^-(\partial^2 - M^2)X^- + \bar{X}^0(\partial^2 - \\
 & \frac{M^2}{c_w^2})X^0 + \bar{Y}\partial^2 Y + igc_w W_\mu^+(\partial_\mu \bar{X}^0 X^- - \partial_\mu \bar{X}^+ X^0) + ig s_w W_\mu^+(\partial_\mu \bar{Y} X^- - \\
 & \partial_\mu \bar{X}^+ Y) + igc_w W_\mu^-(\partial_\mu \bar{X}^- X^0 - \partial_\mu \bar{X}^0 X^+) + ig s_w W_\mu^-(\partial_\mu \bar{X}^- Y - \\
 & \partial_\mu \bar{Y} X^+) + igc_w Z_\mu^0(\partial_\mu \bar{X}^+ X^- - \partial_\mu \bar{X}^- X^+) + ig s_w A_\mu(\partial_\mu \bar{X}^+ X^- - \\
 & \partial_\mu \bar{X}^- X^+) - \frac{1}{2}gM[\bar{X}^+ X^+ \mathbf{H} + \bar{X}^- X^- \mathbf{H} + \frac{1}{c_w^2}\bar{X}^0 X^0 \mathbf{H}] + \\
 & \frac{1-2c_w^2}{2c_w}igM[\bar{X}^+ X^0 \phi^+ - \bar{X}^- X^0 \phi^-] + \frac{1}{2c_w}igM[\bar{X}^0 X^- \phi^+ - \bar{X}^0 X^+ \phi^-] + \\
 & igM s_w[\bar{X}^0 X^- \phi^+ - \bar{X}^0 X^+ \phi^-] + \frac{1}{2}igM[\bar{X}^+ X^+ \phi^0 - \bar{X}^- X^- \phi^0]
 \end{aligned}$$

HISTORY OF THE UNIVERSE



The concept for the above figure originated in a 1986 paper by Michael Turner.

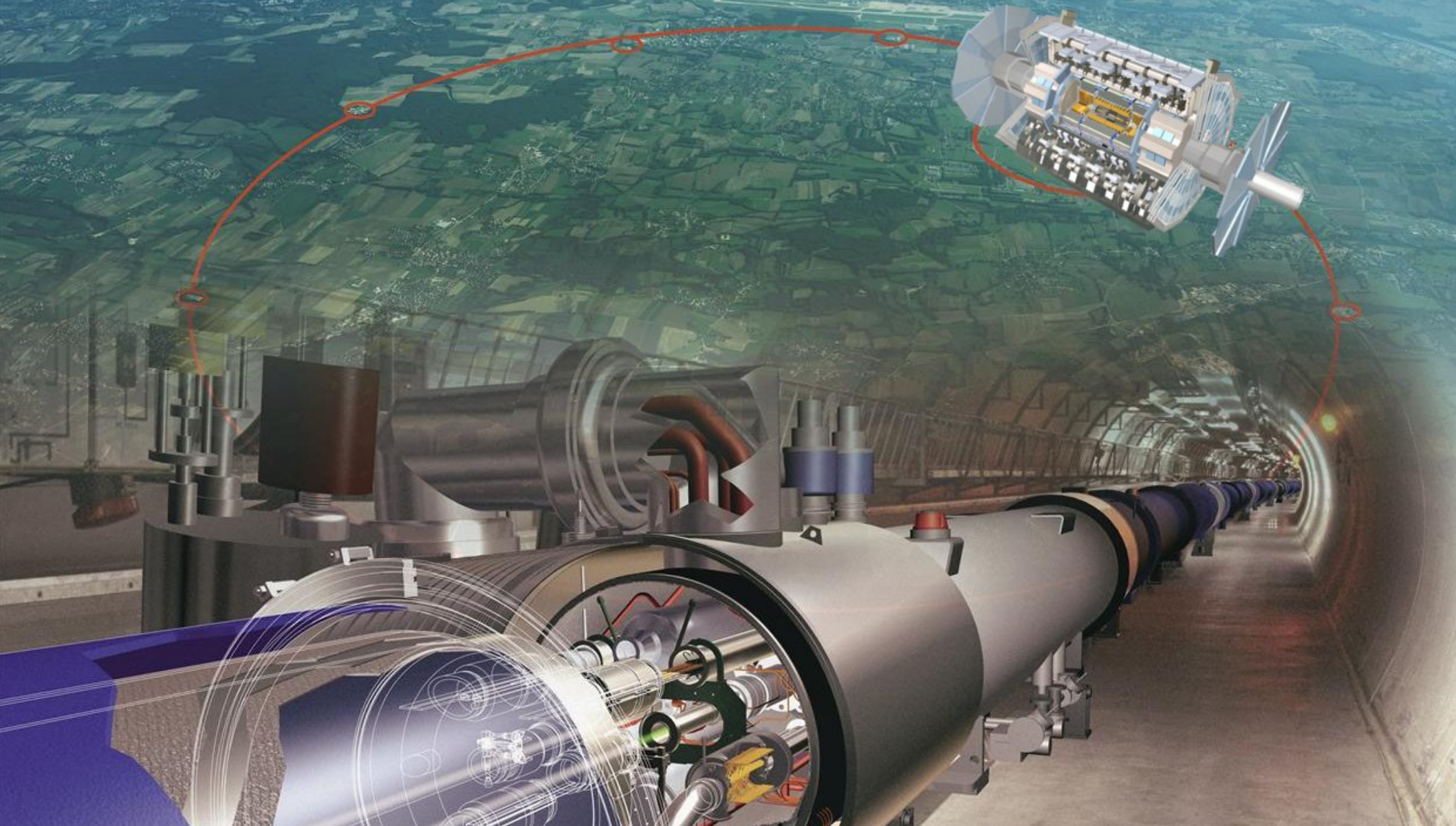
Particle Data Group, LBNL © 2015

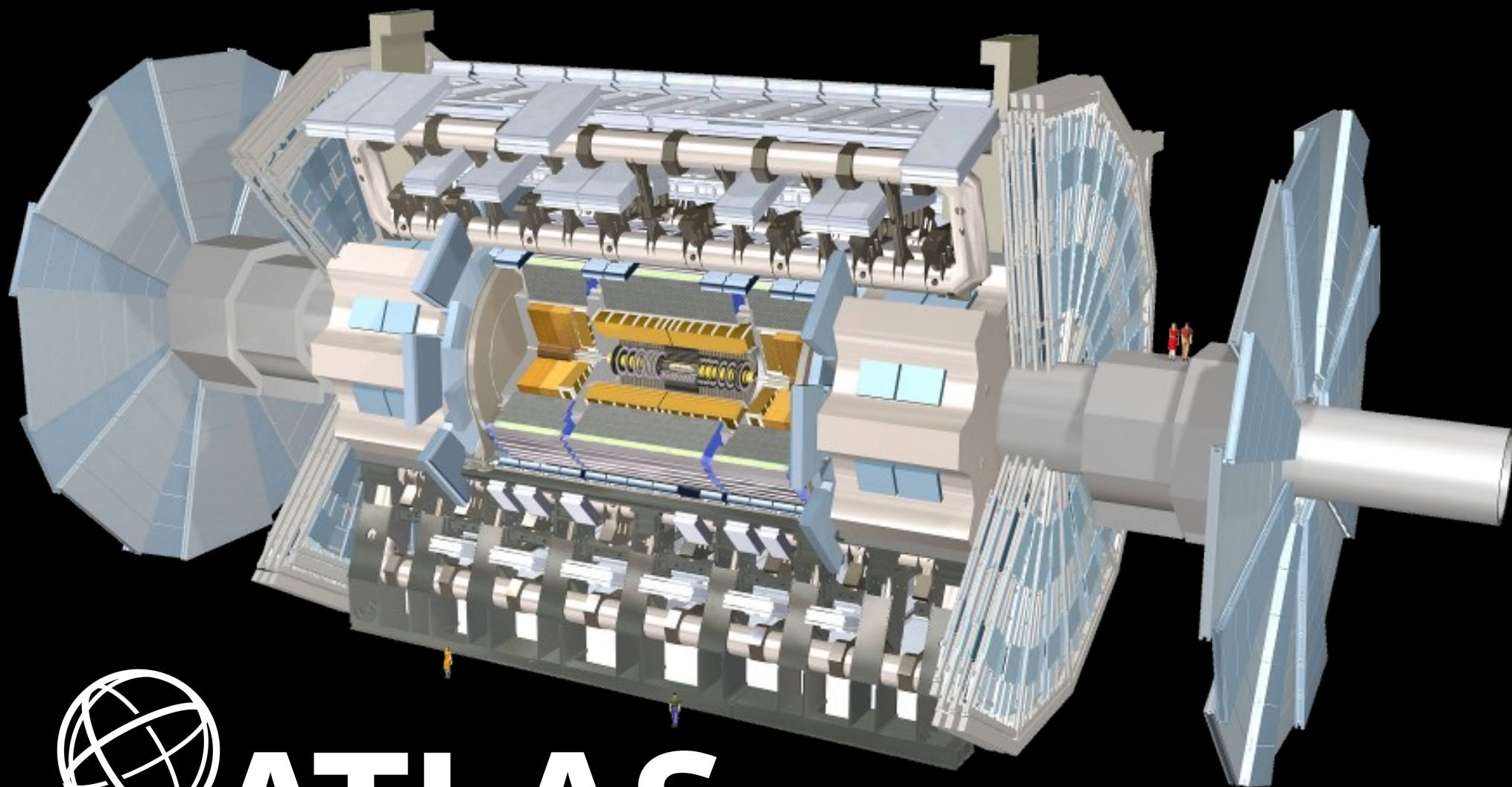
Supported by DOE



Le LHC

(grand collisionneur de hadrons)





ATLAS
EXPERIMENT



A photograph of a large iceberg floating in a blue ocean under a blue sky with wispy clouds. The iceberg is white and jagged, with a significant portion of its mass submerged below the water line. The text "Ce que l'on connaît (5%)" is superimposed on the visible part of the iceberg.

Ce que l'on connaît (5%)

Ce que l'on connaît (5%)

27% Matière noire

68% Énergie noire

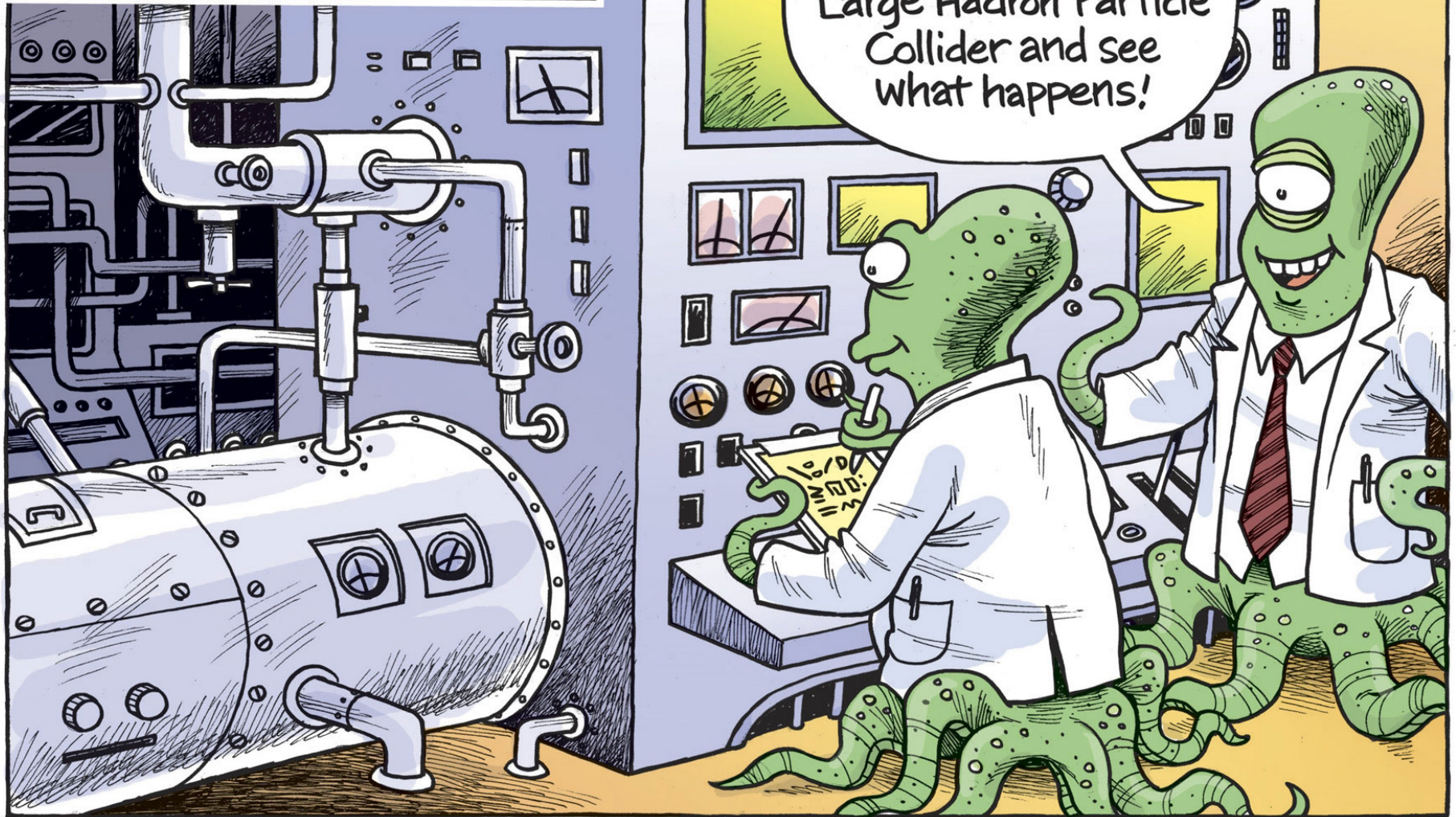
Reste à
découvrir !



© Render by Jonathan Rey



13.8 BILLION YEARS AGO,
A FEW SECONDS BEFORE THE
CREATION OF OUR UNIVERSE...



Salle de contrôle

LHC Page1 Fill: 7495 E: 0 Z GeV 18-03-19 21:30:01

SHUTDOWN: NO BEAM

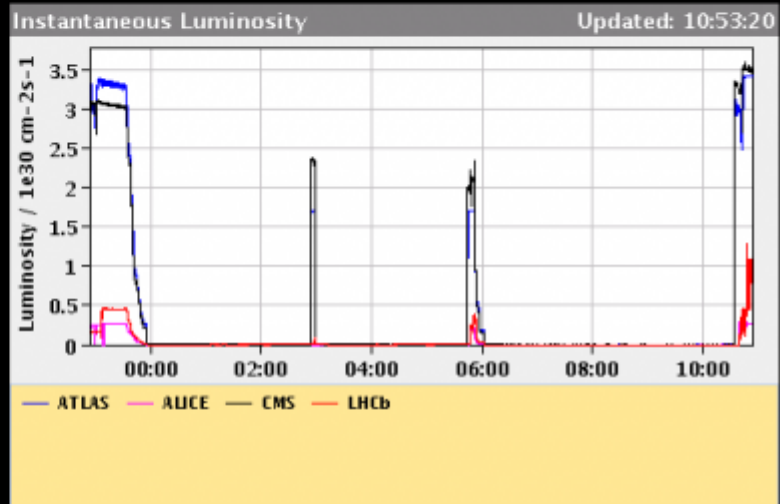
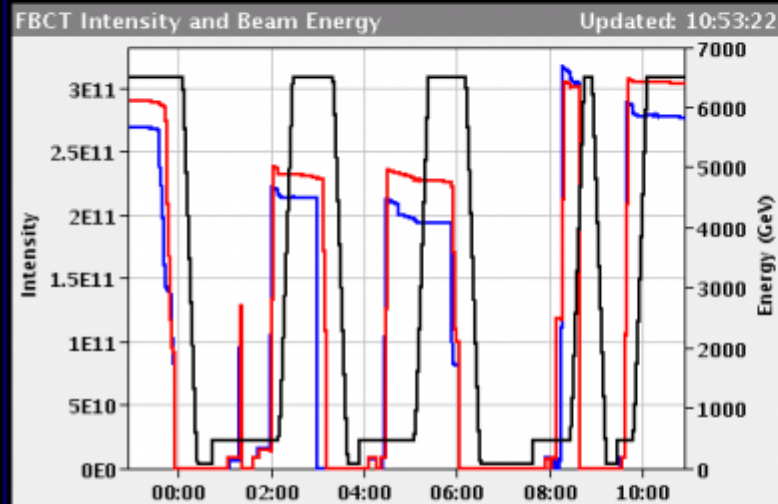
BIS status and SMP flags		B1	B2	
Comments (21-Feb-2019 12:08:02) LS2	Link Status of Beam Permits	false	false	
	Global Beam Permit	false	false	
	Setup Beam	false	false	
	Beam Presence	false	false	
	Moveable Devices Allowed In	false	false	
	Stable Beams	false	false	
AFS: 75_150ns_733Pb_733_702_468_42bpi_20inj	PM Status B1	ENABLED	PM Status B2	ENABLED

