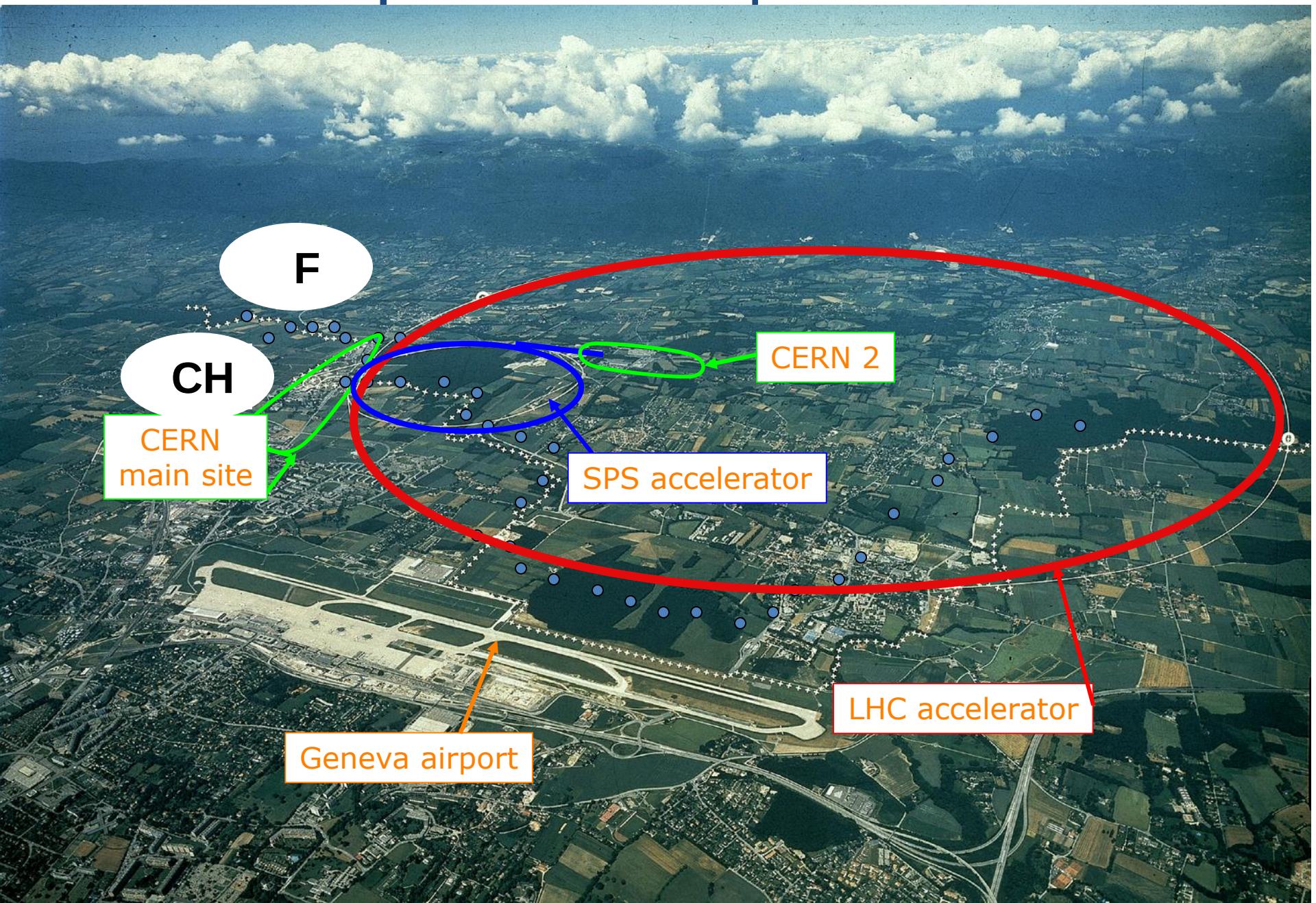
Ласкаво просимо в ЦЕРН!



Короткая биография

1991-1996 Физ-мат лицей 27, г. Харьков

1996-2002 Харьковский национальный университет имени В. Н. Каразина, физ. фак.

1997-2000 Liverpool University, Mphys

1998 CERN Summer Student

2000-2006 Stanford University, PhD

“Изучение распадов Б мезонов на протон-антипротон и адрон на эксперименте BaBar (SLAC)”

2006-2008 Церн Fellow, эксперимент АТЛАС

2008- LAPP, эксперимент АТЛАС

2011-2013, 2016- Организация с Малой Академией школ для украинских учителей в ЦЕРНе

CERN основан в 1954: 12 Европейских стран

"Наука во имя мира"

Сегодня: 22 страна-участница

~ 2300 штатных сотрудников
~ 1050 контрактников
> 10000 пользователей
Budget ~1000 MCHF

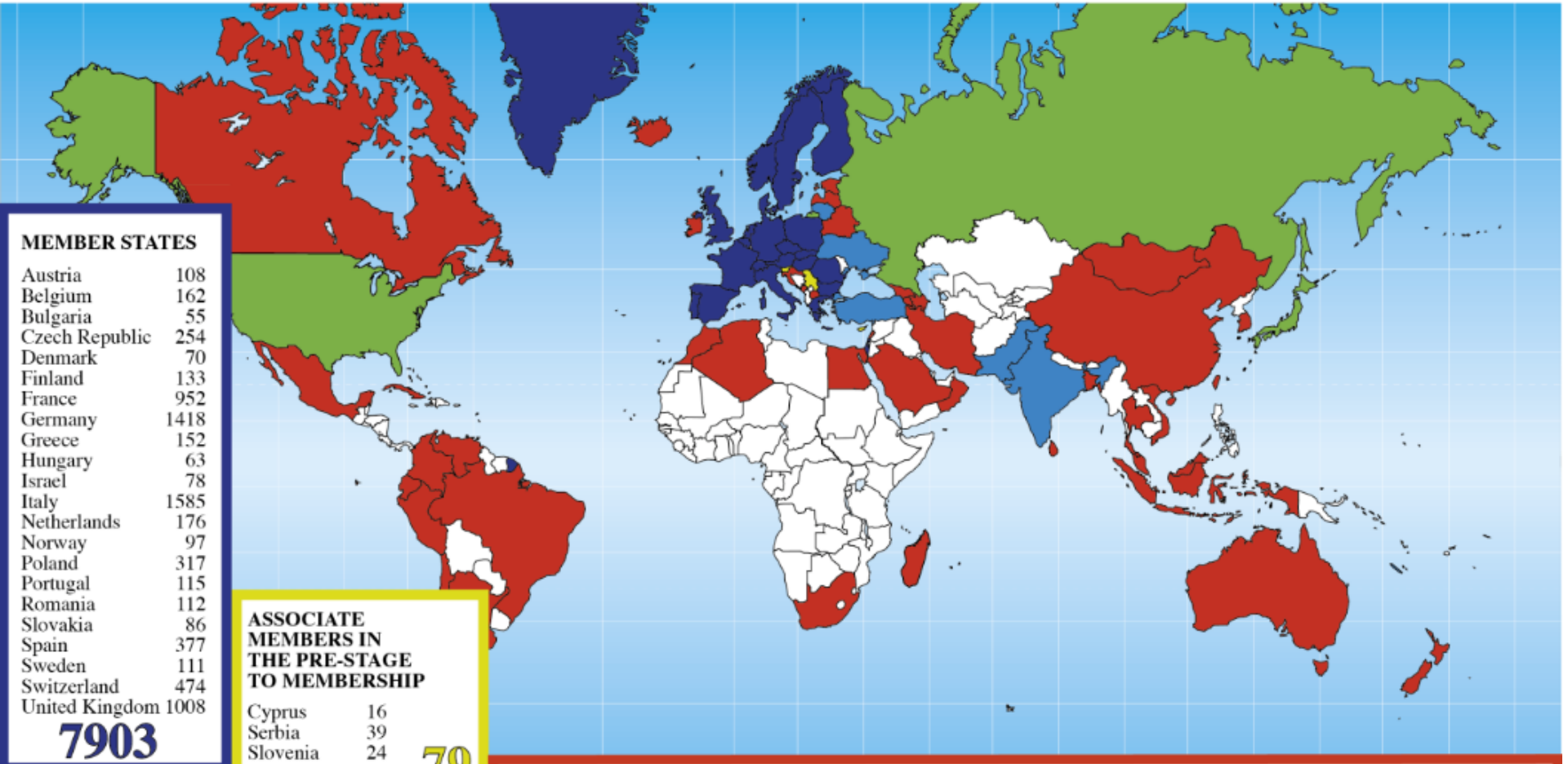
Member States: Austria, Belgium, Bulgaria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Spain, Sweden, Switzerland and the United Kingdom

Candidate for Accession: Cyprus, Serbia, Slovenia

Associate Members: India, Lithuania, Pakistan, Turkey, **Ukraine**

Observers to Council: Japan, Russia, USA

Distribution of All CERN Users by Location of Institute on 24 January 2018



MEMBER STATES

Austria	108
Belgium	162
Bulgaria	55
Czech Republic	254
Denmark	70
Finland	133
France	952
Germany	1418
Greece	152
Hungary	63
Israel	78
Italy	1585
Netherlands	176
Norway	97
Poland	317
Portugal	115
Romania	112
Slovakia	86
Spain	377
Sweden	111
Switzerland	474
United Kingdom	1008

7903

ASSOCIATE MEMBERS 446

India	221
Lithuania	21
Pakistan	38
Turkey	129
Ukraine	37

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP

Cyprus	16
Serbia	39
Slovenia	24

79

OBSERVERS

Japan	285
Russia	1099
USA	2070

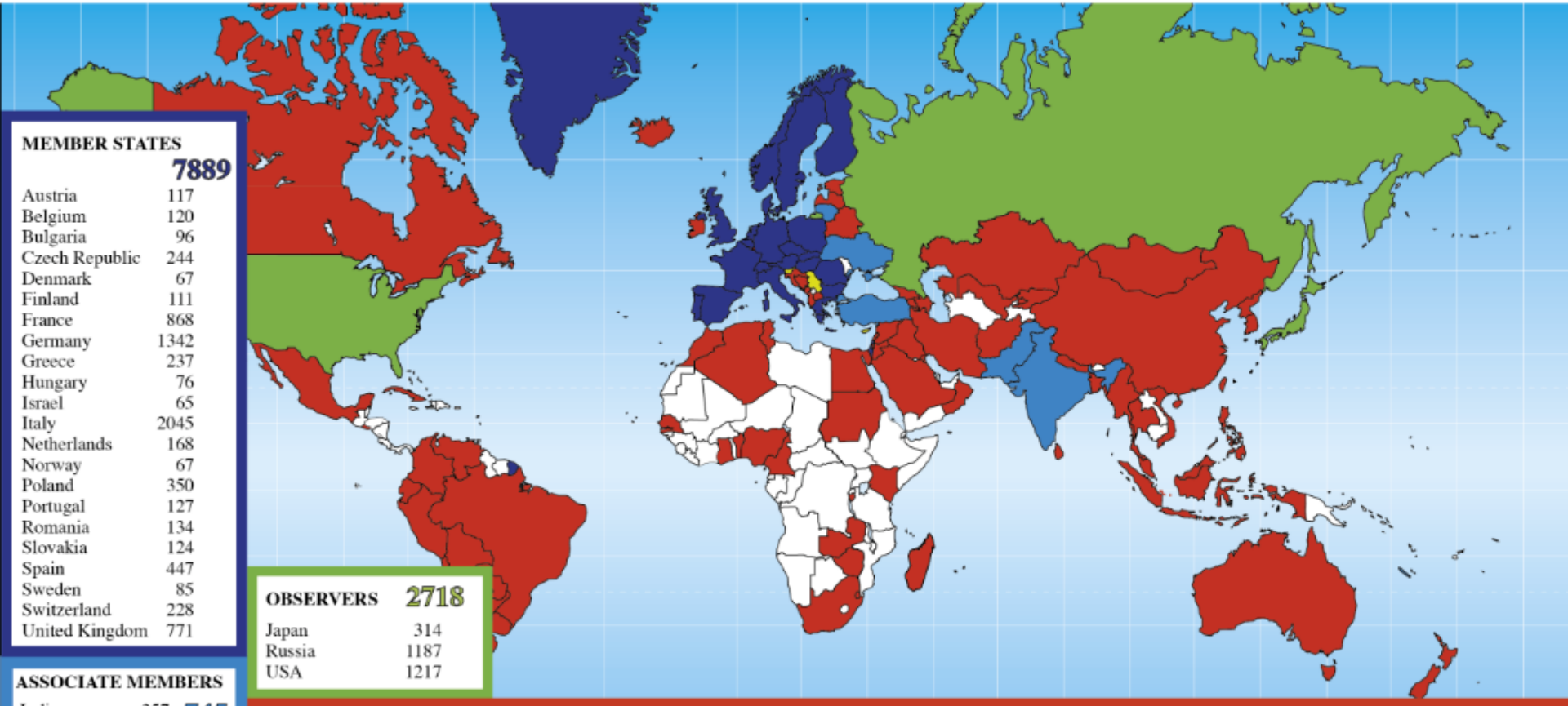
3454

OTHERS

Algeria	1	Chile	23	Iceland	2	Mexico	64	Sri Lanka	3
Argentina	20	China	283	Indonesia	7	Mongolia	2	T.F.Y.R.OM	2
Armenia	14	Colombia	27	Iran	26	Montenegro	7	Taiwan	68
Australia	36	Croatia	31	Ireland	10	Morocco	12	Thailand	19
Azerbaijan	5	Cuba	3	Korea	166	New Zealand	7	Venezuela	1
Bangladesh	3	Ecuador	4	Latvia	1	Oman	4	Viet Nam	1
Belarus	24	Egypt	25	Lebanon	10	Peru	3		
Brazil	135	Estonia	18	Madagascar	3	Saudi Arabia	1		
Canada	190	Georgia	28	Malaysia	7	Singapore	3		
		Hong Kong	19	Malta	8	South Africa	81		

1407

Distribution of All CERN Users by Nationality on 24 January 2018



MEMBER STATES	7889
Austria	117
Belgium	120
Bulgaria	96
Czech Republic	244
Denmark	67
Finland	111
France	868
Germany	1342
Greece	237
Hungary	76
Israel	65
Italy	2045
Netherlands	168
Norway	67
Poland	350
Portugal	127
Romania	134
Slovakia	124
Spain	447
Sweden	85
Switzerland	228
United Kingdom	771

OBSERVERS	2718
Japan	314
Russia	1187
USA	1217

ASSOCIATE MEMBERS		745
India	357	
Lithuania	35	
Pakistan	65	
Turkey	173	
Ukraine	115	

ASSOCIATE MEMBERS IN THE PRE-STAGE TO MEMBERSHIP	118
Cyprus	26
Serbia	57
Slovenia	35

OTHERS	1872	Bolivia	4	Egypt	31	Kazakhstan	5	Mongolia	2	Philippines	3	Thailand	22
		Bosnia & Herzegovina	2	El Salvador	1	Kenya	3	Montenegro	11	Saint Kitts		T.F.Y.R.O.M.	2
Afghanistan	1	Brazil	135	Estonia	15	Korea Rep.	185	Morocco	20	and Nevis	1	Tunisia	5
Albania	3	Burundi	1	Georgia	46	Kyrgyzstan	1	Myanmar	1	Saudi Arabia	2	Uruguay	1
Algeria	14	Cameroon	1	Ghana	1	Latvia	2	Nepal	10	Senegal	1	Uzbekistan	4
Argentina	27	Canada	161	Hong Kong	1	Lebanon	23	New Zealand	5	Singapore	4	Venezuela	10
Armenia	19	Chile	20	Iceland	3	Luxembourg	2	Nigeria	3	South Africa	56	Viet Nam	13
Australia	31	China	510	Indonesia	11	Madagascar	4	North Korea	1	Sri Lanka	6	Zambia	1
Azerbaijan	10	Colombia	45	Iran	51	Malaysia	15	Oman	3	Sudan	1	Zimbabwe	2
Bangladesh	11	Croatia	41	Iraq	1	Malta	9	Palestine (O.T.).	7	Swaziland	1		
Belarus	48	Cuba	12	Ireland	16	Mauritius	1	Paraguay	2	Syria	1		
Benin	1	Ecuador	6	Jordan	1	Mexico	82	Peru	7	Taiwan	51		

Украина в ЦЕРНе

- 1993 Украина и ЦЕРН подписали соглашение о сотрудничестве
- 2011 МАНУ и ЦЕРН подписали декларацию об участии студентов и учителей в программах ЦЕРНа (2011, 2012, 2013, 2016)
- 2016 Украина принята в Ассоциированные члены ЦЕРНа

Асоційоване членство

http://cerncourier.com/cws/article/cern/66875

Associate membership will open a new era of co-operation that will strengthen the long-term partnership between CERN and the Ukrainian scientific community. It will allow Ukraine to participate in the governance of CERN, in addition to allowing Ukrainian scientists to become CERN staff and to participate in CERN's training and career-development programmes. Finally, it will allow Ukrainian industry to bid for CERN contracts, thus opening up opportunities for industrial collaboration in areas of advanced technology.

Асоційоване членство відкриє нову еру співпраці, яка зміцнить довгострокове партнерство між ЦЕРНом і українською науковою спільнотою. Це дозволить Україні брати участь в управлінні ЦЕРНом, надоє можливості українським вченим, щоб стати співробітниками у ЦЕРНі і взяти участь в програмах навчання і розвитку кар'єри у ЦЕРНі. І, нарешті, це дозволить українській промисловості взяти участь в торгах за контрактами ЦЕРН, що відкриває можливості для промислового співробітництва в області передових технологій.

