Quelques nouvelles récentes

Sébastien Descotes-Genon

descotes@th.u-psud.fr
Laboratoire de Physique Théorique
CNRS & Université Paris-Sud, 91405 Orsay, France

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LPT Orsay

Été comme hiver

Les “confs”

- En physique des particules, conférences d’hiver (Moriond) et d’été (ICHEP, Lepton-Photon, EPS-HEP)
- EPS-HEP: conf. européenne, organisée sous l’égide de la Société Européenne de Physique, tous les 2 ans, un endroit différent
- Cette année du 10 au 17 juillet, à Gant (Belgique)

- Environ 800 participants littéralement du monde entier
- Autant pour les présentations, calibrées, que pour les discussions, informelles, aux pauses (rumeurs...)

D’autres occasions de rencontres

- réunions satellites de grandes conf

  réunion ECFA European Commitee for Future Accelerators
- conférences thématiques et workshops spécialisés

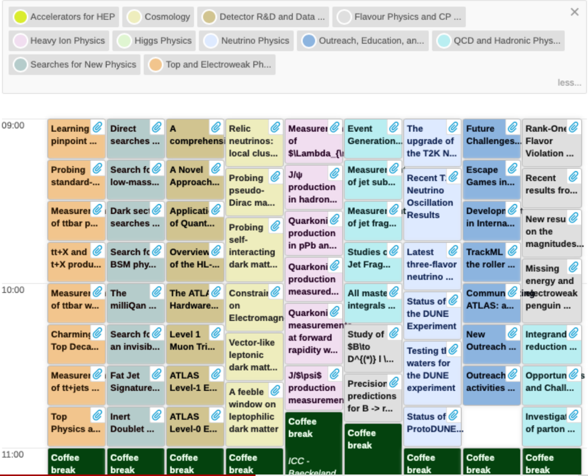
  par ex, la semaine prochaine à Orsay: Higgs Hunting
- écoles (d’été, d’hiver et autres)

  CERN summer school, Les Houches, Cargèse. . .
- séminaires et visites dans d’autres laboratoires

  en permanence !

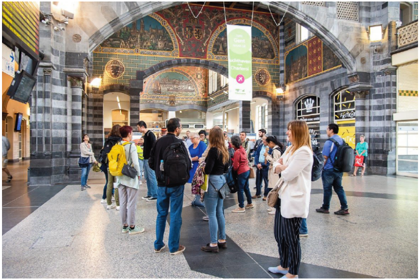
Les trois premiers jours d'EPS-HEP 2019

- Sessions parallèles (9 sessions, 15-20 min sur sujet spécifique)
- Près de 600 interventions !
- Une après-midi "Accélérateurs Futurs" + expo "Art@CMS"
- Concert et séminaire. . . sur les bières belges



Astroparticle and gravitational waves, Cosmology, Dark Matter, Neutrino Physics, Heavy Ion Physics, QCD and hadronic physics, Top and electroweak physics, Flavour physics and CP violation, Higgs physics, Searches for new physics, Quantum field and string theory, Detector R&D and data handling, Acclerators for HEP, Outreach, education and diversity . . .

En images



En texte

The Standard Waffle

EUROPEAN PHYSICAL SOCIETY HEP2019

Daily EPS-HEP 2019 Newsletter **Tuesday 16 July 2019**

With our second day of plenaries, we switch to a variety of topics, from flavour physics, over neutrinos to astroparticle physics and more. Along with our usual segments, we also look back to the other social activities that took place during the weekend.

Today's programme

The morning plenary session will start with reviews of flavour physics, CP violation, rare decays, and highlights from the LHCb and Belle II experiments. Gravitational waves, cosmic rays, and multimessenger astroparticle physics will close the morning programme.
In the afternoon, neutrinos and dark matter will take the stage. Theoretical and experimental reviews of neutrino physics, dark matter, and axion searches will conclude today's physics programme.
At the end of the afternoon session, few minutes after 18:00, buses will pick us up from the entrance of the ICC to take us to the quaint *Eskimofabriek* for the conference dinner.

Highlights from Monday

The plenary sessions kicked off yesterday with a warm welcome by the conference organizers, the Dean of the faculty of Sciences, and the vice-rector of Ghent University. Next, the High-Energy and Particle Physics division of the EPS held its prize ceremony, awarding outstanding achievements in various areas.

Next, an impressive set of new results of the ATLAS and CMS Collaborations using the full Run II data sets were presented. The emphasis was naturally put on the most recent Higgs measurements, showing the enormous progress made by the two experiments since the Higgs discovery. Promising results on the couplings of the Higgs boson to quarks and leptons of the second generation are now available, even if more data will be needed to reach the sensitivity to test the SM couplings.

Additionally, many other important results on a broad range of physics topics have been highlighted, including electroweak measurements involving vector bosons and the top quark. It is also interesting to note that both experiments are now exploiting innovative data analysis methods and techniques, including scouting, data parking and machine learning, to maximize their discovery potential.