Salle de contrôle

LHC Page1 Fill: 3819 E: 6500 GeV t(SB): 00:12:50 03-06-15 10:53:23

PROTON PHYSICS: STABLE BEAMS

Energy: 6500 GeV I(B1): 2.94e+11 I(B2): 2.94e+11



Comments (03-Jun-2015 10:48:25)

the LHC is back in business!
(all IPs optimized)

BIS status and SMP flags

B1 B2

Link Status of Beam Permits	false	false
Global Beam Permit	true	true
Setup Beam	false	false
Beam Presence	true	true
Moveable Devices Allowed In	true	true
Stable Beams	true	true

AFS: Single_3b_2_2_2_with_nc_probes

PM Status B1 ENABLED PM Status B2 ENABLED

Salle de contrôle

Back Home

NO USER

02-10-2011 18:07:36

LHC READY OK

Ramp Energy 1377.1 GeV

Injection Permit Y

ATLAS is beam-safe

Stable Beams Flag

Injection: STANDBY

ID	CALO	MUON	SERVICE
PIX OK	LAR OK	MDT OK	CIC OK
SCT OK	TIL OK	RPC OK	EXT OK
TRT OK		TGC OK	TDQ OK
IDE W		CSC OK	FWD OK
			SAF OK

S Object

W IDE Q2:LOCP_038

Time 2011.10.02 18:07:30

1 W E F D

ATLAS STANDBY WARNING

PIX	STANDBY	OK
SCT	STANDBY	OK
TRT	READY	OK
IDE	READY	WARNING
LAR	READY	OK
TIL	READY	OK
MDT	STANDBY	OK
RPC	STANDBY	OK
TGC	STANDBY	OK
CSC	STANDBY	OK
MUON	READY	OK
CIC	READY	OK
EXT	READY	OK
TDQ	READY	OK
LHC	READY	OK
FWD	READY	OK
SAFETY	READY	OK
DCS BE	READY	OK

3D View Zoom: 100 All connected

IDE Back Home

EVCool			ENV			TEH			RAD			BCM			BLM		
EVC	READY	W	ENV	READY	OK	TEH	READY	OK	RAD	READY	OK	BCM	READY	OK	BLM	READY	OK
PIX	READY	W	VOL	READY	OK	ELM	READY	OK	CAN	READY	OK	COM	READY	OK	PS	READY	OK
BAR	READY	OK	HEX	READY	OK	DAR	READY	OK	END	READY	OK	TOR	READY	OK	SEN	READY	OK
ECA	READY	OK	SER	READY	OK	EPS	READY	OK									
ECC	READY	OK	DIP	READY	OK												
PLA	READY	OK	CAN	READY	OK												
PS	READY	OK															
GAS	READY	OK															
RAC	READY	OK															

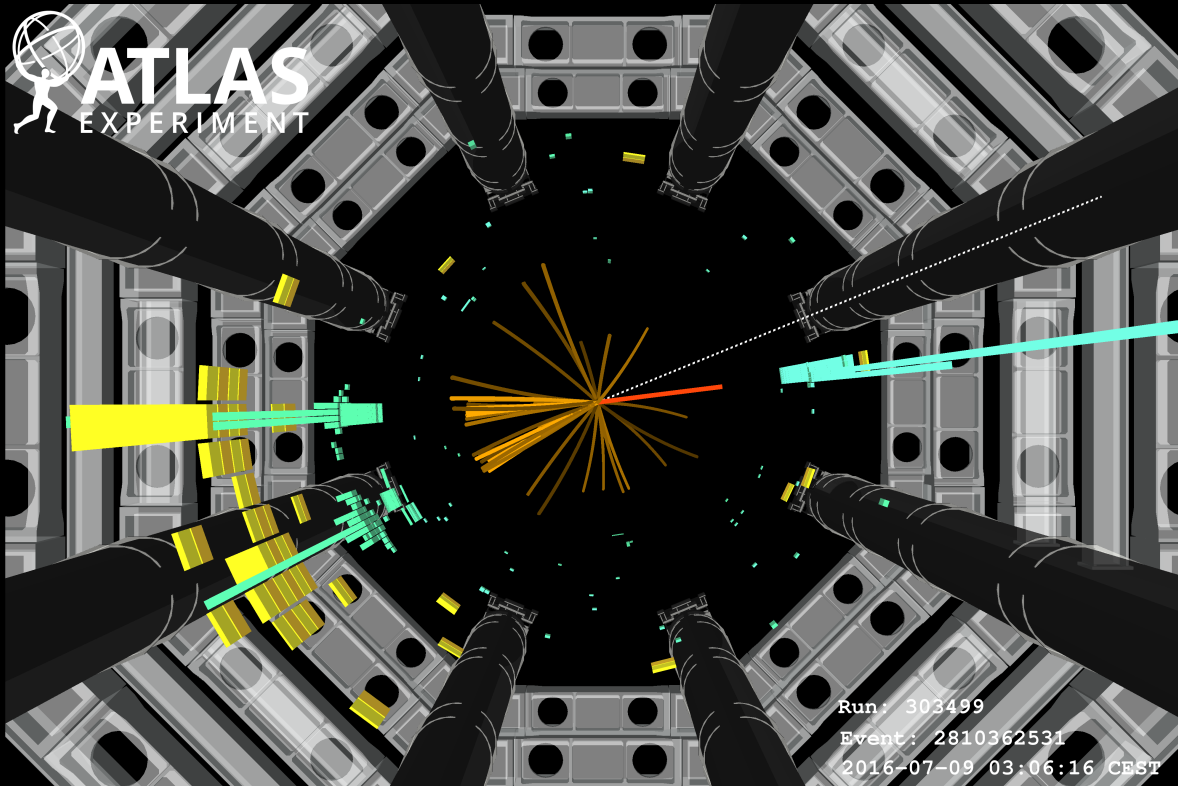
ATLAS DETECTOR CONTROL

Inner Detector			Calorimeter			Muon Spectrometer		
PIX	BARREL	S OK	LAR	EMBA	R OK	MDT	BARREL A	S OK
SCT	B LAYER	S OK	EMBC	R OK	RPC	BARREL C	S OK	
TRT	DISKS	S OK	EMECC	R OK	RPC SIDE A	ENDCAP A	S OK	
	BARREL	S OK	HEC FCAL A	R OK	RPC SIDE C	ENDCAP C	S OK	
	ENDCAP A	S OK	HEC FCAL C	R OK	TGC SIDE A		S OK	
	ENDCAP C	S OK			TGC SIDE C		S OK	
	BARREL A	R OK			CSC SIDE A		S OK	
	BARREL C	R OK			CSC SIDE C		S OK	
	ENDCAP A	R OK						
	ENDCAP C	R OK						

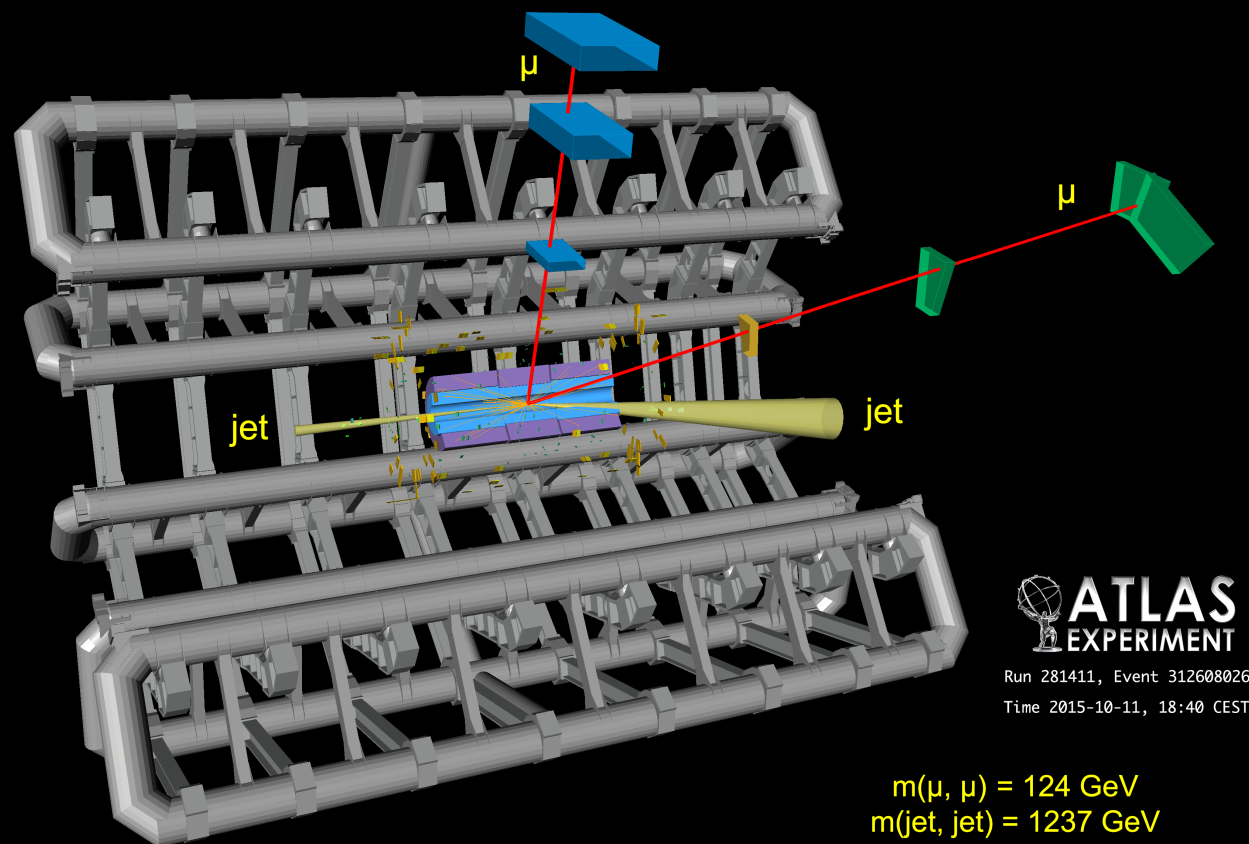
Services		
CSC	ALFA	S OK
TGC	LUCID	R OK
RPC	ZDC	R OK
	DSS	R OK
	SNIFFERS	R OK
	MAGNETS	R OK
	Toroids	20400 A
	Solenoid	7730 A
	TRIGGER L1	R OK

Event displays

Event displays



Event displays



ATLAS
EXPERIMENT

Run 281411, Event 312608026

Time 2015-10-11, 18:40 CEST

$m(\mu, \mu) = 124 \text{ GeV}$
 $m(\text{jet}, \text{jet}) = 1237 \text{ GeV}$

Event displays

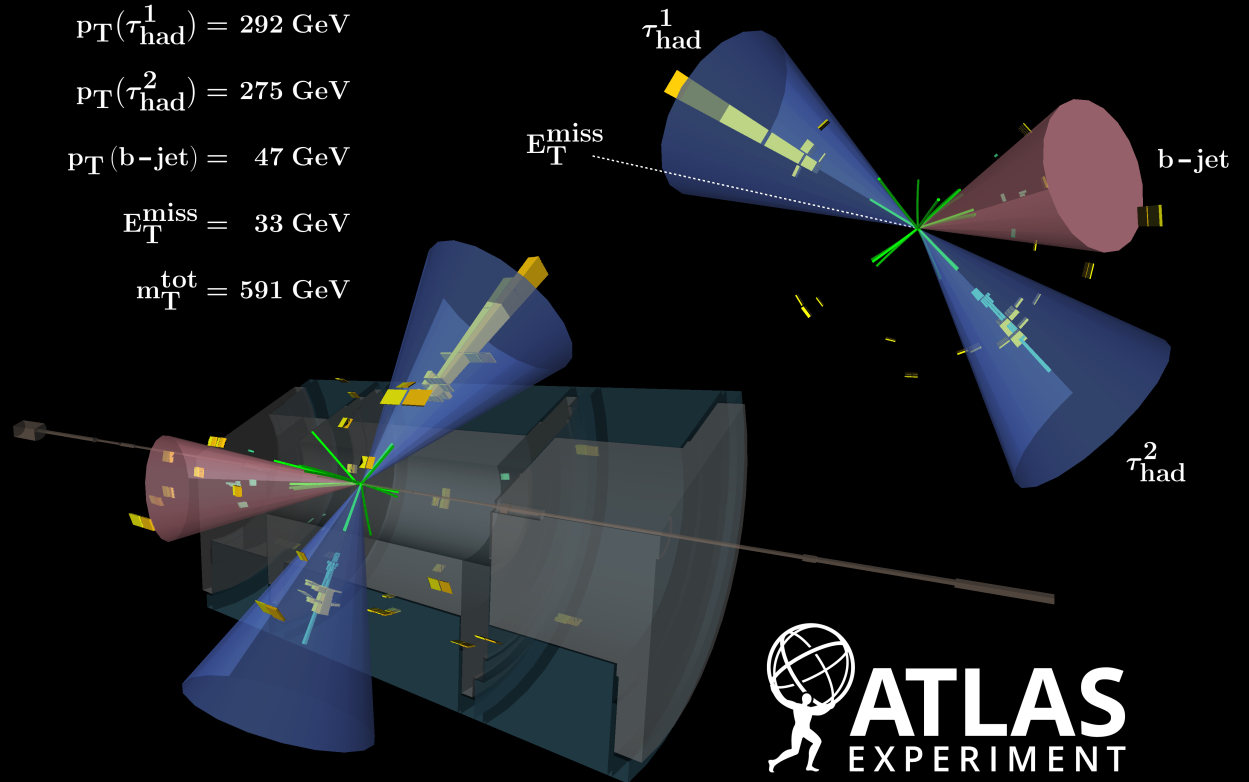
$$p_T(\tau_{\text{had}}^1) = 292 \text{ GeV}$$

