Overview report for 2017 from the SPC

R. Keith Ellis
IPPP, Durham, UK

SPC composition

- Laura Baudis (CH)
- Caterina Biscari (ES)
- Keith Ellis (UK)
- Belen Gavela(ES)
- Beate Heinemann(DE)
- Mark Huyse(BE)
- Francois Le Diberder(F)
- Guido Martinelli (IT)

- Hugh Montgomery(US)
- Yossi Nir(Israel)
- Krysztof Redlich(PL)
- Teresa Rodrigo(ES)
- Valery Rubakov(RU)
- Heidi Schellman(US)
- Yoichiro Suzuki(JP)

- **Ex officio**
- Halina Abramowicz(Israel)
- Francesco Forti (IT)
- Norbert Holtkamp(US)
- Jordan Nash(Australia)
- Karsten Riisager(DK)
- Yoichiro Suzuki(JP)
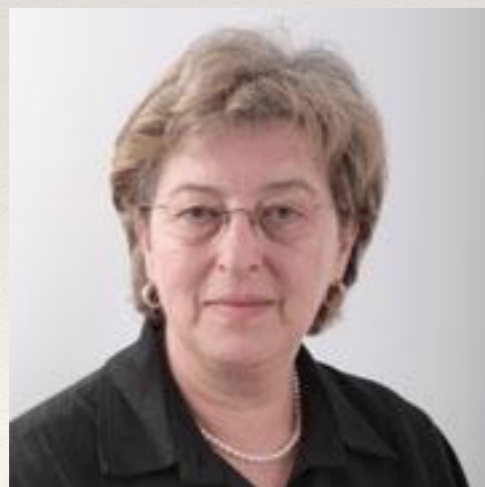
Retiring members

Francois Le Diberder(F)

Teresa Rodrigo Anoro (ES)

Yoichiro Suzuki (JP)

Ex Officio: Outgoing ECFA chair
Halina Abramowicz (Israel)

With heartfelt thanks for their
contributions to the work of the SPC

New SPC members 1.1.2018-12.31.2020

Marie-Helene Schune (F),
LAL, Orsay, LHCb member

Robert Cousins (US), UCLA, CMS
member, expert in the statistical analysis
of small signals

Ex Officio: Incoming ECFA chair,
Jorgen D'Hondt (BE), VUB
Brussels,

Remit=Charge

1. to make recommendations to the Council on the priorities of research programmes and the allocation of research effort both within the Laboratories of the Organization and extramurally;

MTP

2. to examine and make recommendations to the Council on the annual goals of the various scientific activities of the Organization;

MTP

3. to annually assess the achievements of the Organization with regard to the past year annual goals of the various scientific activities;

APR

4. to advise the Council from the point of view of scientific policy on the management and staffing of the Organization, including the visitors programme and the nomination of senior staff;

MTP

5. to advise the Council on any other matters which affect the scientific activities of the Organization.

Future Planning

Annual Progress Report-Safety

- ❖ Triggered by a desire to have more detailed information in the Annual Progress Report.

- ❖ Severity of accidents, (taux de gravité) in line with other research organizations, and below French National average.

- ❖ However contractor severity rate about 5 times the rate for employees.

- ❖ The hope is that raising this issue in the SPC would highlight its importance.

Simon Baird HSE, December 2017

Severity of occupational accidents for employed staff

Severity of occupational accidents for contractors
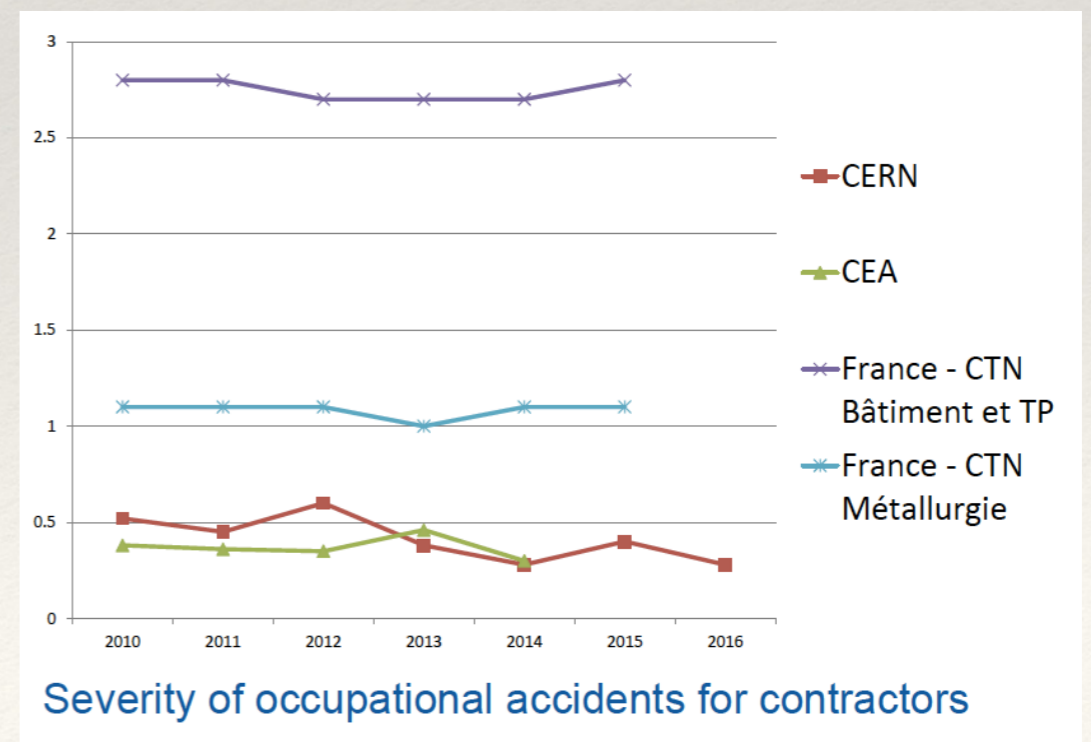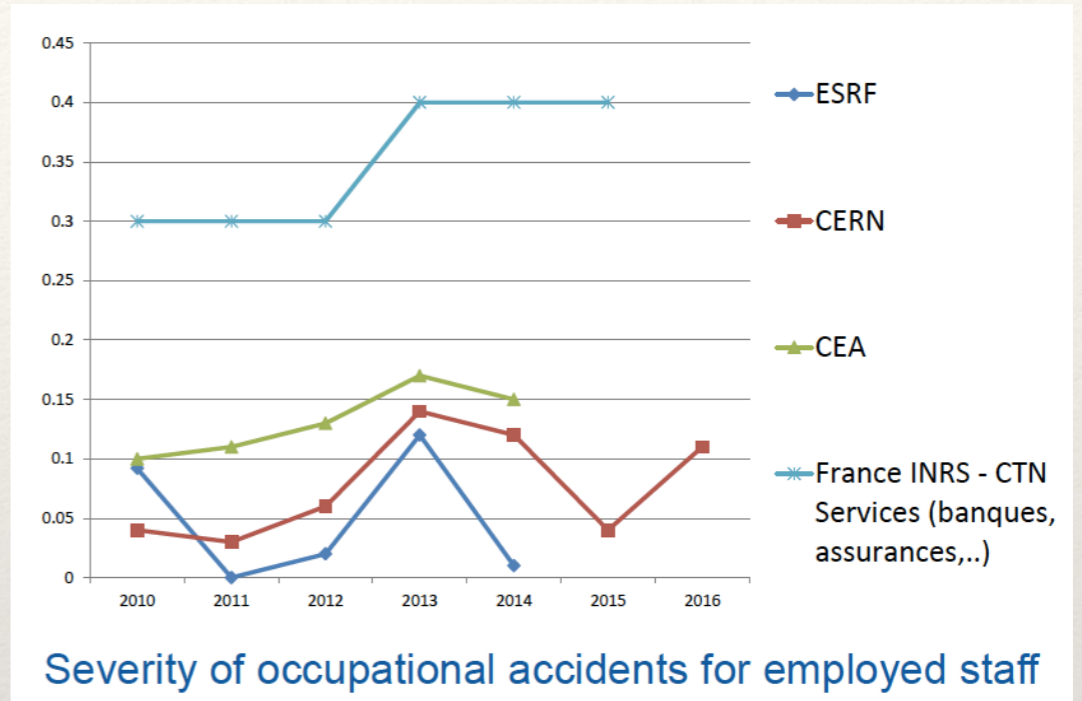
Standing Items