More new LHC results were provided in the afternoon talks dedicated to measurements of SM observables, and searches for supersymmetry and exotica. New results and future prospects were put into a theory perspective. We may not have seen supersymmetry yet, but those who joined the concert on Friday have heard its tune already.

Precision calculations in the standard model are becoming increasingly sophisticated, with conceptual and technical solutions drawing from recent developments in formal theory and pure mathematics. BSM physics is broadening its theoretical viewpoints to embrace a multitude of possible scenarios, opening up new perspectives and observables. Especially in the Higgs sector, new physics effects are under intensive investigation, with exciting new perspectives of probing Higgs boson couplings even in observables without Higgs bosons. The day finished with a review on the most recent developments on quantum gravity and string theory, even highlighting potential routes to observational tests and validations.

art@CMS

The *ORIGIN Poetics 2019* exhibition at the Zwarte Zaal at KASK features a large collection of works from international artists and art students involved in the art@CMS project. At the same time, *Harbinger*, the local Ghent art@CMS project, is exhibiting at the Botanical Garden near the ICC.

The two projects were nicely brought together during the art@CMS event last Saturday at 19h30 in the Zwarte Zaal. About 50 people enjoyed the artworks and followed presentations from selected artists of both projects. The evening was concluded with many discussions about past and future art-and-science projects over a glass of wine.

On Sunday evening the screening of *The Most Unknown* drew a well-balanced audience of physicists and non-physicists to the Sphinx cinema theatre. The documentary addressed the everyday questions of 9 scientists from various fields, which search for answers on the borders of "the great unknown".

Two of the involved scientists, particle physicist Davide D'Angelo and cognitive psychologist Axel Cleeremans, were present to introduce the movie and answer the big stream of questions after the screening. Apart from an interesting view on enthusiastic scientists' life, *The Most Unknown* also brought us lively discussions on artificial consciousness and the mysteries of dark matter.

Did you know?

On the day of the conference dinner, food talk is in the air. We already recommended some typical Flemish dishes in a previous Waffle, but we didn't discuss **desserts** yet. So here we go!
You already got a taste of traditional sweets in your goody bag: cuberdons and chocolates.

Cuberdon is a typical Ghentian candy, also known in Dutch as *Gentse neus* (trad. Ghent nose), because of its conic shape that resembles a human nose. It is gummy and filled with a soft fruity cream.
Belgian **chocolate** is certainly one of the most famous and widespread Belgian products in the world. Just to get an idea, about 2 tonnes of chocolate are sold daily at Brussels airport. Impossible to enclose so much history and tradition in these few lines!
We cannot close this excursus on Belgian sweets without talking about our signature dessert: the **waffle**! Everyone knows the Belgian waffle. But you may not know that the rectangular treat known worldwide as Belgian waffle is only one of the types you can find in Belgium, more precisely the **Brussels waffle**. Equally common is the **Liège waffle**, and just as delicious. Liège waffles are thicker in texture and contain sugar grains and a caramelized sugar coating, with characteristic rounded corners. The waffles consumed in Belgium are typically lighter and fluffier than the versions sold in other countries. As you can see, there is no such thing as a Standard Waffle!

Picture of the day

Today started with the prize ceremony. The 2019 EPS-HEP prize was awarded to CDF and D0 for the discovery of the top quark, while the Giuseppe and Vanna Cocconi Prize for Particle Astrophysics and Cosmology was conferred upon the WMAP and Planck Collaborations for high-precision CMB measurements. Next, a few young outstanding colleagues were rewarded: the 2019 Young Experimental Physicist Prize went to Josh Bendavid and Lesya Shchutska, while the 2019 Gribov Medal was awarded to Douglas Stanford. The EPS-HEP Outreach Prize, finally, was awarded to Rob Appleby, Chris Edmonds and Robyn Watson for the Tactile Collider Project.

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Editorial team: Steven Lowette, Martina Vit, Daniele Trocino, Didar Dobur
Contacts: Michael Tytgat (chair LOC), Barbara Erazmus (chair IOC) Email: info@eps-hep2019.eu

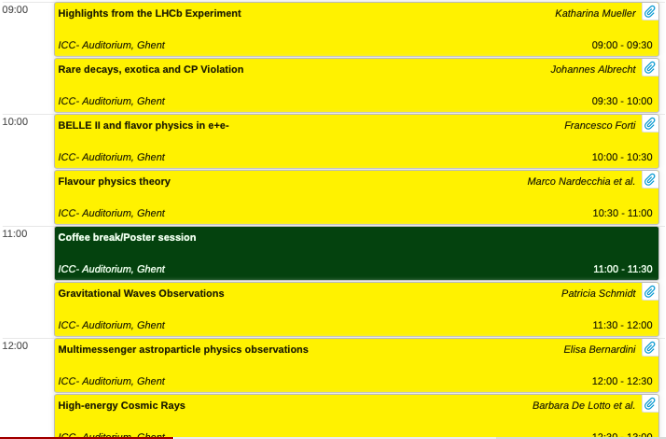
Le dimanche

- Digérer les résultats, travailler, faire du tourisme. . .
- Des activités “sociales” (visites de Gand, Bruges. . .) proposées