$$p_T(\tau_{\text{had}}^2) = 275 \text{ GeV}$$

$$p_T(\text{b-jet}) = 47 \text{ GeV}$$

$$E_T^{\text{miss}} = 33 \text{ GeV}$$

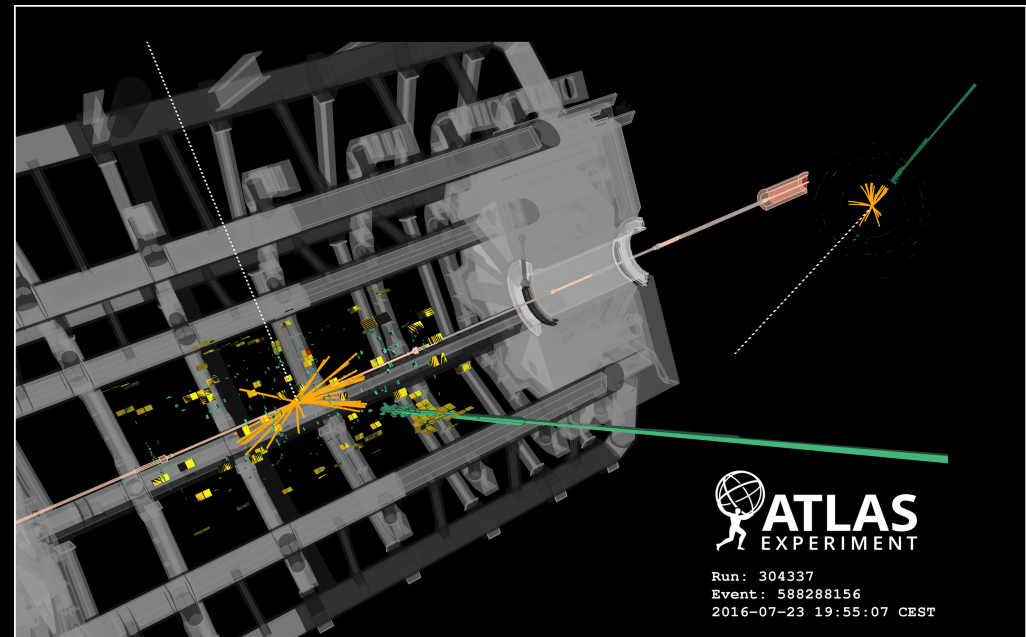
$$m_T^{\text{tot}} = 591 \text{ GeV}$$



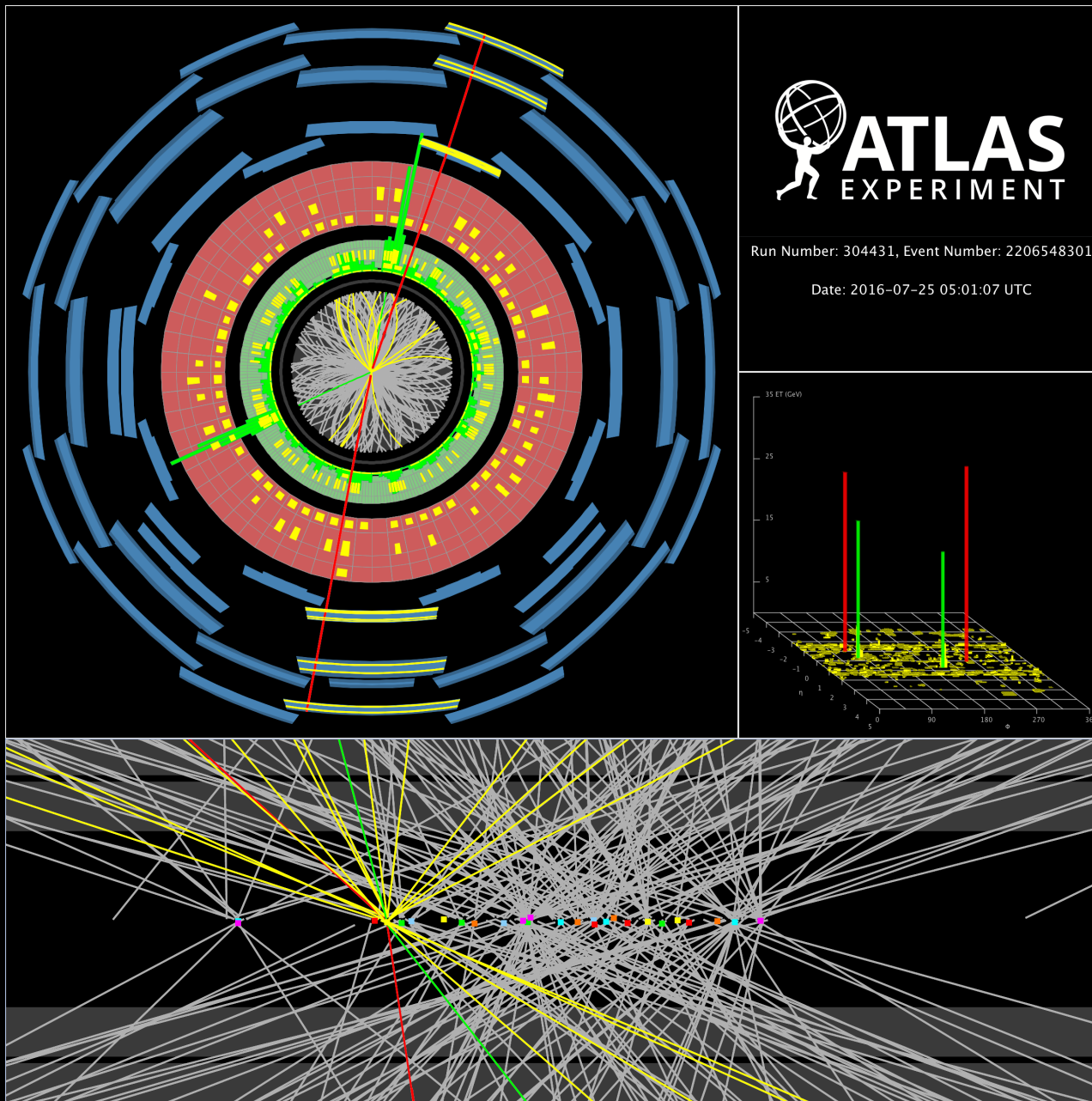
 **ATLAS**
EXPERIMENT

Run: 302393 Event: 264472429
2016-06-20 05:17:18 CEST

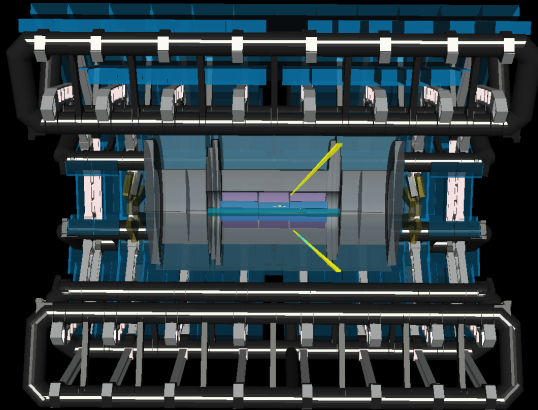
Event displays



Event displays



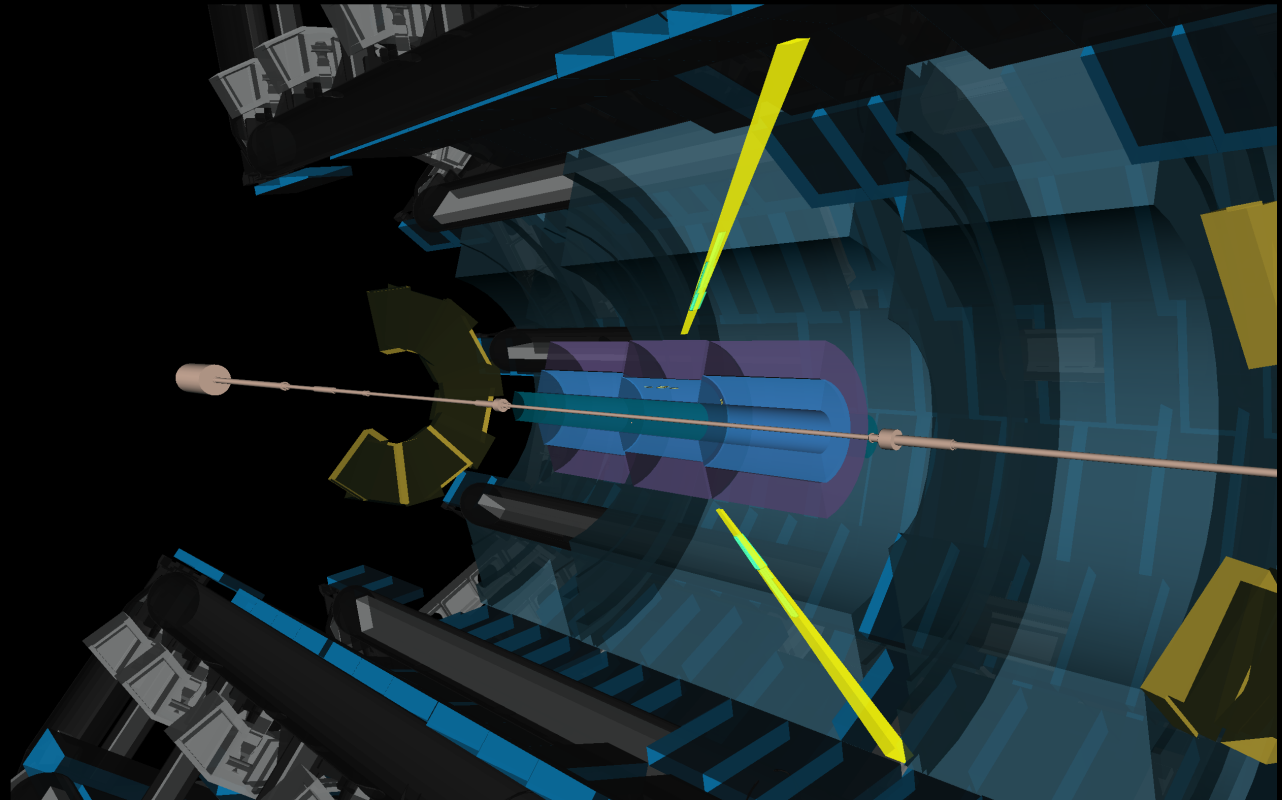
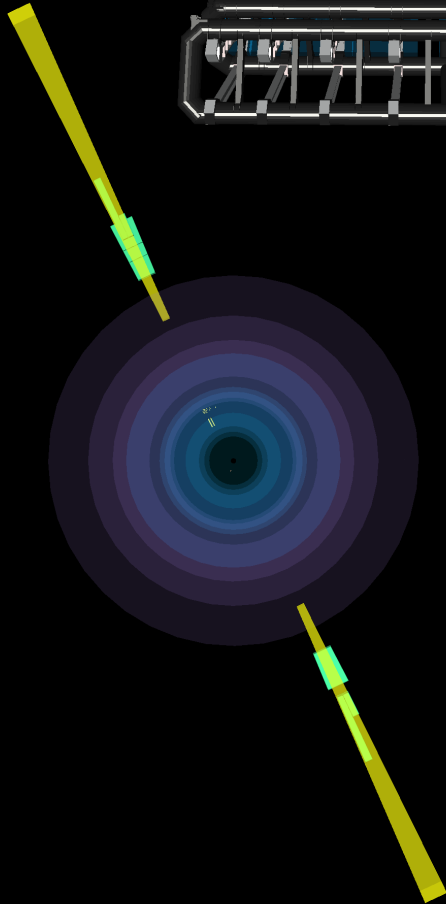
Event displays