❖ Report from the Director of Accelerators and Technology

❖ Report from the Director of Research and Computing

❖ Report from the subsidiary committees, INTC,SPSC,LHCC

Physics reports 2017

- 3/17 Recent results and prospects of the AD experiments for CPT tests   M. Doser

- 5/17 Highlights of the Winter Conferences, T. Gershon 5/17

- 5/17 General overview of the results in neutrino physics, S. Soeldner-Remboldt

- 9/17 LHCb, G. Passaleva

- 9/17 ATLAS, K. Jakobs

- 9/17 ALICE, F. Antinori

- 9/17 CMS, G. Dissertori

- 12/17 Goals and possibilities for future Higgs Physics

Facility/Machine reports 2017

❖ 5/17 Linac4, A. Lombardi +visit & inauguration

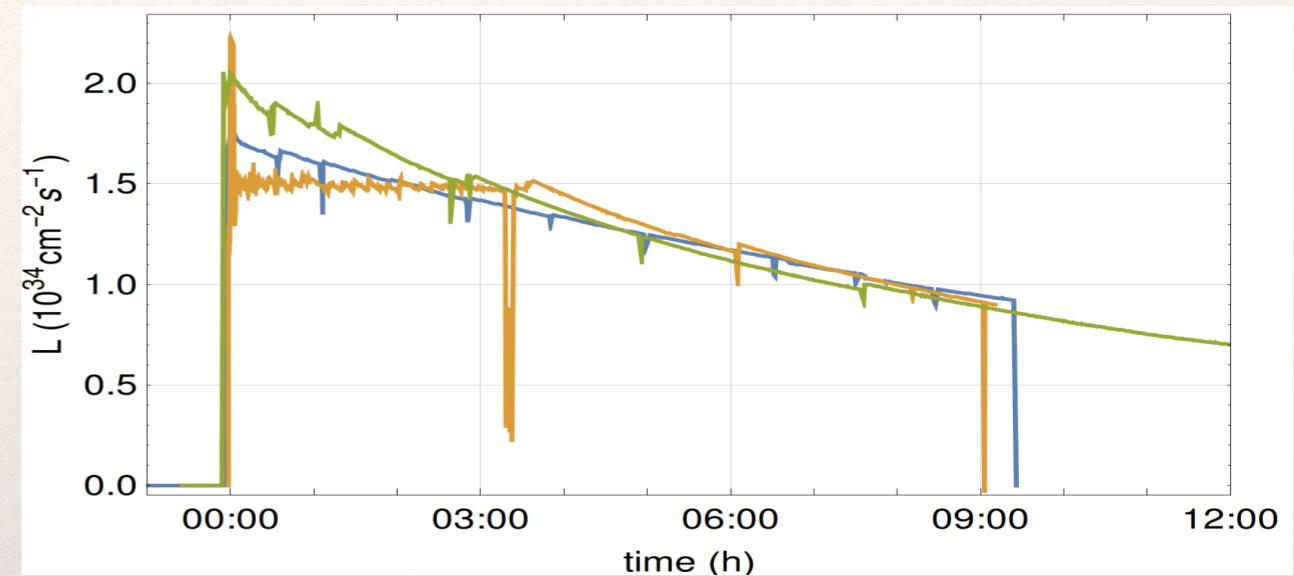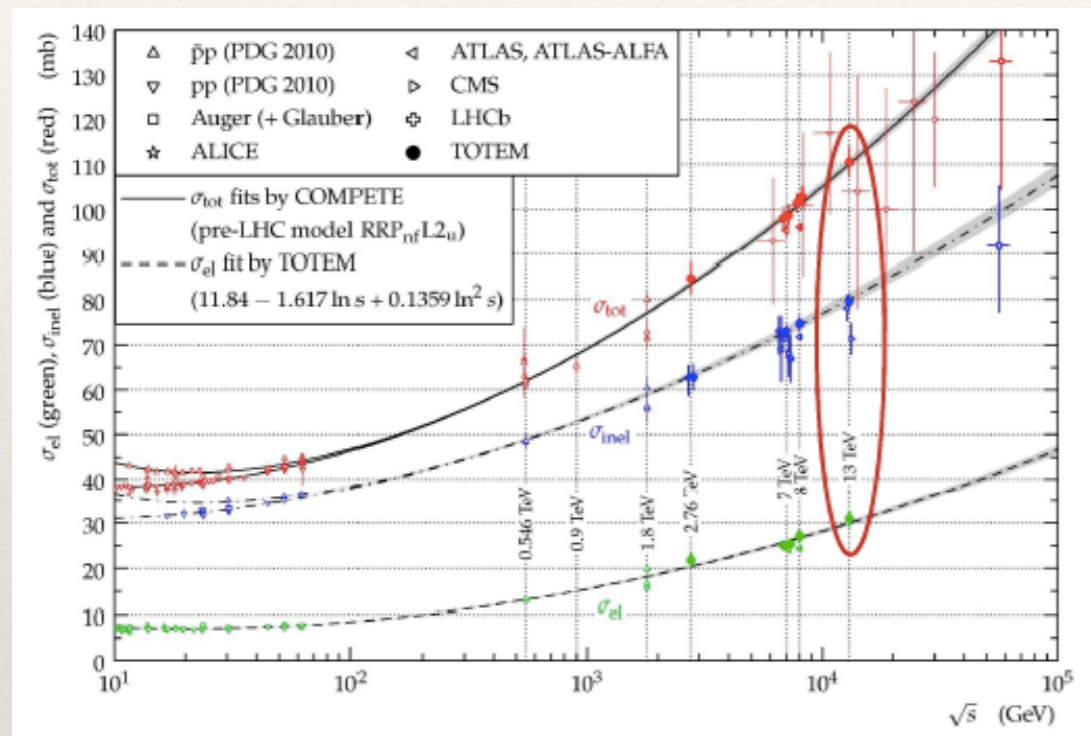❖ 6/17 Neutrino Platform, M. Nessi + visit

❖ 12/17 Report on ILC250, T. Nakada

NP02 — Double Phase detector

Total cross section at 13 TeV

❖ Total cross section at √s=13 TeV, σ=0.1106+.0034 barns

Totem collaboration

❖ Relation to pile-up

❖ In the normal running of the LHC, the contributions to the total cross section are the noise, e.g. cross section.