Украина в ЦЕРНе

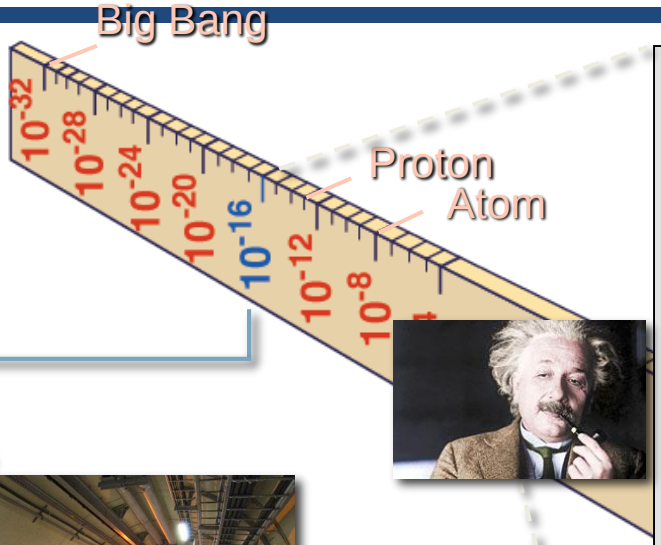
- Украина принимает участие в ALICE, CMS и LHCb экспериментов на БАКе и в научных исследований и разработках новых ускорительных технологий.
- В Украине Действует Tier-2 в вычислительный центр всемирной LHC Computing Grid (WLCG)

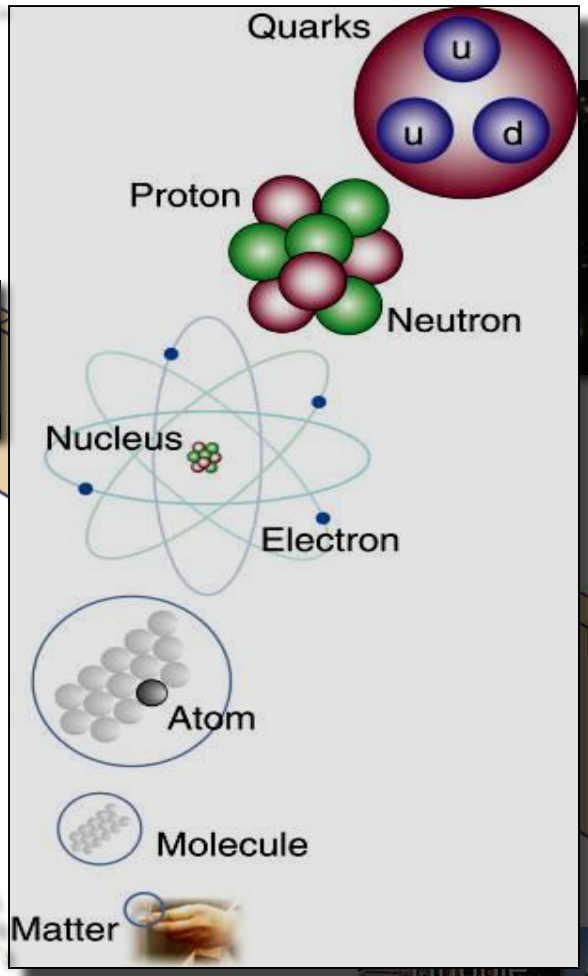
В ЦЕРНе из Украины (Лето 2017)

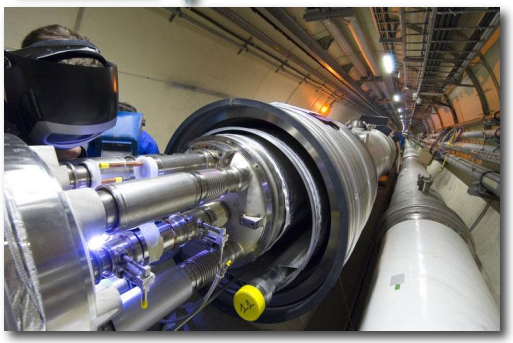
- 3 Fellow, 2 technical students
- 7 визитеров и 6 associates
- 3 летних студента
- Летние программы: 1 Scool Lab student & 2 учителя

Year	Nationality	Institute
2018	115	37
2016	88	30
2014	55	24
2012	45	21
2010	40	17
2008		17
2007		16
2006		13
2004		11
2001	21	17

Из чего «сделана» Вселенная?

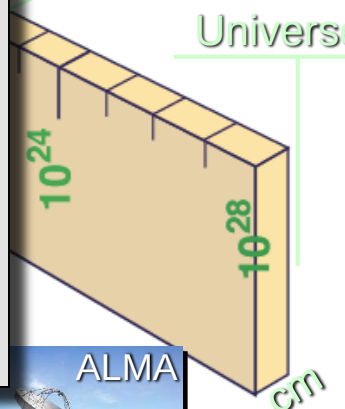






LHC

Super-Microscope



Study physics laws of first moments after Big Bang
increasing Symbiosis between Particle Physics,
Astrophysics and Cosmology

CERN: Физика частиц и инновации

- Связывает фундаментальные исследования и развитие передовых технологий

- CERN Развиваемые технологии и инновации

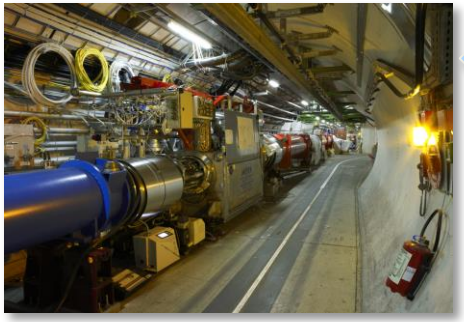
Accelerating particle beams

Detecting particles

Large-scale computing (Grid)

Медицинские приложения, вышедшие из физики частиц

Объединение физики, биологии и медицины для борьбы с раком

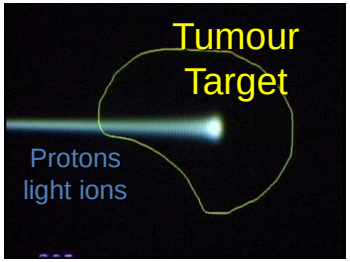


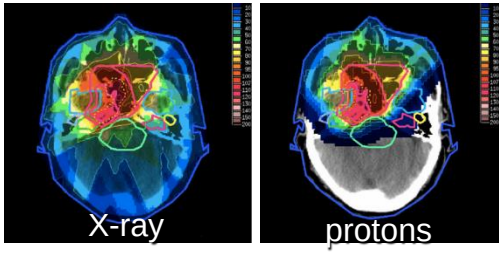
Accelerating particle beams

~30'000 accelerators worldwide

~17'000 used for medicine

Адронная терапия

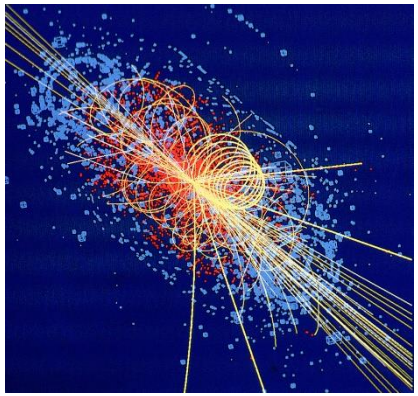




Leadership in Ion Beam Therapy now in Europe and Japan

>70'000 patients treated worldwide (30 facilities)

>21'000 patients treated in Europe (9 facilities)

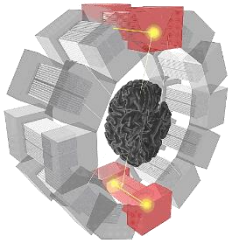


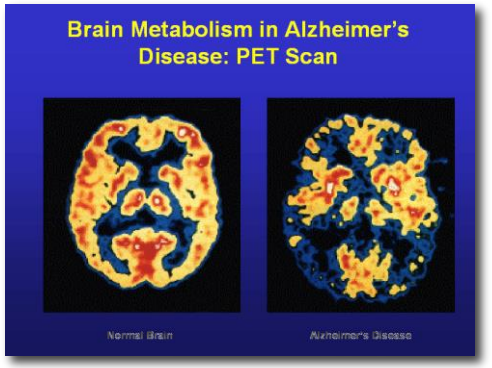
Detecting particles

Восстановление образов

PET Scanner

Clinical trial in Portugal for new breast imaging system (ClearPEM)

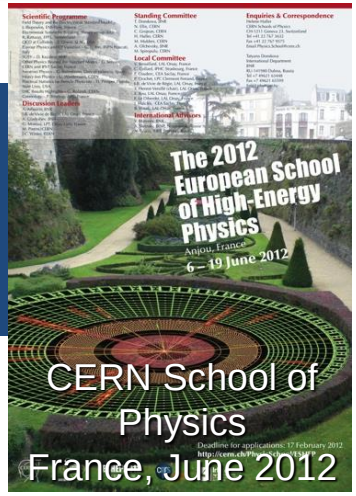




CERN Образовательные программы

Научные сотрудники
Academic Training Programme

Молодые научные сотрудники
CERN School of High Energy Physics
CERN School of Computing
CERN Accelerator School



Студенты-физики
Summer Students
Programme

Школьные учителя физики
International and National
Programmes

Введение в физику частиц

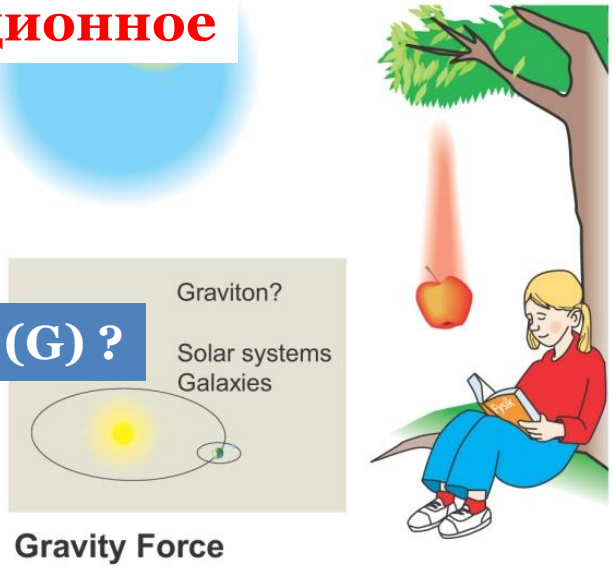
Татьяна Берже-Гринева

(LAPP Annecy, Франция)

Взаимодействия в природе

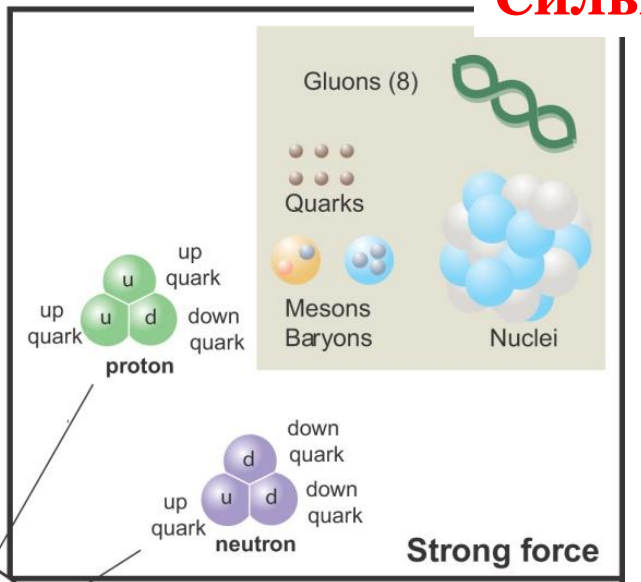
Гравитационное

Гравитон (G) ?



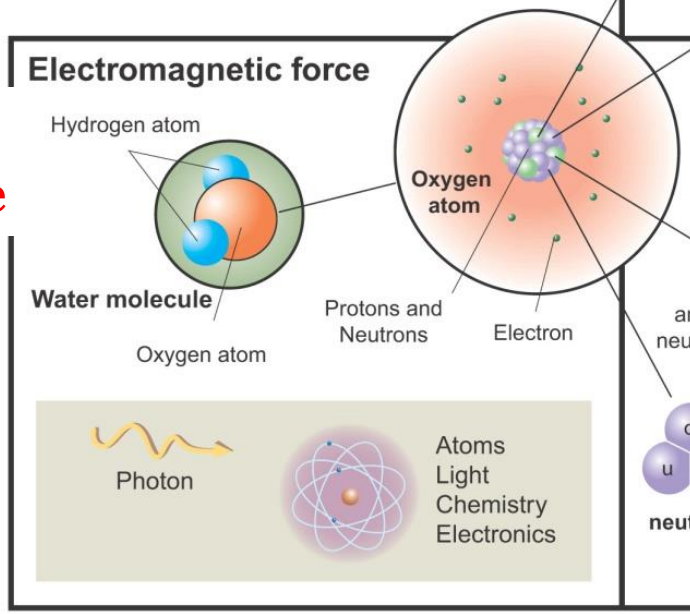
Сильное

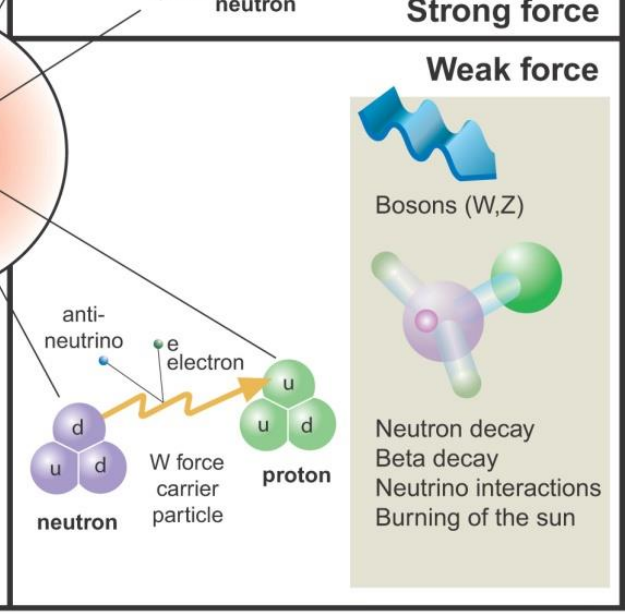
8
Глюон (g)



Электро-магнитное

Фотон γ





Слабое

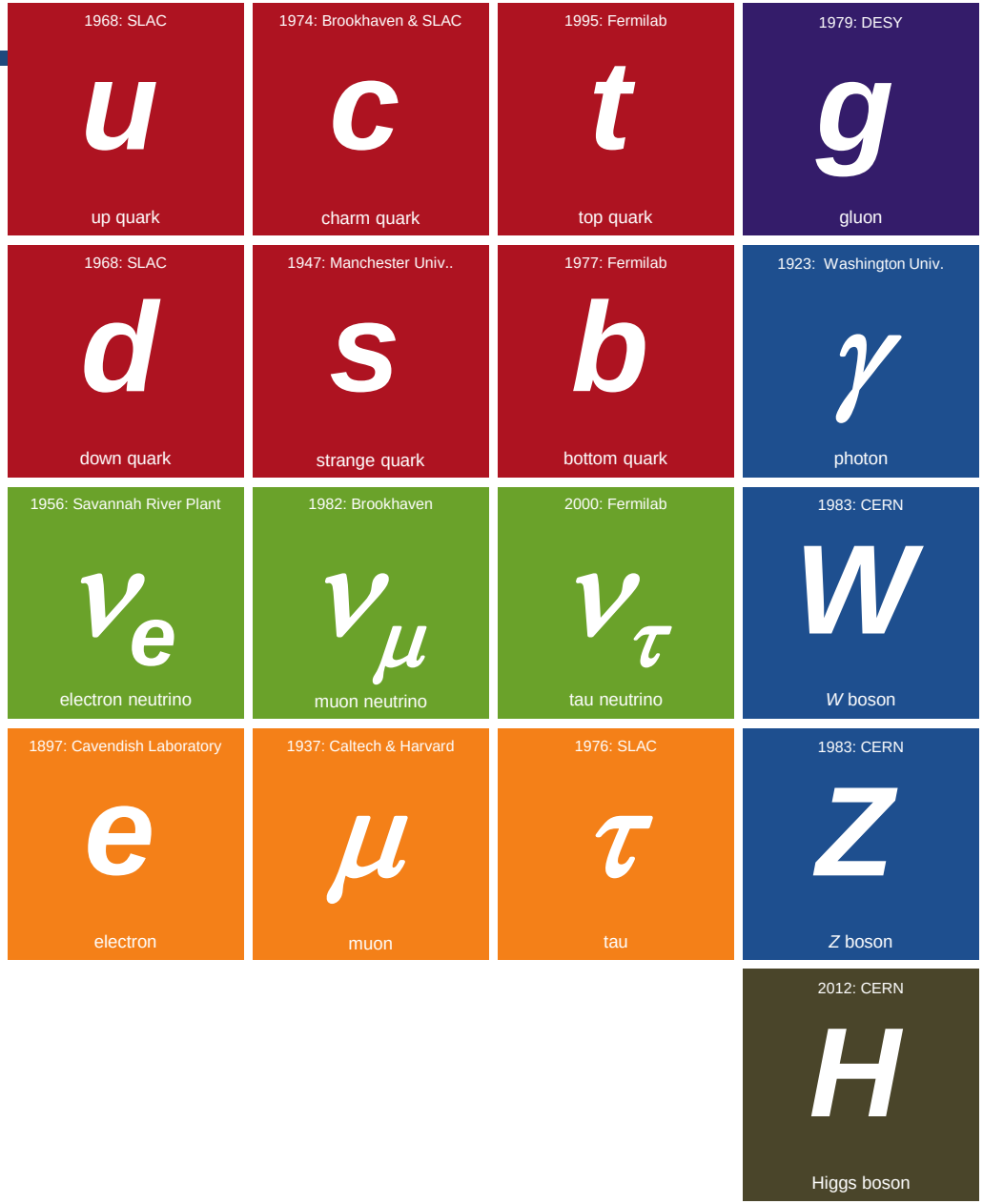
Бозоны $W^{\pm}$, Z

Взаимодействия в природе

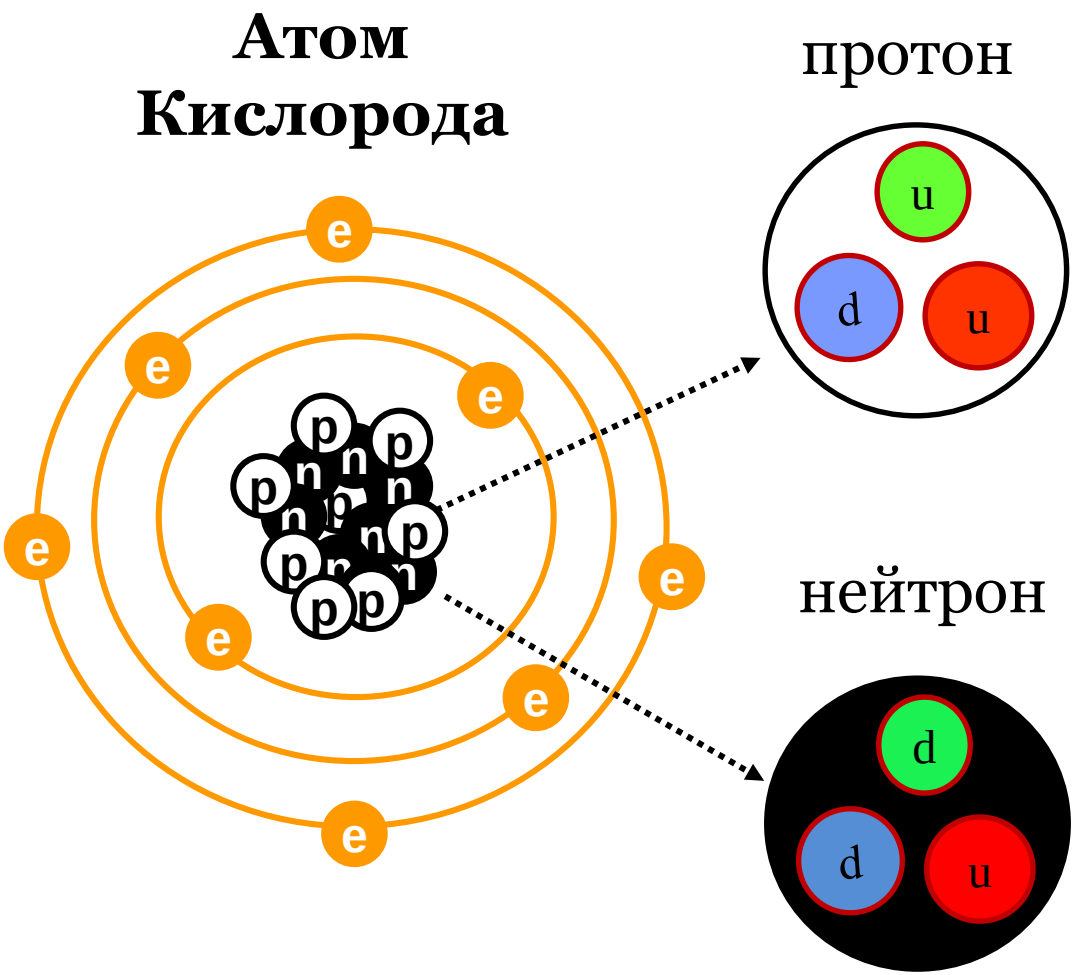
Взаимо-действие	Текущее описание теорией	Частица-переносчик	Квадрат константы	Зависимость от расстояния
Гравитация	Общая теория относительности (ОТО)	Гравитон (гипотетич.)	10^{-40}	$1/r^2$
Слабое	Теория электрослабого взаимодействия (ТЭВ)	W^+ W^- Z^0 бозоны	10^{-6}	$e^{-m_{W,Z}r}/r$
Электромагнитное	Квантовая электродинамика (КЭД)	Фотон	1/137	$1/r^2$
Сильное	Квантовая хромодинамика (КХД)	Глюон	1	$-\frac{4}{3}\frac{\alpha_s}{r} + kr$