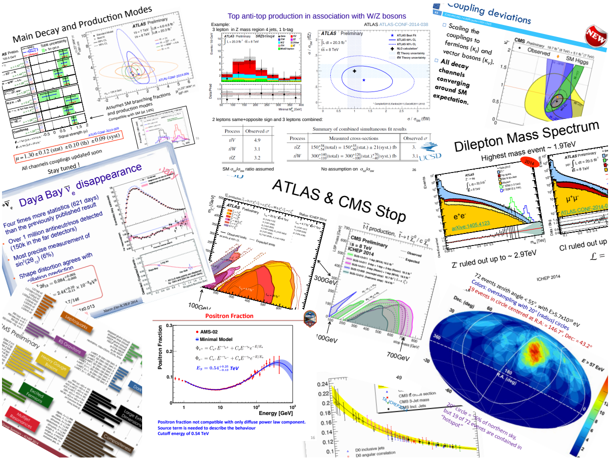



Les trois derniers jours d'EPS-HEP 2019

- 3 jours de sessions plénières (exposés plus longs sur un domaine)
- Remise de prix, dont
  CDF et DØ (quark top), WMAP et Planck (CMB)
- Session poster (vin et fromage, et prix !), banquet



De quoi se cultiver. . .

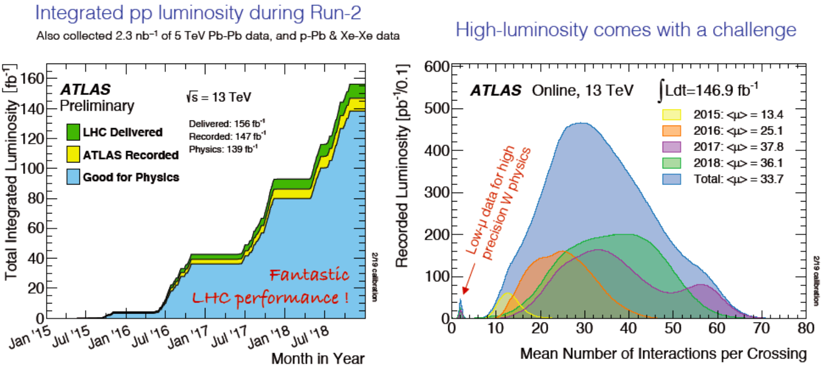


- Beaucoup de transparents
- Des articles paraissent juste après les talks
- Proceedings (comptes-rendus) à écrire dans la foulée

Pousser les limites

De plus en plus de données

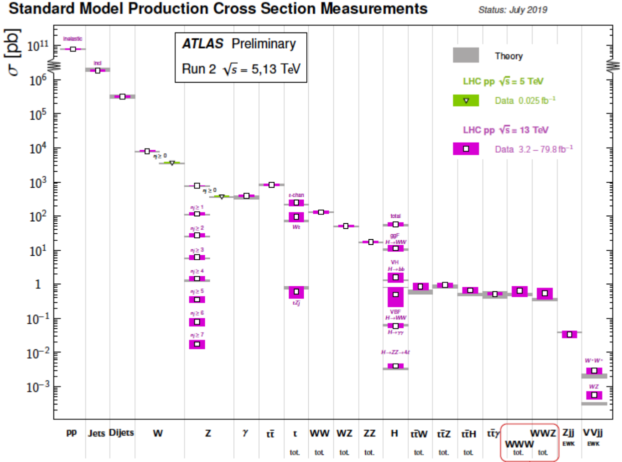
Données du run 2 : 2015-2018 à 13 TeV



- Tester en détail tout le Modèle Standard (MS)
- en particulier le boson de Higgs
- dans un environnement compliqué (beaucoup de collisions)

Un excellent accord avec le MS

Production de différentes particules (W, Z, top, H) dans des collisions pp en excellent accord avec les prédictions du MS (de + en + précises)



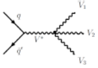
Harvest of ATLAS cross section measurements confirms the predictive power of the Standard Model

Also huge progress on theoretical calculations (NNLO revolution)