❖ Relation to cosmic rays, the power of the collider

Cosmic rays

- In cosmic rays, the beam is free, but you don't quite know what is in it.

- The shower calorimeter (atmosphere) is free but hard to calibrate.

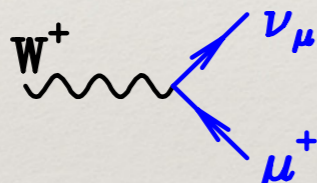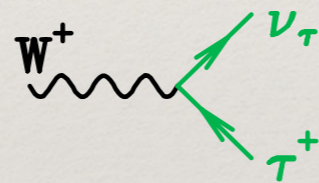- LHC total cross section measurements can give interesting input.

Cosmic Ray Spectra of Various Experiments
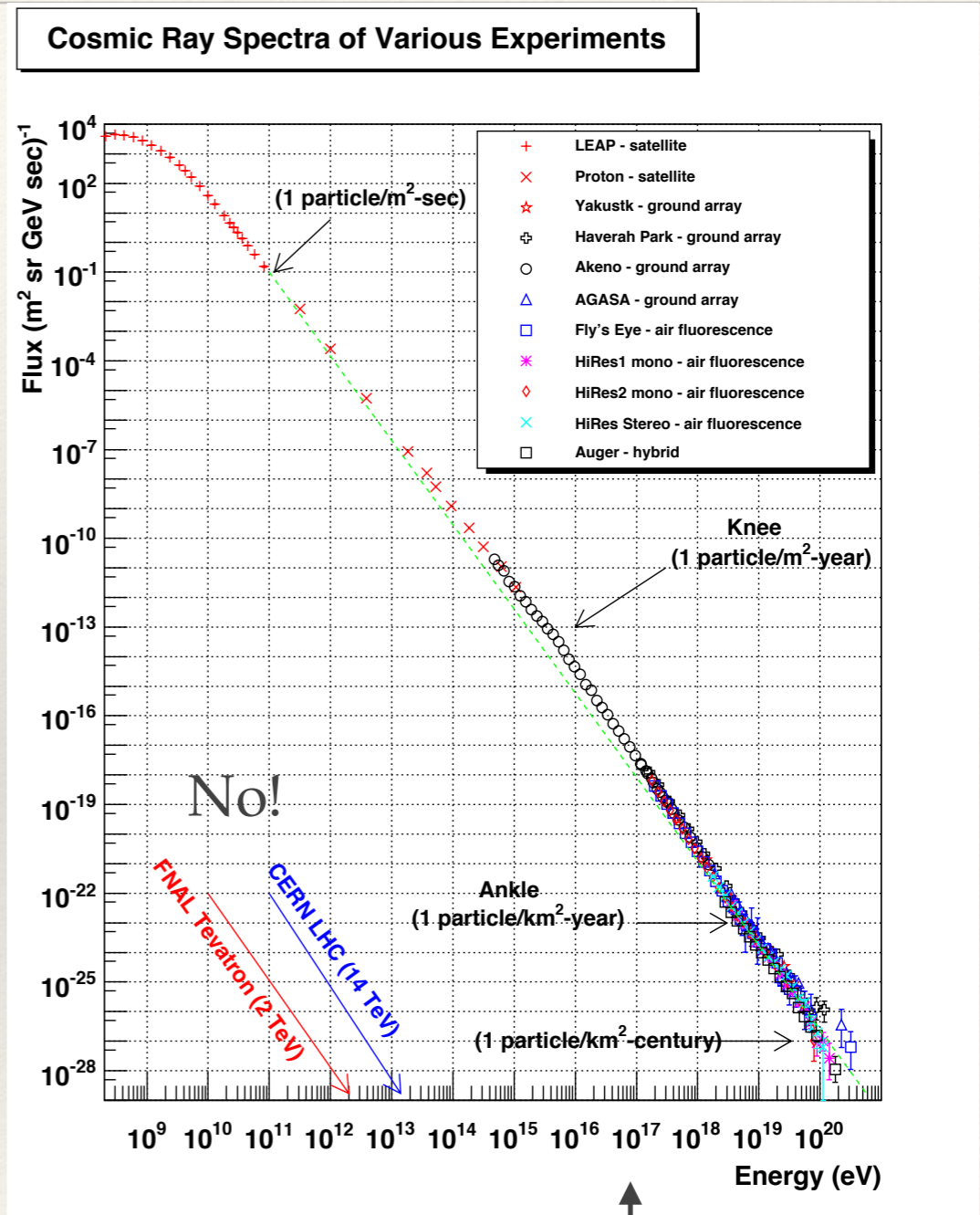
Lepton Universality

❖ Structure and strength of the couplings to gauge bosons are the same, despite the difference in mass.

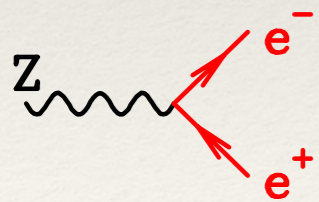$W^+ \to \nu_e\, e^+$ $W^+ \to \nu_\mu\, \mu^+$ $W^+ \to \nu_\tau\, \tau^+$
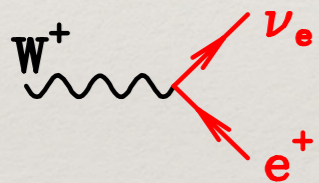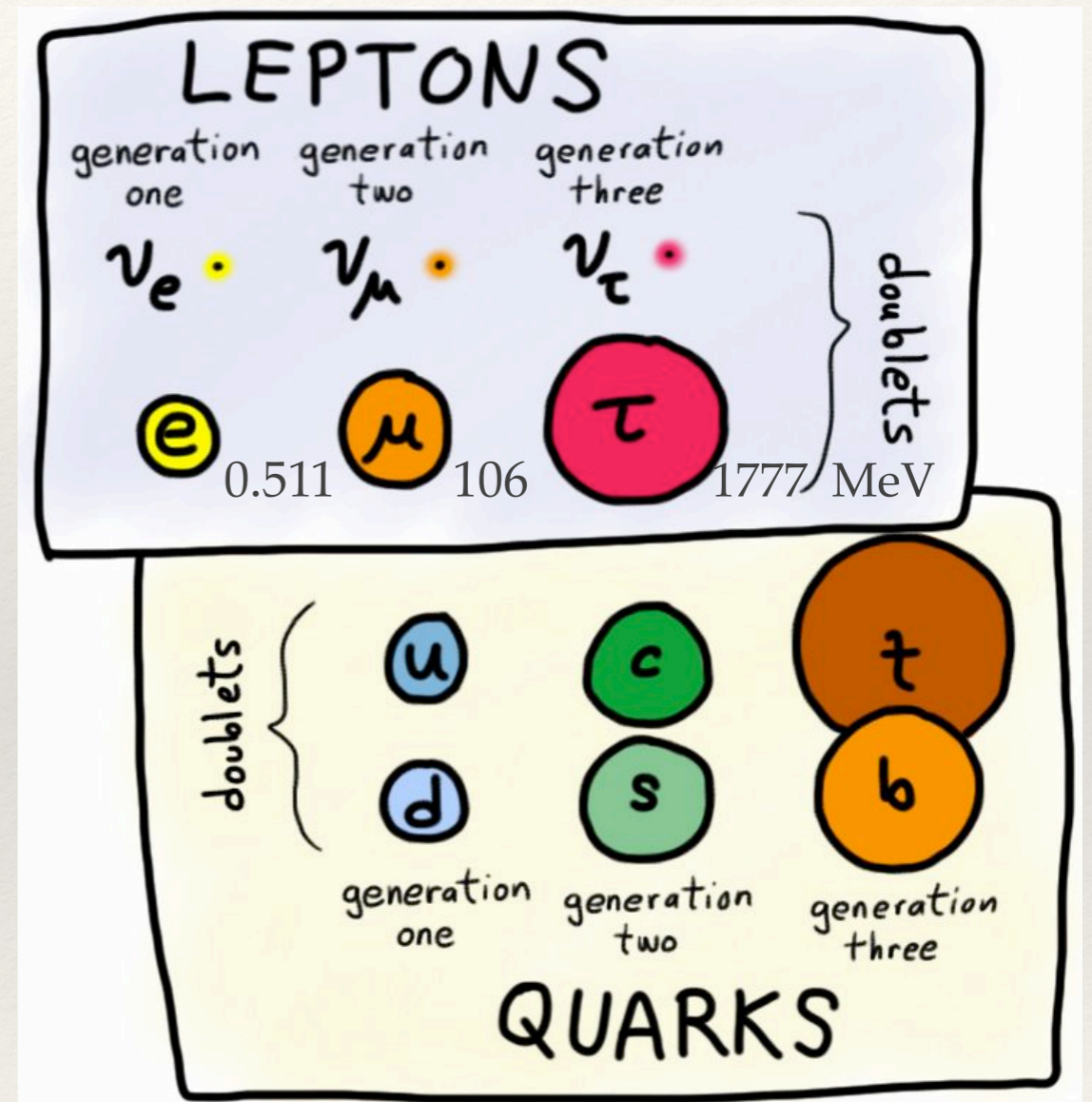
BR=$(10.71\pm0.16)\%$ BR=$(10.63\pm0.15)\%$ BR=$(11.38\pm0.21)\%$