Стандартная Модель описывает сильные, слабые и электро-магнитные взаимодействия

Стандартная Модель (СМ)



Мир вокруг нас



1968: SLAC

u

up quark

1968: SLAC

d

down quark

1956: Savannah River Plant

ν_e

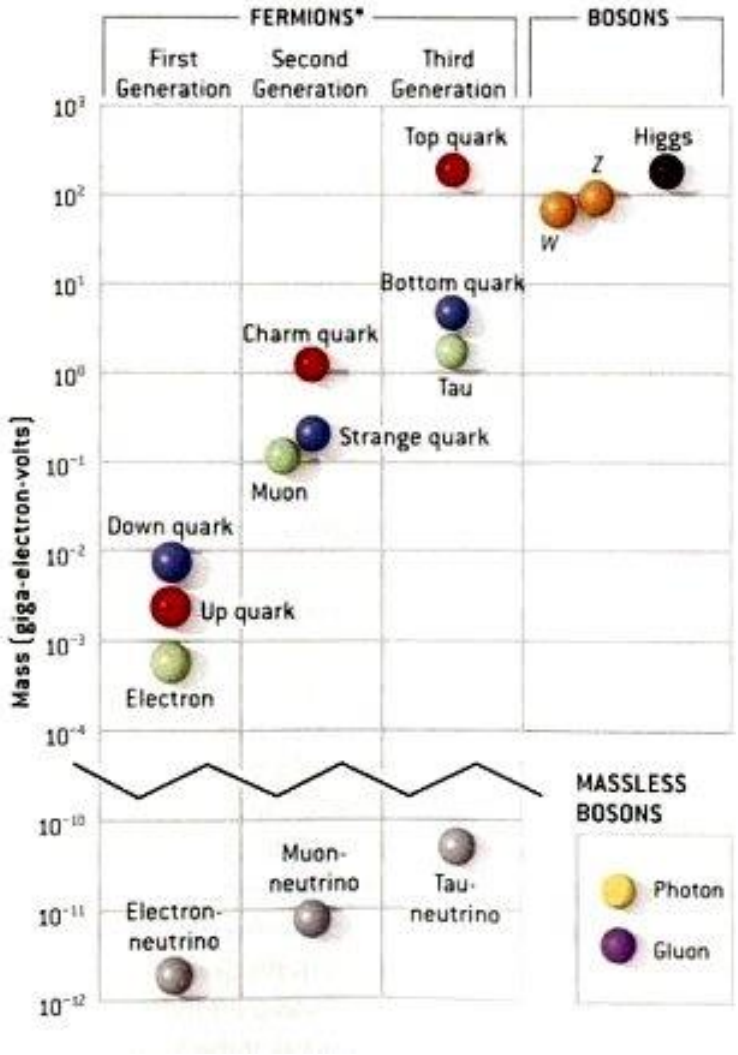
electron neutrino

1897: Cavendish Laboratory

e

electron

Стандартная Модель (СМ)



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1968: SLAC d down quark	1947: Manchester Univ.. s strange quark	1977: Fermilab b bottom quark	1923: Washington Univ. γ photon
1956: Savannah River Plant ν_e electron neutrino	1982: Brookhaven ν_μ muon neutrino	2000: Fermilab ν_τ tau neutrino	1983: CERN W *W* boson
1897: Cavendish Laboratory e electron	1937: Caltech & Harvard μ muon	1976: SLAC τ tau	1983: CERN Z *Z* boson
			2012: CERN H Higgs boson

Стандартная Модель (СМ)

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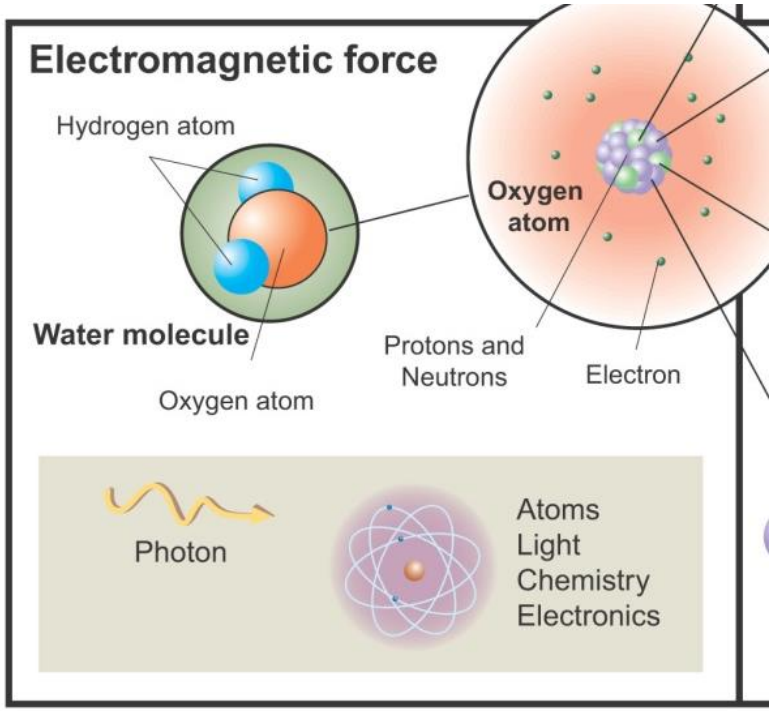

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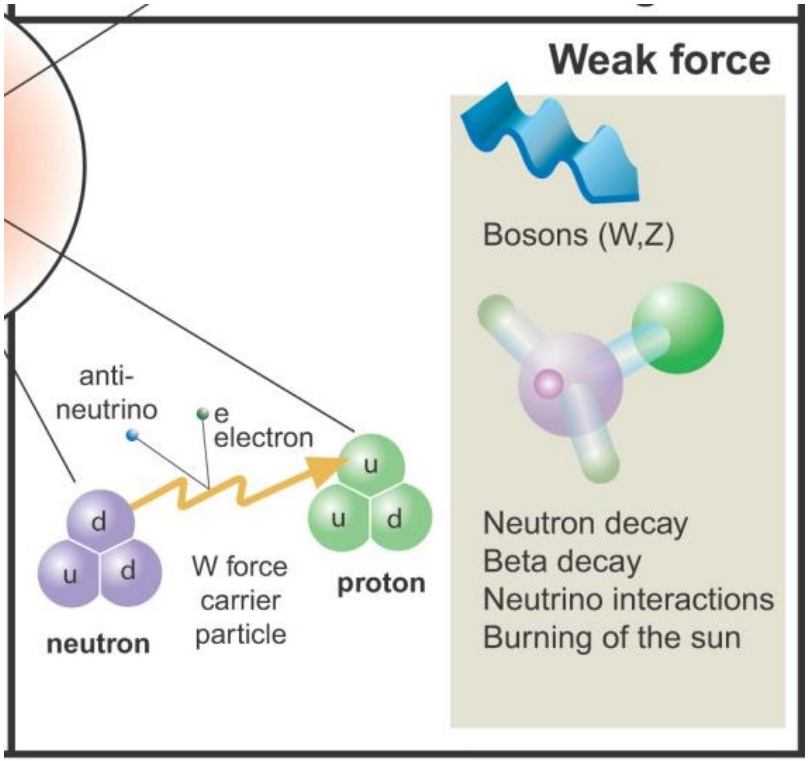
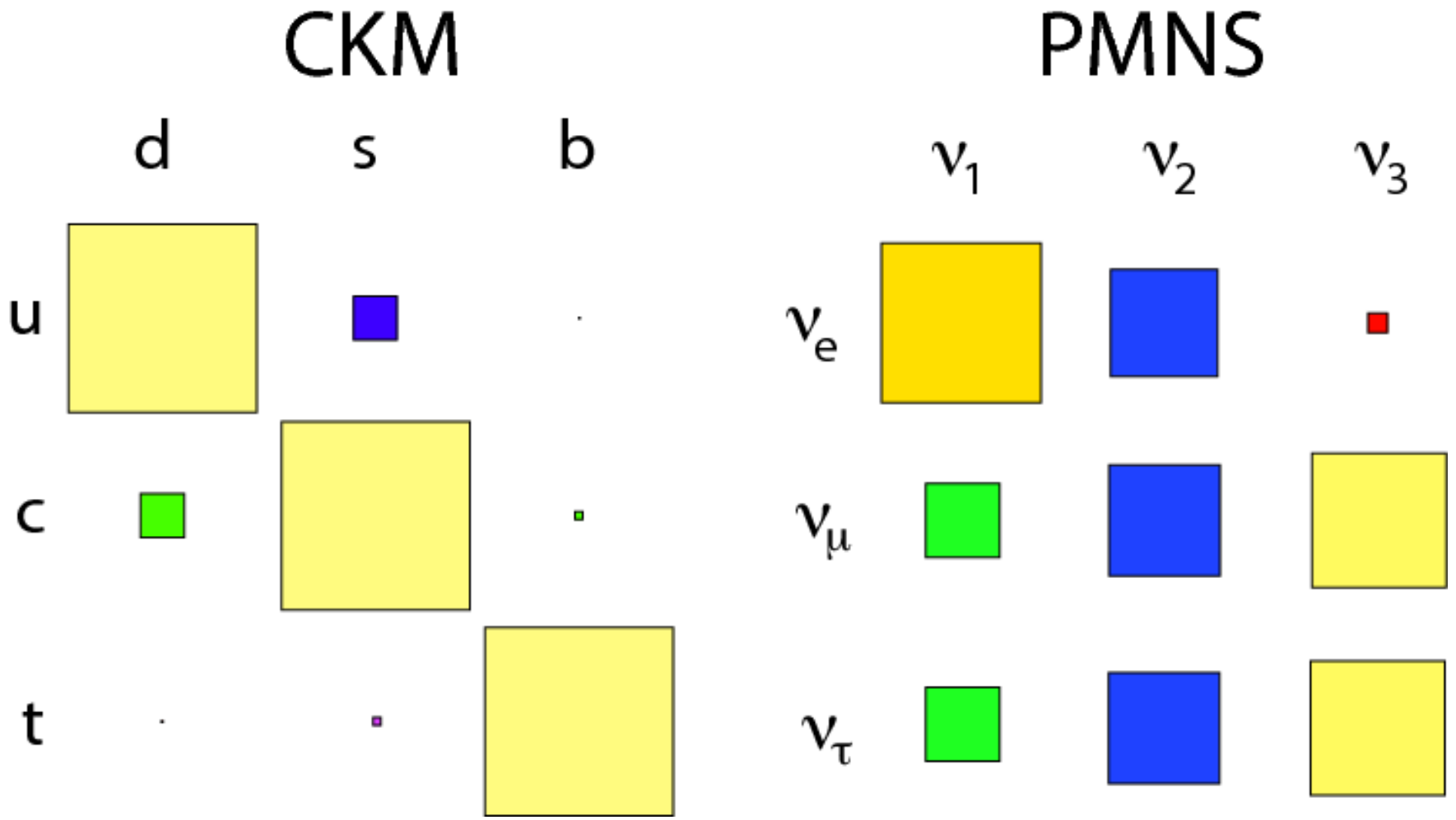


Смешивание частиц



arXiv:1212.6374

Стандартная Модель (СМ)

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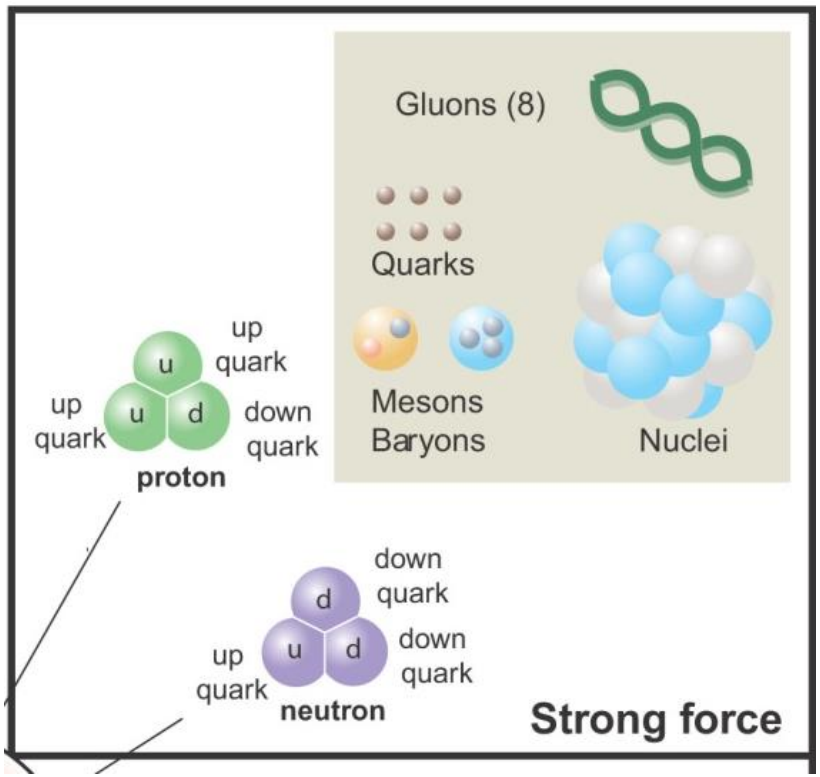
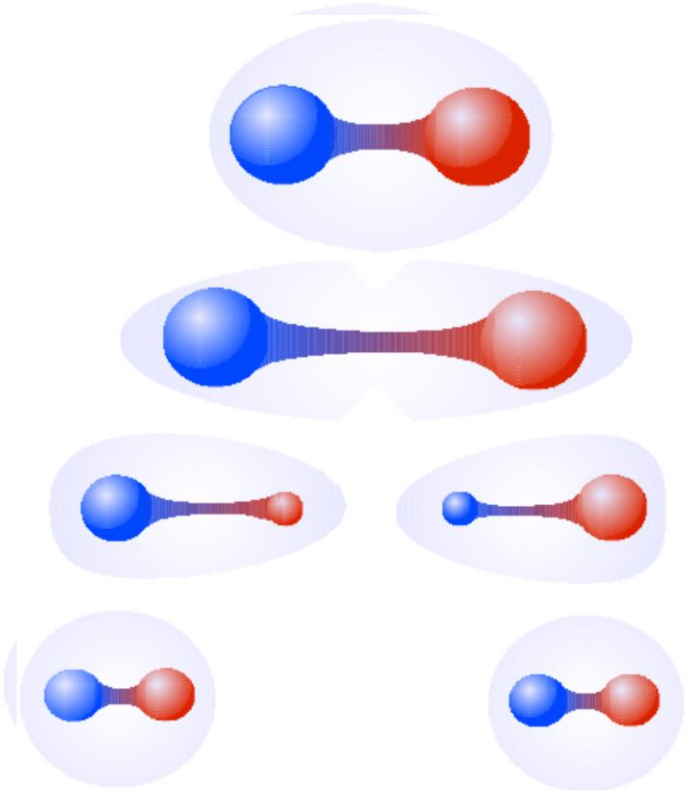


Стандартная Модель (СМ)

$$V_s = -\frac{4}{3}\frac{\alpha_s}{r} + kr$$



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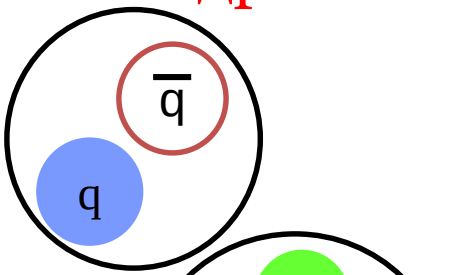
1897: Cavendish Laboratory e electron	1937: Caltech & Harvard μ muon	1976: SLAC τ tau	1983: CERN Z *Z* boson
			2012: CERN H Higgs boson

Стандартная Модель (СМ)

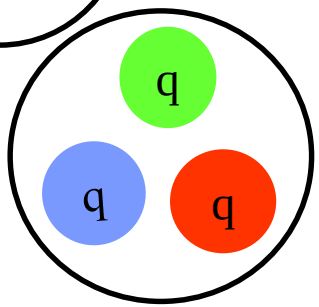
$$V_s = -\frac{4}{3}\frac{\alpha_s}{r} + kr$$

Кварки не существуют в свободном состоянии они формируют «бесцветные» адроны:

Мезоны



Барионы



1968: SLAC **u** up quark	1974: Brookhaven & SLAC **c** charm quark	1995: Fermilab **t** top quark	1979: DESY **g** gluon
1968: SLAC **d** down quark	1947: Manchester Univ.. **s** strange quark	1977: Fermilab **b** bottom quark	1923: Washington Univ. **γ** photon
1956: Savannah River Plant ν_e electron neutrino	1982: Brookhaven ν_μ muon neutrino	2000: Fermilab ν_τ tau neutrino	1983: CERN **W** *W* boson
1897: Cavendish Laboratory **e** electron	1937: Caltech & Harvard **μ** muon	1976: SLAC **τ** tau	1983: CERN **Z** *Z* boson
			2012: CERN **H** Higgs boson

Стандартная Модель (СМ)

9 масс частиц

4 параметра матрицы смешивания кварков

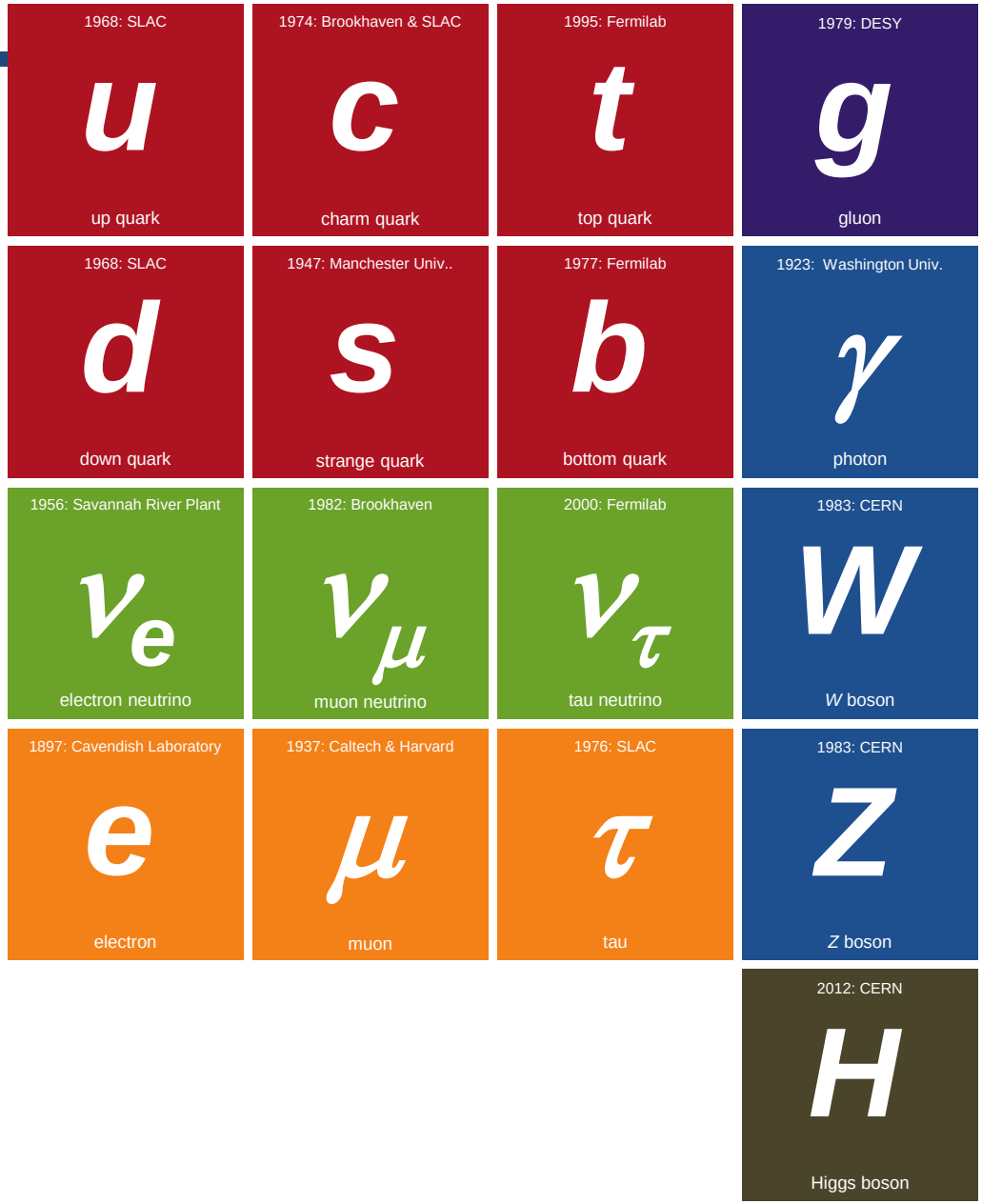
2 параметра [поля Хиггса]