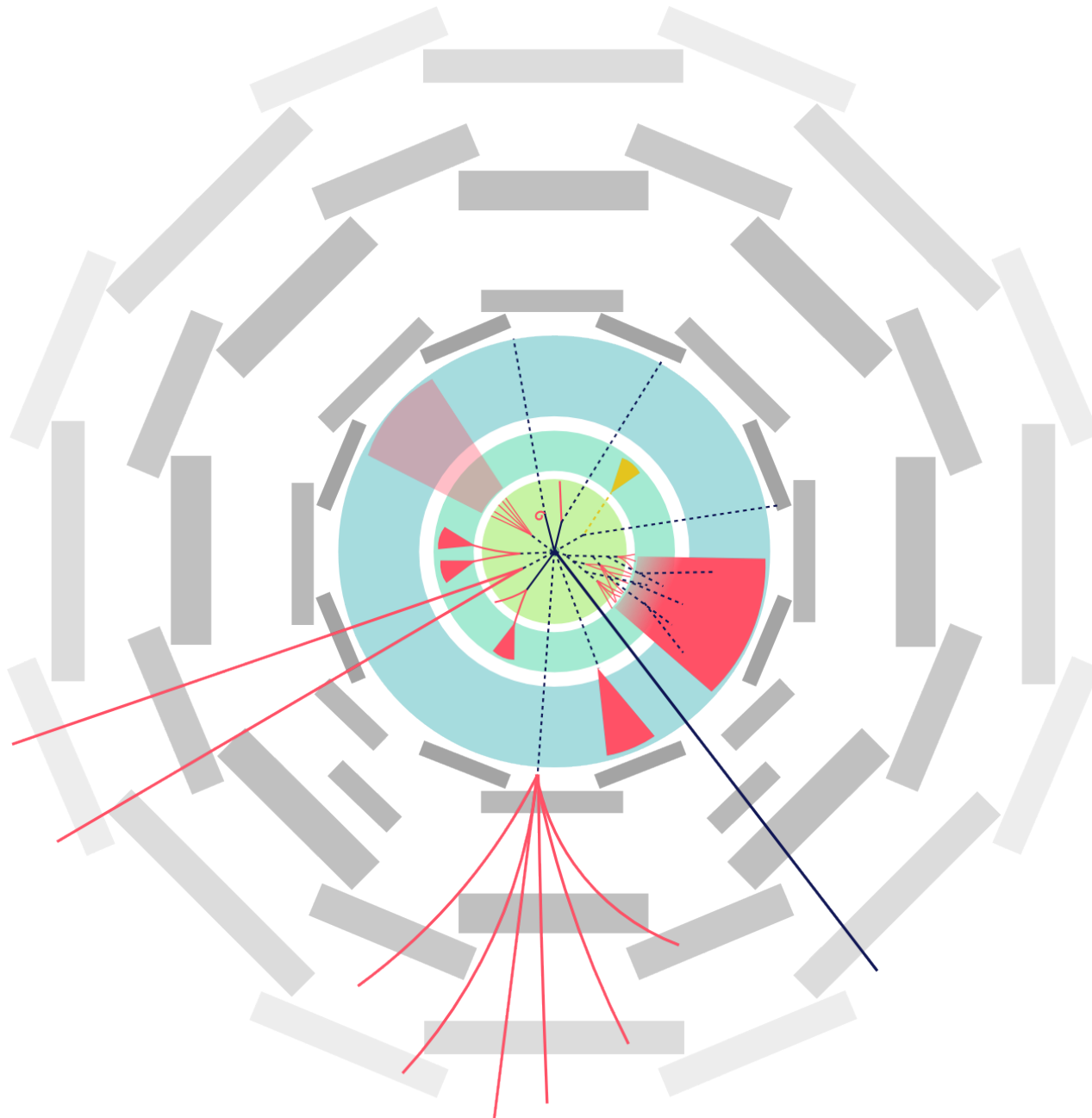
Run: 287931

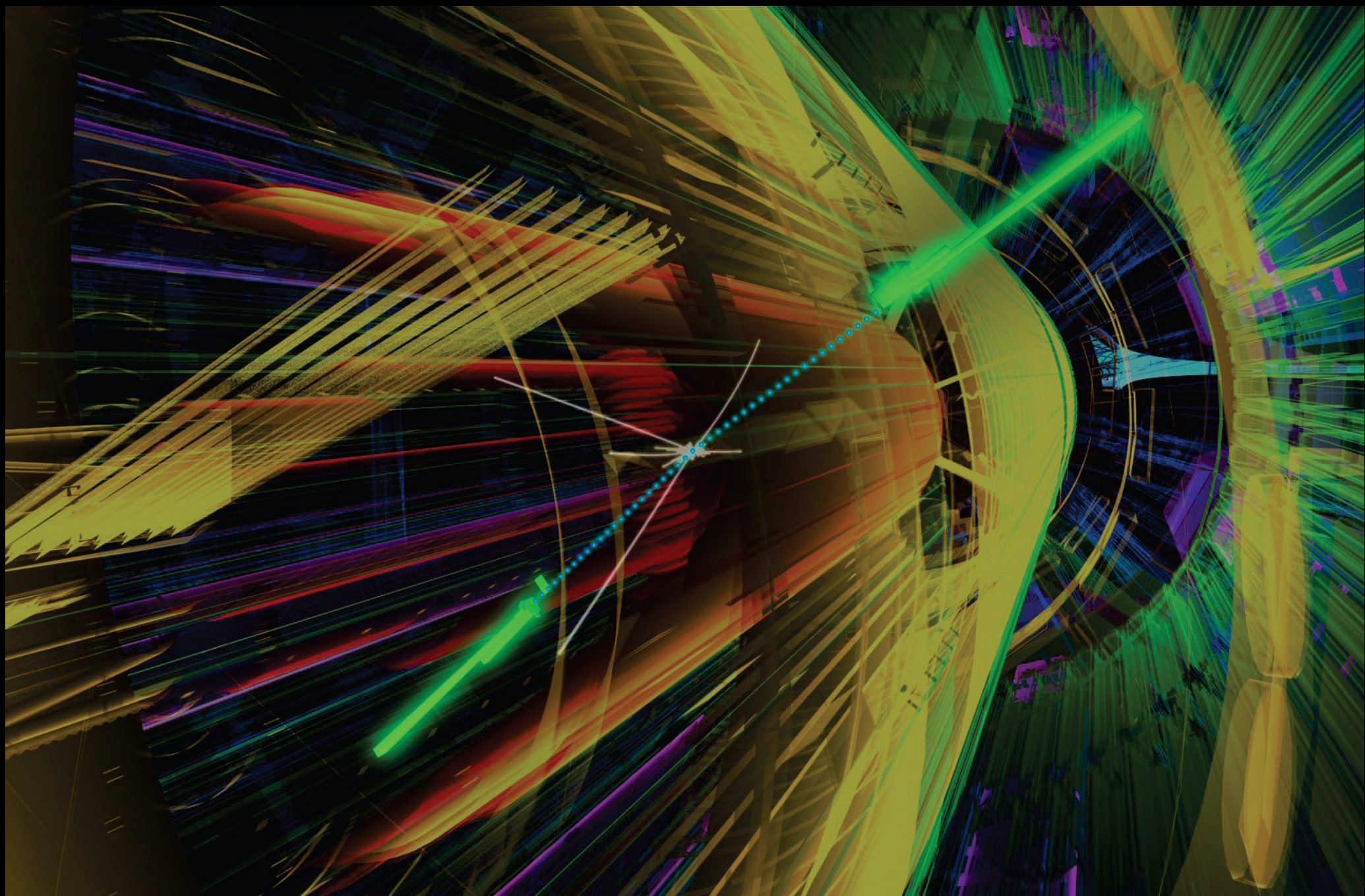
Event: 461251458

2015-12-13 09:51:07 CEST



Event displays

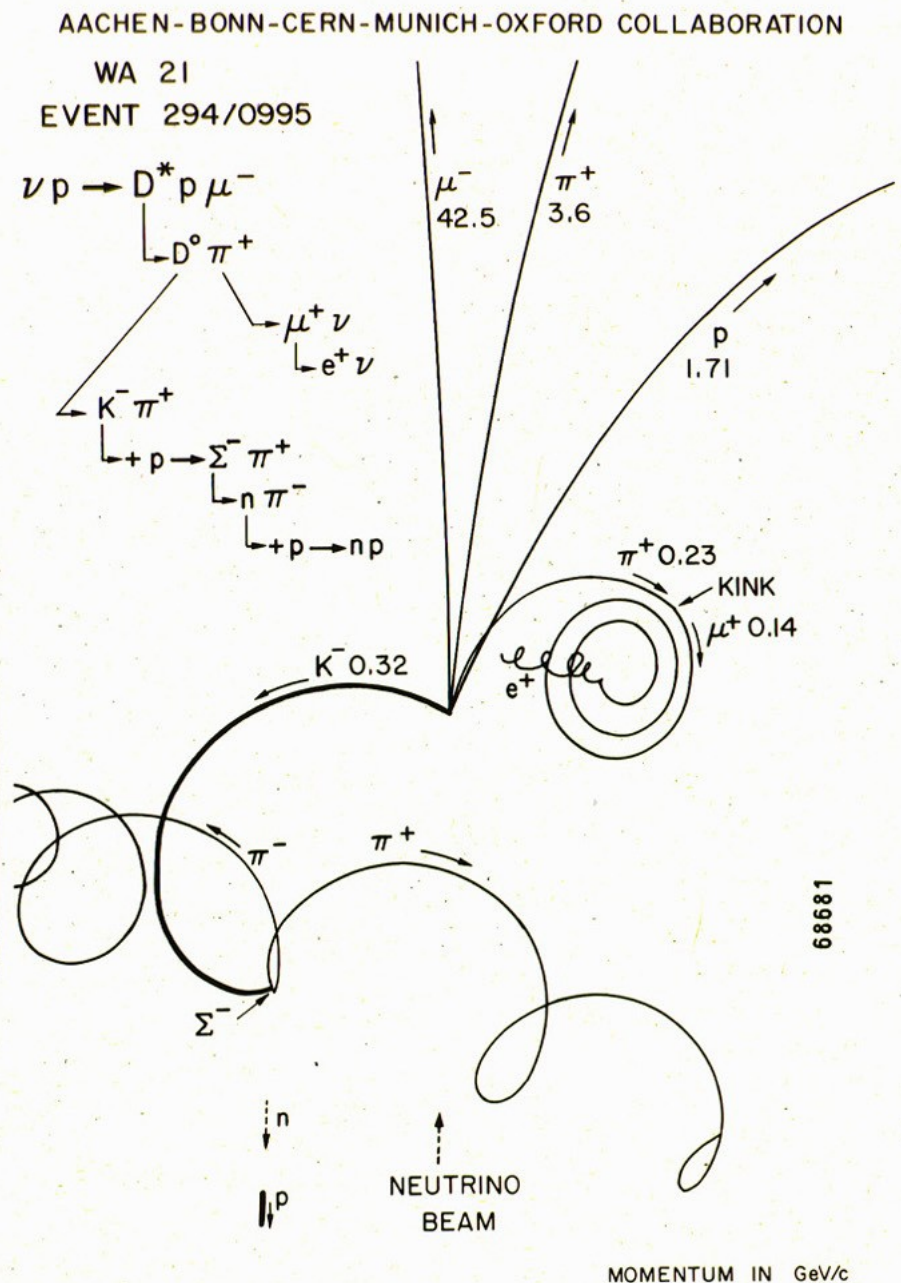
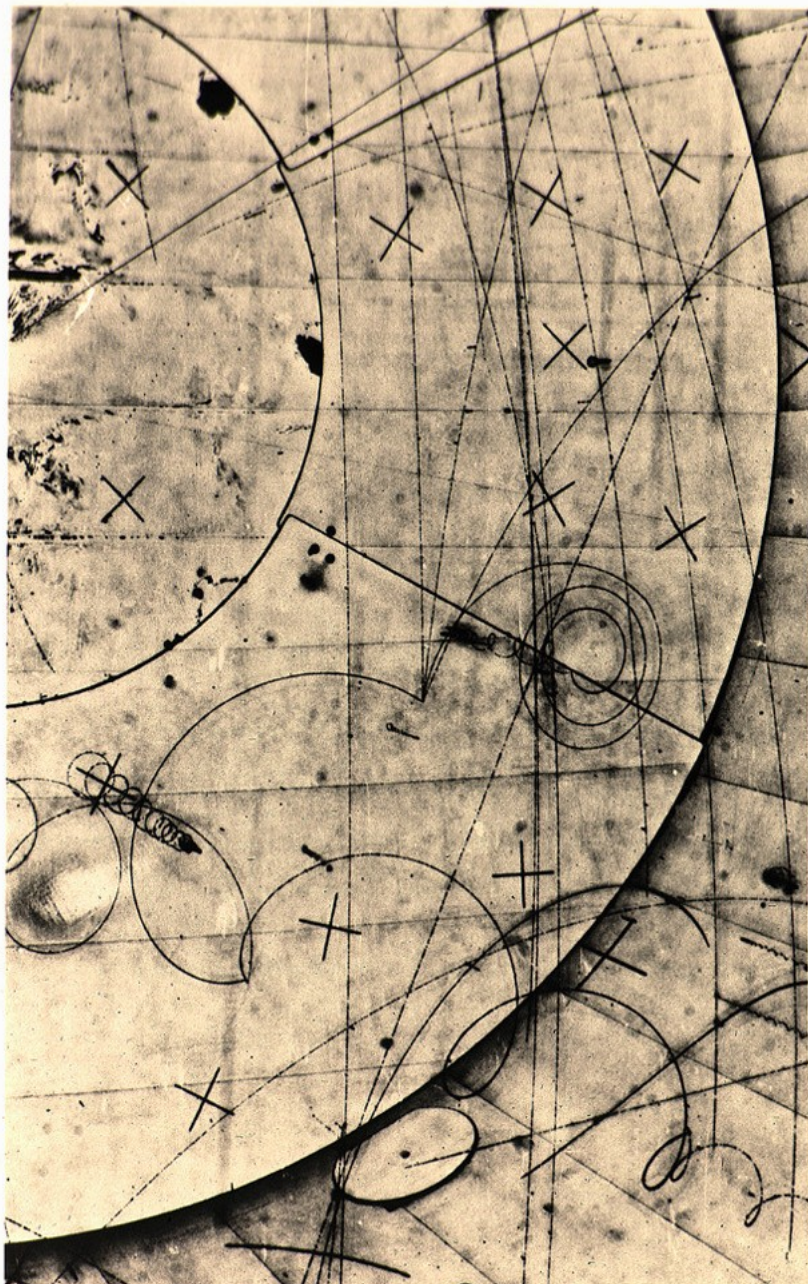




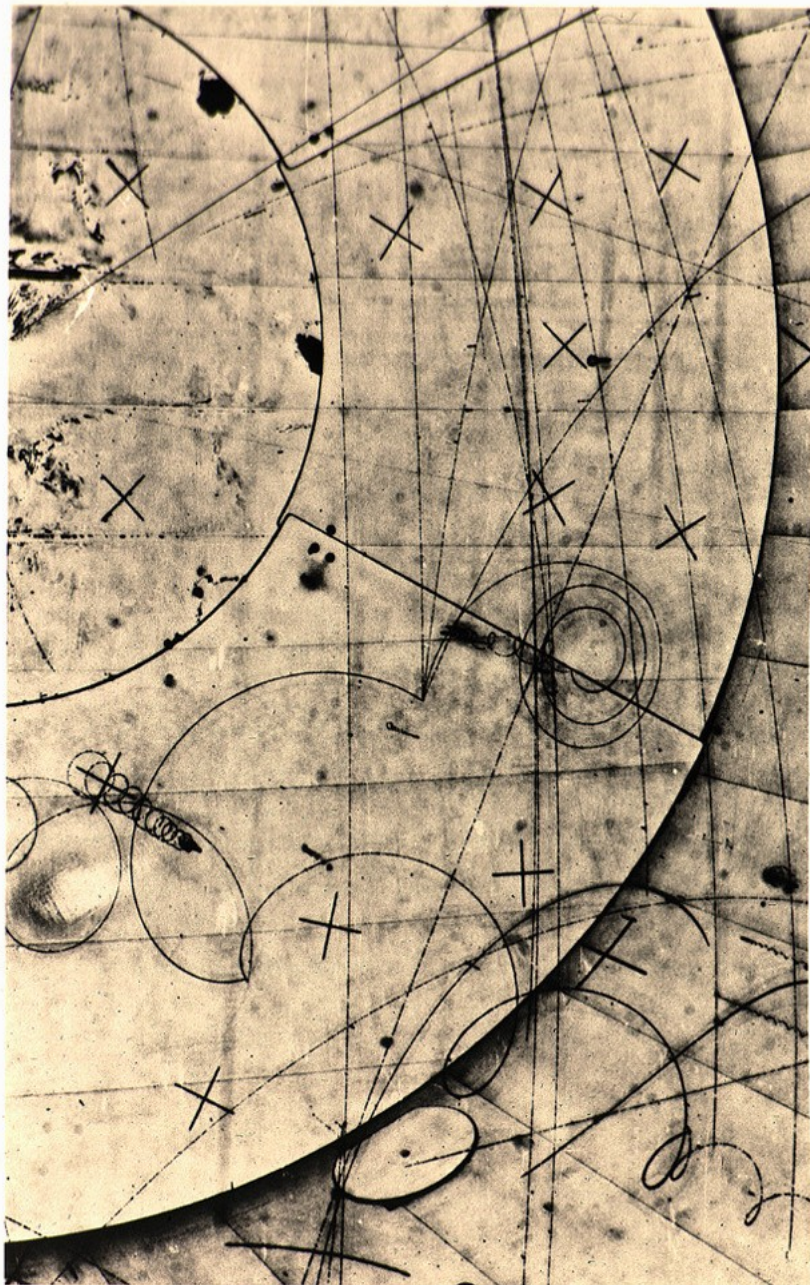
« Vraies » photographies



« Vraies » photographies



« Vraies » photographies



AACHEN-BONN-CERN-MUNICH-OXFORD COLLABORATION

EVER
 ν/p



KINK

.14

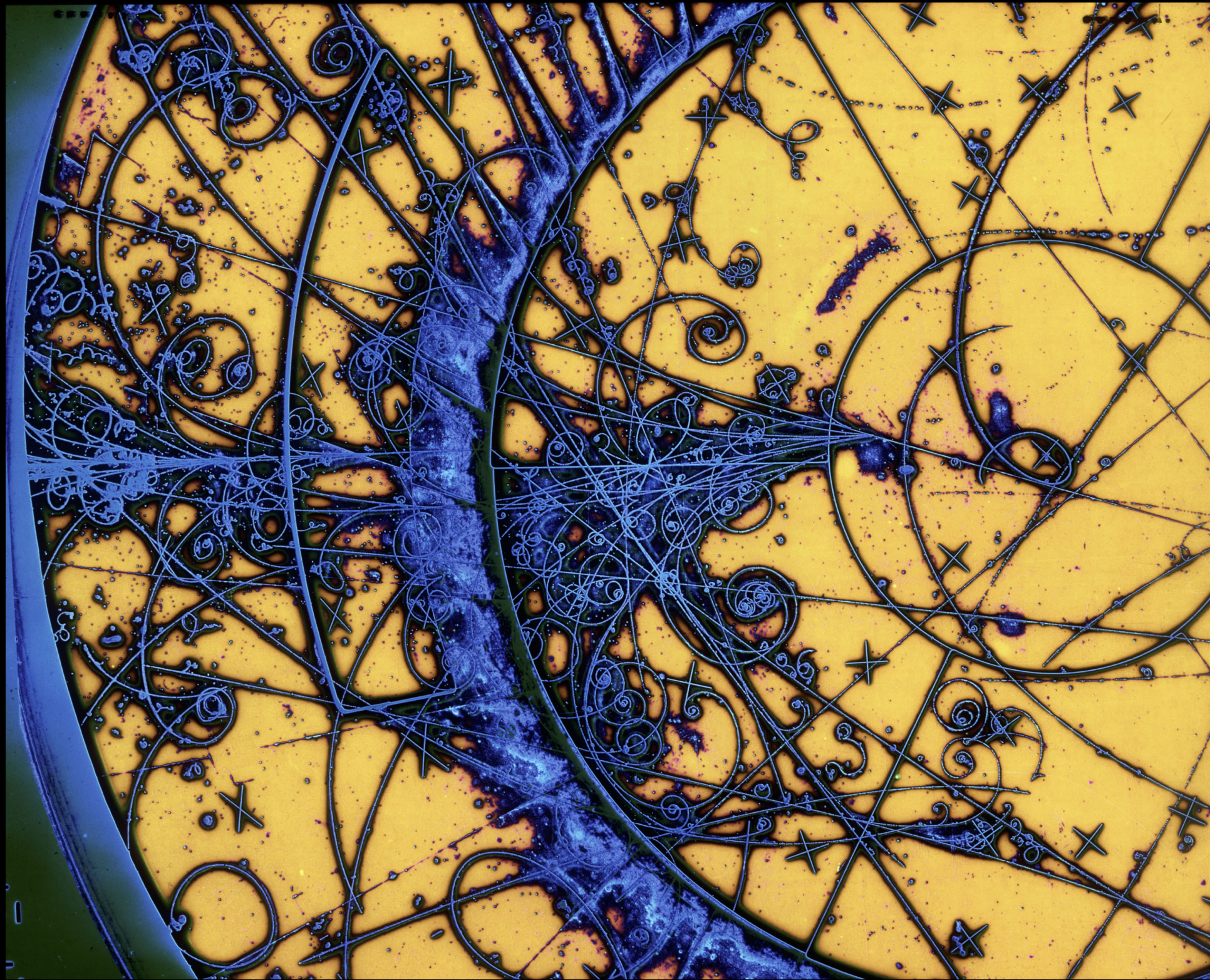


68681

n
 p

NEUTRINO
BEAM

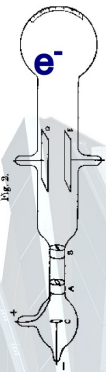
MOMENTUM IN GeV/c



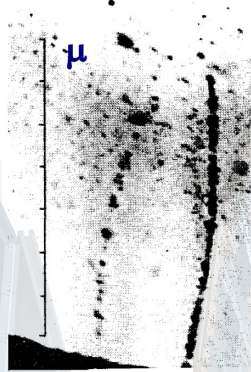
Le modèle standard redécouvert

LHC 2010 : un siècle en un an

Découverte
historique



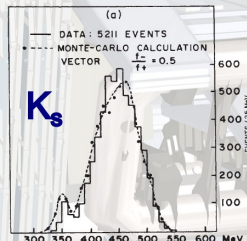
1897



1937



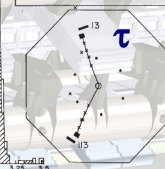
1947



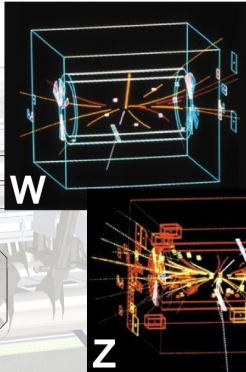
1964



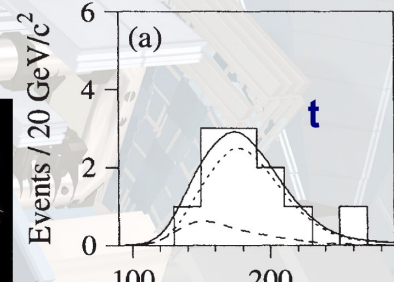
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1976



1983

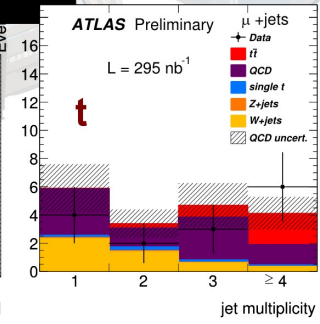
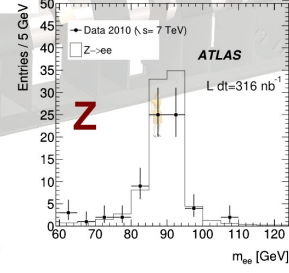
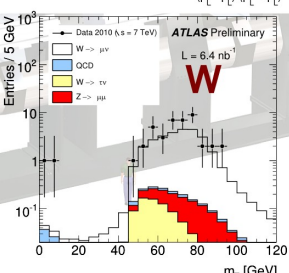
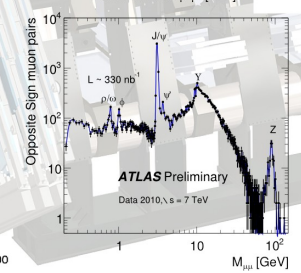
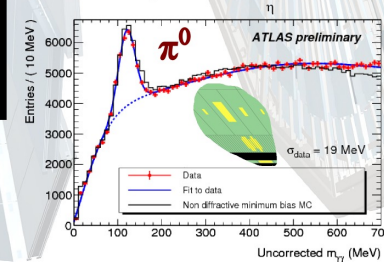
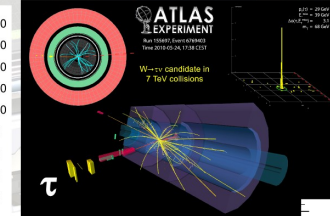
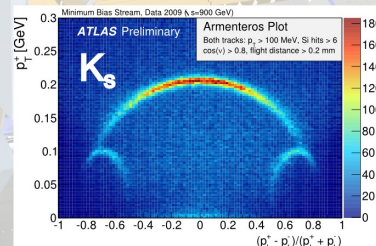
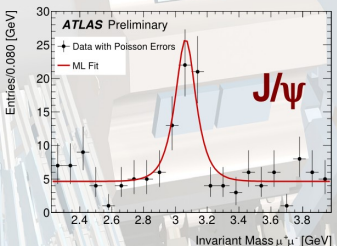
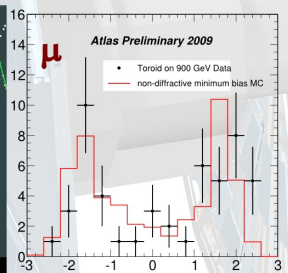
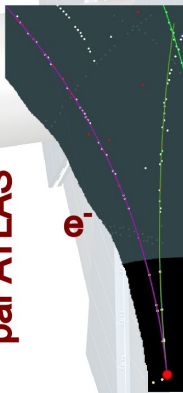