Many more detailed fiducial and differential cross section measurements

> 4σ Evidence for weak triboson production by ATLAS using 2015–2017 data

arXiv:1903.10415



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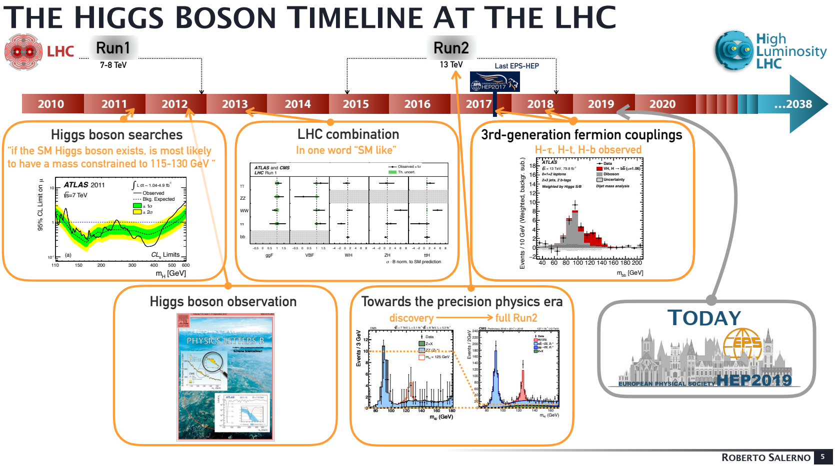
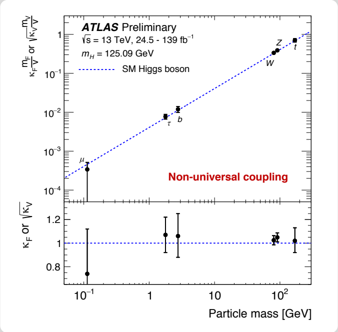
Un boson *H* de mieux en mieux connu



Comment parle-t-il aux autres particules ?



The scalar sector is directly connected with profound questions: naturalness, vacuum stability & energy, flavour

The Higgs boson discovery allows us to directly study this sector, requiring a broad experimental programme that will extend over decades

And the Higgs boson does more …

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La course à la seconde génération (1)

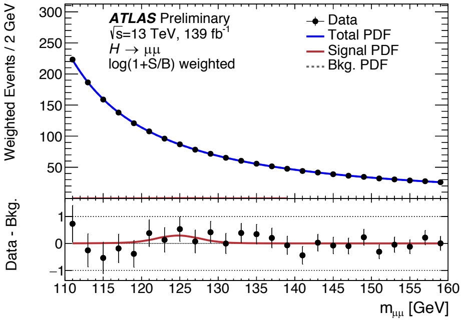
Higgs boson coupling to (lighter) 2nd generation fermions

Full Run-2

Constraints from direct and indirect ATLAS searches for $H \to cc$ sensitive to $\kappa_c \sim 10$
More promising: $H \to \mu\mu$, but challenging due to huge $pp \to Z/\gamma^* \to \mu\mu$ background

Analysis strongly exploits expected features of signal and background via specific categories and BDTs
Robust empirical background modelling, validated against "spurious signal" using large simulated samples

ATLAS-CONF-2019-028



$\sigma(\text{obs}) / \sigma(\text{SM}) = 0.5 \pm 0.7$
< 1.7 at 95% CL

Sensitivity: 0.8σ, for 1.5σ expected

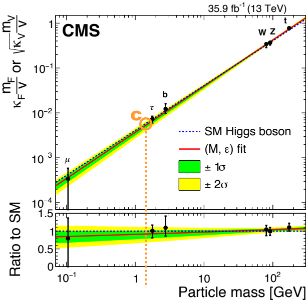
50% sensitivity improvement over 2018 (80 fb^{-1}) analysis

La course à la seconde génération (2)

2nd–GENERATION FERMION COUPLING : c–H

charm-Higgs coupling $\lambda_c \sim \lambda_\tau$, but way harder to probe :

- BR(H→cc)~0.05×BR(H→bb)
- H→bb is background
- large (hadronic) background
- charm jet ID is highly challenging



Complementary approaches exist :

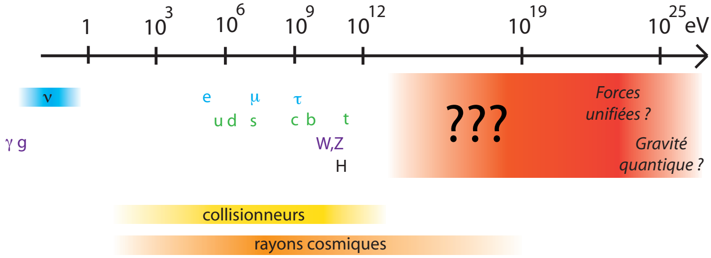
- Direct search for H→cc decay
- Extract constraints on λ_c from kinematics
- Searches for charmonium decays: H→J/Ψγ
- Total width / global analysis

Rare decays/production

ROBERTO SALERNO 31

Au-delà du Modèle Standard (1)

- Masse et propriétés du boson de Higgs en parfait accord avec les attentes basées sur les expériences antérieures
- Chaque montée en énergie a donné lieu à des découvertes: sous-structure, nouvelle interaction, nouvelles particules