3 константы взаимодействия

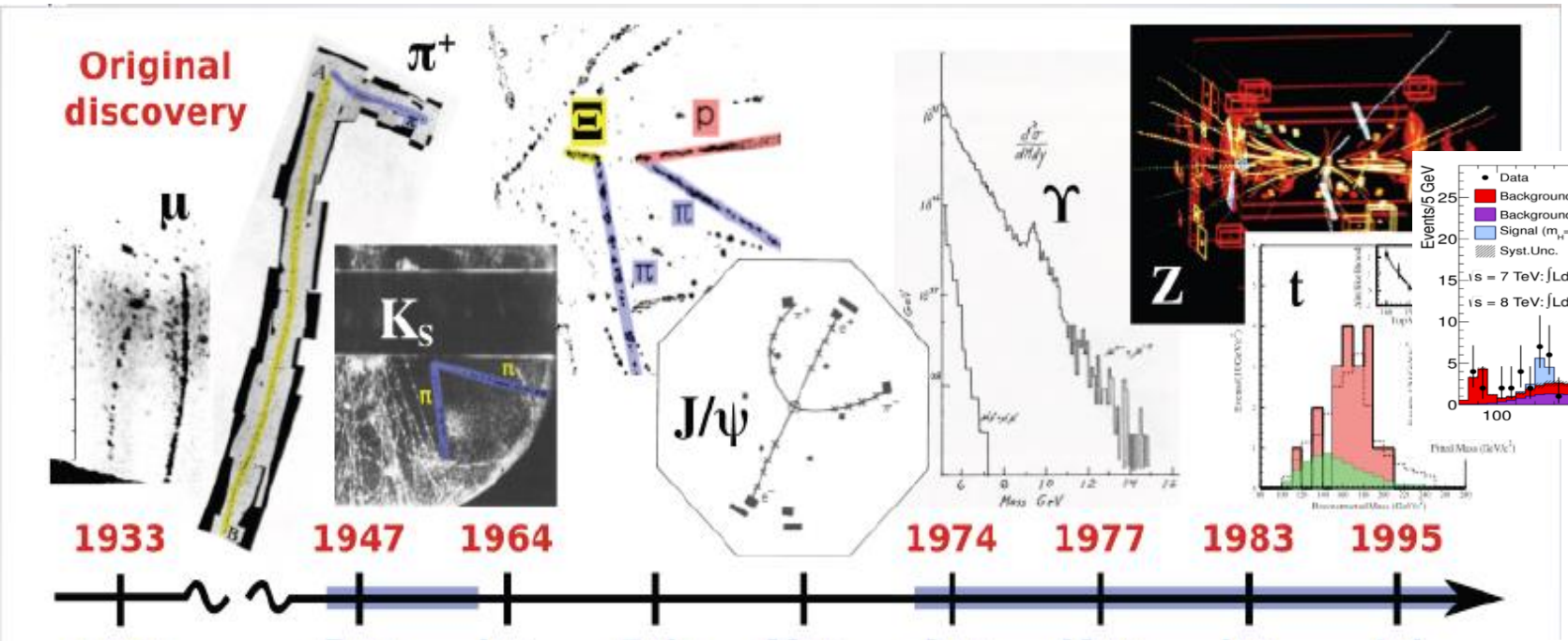
---

3 массы нейтрино

4+2 параметра матрицы смешивания нейтрино



“Открытие” Стандартной Модели

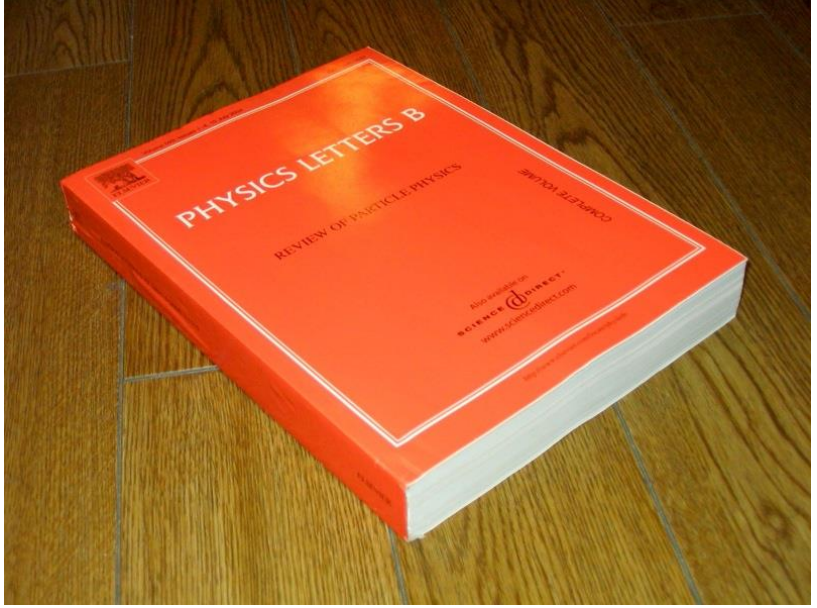


- Открыто более 400 частиц
- Источники частиц: космические лучи и ускорители

Частицы

Свойства частицы:

- Масса
- Электрический заряд
- Спин (собственный момент импульса)
- ...
- Время жизни



Citation: K.A. Olive *et al.* (Particle Data Group), Chin. Phys. C, **38**, 090001 (2014) and 2015 update

LEPTONS

e

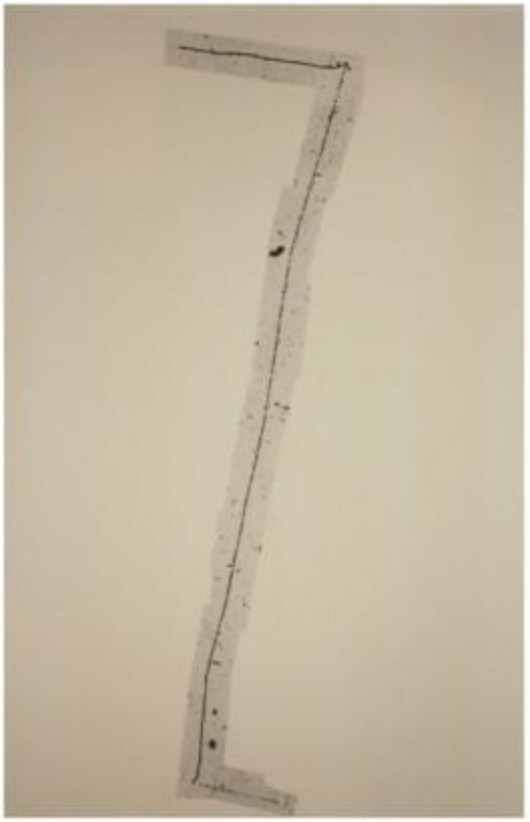
$J = \frac{1}{2}$

Mass $m = (548.57990946 \pm 0.00000022) \times 10^{-6}$ u
Mass $m = 0.510998928 \pm 0.000000011$ MeV
$\left|m_{e^+} - m_{e^-}\right|/m < 8 \times 10^{-9}$, CL = 90%
$\left|q_{e^+} + q_{e^-}\right|/e < 4 \times 10^{-8}$
Magnetic moment anomaly
$(g-2)/2 = (1159.65218076 \pm 0.00000027) \times 10^{-6}$
$(g_{e^+} - g_{e^-}) / g_{\text{average}} = (-0.5 \pm 2.1) \times 10^{-12}$
Electric dipole moment $d < 0.87 \times 10^{-28}$ e cm, CL = 90%
Mean life $\tau > 4.6 \times 10^{26}$ yr, CL = 90% [a]

Частицы

Все частицы распадаются, если этому не препятствуют законы сохранения:

- энергии-импульса
- момента импульса
- заряда
- цвета
- барионного числа
- лептонного числа

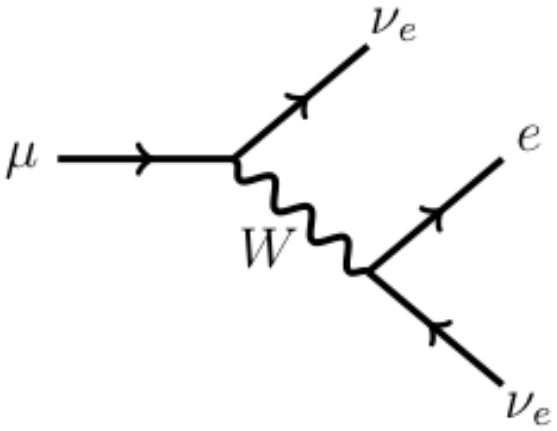


μ^- DECAY MODES		Fraction (Γ_i/Γ)	Confidence level	(MeV/c)
$e^-\overline{\nu}_e\nu_\mu$		$\approx 100\%$		53
$e^-\overline{\nu}_e\nu_\mu\gamma$	[d]	(1.4 ± 0.4) %		53
$e^-\overline{\nu}_e\nu_\mu e^+e^-$	[e]	$(3.4\pm0.4)\times10^{-5}$		53

Частицы

Стабильные частицы: e (электрон), γ (фотон), нейтрино, p(uud) протон

Долгоживущие частицы: μ (мюон), $\pi^+(u\bar{d})$ пион, $K^+(u\bar{s})$ каон, n(udd) нейтрон…



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1897: Cavendish Laboratory *e* electron	1937: Caltech & Harvard μ muon	1976: SLAC τ tau	1983: CERN *Z* *Z* boson
			2012: CERN *H* Higgs boson

Определения из Википедии (1)

- **Резонанс —** элементарная частица с коротким времем жизни. Оределяются как пик в распределении энергии вторичных частиц.

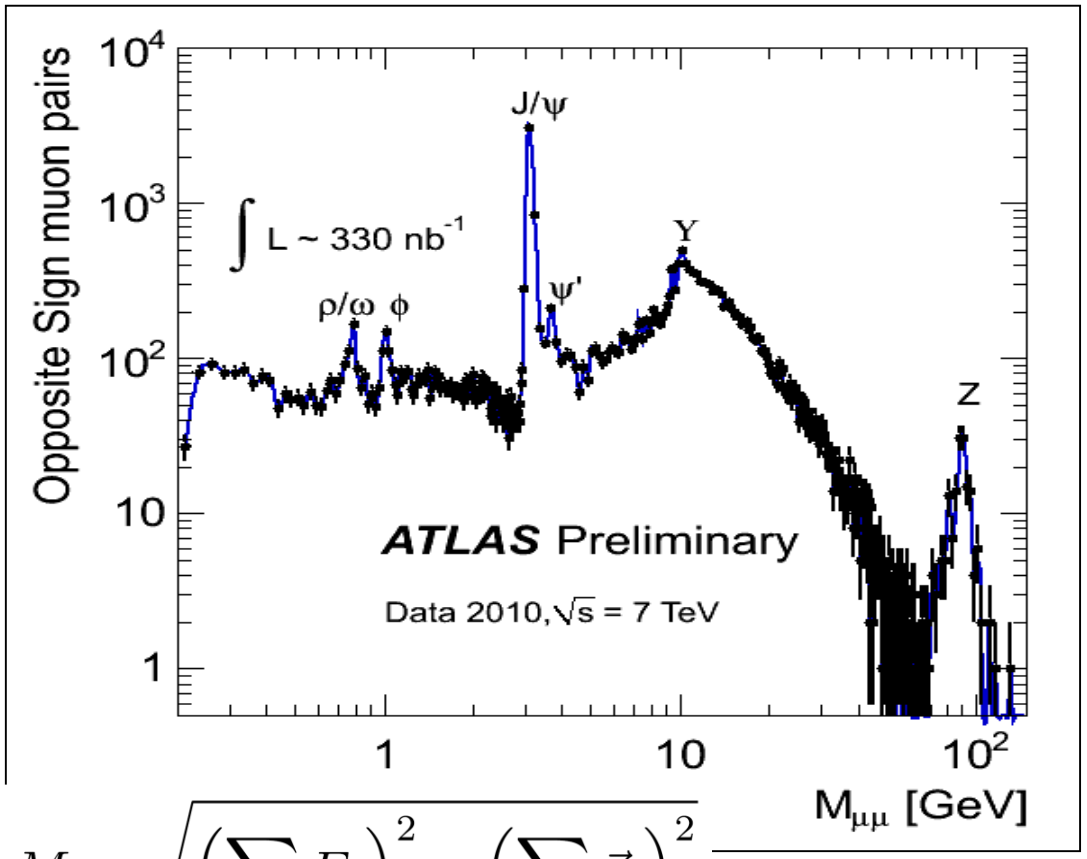
$$E^2 = \vec{p}^2 + m^2$$

$$E = m\gamma \qquad \vec{p} = m\gamma\vec{\beta}$$

$$\beta = \frac{v}{c} \qquad \gamma = \frac{1}{\sqrt{1-\beta^2}}$$

$$\ell = \frac{\ell_0}{\gamma}$$

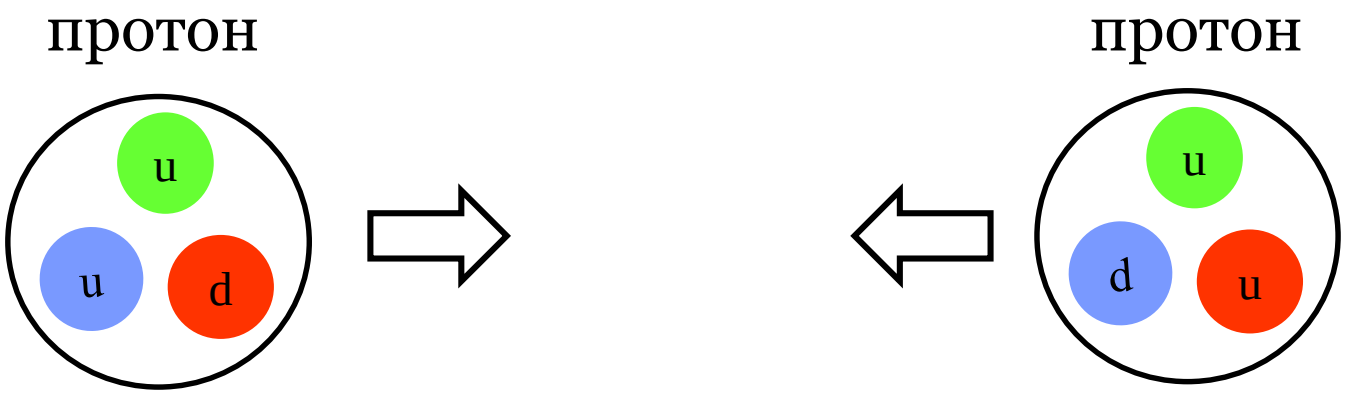
$$t = t_0\gamma$$



$$M = \sqrt{\left(\sum E_i\right)^2 - \left(\sum \vec{p}_i\right)^2}$$

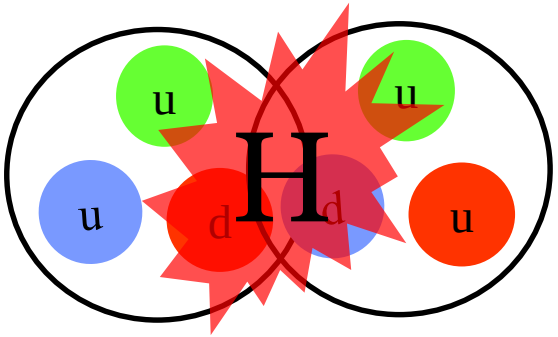
Как найти новые частицы?