1995

déc 2009

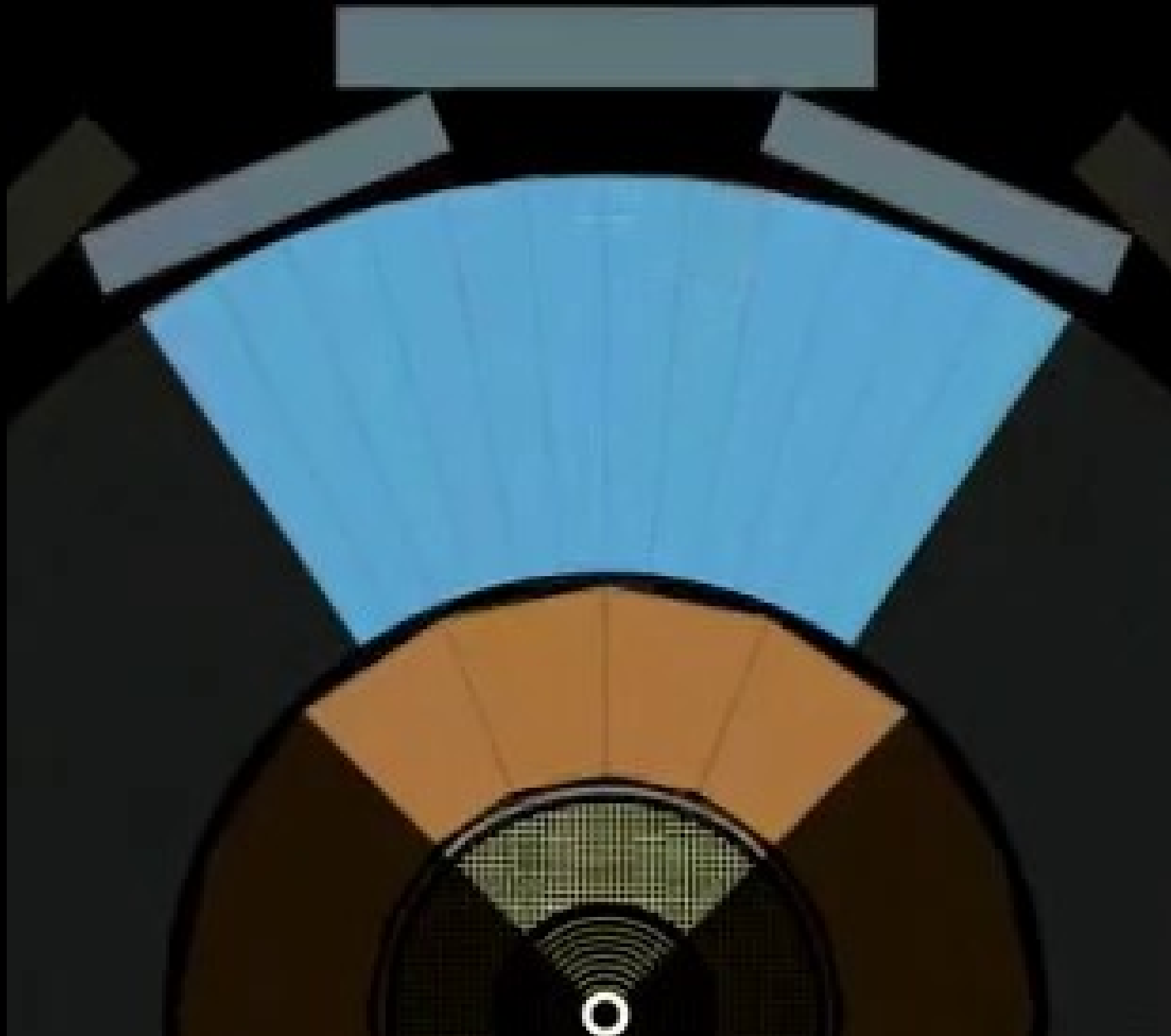
août 2010

Redécouverte
par ATLAS



Diagrammes de Feynman

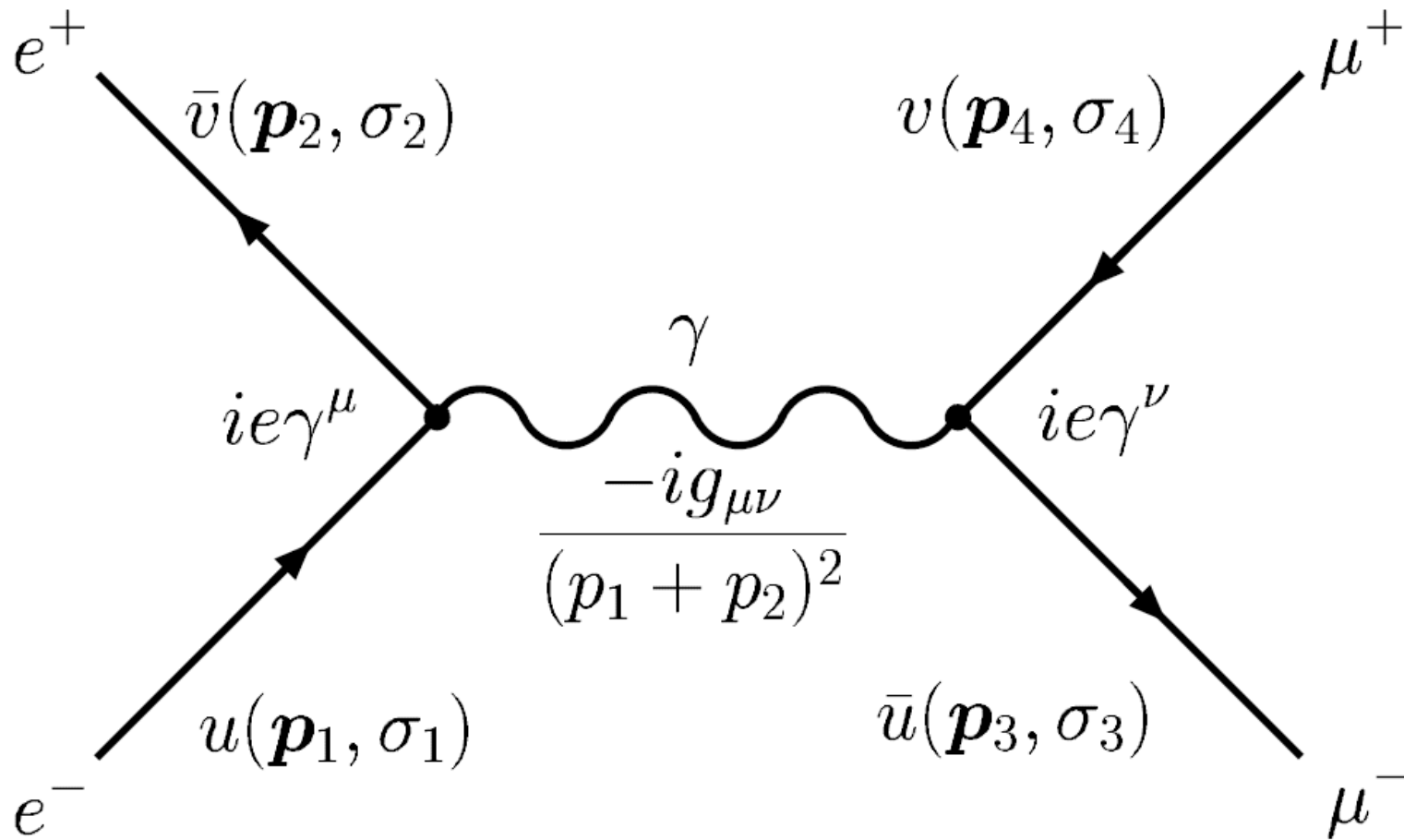
$$\mathcal{M} = \frac{e^2}{(p_1 + p_2)^2} [\bar{u}_3 \gamma_\mu v_4] [\bar{v}_2 \gamma^\mu u_1]$$

Diagrammes de Feynman



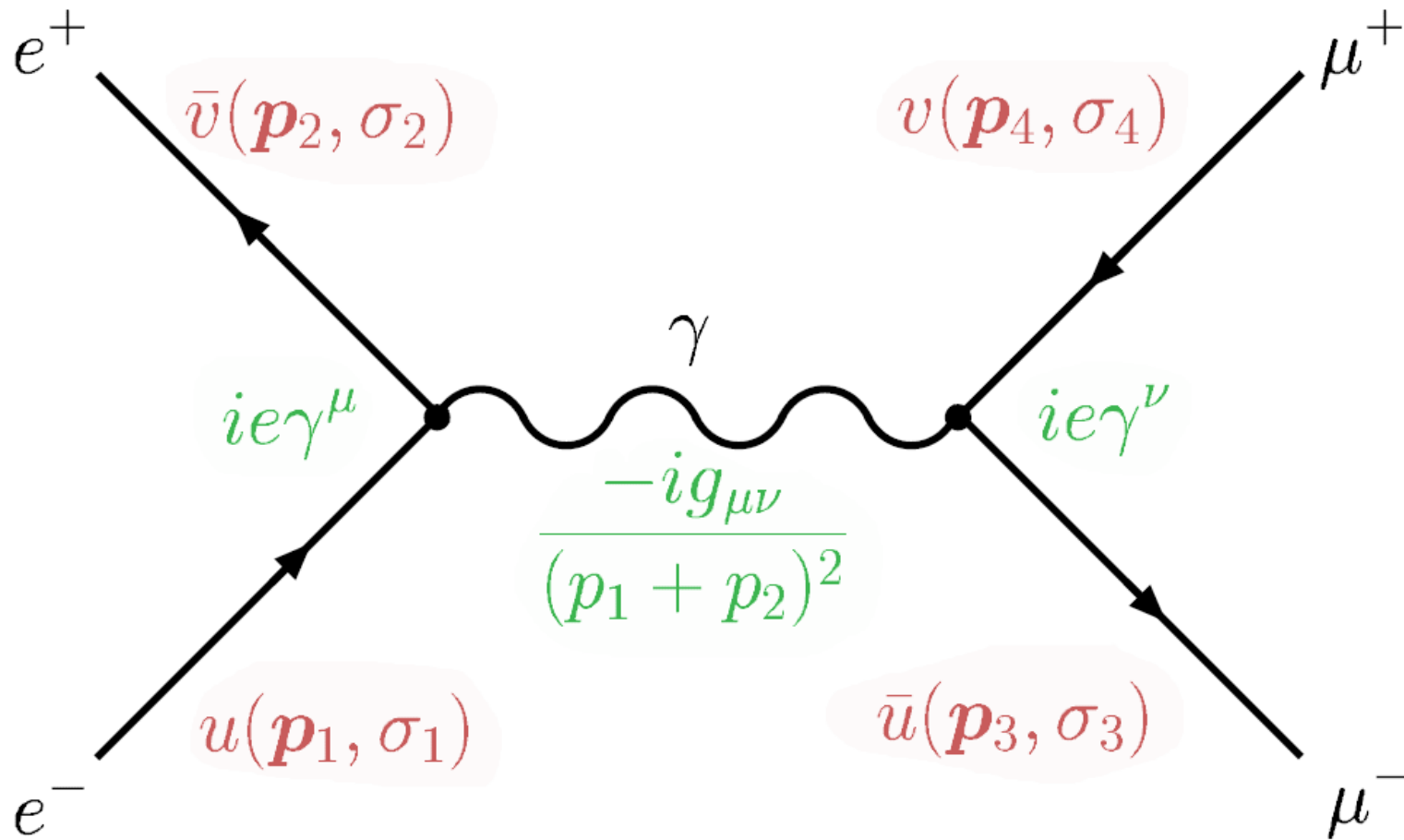
$$\mathcal{M} = \frac{e^2}{(p_1 + p_2)^2} [\bar{u}_3 \gamma_\mu v_4] [\bar{v}_2 \gamma^\mu u_1]$$

Diagrammes de Feynman



$$\mathcal{M} = \frac{e^2}{(p_1 + p_2)^2} [\bar{u}_3 \gamma_\mu v_4] [\bar{v}_2 \gamma^\mu u_1]$$

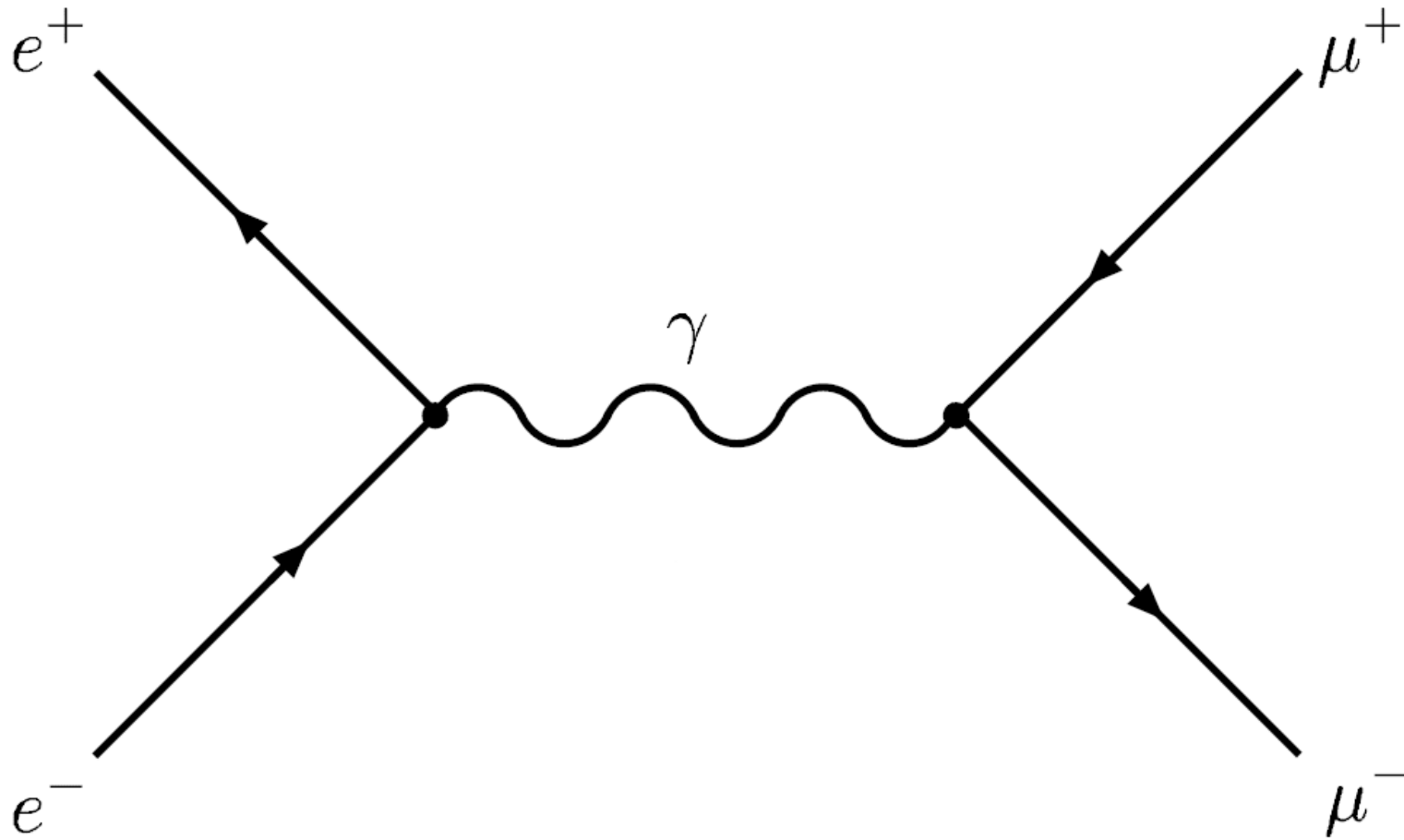
Diagrammes de Feynman



$$-i\mathcal{M} = [\bar{u}(p_3, \sigma_3)(ie\gamma^\nu)v(p_4, \sigma_4)] \frac{-ig_{\mu\nu}}{(p_1 + p_2)^2} [\bar{v}(p_2, \sigma_2)(ie\gamma^\mu)u(p_1, \sigma_1)]$$