$Z \to e^-\, e^+$ $Z \to \mu^-\, \mu^+$ $Z \to \tau^-\, \tau^+$
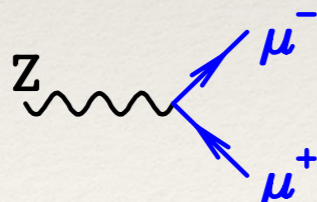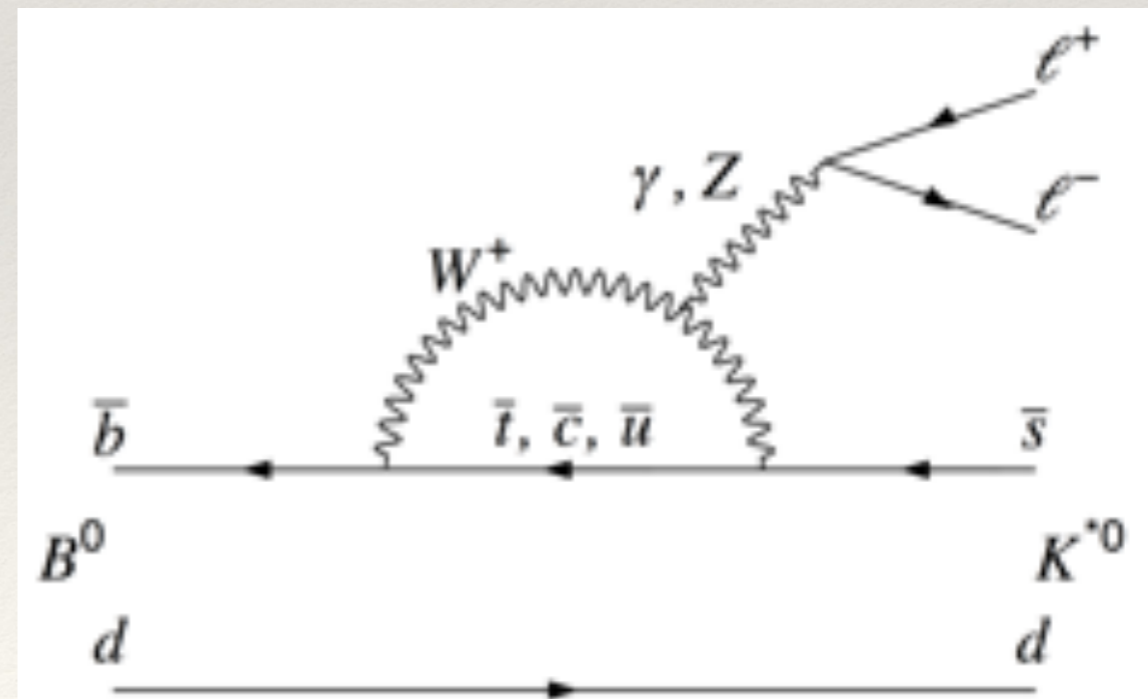
$\Gamma_{\mu\mu}/\Gamma_{ee}=1.0009\pm0.0028$ $\Gamma_{\tau\tau}/\Gamma_{ee}=1.0019\pm0.0032$
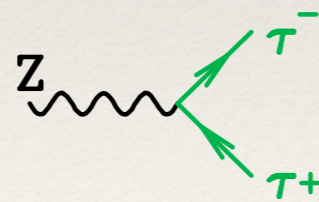
LHCb results

- ❖ Two main classes of decays have been studied

- ❖ $B^0 \to D^{*-} l^+ \nu$, tree level decay

- ❖ $b \to s\, l^+\, l^-$ decays, e.g. $B^0 \to K^{*0}\, l^+l^-$, Flavour changing neutral current.
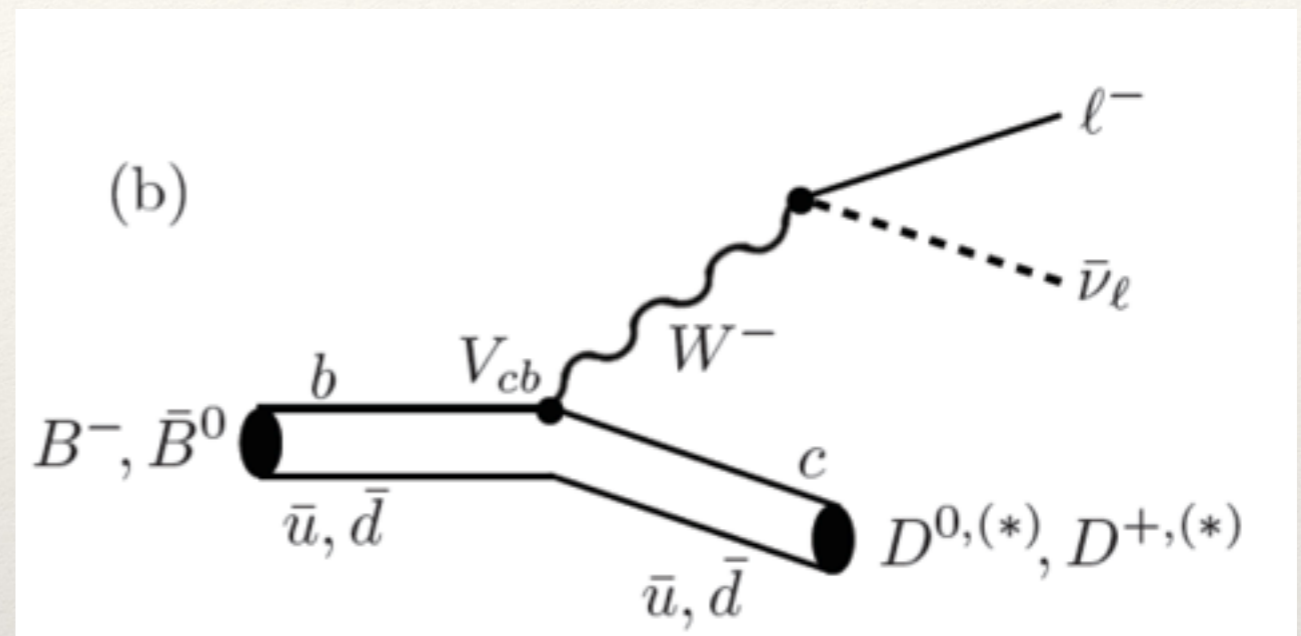
Universality τ-μ