- Космические лучи
- Ускорители/коллайдеры:



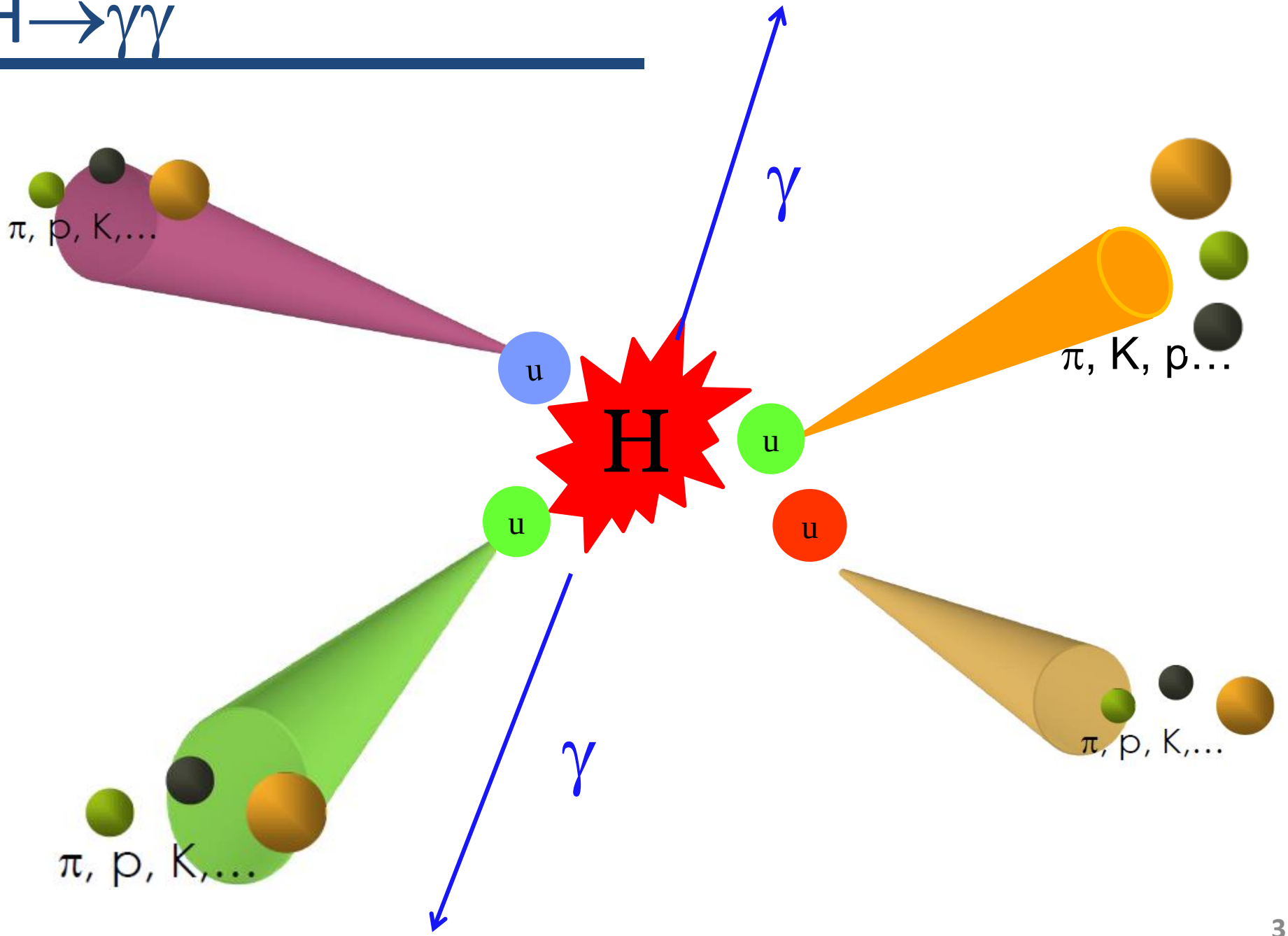
– Высокая энергия $E = mc^2$

– Большое количство событий $N = \mathcal{L} \cdot \sigma$



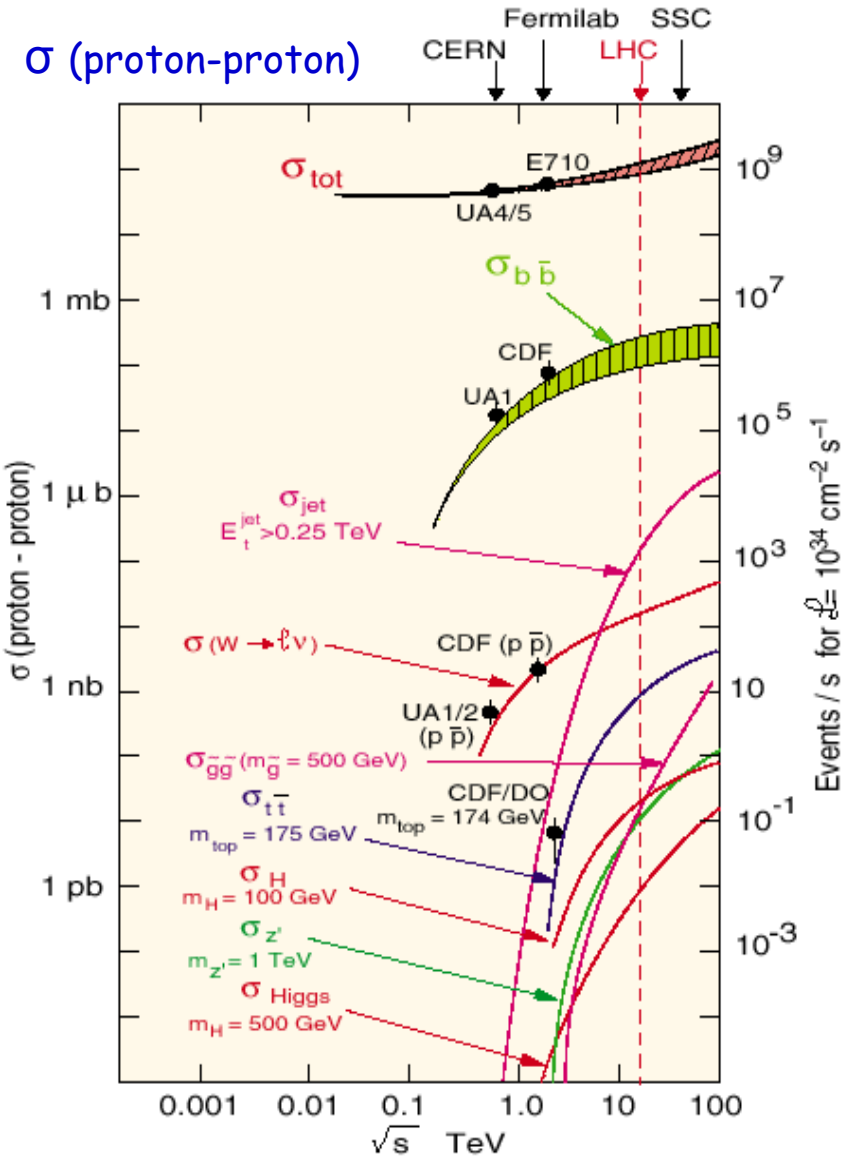
Бозон Хигса

H→γγ

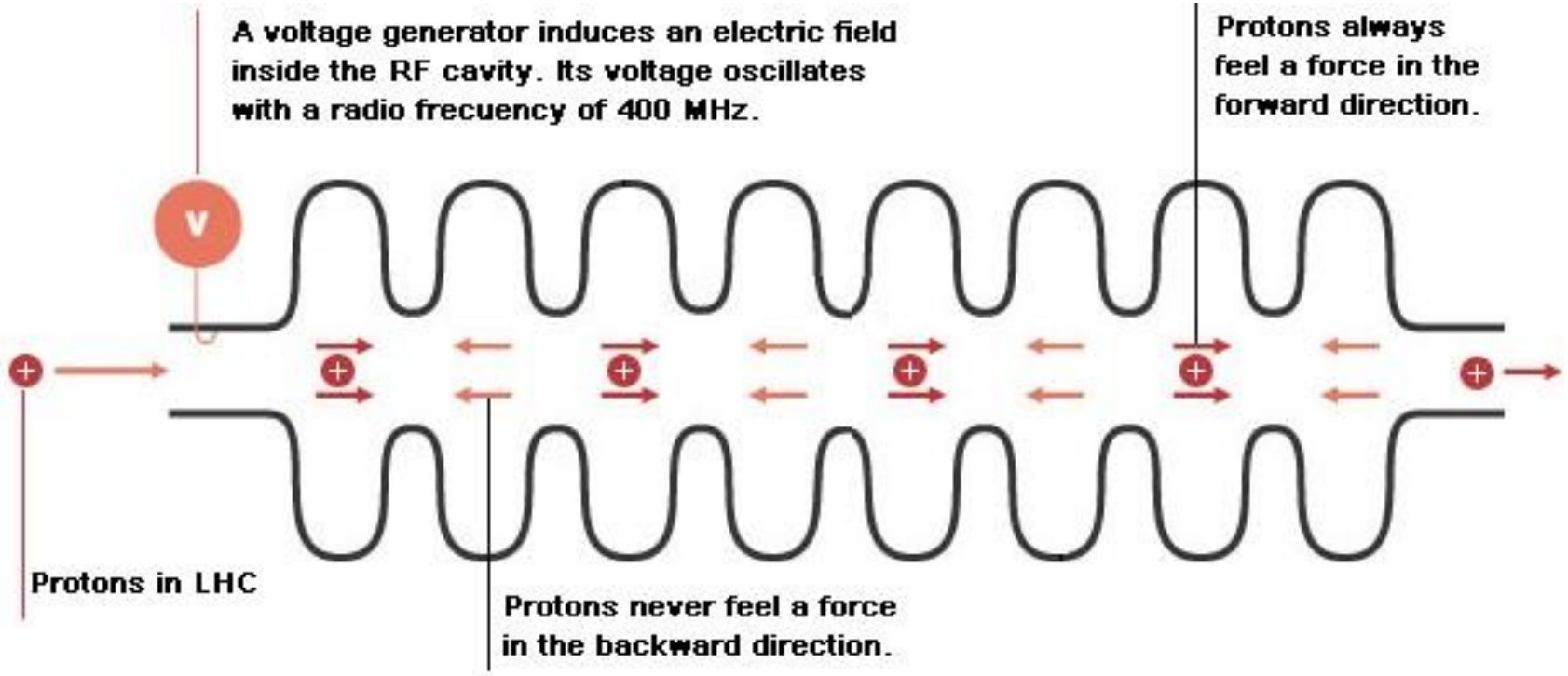


Эффективное поперечное сечение

- **Эффективное поперечное сечение** (σ) — это [физическая](#) величина, характеризующая вероятность перехода системы двух взаимодействующих частиц в определённое конечное состояние.



Как ускорить частицы?



Единица измерения в физике частиц: 1 эВ = 1.6 10^{-19} Дж

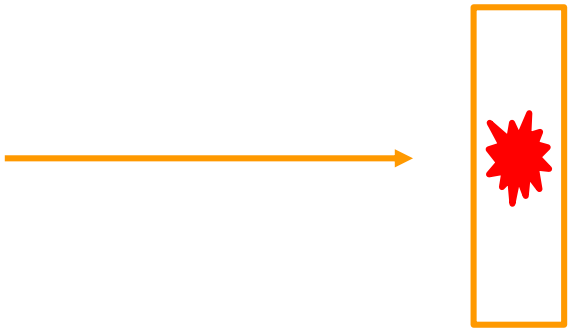
Масса протона = 0.94 ГэВ

Масса электрона = 0.5 МэВ

http://www.lhc-closer.es/taking_a_closer_look_at_lhc/0.rf_cavities

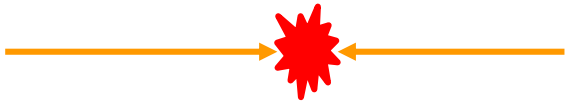
Ускорители

Неподвижная Мишень

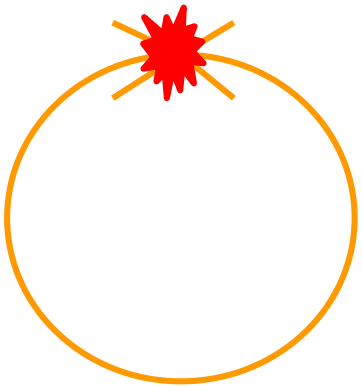


$$E_{\text{fix}} = 2\frac{E_{\text{col}}^2}{m} - m$$

Линейный коллайдер



Круговой коллайдер



$$\mathcal{L} = \frac{1}{4\pi}\frac{fkN_1N_2}{\sigma_x\sigma_y}$$

Частицы в магнитном поле

Magnetic Force on a Moving Charge

$$\vec{F}_B = q\vec{v} \times \vec{B}$$

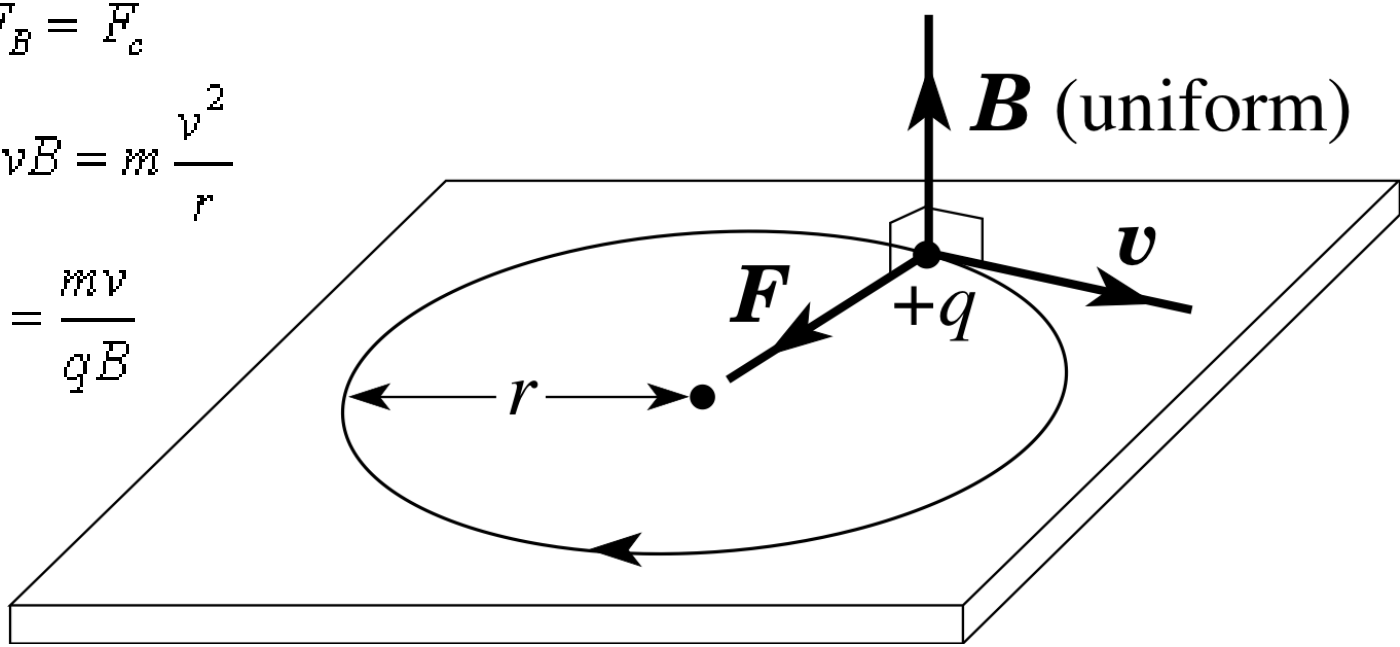
$$F_B = qvB\sin\theta$$

Uniform Circular Motion (U.C.M.)

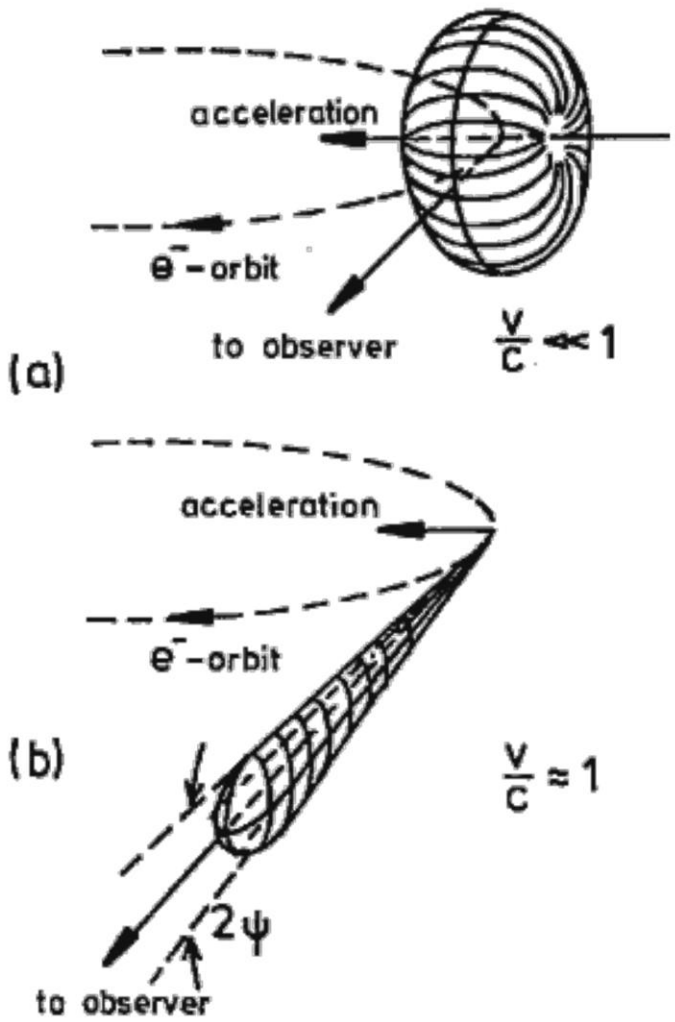
$$F_B = F_c$$

$$qvB = m\frac{v^2}{r}$$

$$r = \frac{mv}{qB}$$



Синхротронное излучение



energy lost per revolution

$$\Delta E = \frac{4\pi}{3}\frac{1}{4\pi\epsilon_0}\left(\frac{e^3\beta^3\gamma^4}{R}\right)$$

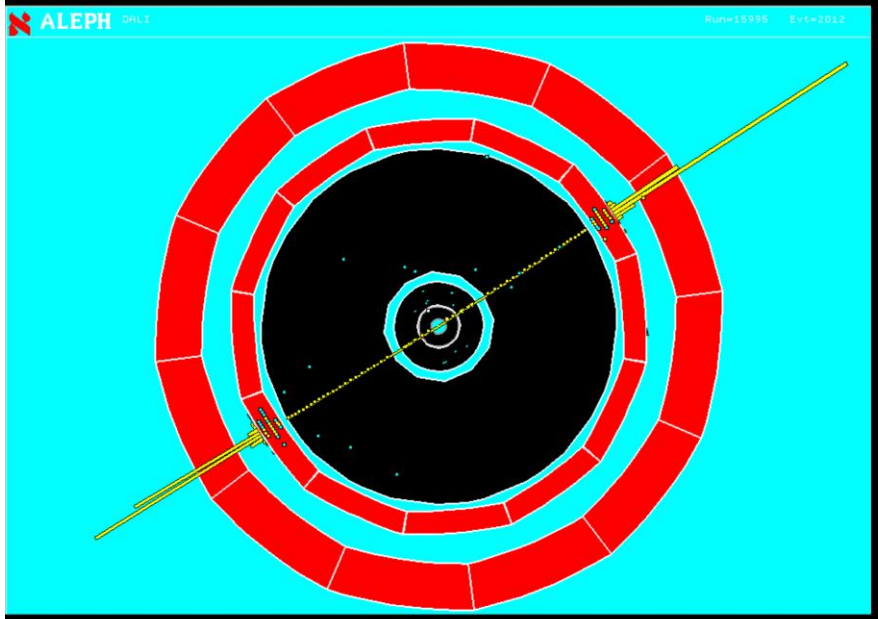
electrons vs. protons

$$\frac{\Delta E_e}{\Delta E_p} \simeq \left(\frac{m_p}{m_e}\right)^4$$

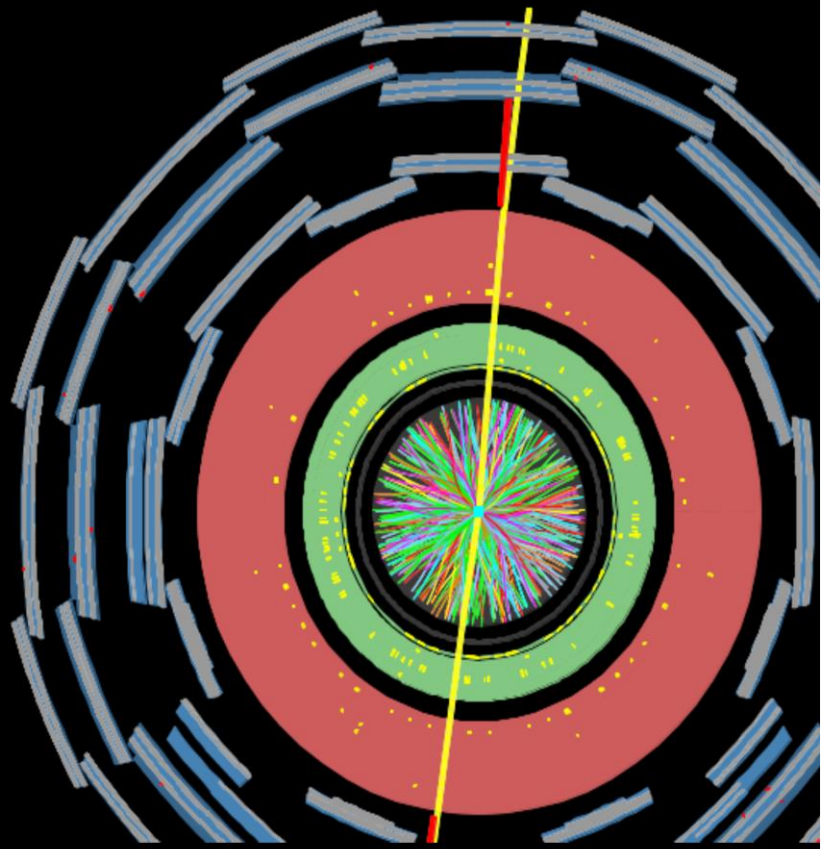
It's easier to accelerate protons to higher energies, but protons are fundamentals…