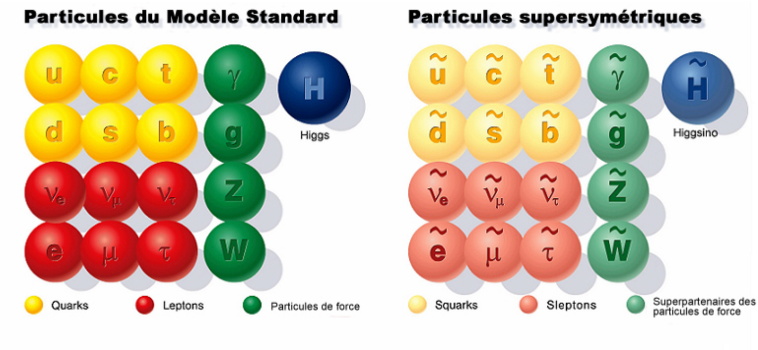


Modèle Standard très efficace, mais pas parfaitement satisfaisant

- Nombreux paramètres (19 !) fixés à des valeurs arbitraires
- Pourquoi trois familles, avec la même structure d'interactions ?
- Pourquoi trois interactions très différentes ?
- Astro/Cosmo: gravitation ? matière noire ? si peu d'antimatière ?

Au-delà du Modèle Standard (2)

- De nouvelles symétries (limiter le nombre de paramètres ?),
- De nouvelles interactions (cadre plus cohérent ?),
- De nouvelles dimensions (accomoder la gravitation ?)...



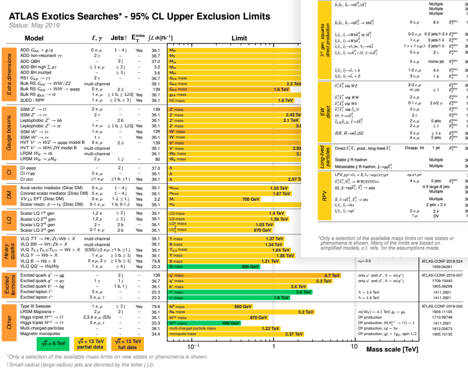
- Ne pas être en désaccord avec les observations antérieures
- Avoir des conséquences observables...

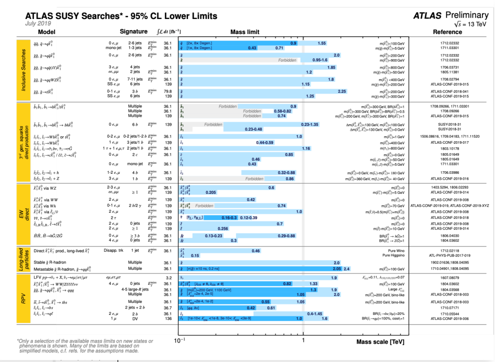
Pour l'instant, la Nouvelle Physique se cache. . .

Searches for new physics

Cover all areas: high mass, electroweak production, long-lived particles, forbidden decays, …

Theory-agnostic, signature based searches, as well as highly targeted model-dependent ones

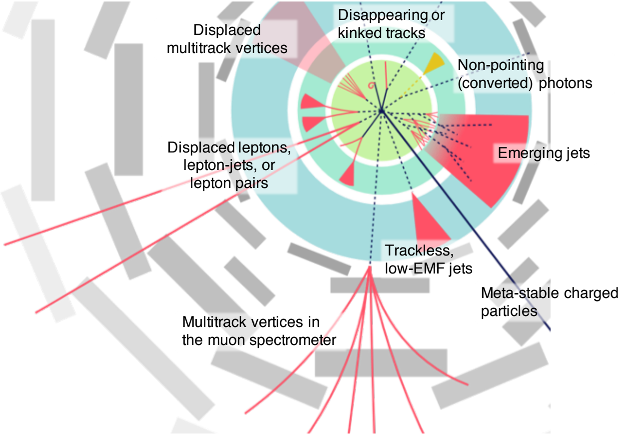




La course aux particules de longue durée de vie

And what if new physics is all different? For example long-lived?

Long-lived particles can occur in case of weak couplings, small phase space (mass degeneracy), high virtuality (scale suppression)



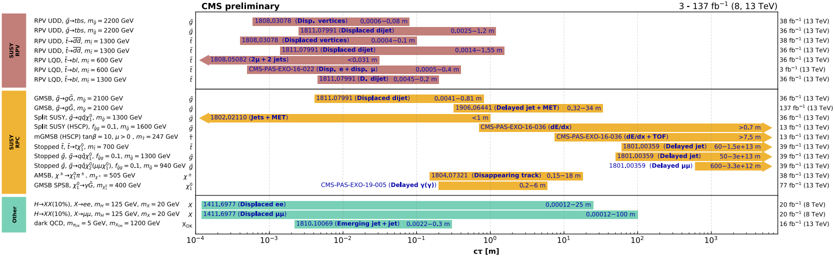
Diverse set of signatures that need to be pursued by dedicated, usually non-standard analyses, some requiring special triggers

Pour l'instant sans succès

- Marquée par des signatures inhabituelles
- Traces absentes, énergie manquante...