$$R(D^*) = K_{had}(D^*) \times \frac{BR(B^0 \to D^{*-}\pi^+\pi^-\pi^+)}{BR(B^0 \to D^{*-}\mu^+\nu_\mu)}$$

$$K_{had}(D^*) = \frac{BR(B^0 \to D^{*-}\tau^+\nu_\tau)}{BR(B^0 \to D^{*-}\pi^+\pi^-\pi^+)}$$
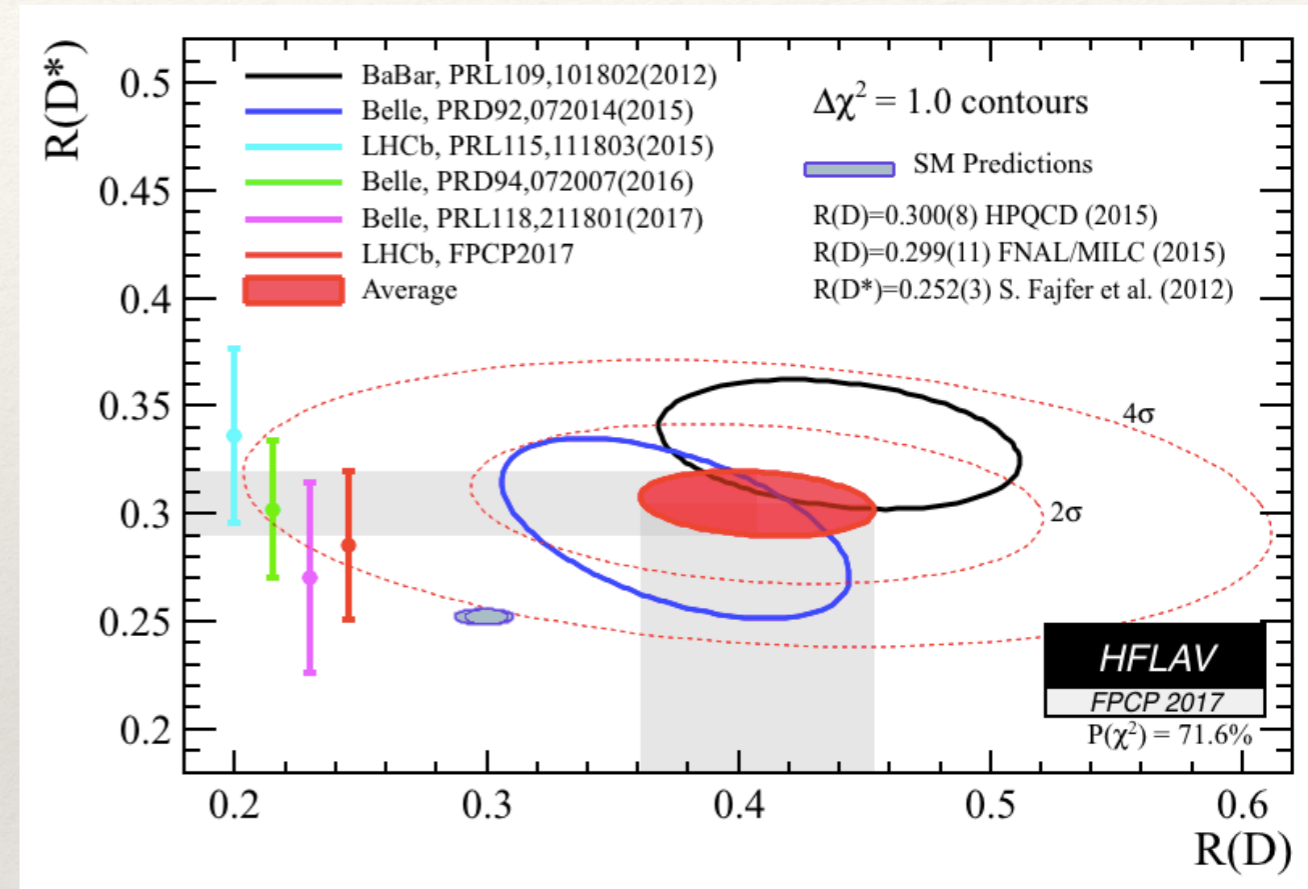
Results are internally consistent and 4 sigma from standard model.

Universality e-μ, R(K*)