Электроны и протоны

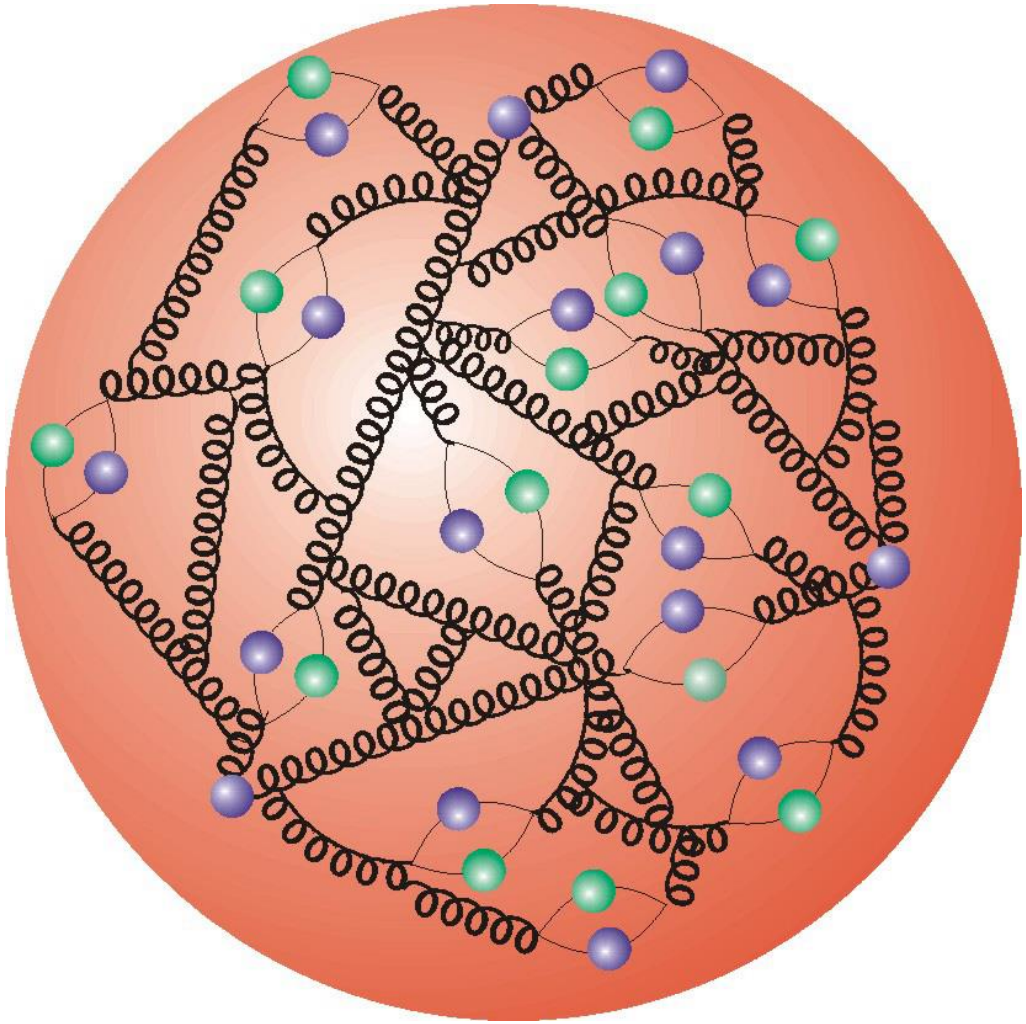
ALEPH @ LEP



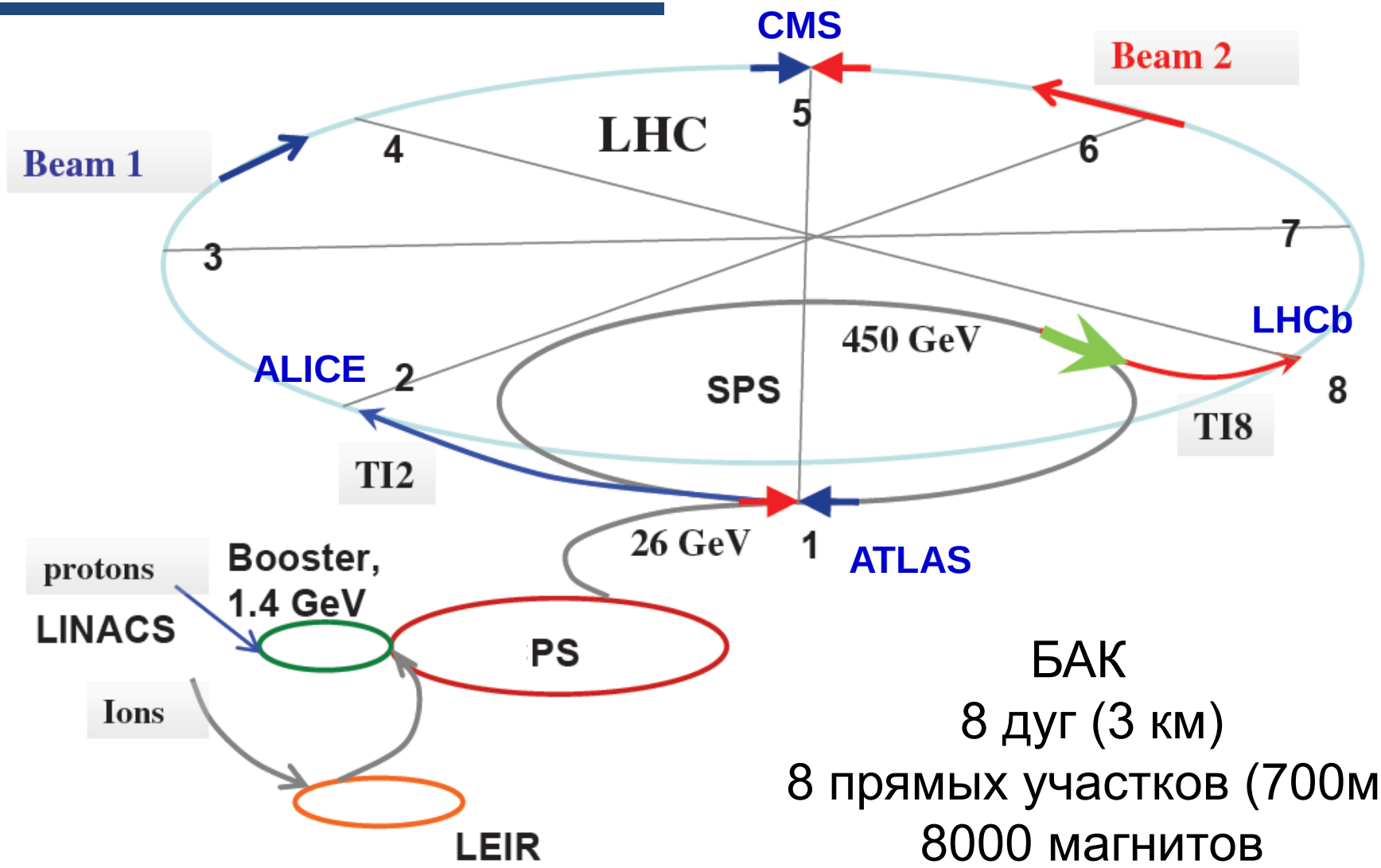
ATLAS @ LHC



Внутри протона



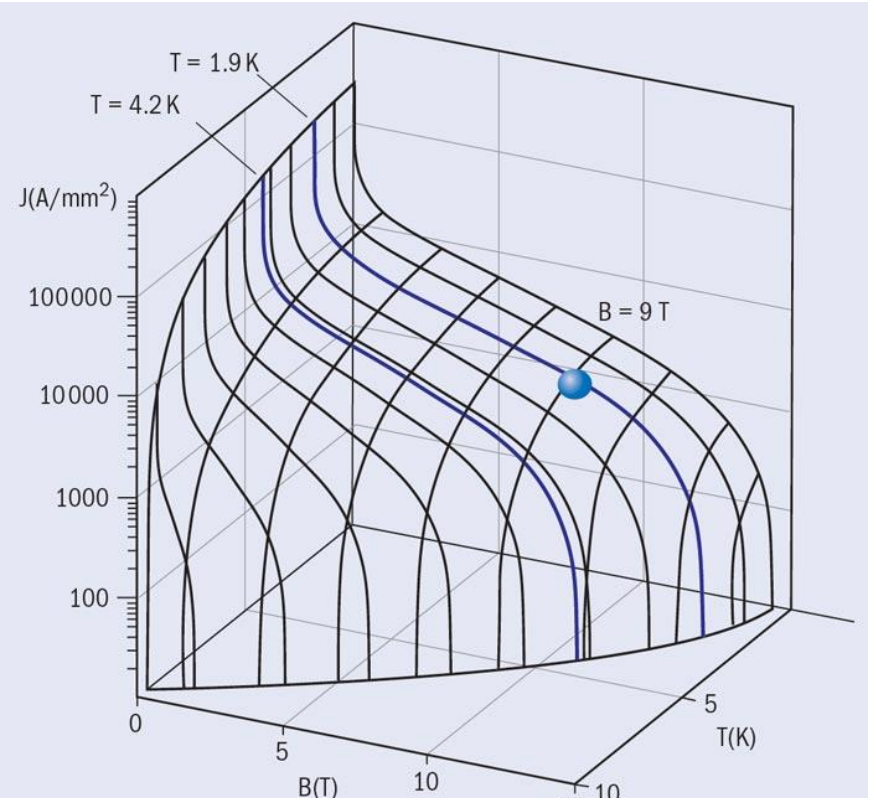
Ускорительный комплекс ЦЕРНа



БАК
8 дуг (3 км)
8 прямых участков (700м)
8000 магнитов
1 вакуумная камера
4 точки взаимодействия

БАК сверхпроводящий коллайдер

- $B = p/R$; $R_{LHC} = 2804m$
- p = 7TeV **B = 8.3T**
- сверхпроводящие магниты диполи Nb-Ti @ 1.9K (~ -271°C)
  5000 тонн гелия для охлаждения



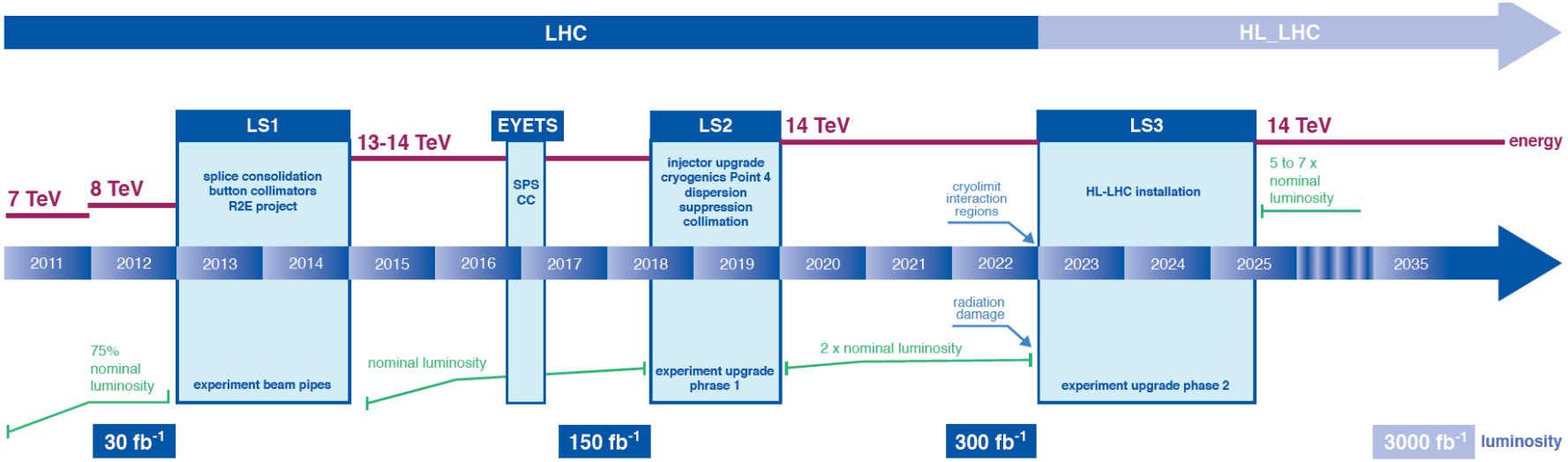
Магнит сверхпроводящ если температура, магнитное поле и плотность тока ниже критических значений. Энергия в магнитах:

10ГДж= @700км/ч

http://cerncourier.com/cws/article/cern/54383

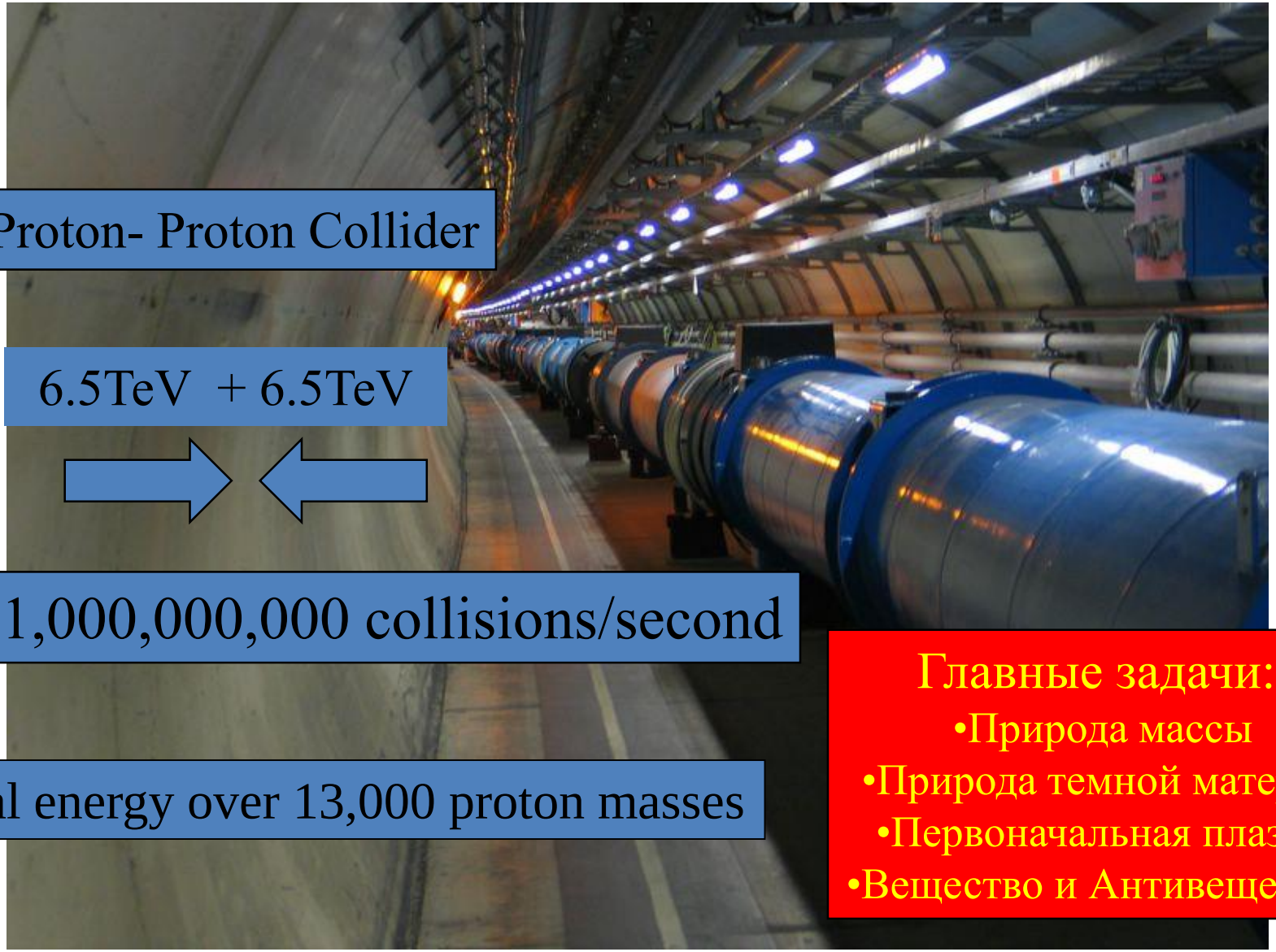
LHC beyond Run 2

$$\mathcal{L} = \frac{1}{4\pi} \frac{f k N_1 N_2}{\sigma_x \sigma_y}$$



- 100 fb^{-1} в конце Run 2 (2018)
- 300 fb^{-1} в конце Run 3 (2023)
- 3000 fb^{-1} в конце программы БАК (~2037)

Большой адронный коллайдер (LHC)



Proton- Proton Collider

6.5TeV + 6.5TeV

1,000,000,000 collisions/second

Total energy over 13,000 proton masses

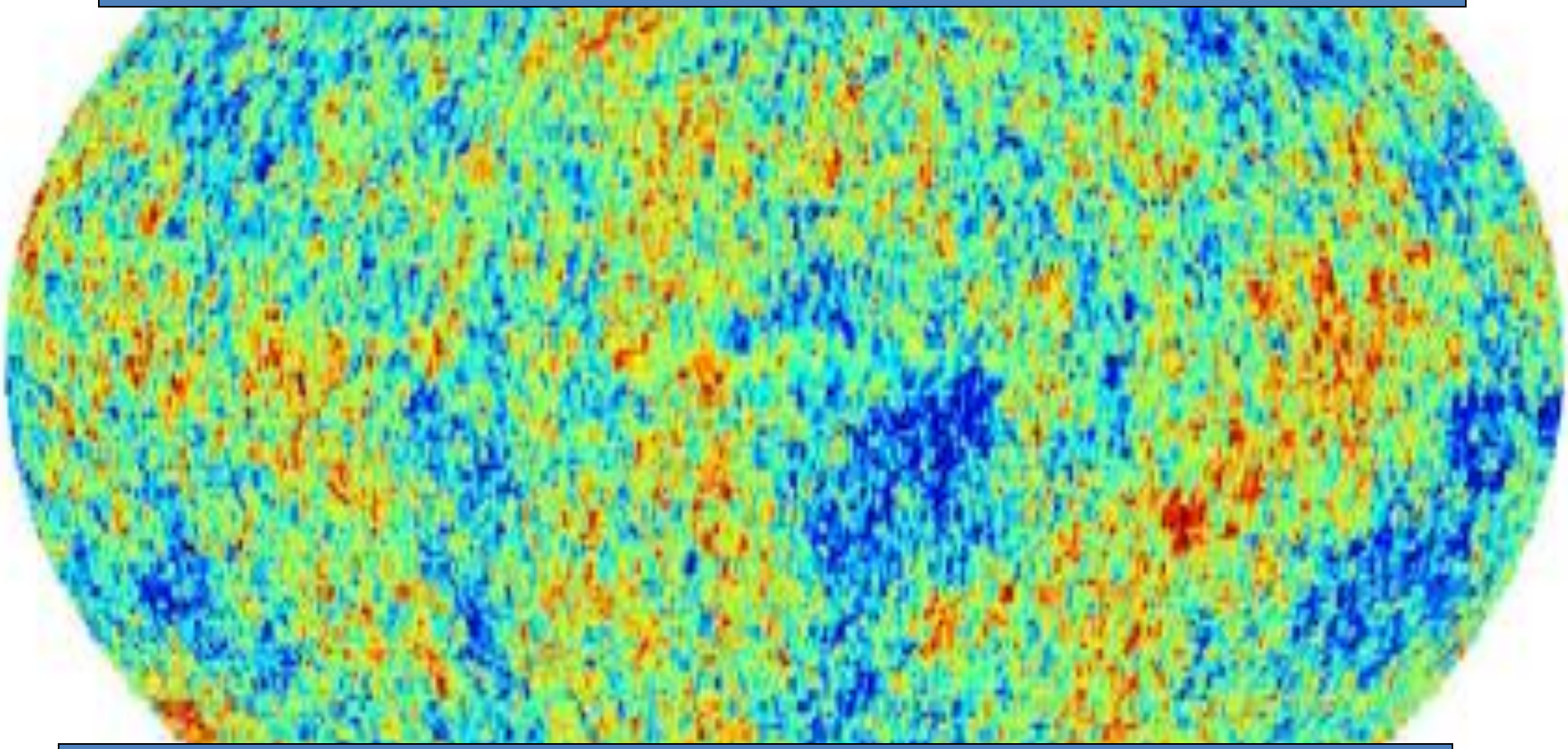
Главные задачи:

- Природа массы
- Природа темной материи
- Первоначальная плазма
- Вещество и Антивещество

Наиболее «пустое» место Солнечной системы

Вакуум как в межпланетном прстранстве: давленение в пучковых трубках в 10 раз меньше, чем на поверхности Луны.