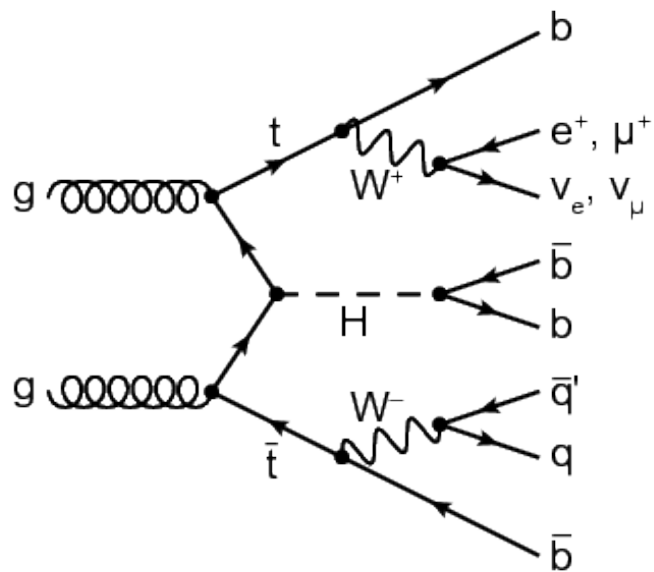
$$\mathcal{M} = \frac{e^2}{(p_1 + p_2)^2} [\bar{u}_3 \gamma_\mu v_4] [\bar{v}_2 \gamma^\mu u_1]$$

Diagrammes de Feynman

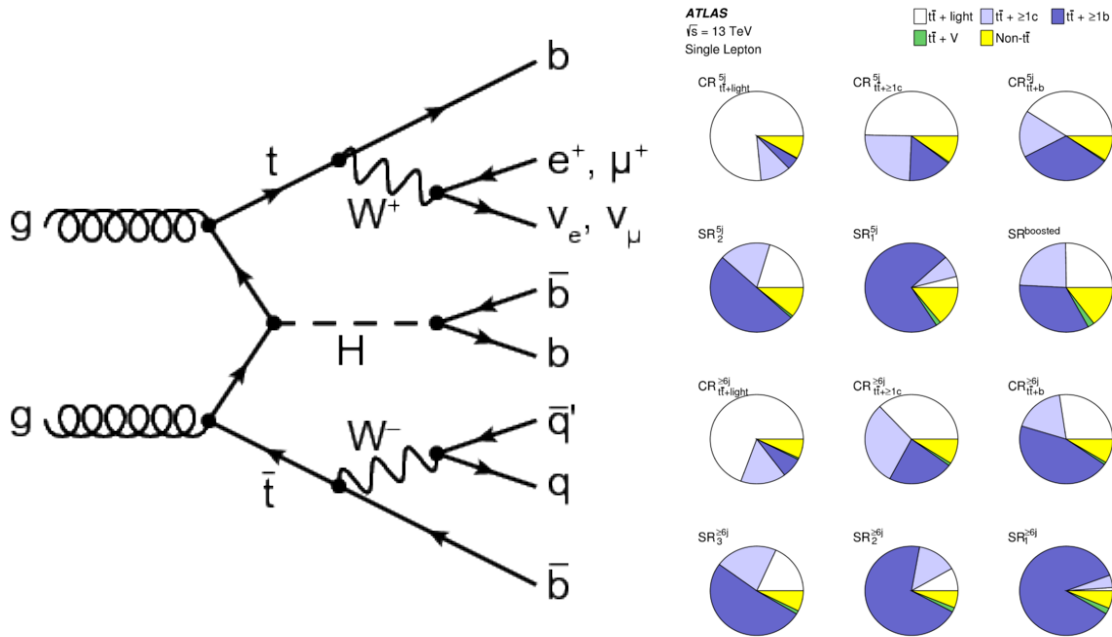


$$\mathcal{M} = \frac{e^2}{(p_1 + p_2)^2} [\bar{u}_3 \gamma_\mu v_4] [\bar{v}_2 \gamma^\mu u_1]$$

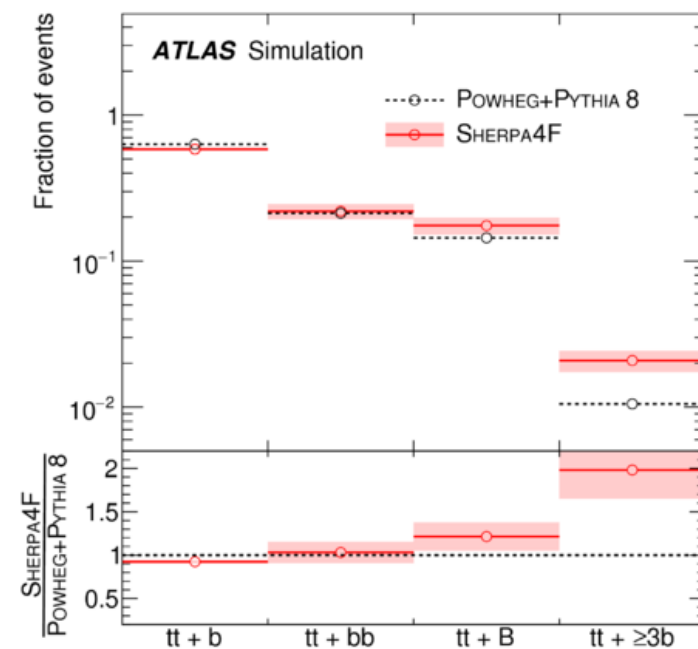
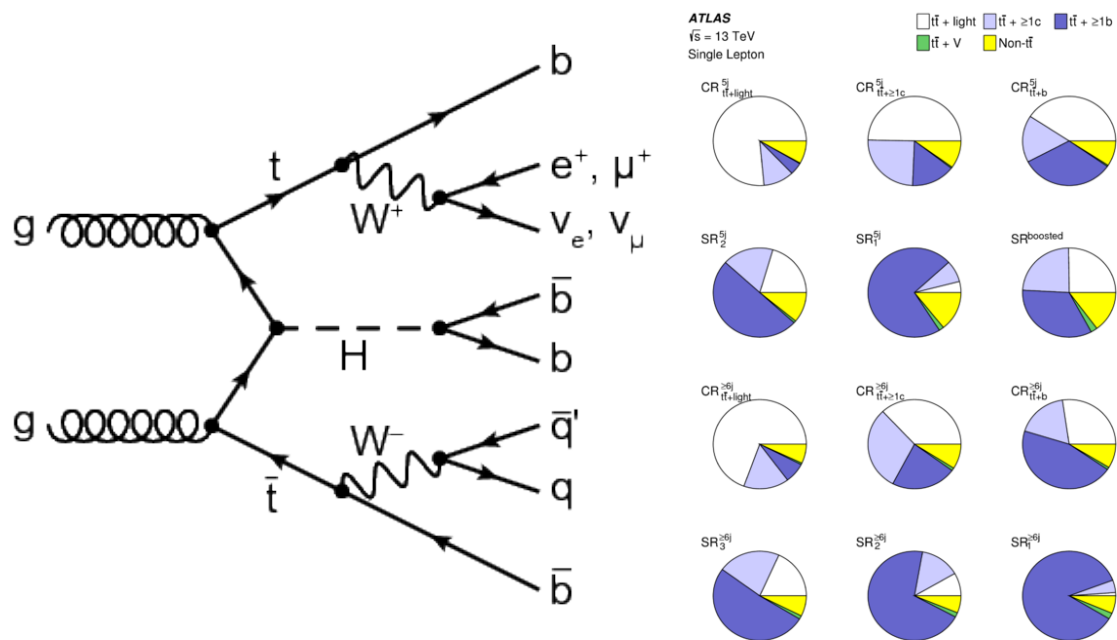
Analyse de données



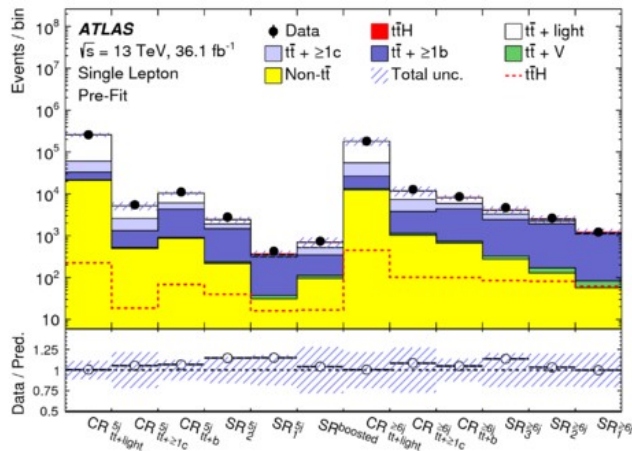
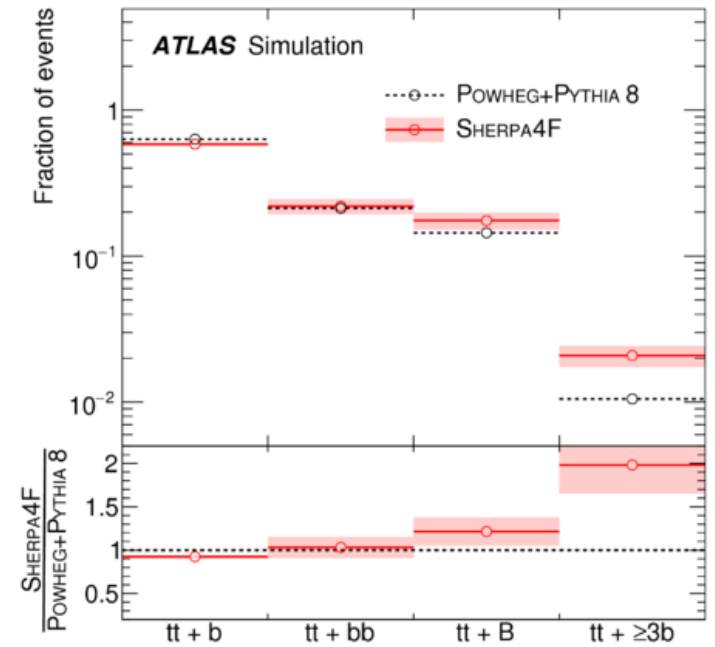
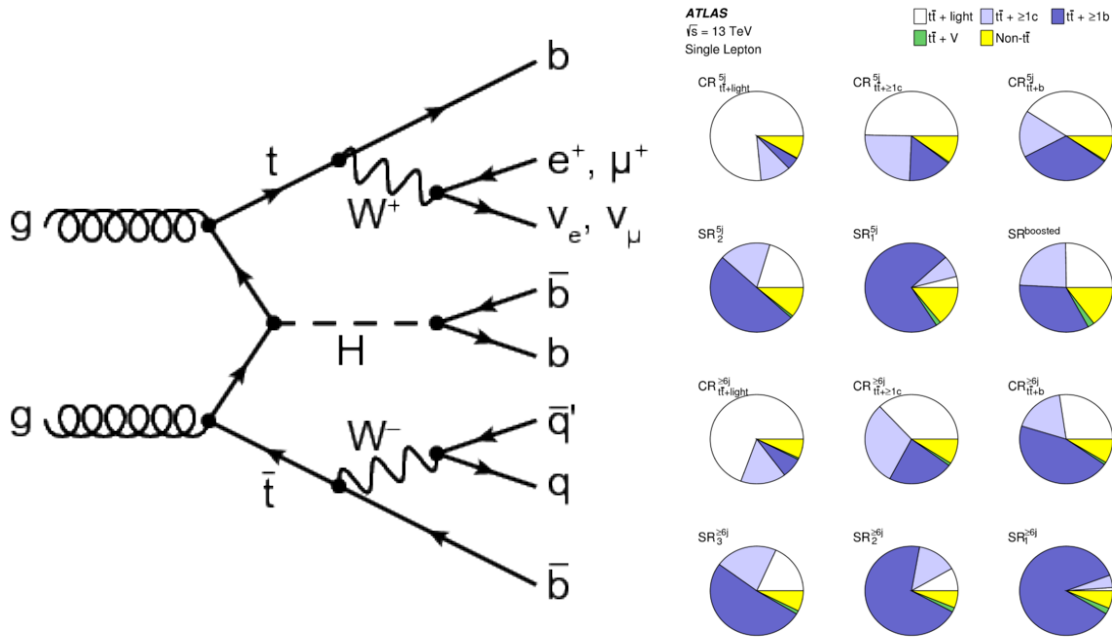
Analyse de données



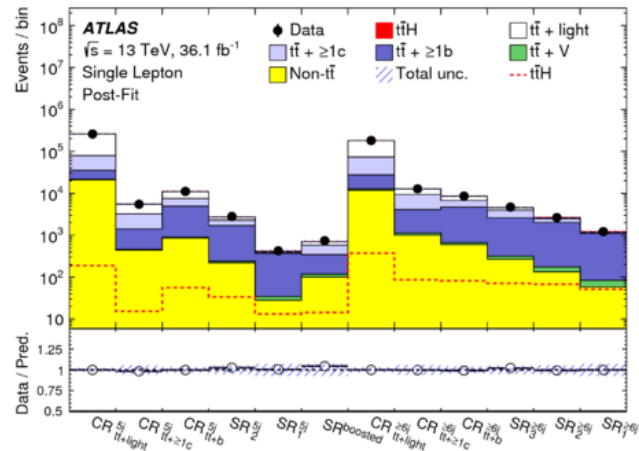
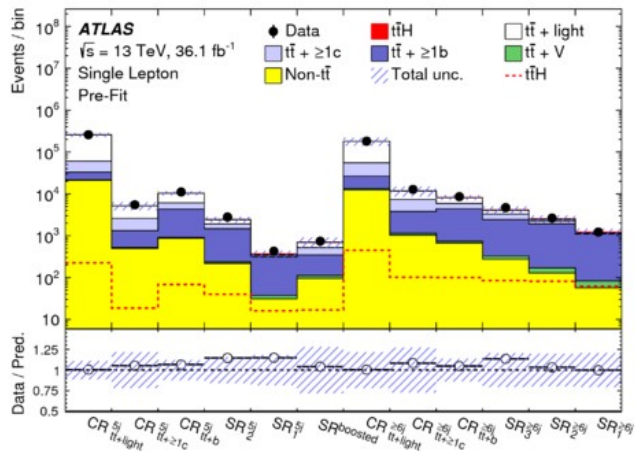
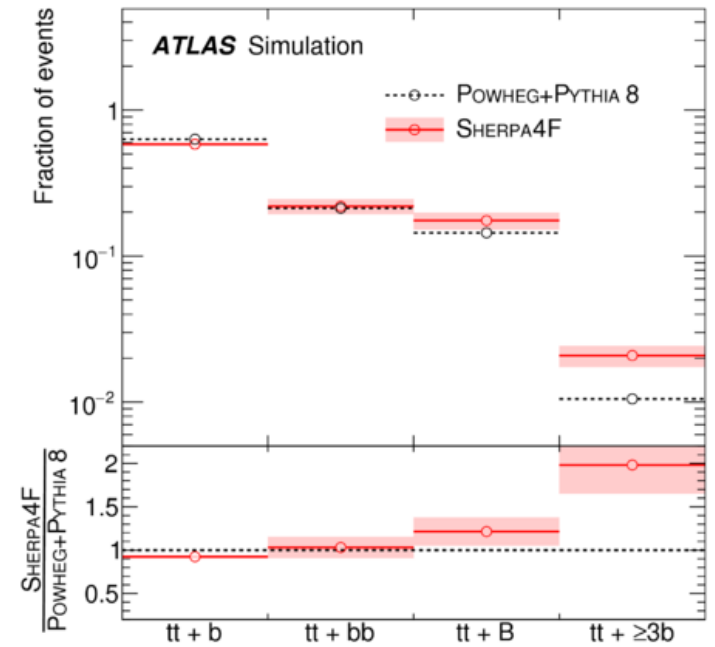
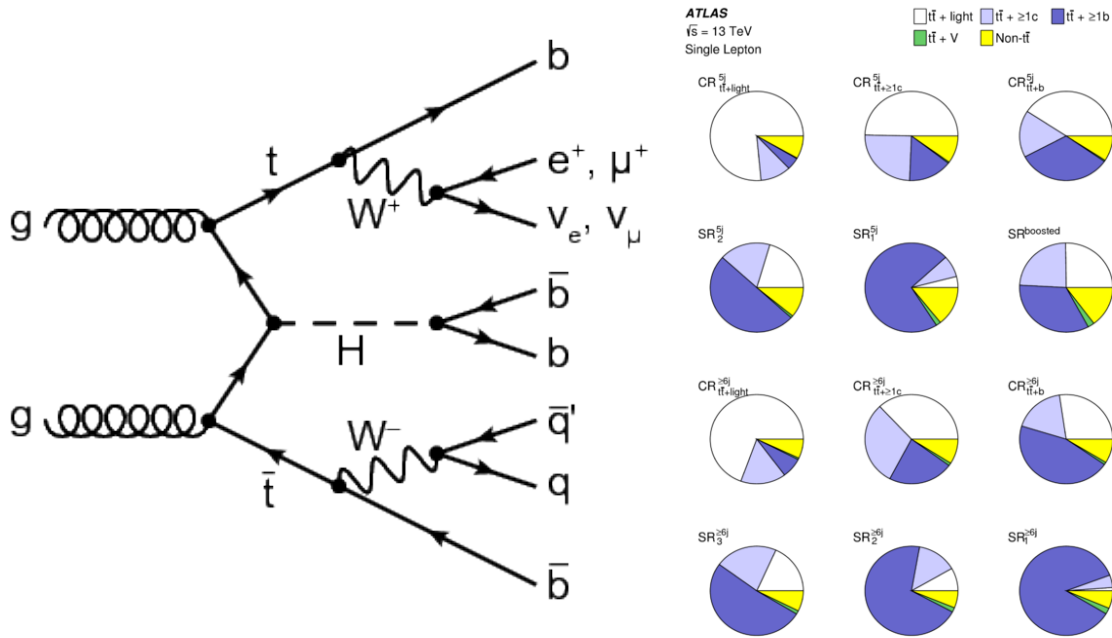
Analyse de données