$$R_{K^{*0}} = \frac{\mathcal{B}(B^0 \to K^{*0}\mu^+\mu^-)}{\mathcal{B}(B^0 \to K^{*0}J/\psi(\to \mu^+\mu^-))} \bigg/ \frac{\mathcal{B}(B^0 \to K^{*0}e^+e^-)}{\mathcal{B}(B^0 \to K^{*0}J/\psi(\to e^+e^-))}$$
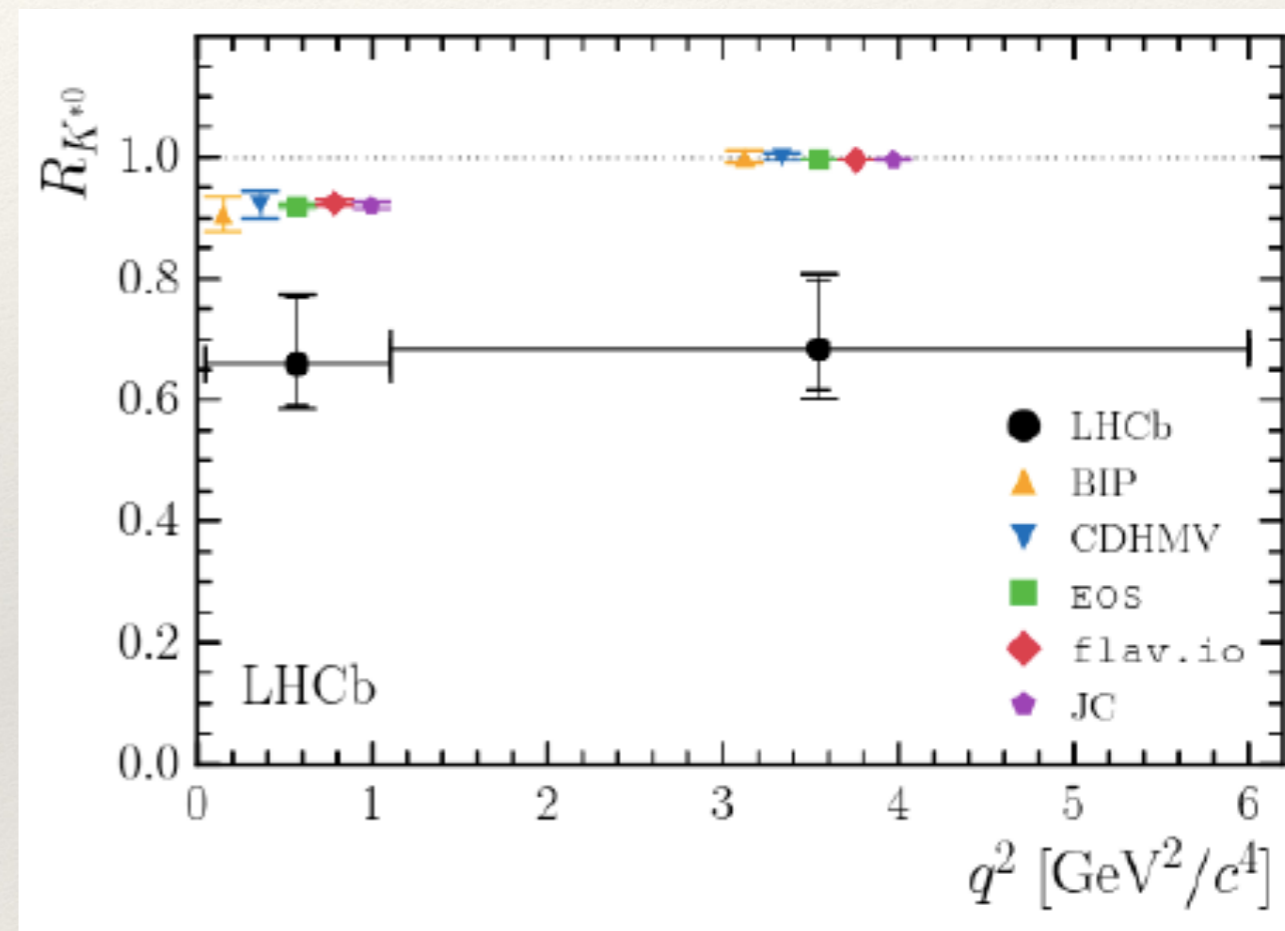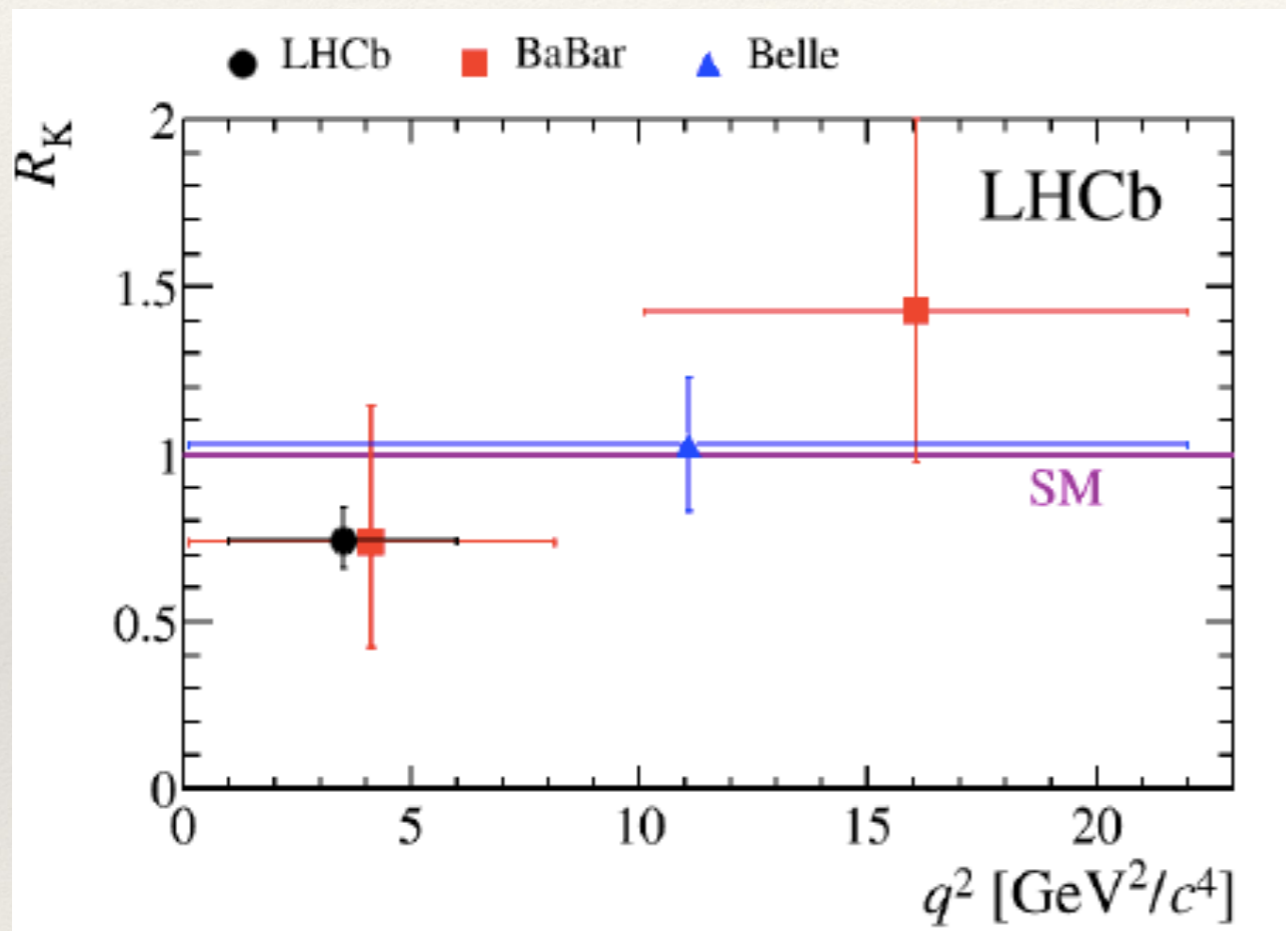
- Results 2 to 2.5 σ away from the standard model, with the potential to become 4-5 σ in a few years

- Results based on 3 fb-1 from 2011-2012, 3.8 fb-1 of data from subsequent years still to be analysed.

3 sigma, 5 sigma

❖ Imagine making a measurement of a normal distribution once a day, how often should one expect to find a result outside a given sigma range.

Range	Approximate frequency of occurrence outside range	
$\mu \pm \sigma$	1 in 3	twice a week
$\mu \pm 2\sigma$	1 in 22	once every three weeks
$\mu \pm 3\sigma$	1 in 370	once a year
$\mu \pm 4\sigma$	1 in 15,787	twice in a lifetime
$\mu \pm 5\sigma$	1 in 1,744,278	once in recorded history (4776y)

❖ 3σ=evidence, 5σ=discovery

❖ Systematic errors coming from errors in calibration etc, are whole different story.

❖ So it is premature to claim discovery from the LHCb anomalies

Happy birthday b-quark

- The b-quark is 40 years old this year.

- B-physics continues to be an active field of investigation 40 years later, LHCb, BelleII

- It is completely obvious to me that, 40 years on in 2052, the physics of the Higgs boson will still present challenges and be an object of intense study.