И «холоднее», чем в открытом космосе



LHC 1.9 К = - 271 С

Открытый космос 2.7 К = - 270 С

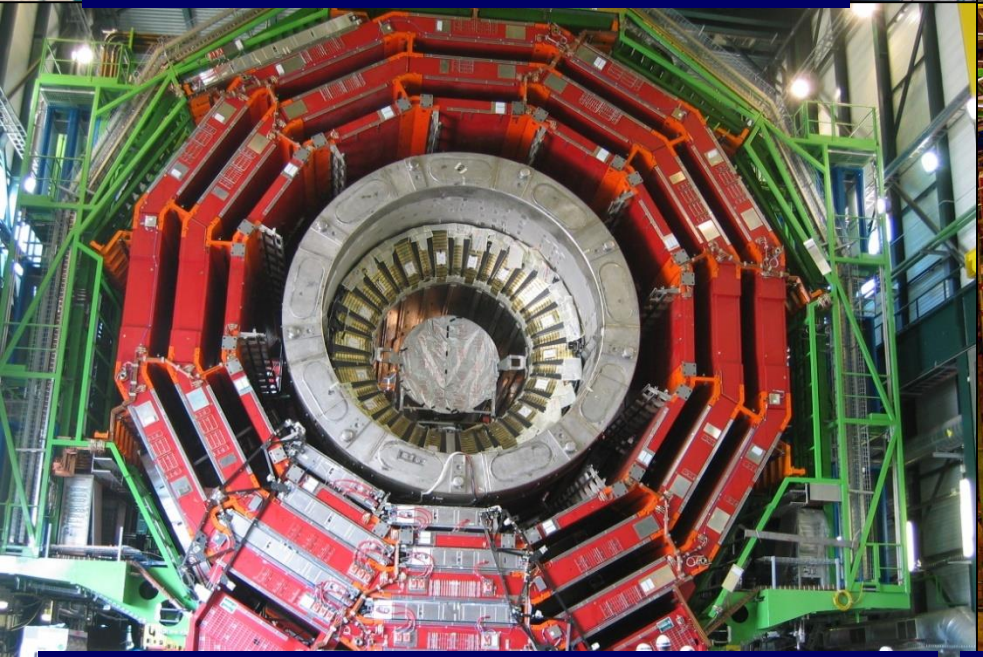
Общий вид LHC и экспериментов

Столкновения протонов... ...регистрируются в гигантских детекторах

27 км длина окружности
на ~ 100 м глубине

ALICE: «Исходная» плазма

ATLAS: Хиггс, суперсимметрия, ..



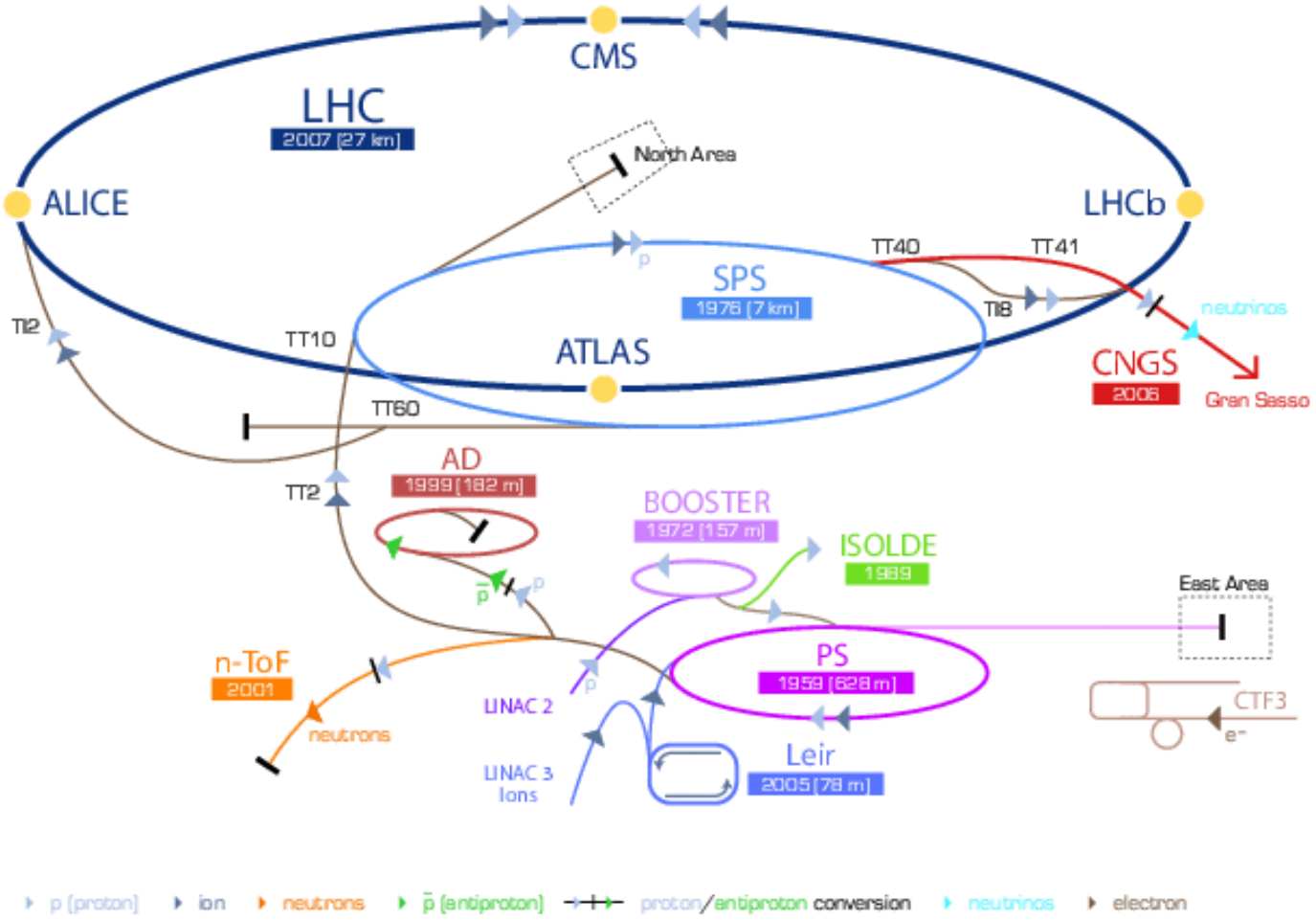
CMS:Хиггс, суперсимметрия, ...

LHCb: Различия вещества-антивеще

Наиболее «горячее» место во Вселенной

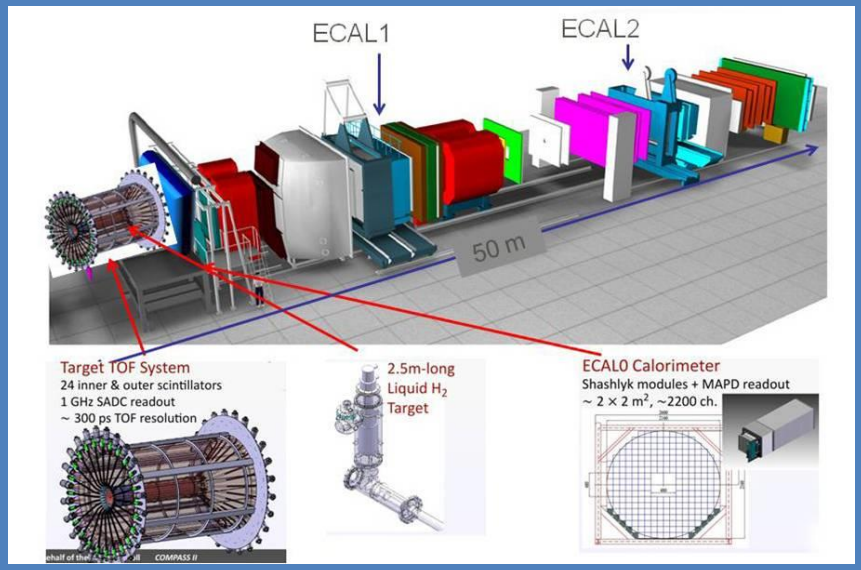
Столкновения частиц создают (в маленьком объеме) темературы, в миллиарды раз выше, чем на Солнце

CERN – самый большой комплекс ускорителей



Программа экспериментов на выведенных пучках SPS (Эксперименты на фиксированных мишенях)

COMPASS - изучение структуры протонов (спиновой)

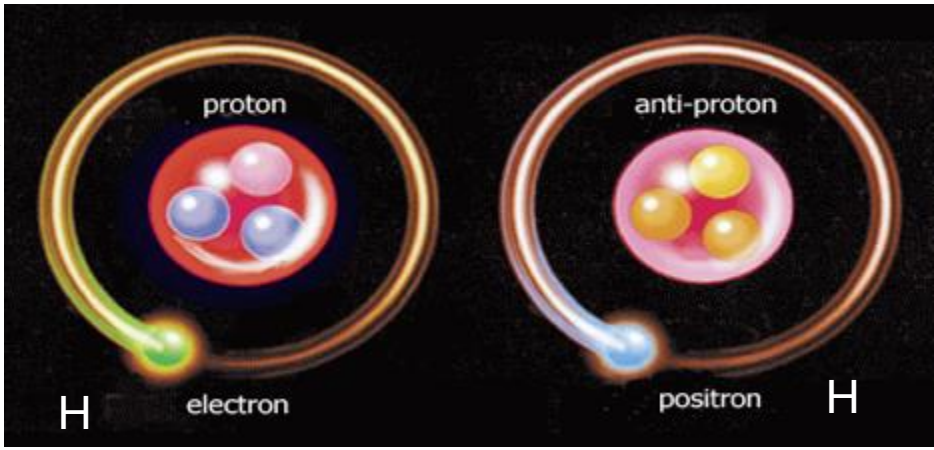


NA62 - изучение распадов Каонов (поиск новых и изучение редких распадов)

Физика антивещества

Сравнение вещества и антивещества

Фундаментально для теории



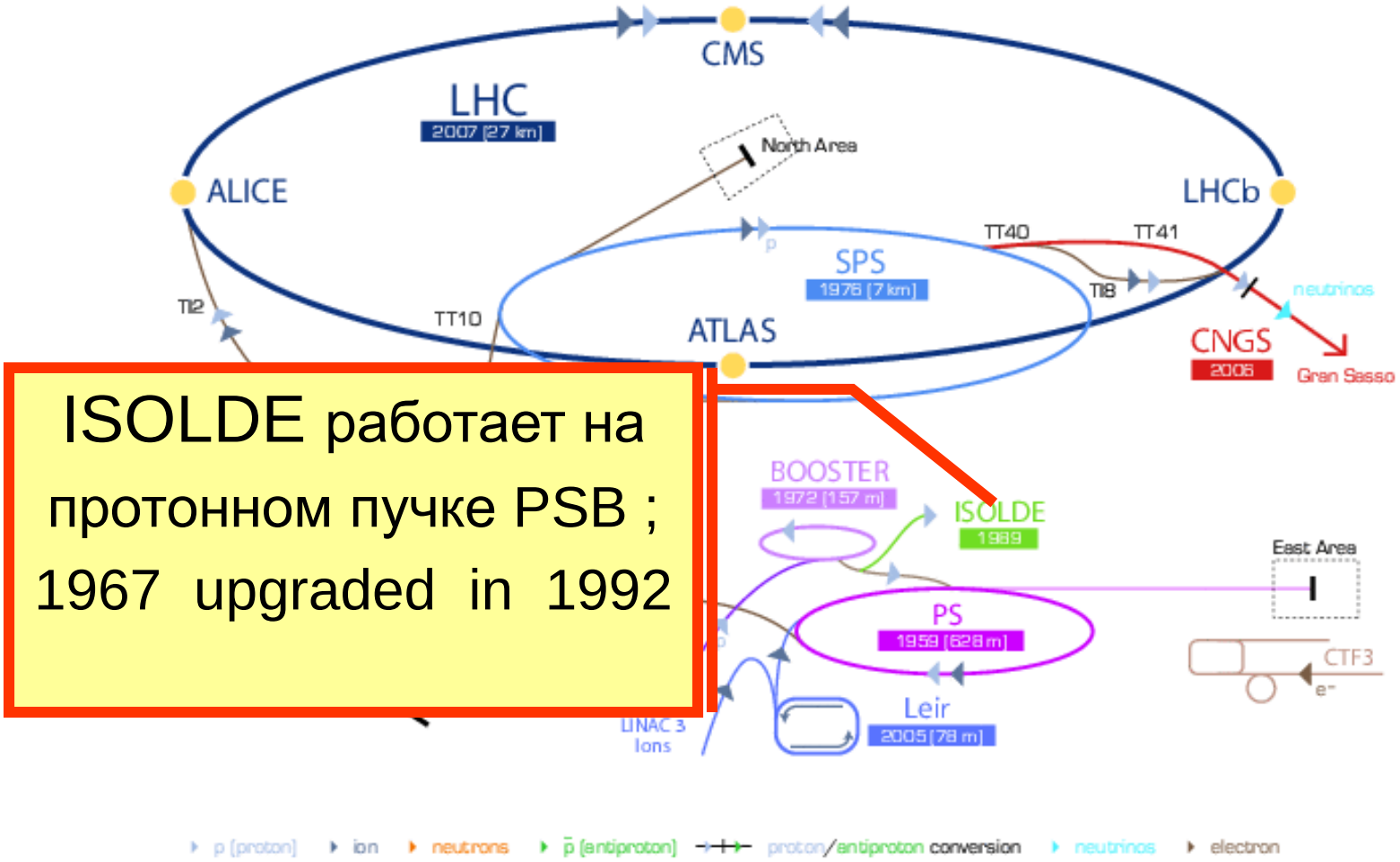
ASACUSA
ATRAP
ALPHA

Ловушки анти-H в магнитном поле типа «бутылки»

AEGIS Наблюдение свободного падения анти-H
Эксперимент Галилея, антивещество!

ACE Биологический эффект
анти-p -> терапия

Ускорительный комплекс CERN, работает не только для LHC



ИЗОЛЬДА - Isotope Separator On Line

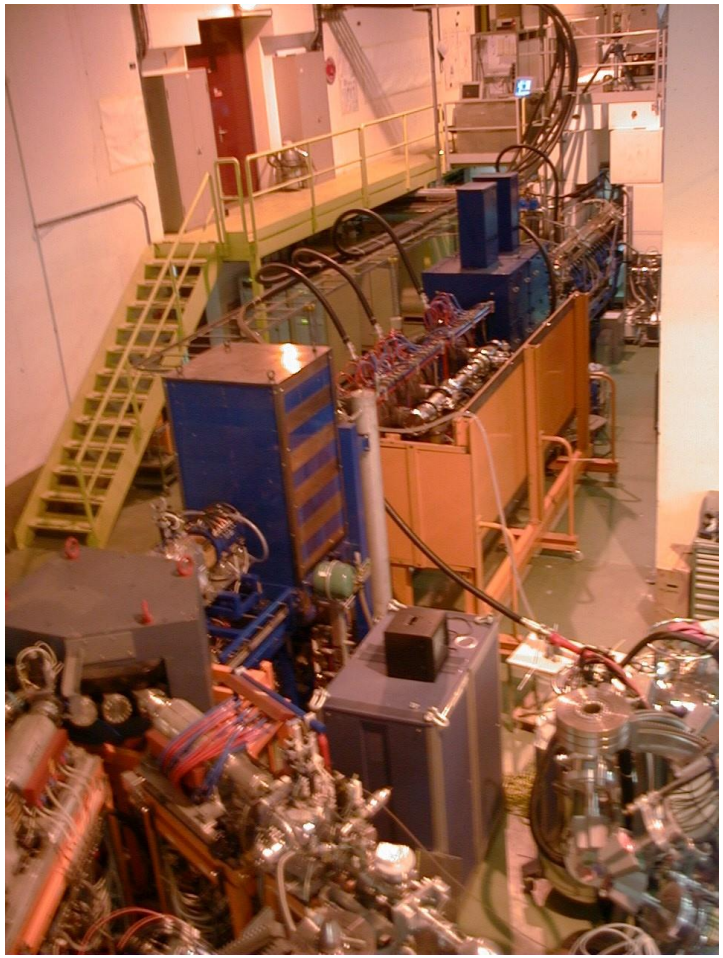
РЕКС - Radioactive beam EXperiment

Фабрика алхимии

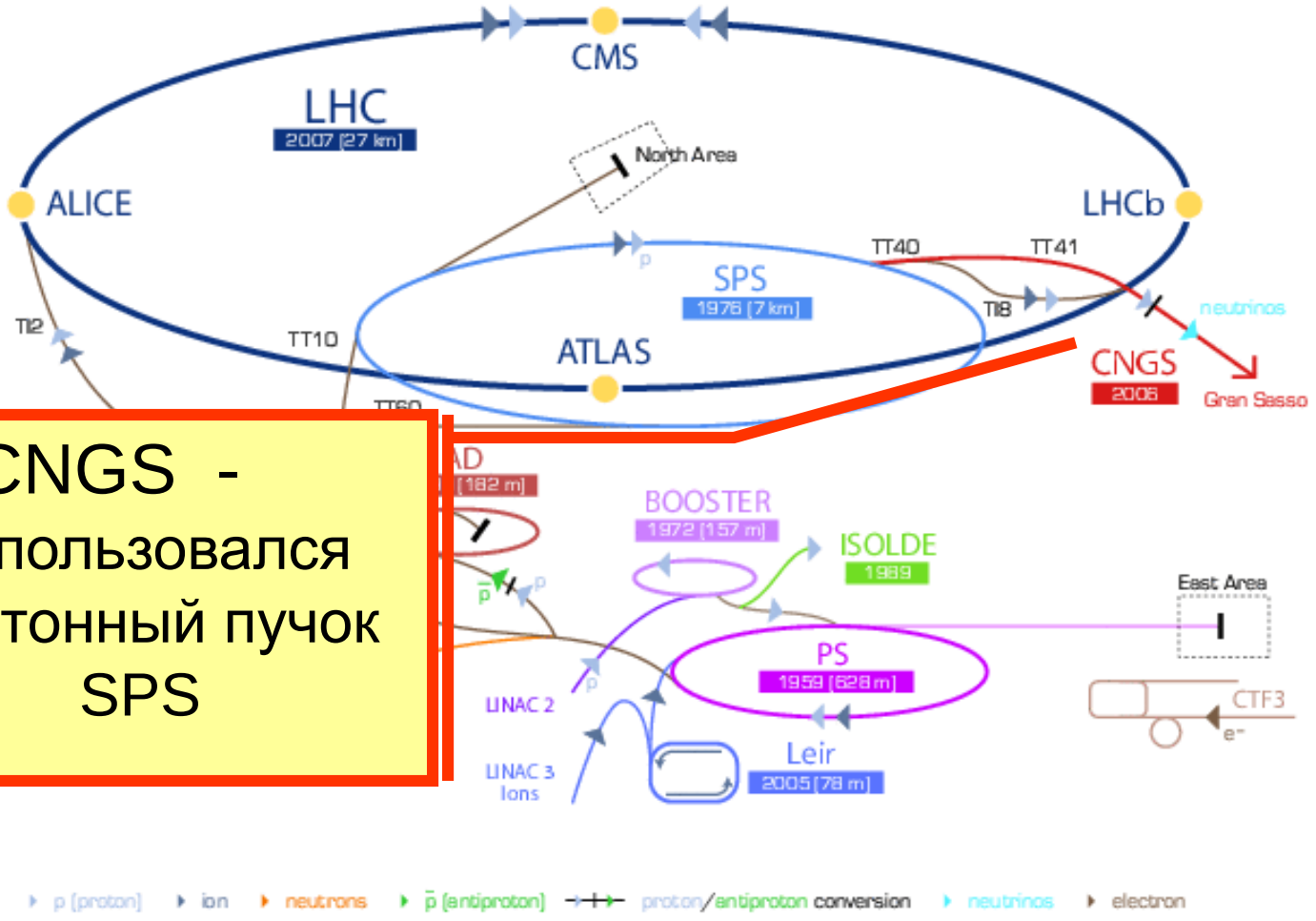
(для ядерной физики)

Низко-энергетические пучки радиоактивных ядер на Бустере протонного синхротрона (PSB).