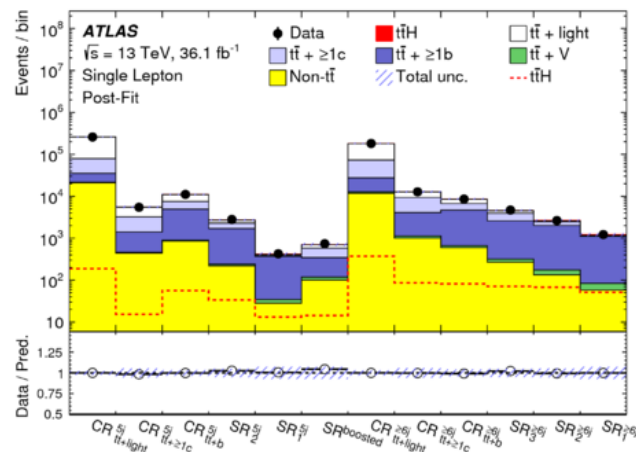
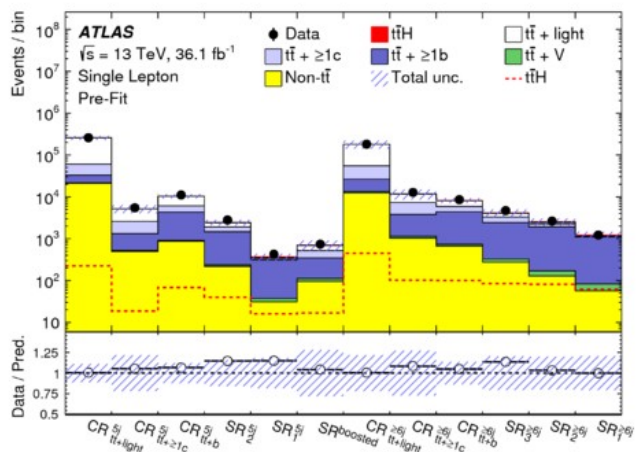
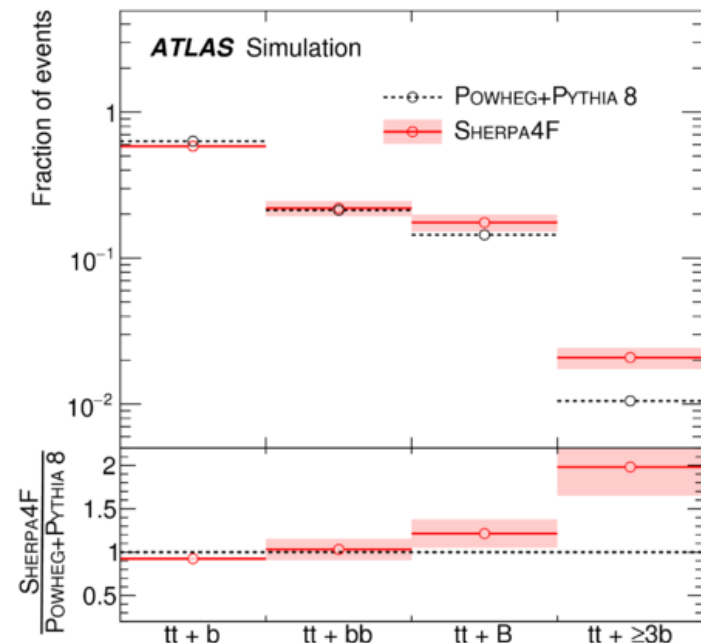
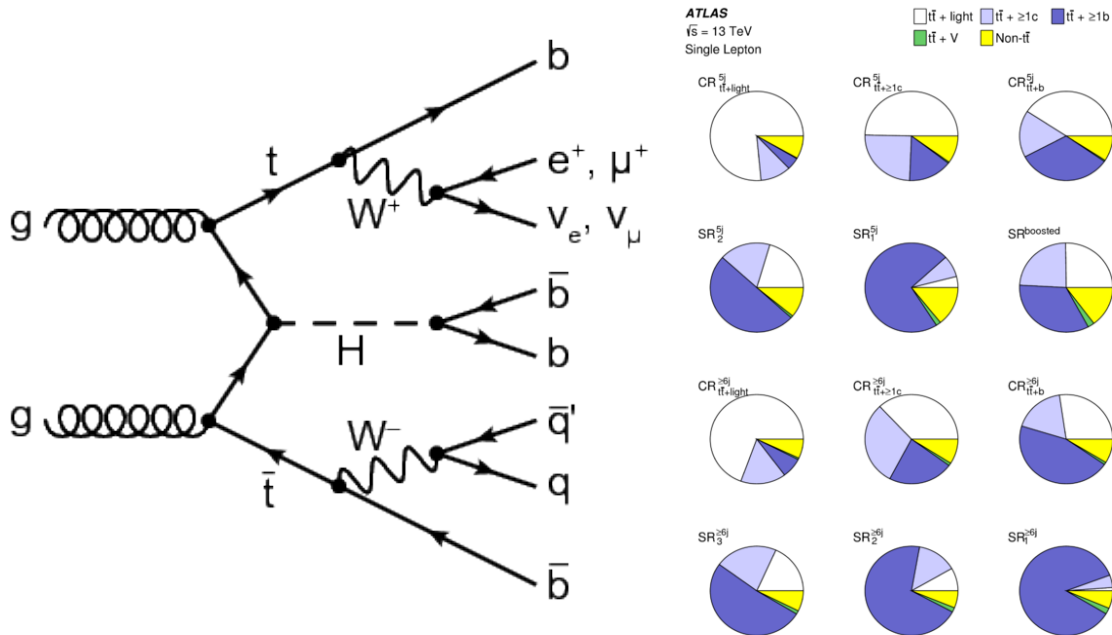
Analyse de données



Analyse de données



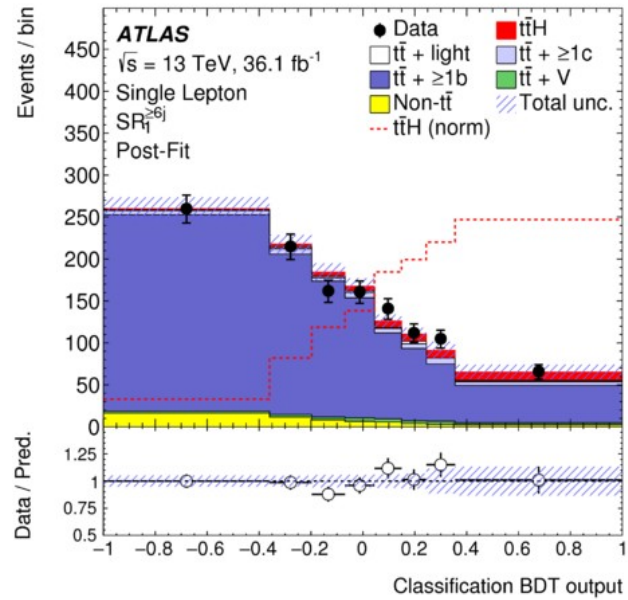
Analyse de données



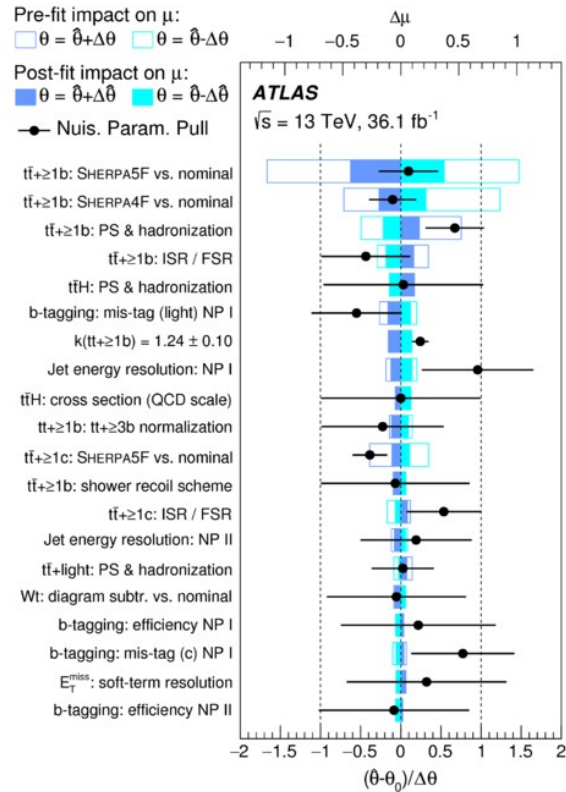
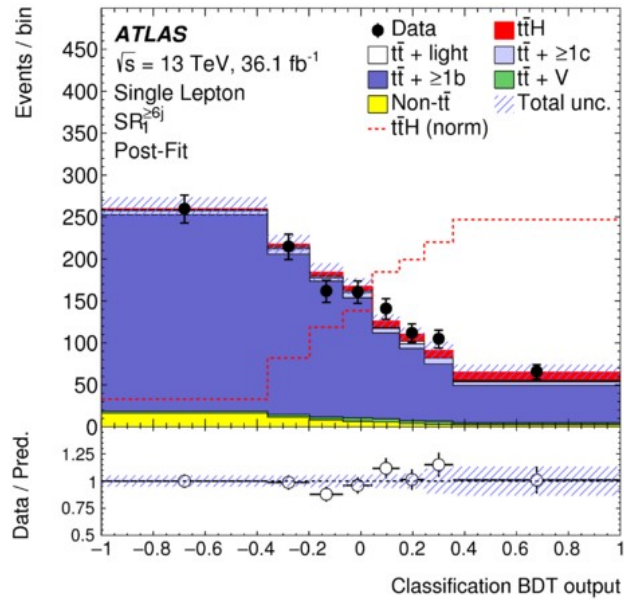
Sample	$CR_{t\bar{t}+\text{light}}^{5j}$		$CR_{t\bar{t}+\geq 1c}^{5j}$		$CR_{t\bar{t}+\geq 1b}^{5j}$	
	Pre-fit	Post-fit	Pre-fit	Post-fit	Pre-fit	Post-fit
$t\bar{t}H$	224 ± 22	190 ± 140	18.7 ± 2.5	15 ± 12	68.0 ± 7.6	57 ± 42
$t\bar{t} + \text{light}$	197 000 ± 26 000	179 900 ± 4900	2580 ± 720	2300 ± 210	4250 ± 920	3560 ± 240
$t\bar{t} + \geq 1c$	27 500 ± 4300	44 100 ± 5500	1280 ± 500	1840 ± 250	1770 ± 270	2590 ± 390
$t\bar{t} + \geq 1b$	11 300 ± 1100	13 500 ± 1300	790 ± 130	944 ± 94	3400 ± 440	4030 ± 320
$t\bar{t} + V$	589 ± 55	584 ± 54	23.2 ± 4.1	21.3 ± 2.9	48.1 ± 5.9	46.6 ± 5.4
Non- $t\bar{t}$	21 300 ± 4100	20 900 ± 3200	520 ± 180	440 ± 100	960 ± 190	860 ± 160
Total	258 000 ± 29 000	259 320 ± 910	5200 ± 1100	5560 ± 160	10 400 ± 1300	11 140 ± 290
Data	259 320		5465		11 095	

Sample	SR_2^{5j}		SR_1^{5j}		SR_{boosted}^{5j}	
	Pre-fit	Post-fit	Pre-fit	Post-fit	Pre-fit	Post-fit
$t\bar{t}H$	40.1 ± 5.1	34 ± 25	15.9 ± 2.1	13.3 ± 9.8	16.9 ± 1.9	14 ± 10
$t\bar{t} + \text{light}$	500 ± 210	393 ± 67	15 ± 33	12.5 ± 9.3	180 ± 120	112 ± 32
$t\bar{t} + \geq 1c$	436 ± 92	610 ± 100	30 ± 17	28 ± 14	168 ± 70	235 ± 39
$t\bar{t} + \geq 1b$	1230 ± 200	1450 ± 110	273 ± 53	335 ± 25	236 ± 89	229 ± 33
$t\bar{t} + V$	19.9 ± 2.9	19.7 ± 2.4	6.4 ± 1.3	6.4 ± 1.2	16.1 ± 2.9	16.6 ± 2.4
Non- $t\bar{t}$	269 ± 64	220 ± 52	54 ± 11	28.1 ± 8.4	104 ± 30	101 ± 26
Total	2440 ± 390	2724 ± 70	371 ± 68	423 ± 23	710 ± 200	708 ± 40
Data	2798		426		740	

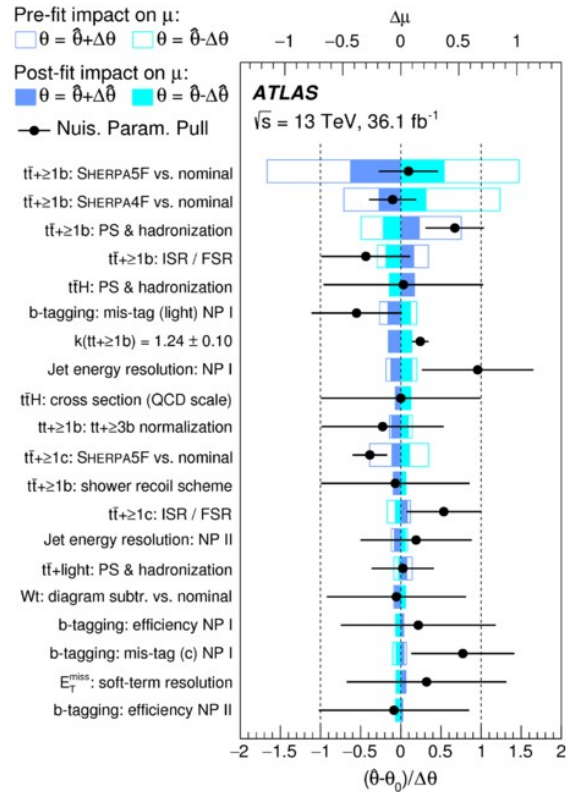
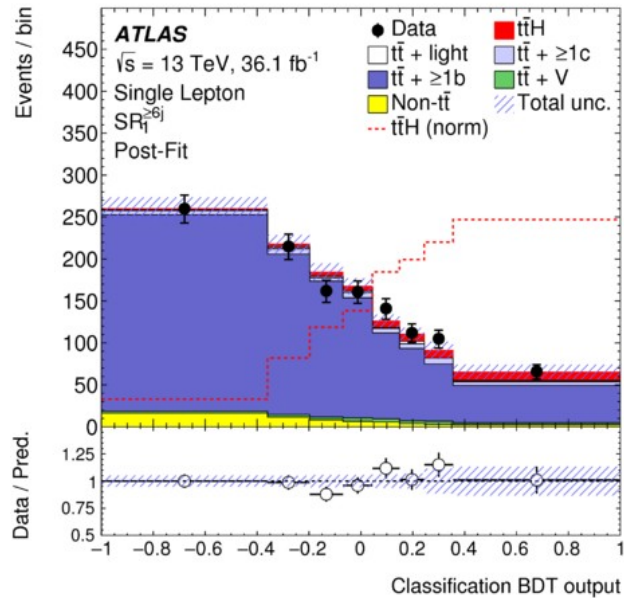
Analyse de données