Observation of a Dimuon Resonance at 9.5 GeV in 400-GeV Proton-Nucleus Collisions

S. W. Herb, D. C. Hom, L. M. Lederman, J. C. Sens,[a] H. D. Snyder, and J. K. Yoh
Columbia University, New York, New York 10027

and

J. A. Appel, B. C. Brown, C. N. Brown, W. R. Innes, K. Ueno, and T. Yamanouchi
Fermi National Accelerator Laboratory, Batavia, Illinois 60510

and

A. S. Ito, H. Jöstlein, D. M. Kaplan, and R. D. Kephart
State University of New York at Stony Brook, Stony Brook, New York 11974
(Received 1 July 1977)
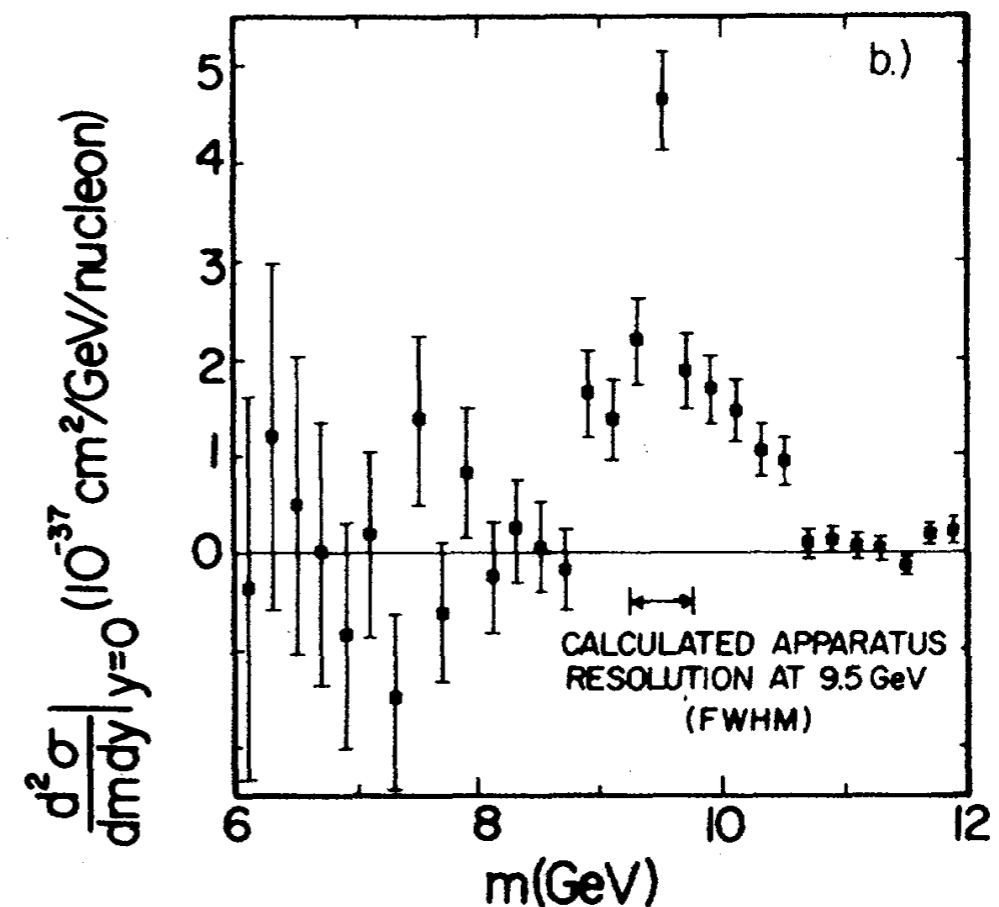
Discussion on future machines

- Thus we have an obligation to study the Higgs boson

- To face up to this eventuality (to be extended later other topics) we have started a discussion in the SPC on the different ways to study Higgs physics at future machines.

- This serves to educate ourselves, to begin to formulate an appropriate response to initiatives taken elsewhere.

- A second aim is to identify pieces of information that could improve the quality of the discourse, in the coming year.

Higgs boson decays

- Higgs boson couples proportional to mass.

- New results this year completed measurement of the couplings to the 3rd generation, t,b,τ

- Next one to be observed, $\mu+\mu-$, (in Run 3)?

- We don't yet know these rates very precisely.