Summary long-lived particles

Overview of CMS long-lived particle searches



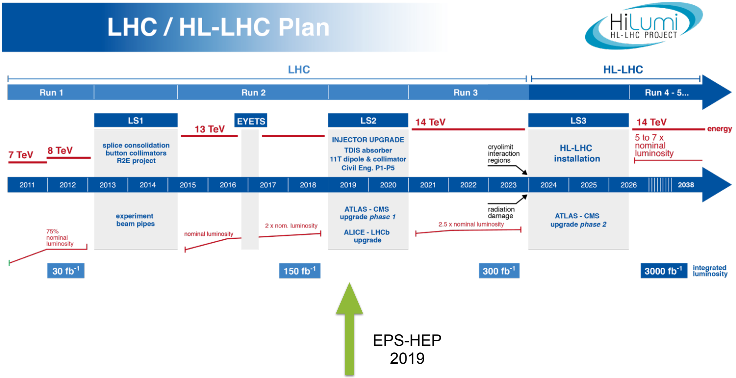
Selection of observed exclusion limits at 95% C.L. (theory uncertainties are not included). The y-axis tick labels indicate the studied long-lived particle.

July 2019

W. Adam: Highlights from the CMS experiment *EPS-HEP 2019* **56**

Et pour la suite ?

The road to high luminosity



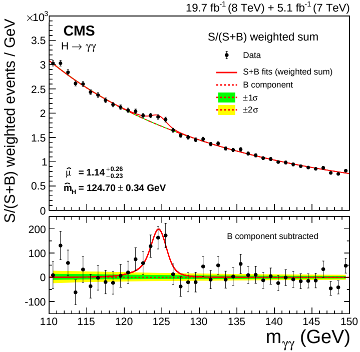
W. Adam: Highlights from the CMS experiment *EPS-HEP 2019* **35**

- réflexion au CERN sur le futur
- high-luminosity LHC + upgrade des détecteurs
- à plus long terme, monter en énergie

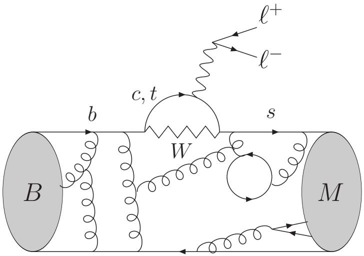
Tous les leptons naissent
libres et égaux en droits ?
Pas si sûr !

Deux chemins complémentaires

Voie relativiste: $E = mc^2$



Voie quantique: $\Delta E \Delta t \geq \hbar/2$



Collisions avec assez dénergie pour produire directement des particules au-delà du MS

Haute énergie

Preuve “directe”

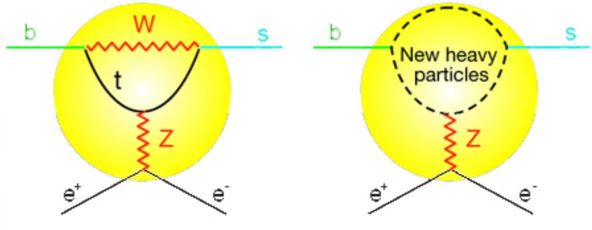
Petites déviations venant d’états intermédiaires avec des particules lourdes

Haute intensité

Preuve indirecte

$b \to s\ell^+\ell^-$ $\quad (\ell = e$ ou $\mu)$

- Courant neutre changeant la saveur: *b* et *s* de même charge
- Processus avec une très faible probabilité dans le Modèle Standard (passage via *W* et *t* virtuels)
- Sensible à des états intermédiaires virtuels lourds au-delà du MS, qui se manifesteront par des écarts entre MS et expérience



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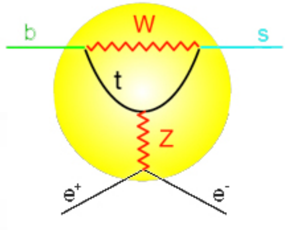
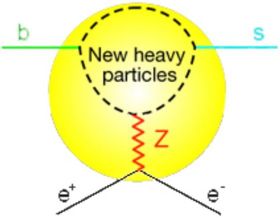
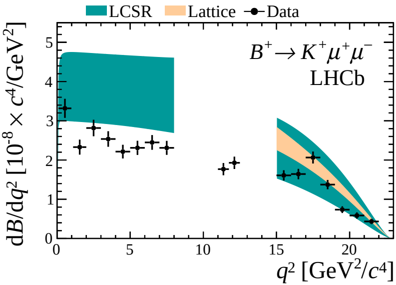
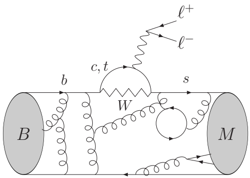




- Processus théorique en termes de quarks, mais expériences mesurées en termes de hadrons: compliqué sur le plan théorique !
- Beaucoup de transitions possibles entre différents hadrons: $B \to K\ell^+\ell^-$, $B \to K^*\ell^+\ell^-$, $B_s \to \phi\ell^+\ell^-$, $\Lambda_b \to \Lambda\ell^+\ell^-\ldots$