Analyse de données

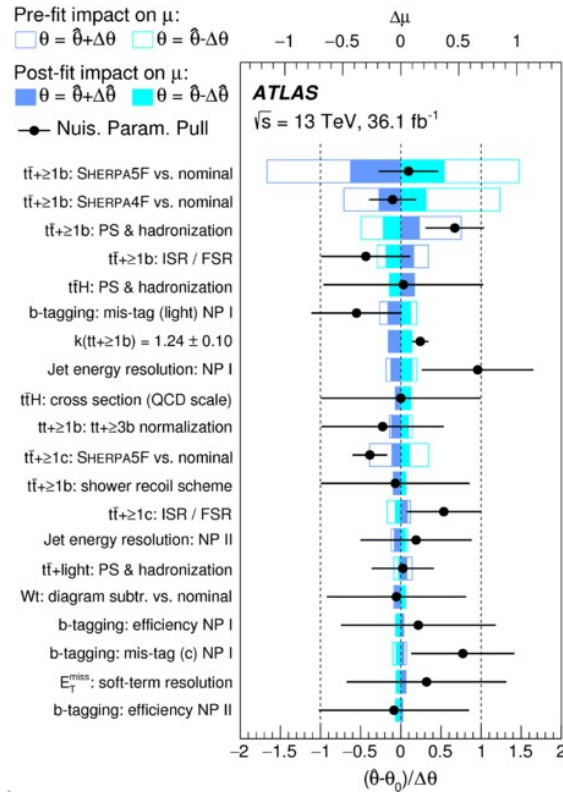
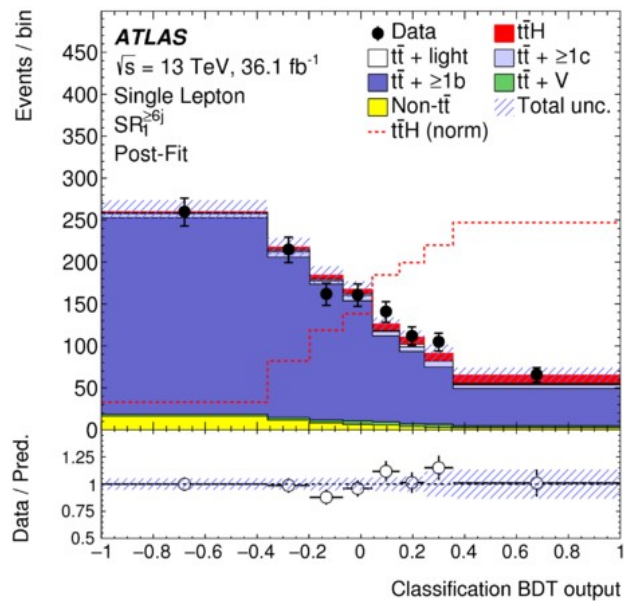


Analyse de données

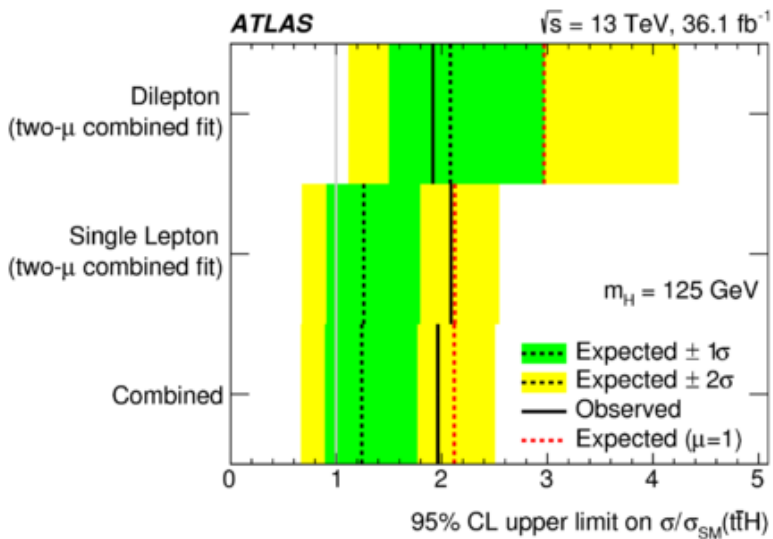


Uncertainty source	$\Delta\mu$	
$tt + \geq 1b$ modeling	+0.46	-0.46
Background-model stat. unc.	+0.29	-0.31
b -tagging efficiency and mis-tag rates	+0.16	-0.16
Jet energy scale and resolution	+0.14	-0.14
ttH modeling	+0.22	-0.05
$tt + \geq 1c$ modeling	+0.09	-0.11
JVT, pileup modeling	+0.03	-0.05
Other background modeling	+0.08	-0.08
$tt + \text{light}$ modeling	+0.06	-0.03
Luminosity	+0.03	-0.02
Light lepton (e, μ) id., isolation, trigger	+0.03	-0.04
Total systematic uncertainty	+0.57	-0.54
$tt + \geq 1b$ normalization	+0.09	-0.10
$tt + \geq 1c$ normalization	+0.02	-0.03
Intrinsic statistical uncertainty	+0.21	-0.20
Total statistical uncertainty	+0.29	-0.29
Total uncertainty	+0.64	-0.61

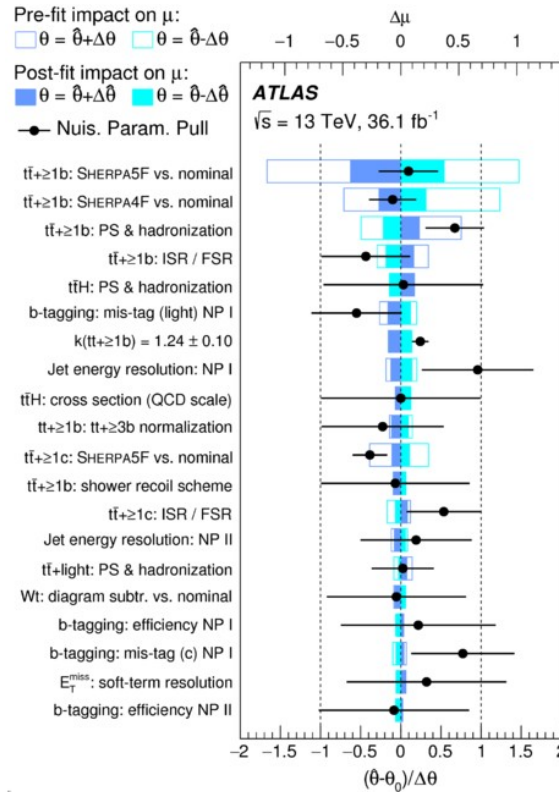
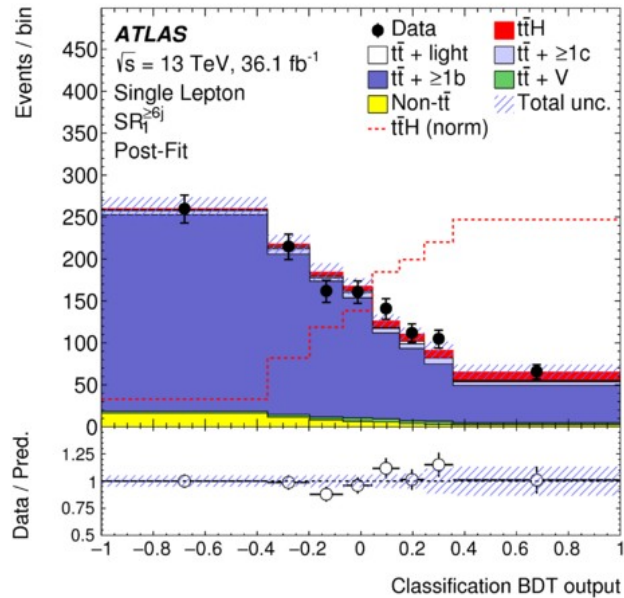
Analyse de données



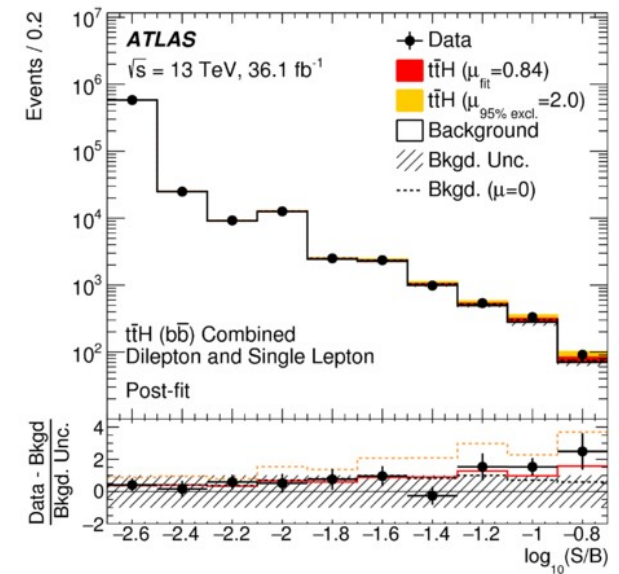
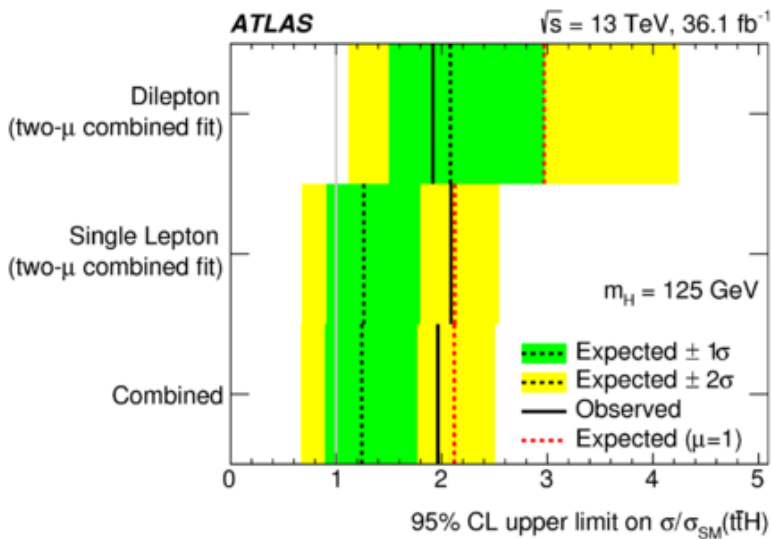
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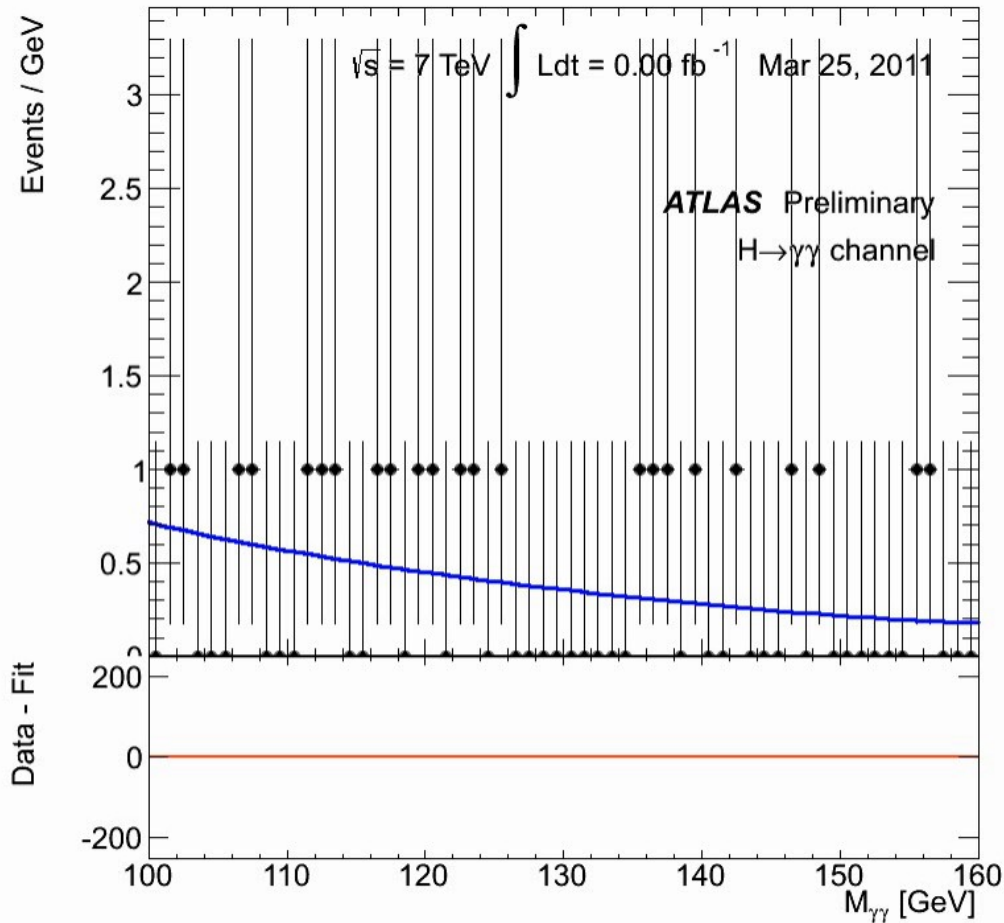
Analyse de données



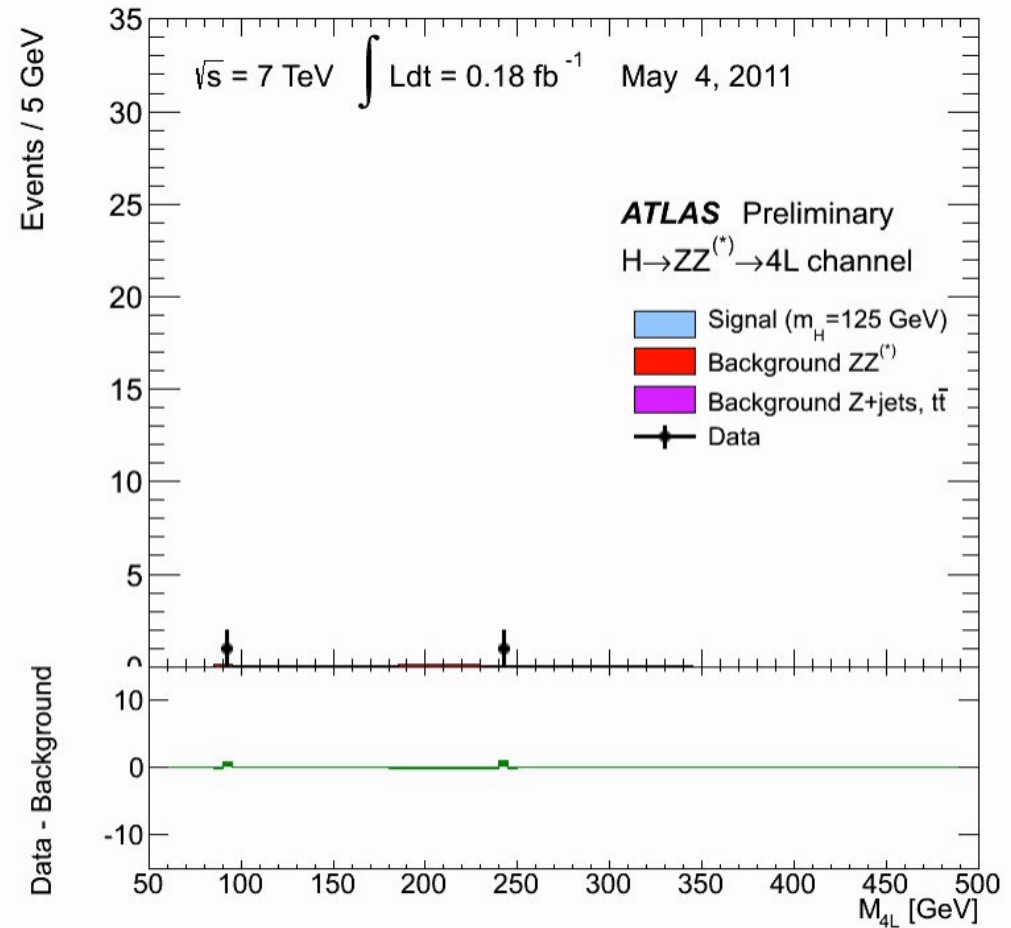
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Analyse de données

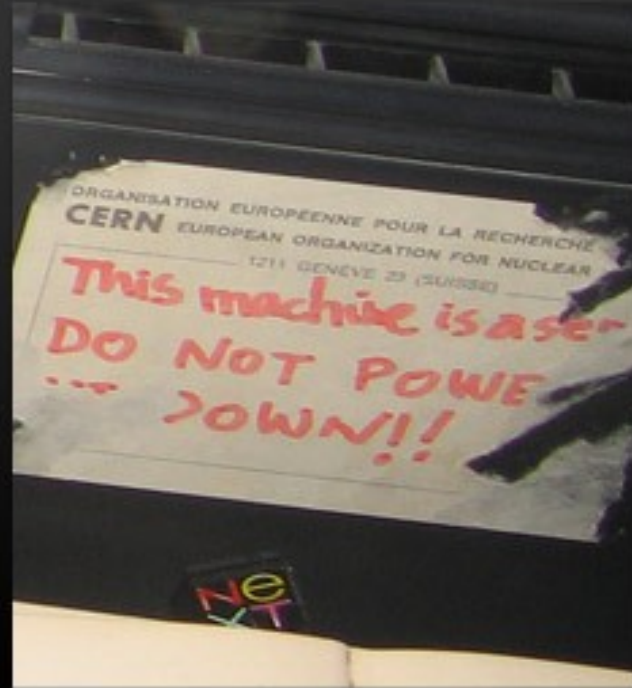


$$H \rightarrow \gamma\gamma$$



$$H \rightarrow ZZ^* \rightarrow 4l$$

CERN, where the Web was born!



« vague, but exciting »



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À SA CRÉATION)



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HO! UN BOSON
HIGGS !!!



Mécanisme de Higgs