- We would like to know all these rates with great precision, also total width (lifetime of the Higgs), how strongly the Higgs boson couples to itself
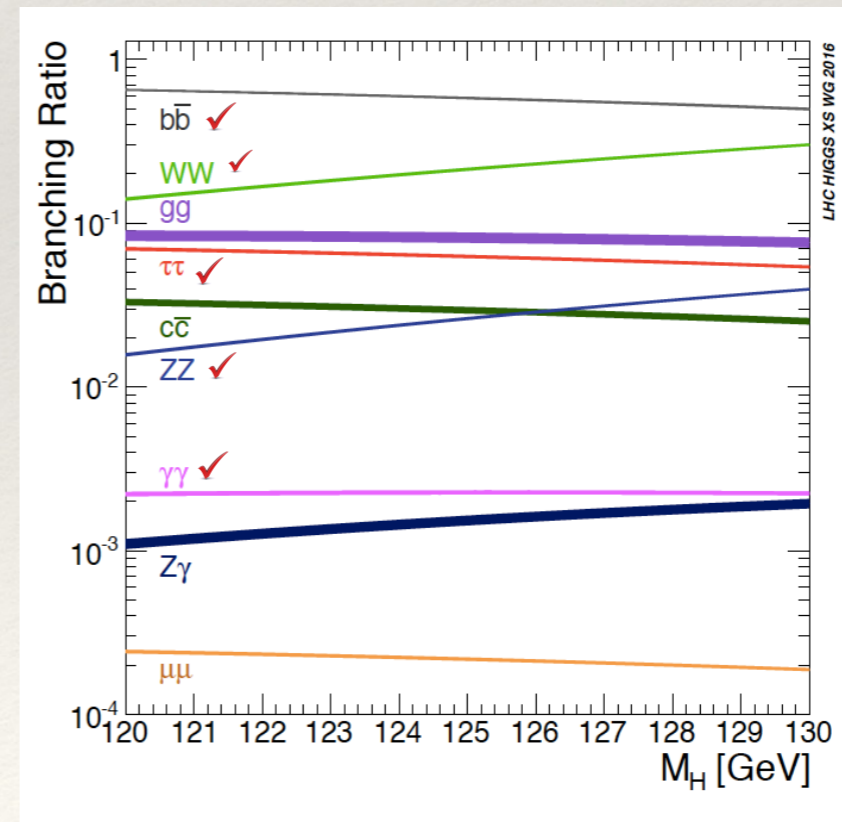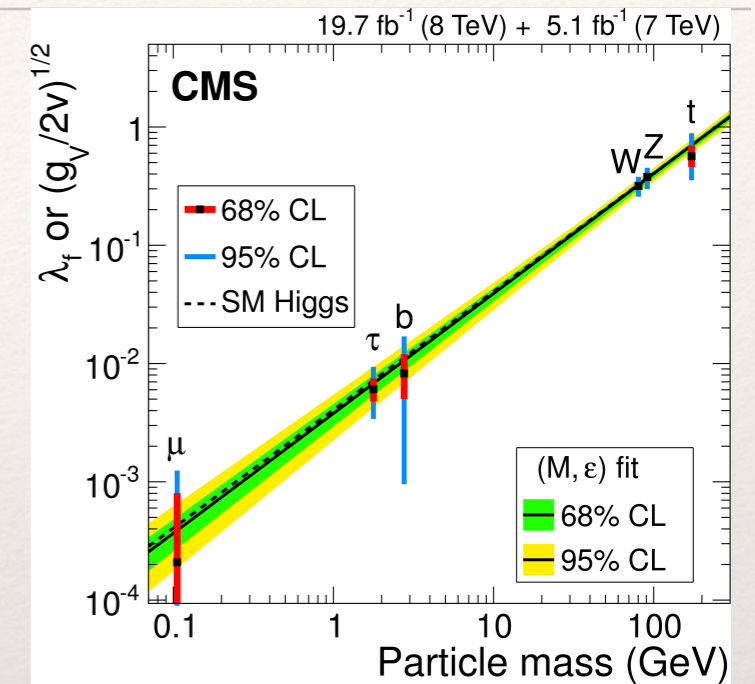
Luminosity at lepton colliders
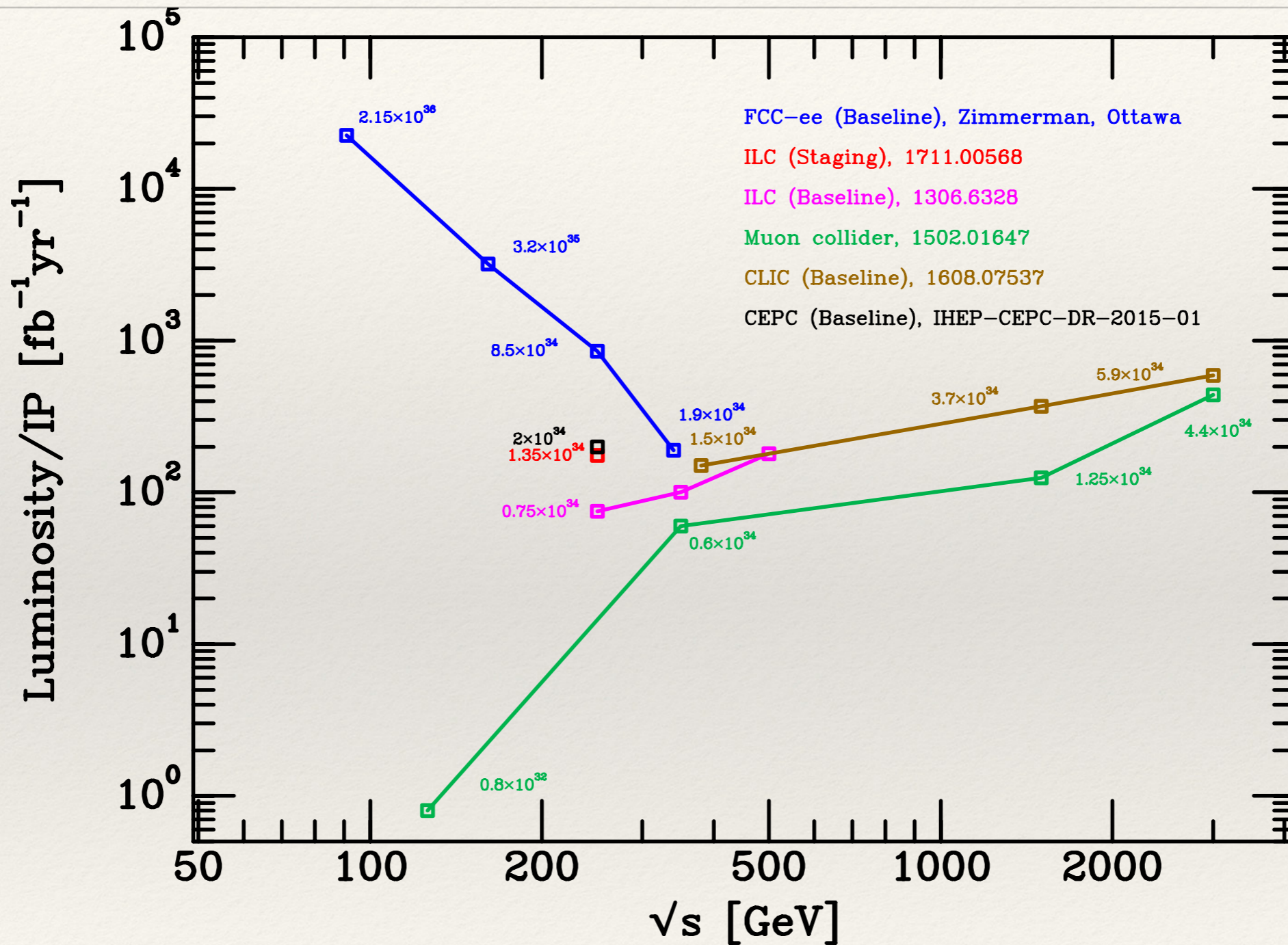
$N[\text{events per year}] = \text{Lumi}[\text{fb}^{-1}\text{yr}^{-1}] \ \sigma[\text{fb}]$

Comparison of precision on Higgs couplings

Parameter	HL-LHC	FCC-ee	FCC-ee	ILC	CLIC	CEPC	μ-Coll
$\sqrt{s}$[TeV]	14	350	240	250	1400	240	125
Lum/IP[E34]	5	1.9	8.5	1.35	1.5	2	0.01?
total[ab^{-1}]	3+(3)	1.3+1.3	5+5	2	1.5	2+2	0.002?
years[Sn'm'ss]	6	6.8	5.9	15	10	10	2?
Δm_h[MeV]	~ 100			14	47	5.9	0.06
Γ_h[%]	-	1.2	2.4	3.9	3.7	2.7	3.6
Δg_{hZZ}[%]	4	0.15	0.16	0.38	0.8	0.26	
Δg_{hWW}[%]	4.5	0.19	0.85	1.8	0.9	1.2	2.2
Δg_{hbb}[%]	11	0.42	0.88	1.8	1.0	1.3	2.3
$\Delta g_{h\tau\tau}$[%]	9	0.54	0.94	1.9	1.7	1.4	2.3
$\Delta g_{h\gamma\gamma}$[%]	4.1	1.5	1.7	1.1	5.7	4.7	5
Δg_{hcc}[%]	-	0.71	0.71	2.4	2.3	1.7	10
Δg_{hgg}[%]	6.5	0.8	0.80	2.2	1.8	1.5	-
Δg_{htt}[%]	8.5	-	-	-	4.2	-	-
$\Delta g_{h\mu\mu}$[%]	7.2	6.2	6.4	5.6	14.1	8.6	2.1
$\Delta \Gamma_{\mathrm{invis}}$[%]	~ 10			0.32			
Δg_{hhh}[%]	-400,1200	-	-	-	40	-	
References	ATL-PHYS-PUB -2014-016	1308.6176	1308.6176	1710.07621 1711.00568	1608.07538	IHEP-CEPC-DR -2015-01	1304.5270 1308.2143

Update of strategy process 2018-May 2020

❖ 2018 to early 2019 is a year of preparation, and for generation of ideas.

❖ "Letting a hundred flowers blossom and a hundred schools of thought contend is the policy for promoting progress in the arts and the sciences"…

❖ 2019-2020 is to do with fiscal reality, hammering out consensus, uniting the community with common goals.

❖ The SPC is enthusiastic to play its part.