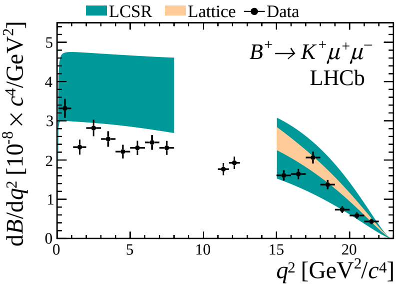
$B \to K\ell\ell$

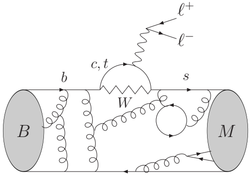


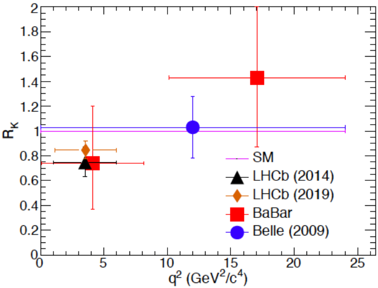


- LHCb: $Br(B \to K\mu\mu)$ trop bas par rapport au MS
- fonction de $q^2 = (p_{\mu^-} + p_{\mu^+})^2$

$B \to K\ell\ell$

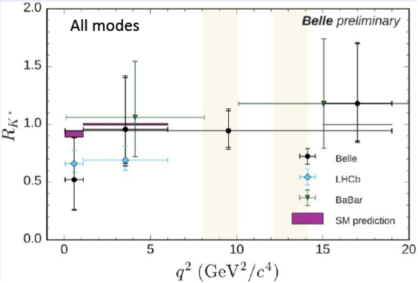




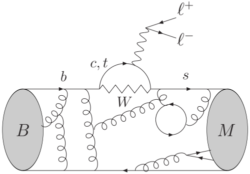


- LHCb: $Br(B \to K\mu\mu)$ trop bas par rapport au MS
- fonction de $q^2 = (p_{\mu^-} + p_{\mu^+})^2$
- $R_K = \frac{Br(B\to K\mu\mu)}{Br(B\to Kee)} = 1$ dans le MS (universalité du couplage leptonique)
- Déviations observées par LHCb, mais pas confirmées, ni infirmées par Belle

$B \to K^*\ell\ell$



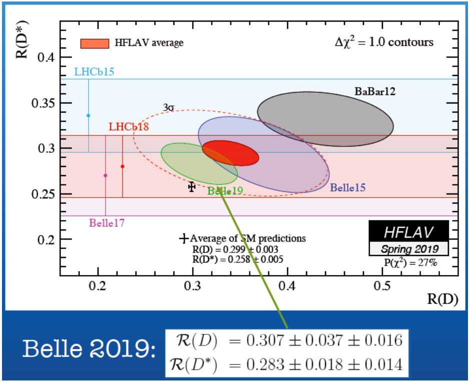
$$R_{K^*} = Br(B \to K^*\mu\mu)/Br(B \to K^*ee)$$

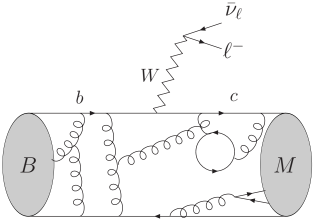


- R_{K^*} est lui aussi trop bas par rapport au MS selon LHCb
- $\simeq$ 1 dans le MS (universalité du couplage leptonique)
- L'universalité des couplages leptoniques serait donc bien mise en défaut !
- Là encore, ni infirmé ni confirmé par Belle
- D'autres déviations observées (R_K, mais aussi d'autres observables $b \to s\mu\mu$)
- En accord avec une contribution de NP de 25% par rapport au MS

Les μ, mais aussi les τ ?

- Comparaison des transitions $b \to c\ell\nu_\ell$ ($\ell = e, \mu$) et $b \to c\tau\nu_\tau$
- Déviations inattendues, réduites avec résultats de Belle en 2019
- Dues à une non-universalité aussi dans le secteur des τ ?

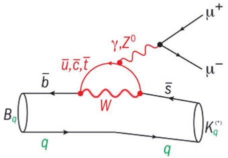


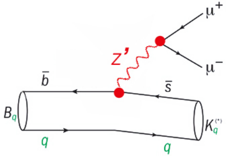


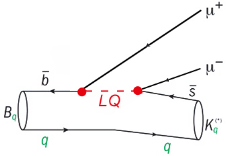
$$R_{D(*)} = \frac{Br(B \to D(^*)\tau\nu)}{Br(B \to D(^*)\ell\bar{\nu}_\ell)}$$

De la Nouvelle Physique ?

- Nouvelles interactions W' et Z' ?
- Leptoquarks, couplant quark + lepton des 2ème et 3ème familles ?