Могут производить более чем 1000 различных радиоактивных изотопов для широкой области исследований



Ускорительный комплекс CERN, работает не только для LHC

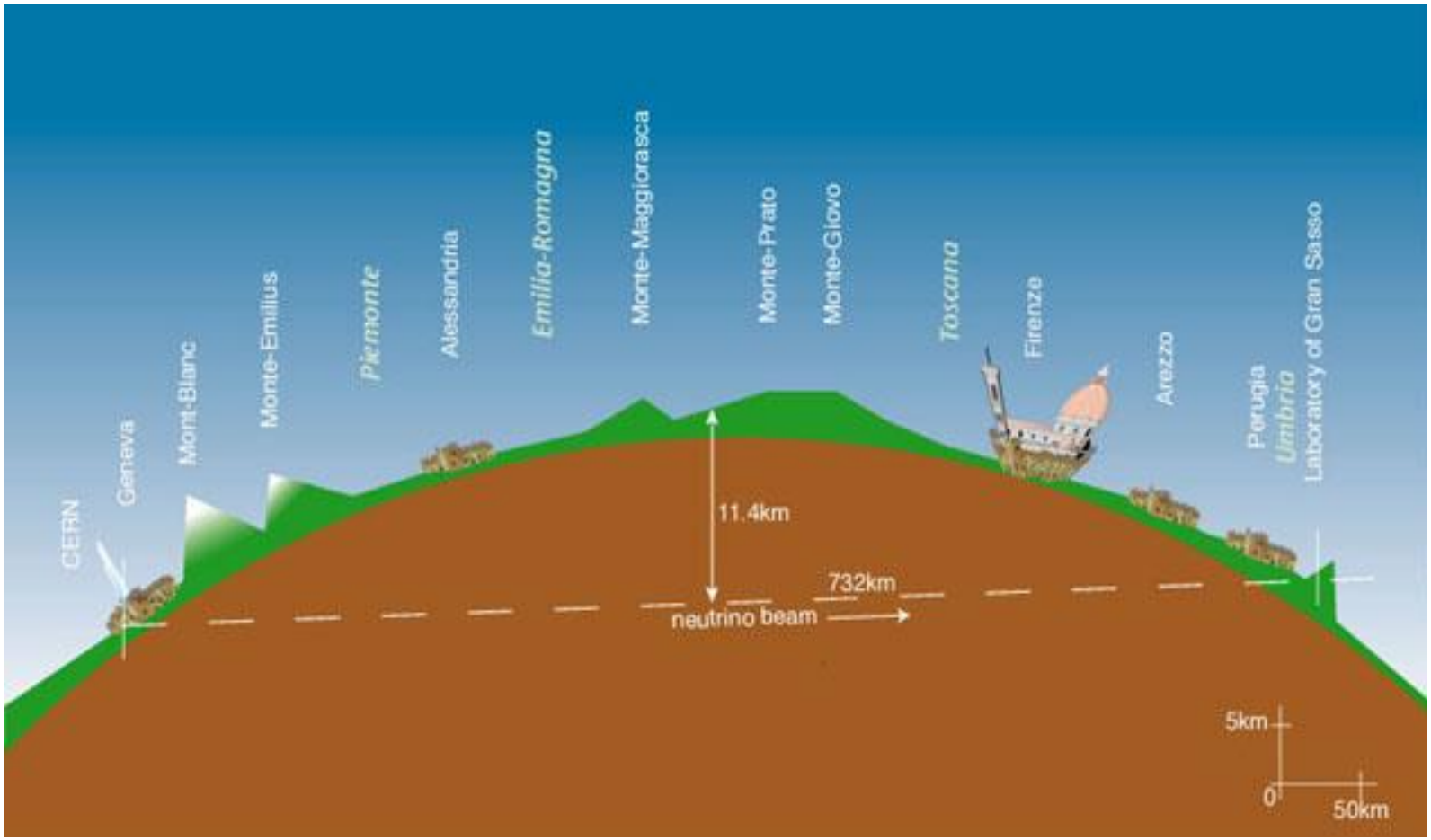


CNGS - использовался протонный пучок SPS

CNGS – CERN Neutrino to Gran Sasso experiment

- исследовали свойства нейтрино (2008-2012)

CERN sends muon neutrinos to the Gran Sasso National Laboratory (LNGS), 732 km away in Italy. There, two experiments, OPERA and ICARUS, wait to find out if any of the muon neutrinos have transformed into tau neutrinos. To create the neutrino beam, a proton beam from the Super Proton Synchrotron (SPS) is used.



Космические лучи - > образование облаков

(cosmic rays “simulated “ by T11 beam, clouds created in a large climatic chamber

Backups

Работа в “ЦЕРНе”

https://jobs.web.cern.ch/content/join-us

https://jobs.web.cern.ch/join-us/summer-student-programme-member-states

Вакансии на экспериментах:

- http://lhcb.web.cern.ch/lhcb/lhcb_page/collaboration/jobs/
- http://cms.web.cern.ch/org/jobs
- https://espace.cern.ch/Administration-ATLAS-Secretariat/Jobs/SitePages/Jobs.aspx
- …

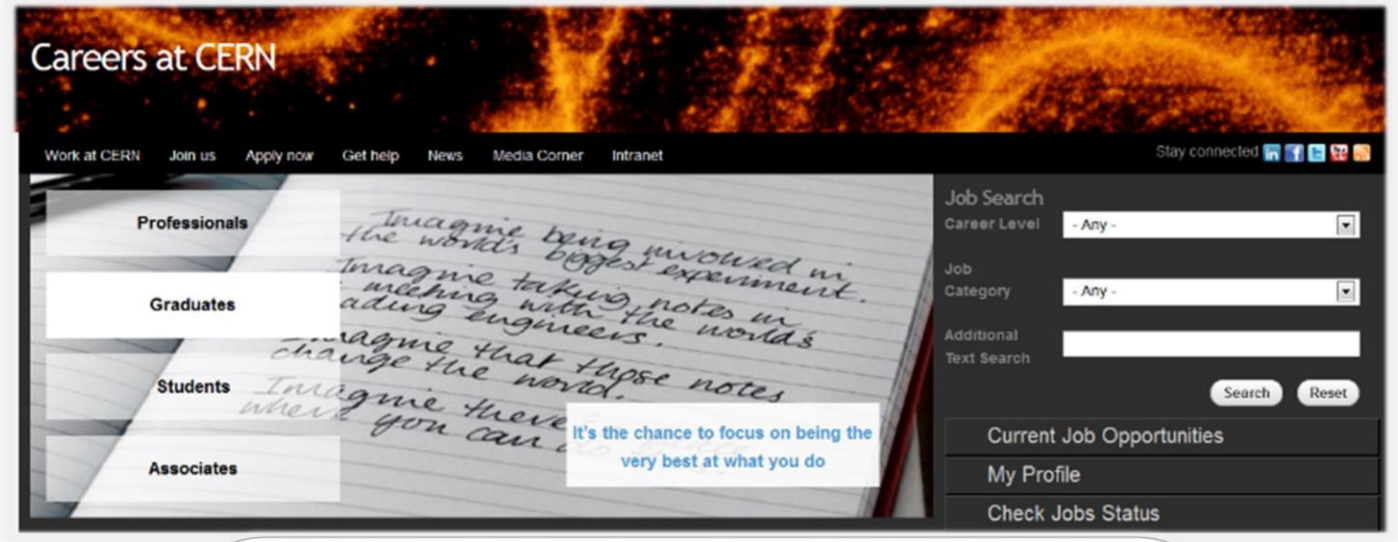
Each year CERN welcomes….

Over 600 Students:

- 300 Summer Students
- 200 Technical Students
- 80 Doctoral Students
- 30 Administrative Students

- Over 250 Fellows:
  - Including 40 – 50 Technician Training Experience fellows
- Over 150 Staff
- And a number of associates

Working at CERN: How?



cern.ch/jobs

Technical Students programme

For students looking for a practical training assignment or who would like to write their bachelor or masters thesis at CERN

"It's a great place to start a career, it's a great place to learn new skills, make new friends…"

~ 200 positions/year

Fields	Computing (~50% of the students)
	Engineering
	Physics (excl. theory and particle physics)
Length	**4 to 14 months for technical students**
Eligibility	**18 months of technical undergraduate studies.**
	Registered student during stay at CERN
Features	**Technical project with a CERN supervisor**
	A living allowance of 3238 CHF
	Health insurance provisions

Committees in June and December

Admin Students programme

"My Admin Studentship was a great experience – I had exposure to more activities than I could have imagined"

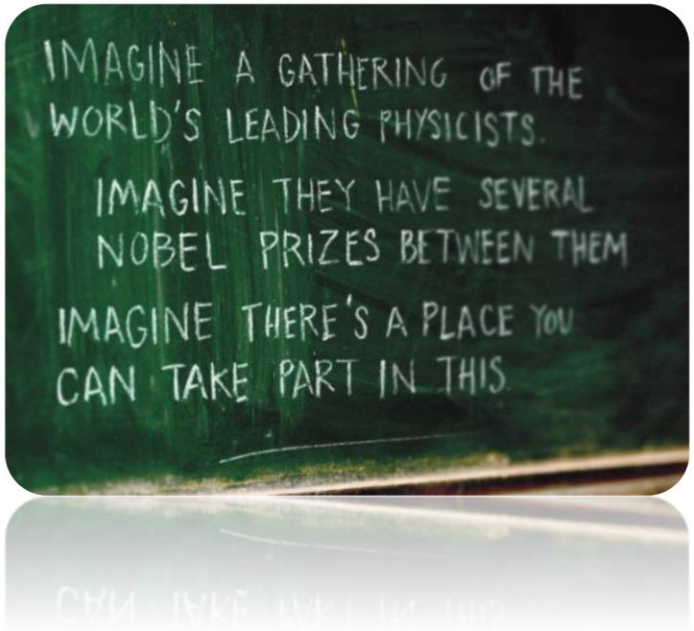
~ 30 positions/year

FIELDS :	Translation, human resources, business administration, law, finance, librarianship, science communication, audiovisual, communication and public relations…
LENGTH :	4 to 12 months
ELIGIBILITY :	18 months of undergraduate studies
FEATURES :	an administrative project with a CERN supervisor a living allowance, incl. health insurance

Committees in June and December

Doctoral Student programme

For students who would like to spend 3 years at CERN to work on their thesis



"Gave me the opportunity to meet important people, especially in the research fields"

~80 positions/year

FIELDS :	applied physics, engineering, computing
LENGTH :	6 mths -3 years
ELIGIBILITY :	enrolled in a doctoral program in a Member State university
FEATURES :	a technical project, leading to a PhD thesis co-supervised by the university thesis advisor and a CERN staff member a living allowance incl. Health insurance

Committees in June and December

Summer Students programme

Participate in the day to day life of a research team and follow lectures.
~300 positions/year (~ 150 for Member States and ~ 150 for Non Member States)

"Can't imagine a better way to spend my summer"

Fields	Physics (incl. particle physics) =2/3 of students engineering, computing
Length	8 to 13 weeks, during the summer
Eligibility	3 years of full-time studies at university level
Features	High-quality lecture programme over 6 weeks
	Visits and workshops
	Living allowance of 90 CHF p/d
	Health insurance provisions
	Accommodation in the CERN hostel

Application & Selection:

- Deadline: end January
- Web selection: Mid-March
- First students arrive beginning June

Over 6000 young scientists have benefitted to date…

Selection in February

Fellows

"An ideal place to follow the most recent ideas in physics and start new collaborations"

~250 positions/year

FIELDS :	physics, engineering, computing - from junior engineers to posst-doc research physicists
LENGTH:	**2-3 years**
ELIGIBILITY :	BSc, MSc or PhD no more than 10 years relevant post-MSc experience
FEATURES :	employment contract attractive salary incl. social benefits training and networking

Fellows are normally nationals of the Member States of CERN. There also exist a limited number of places for Fellows from non-Member States.

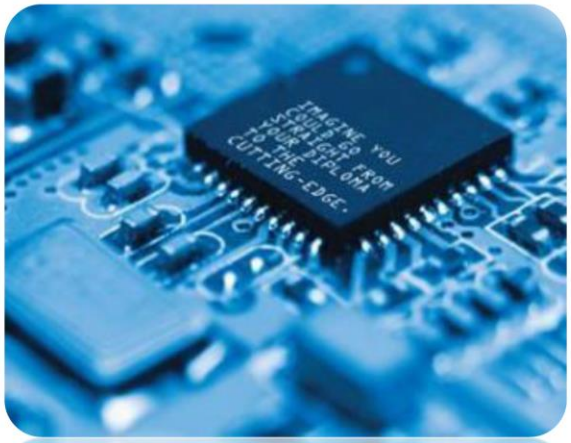
Committees in May and November

Marie Sklodowska-Curie

For university graduates

FIELDS :	physics, engineering, computing
DURATION:	up to 3 years
ELIGIBILITY :	MSc or PhD
	≤5 years post-degree experience
FEATURES :	funded by the European Commission
	an employment contract with CERN
	specific Marie-Curie vacancies published on CERN web pages
	an attractive salary, social benefits, allowances
	international network

Technician Training Experience



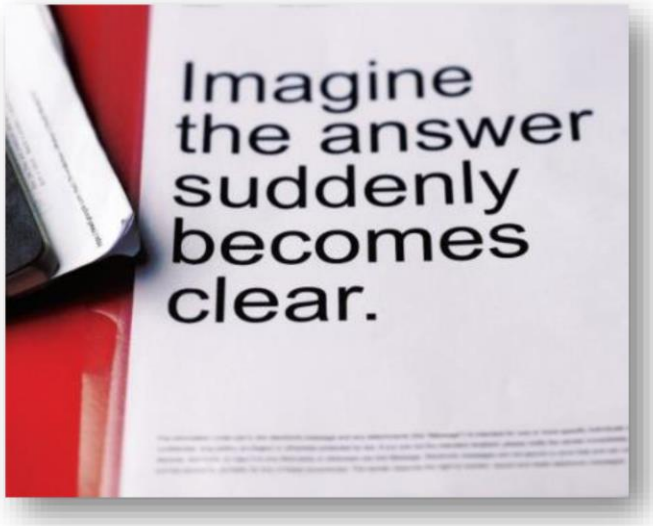
"I never imagined the possibilities CERN would offer me."

~30-50 positions/year

FIELDS :	Mechanics, electronics, electricity, etc.
ELIGIBILITY :	Technical diploma
	no more than 4 years relevant experience
SELECTION:	All applications for TTE opportunities will be considered by a panel of CERN specialists.
FEATURES :	An initial contract of one year renewable for a second year
	Project with CERN supervisor
	Training and networking (on the job, formal, languages)
	Employment contract with attractive salary incl. social benefits

Committees in June and December

Staff positions

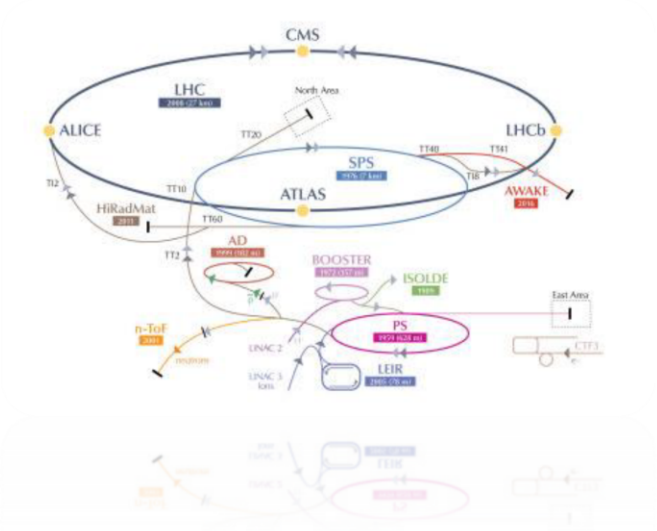


"It's the chance to focus on being the very best at what you do."

~ 150 positions/year
(> 200 in 2017)

FIELDS :	physics, engineering, computing, technicians, administrative staff
ELIGIBILITY :	from apprenticeship to PhD
SELECTION:	advertised on cern.ch/jobs
	application via the website
	Asynchronous video-screening (Sonru)
	Interview at CERN (typically 4 invited)
FEATURES:	up to 5 year initial limited duration contract
	competitive salaries incl. social benefits
	relocation expenses
	training (language courses, technical training)

Associates



Scientific Associates

Experienced individuals on leave of absence mainly in physics

Normally 12 months (24 months max)

Cooperation associates / Users

Scientists (including PhD students in physics)

Corresponding Associates

Experienced individuals from smaller Member States on leave of absence mainly in physics

Up to 6 months

Project Associates

Physicists, engineers and technicians invited by Departments (according to agreements)

Up to 3 years