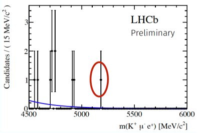
LFV: $B^+ \to K^+ e^+ \mu^-$

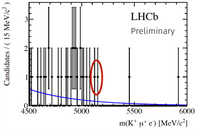
LHCb-PAPER-2019-022

- Some New Physics models that explain the flavour anomalies predict sizeable branching fractions in **lepton flavour violating decays**
  [PRL 114 (2014) 091801, PL B750 (2015) 367, JHEP 06 (2015) 072, PL B760 (2016) 442, JHEP 12 (2016) 027]
- Natural candidate: $B^+ \to K^+ e^+ \mu^-$
- LHCb recently published a search using the Run 1 dataset
  - No signal seen, determine limits @90% CL

$$BR(B^+ \to K^+ \mu^- e^+) \leq 7.0 \times 10^{-9}$$
$$BR(B^+ \to K^+ \mu^+ e^-) \leq 7.1 \times 10^{-9}$$

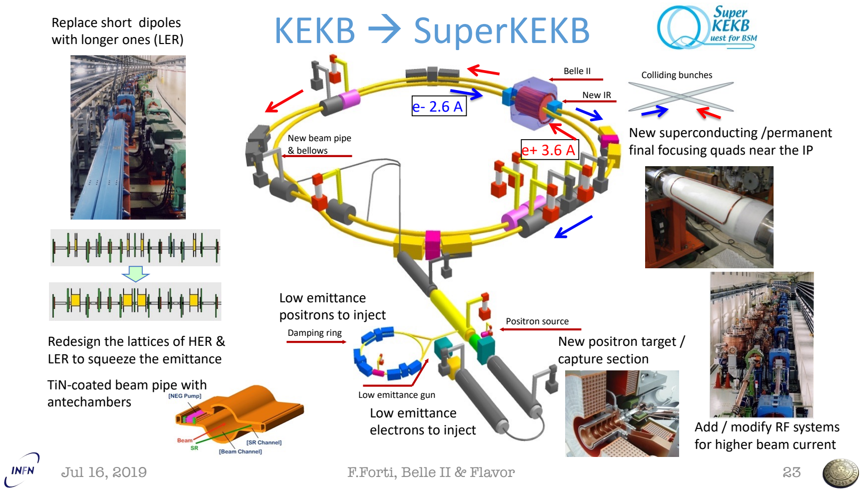
  - Limits improved by more than 1 order of magnitude





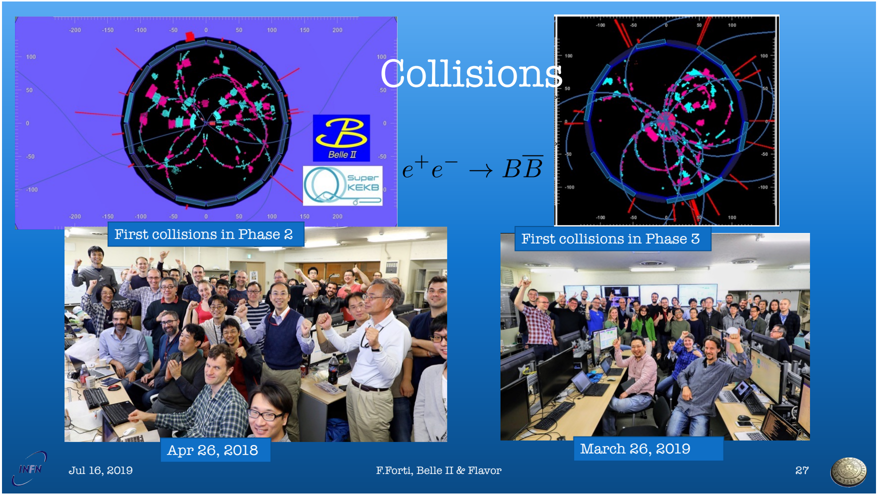
16. July 2019 Johannes Albrecht 21/25

A l'est, du nouveau



- Collisionneur e^+ (4 GeV) e^- (7 GeV) situé à Tsukuba (Japon)
- Etude intensive des désintégrations du quark b
- 25 pays, 110 institutions, 800 chercheurs

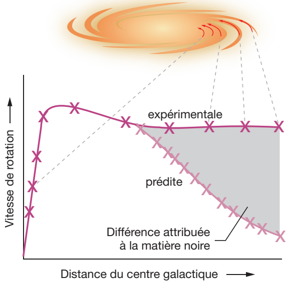
Belle II entre en action

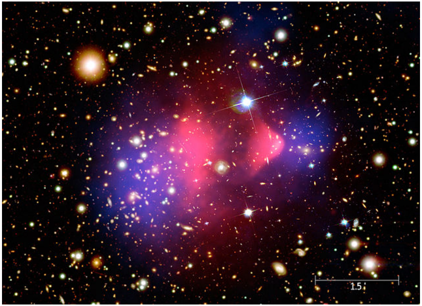


Premier run de physique terminé en juillet 2019 !

Lumière sur la matière noire

Matière noire et nouvelle physique





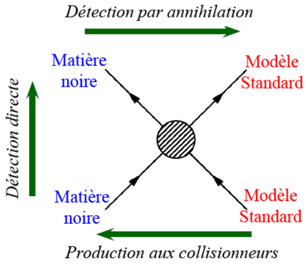
En se basant sur les lois de la gravitation, pas assez de matière visible

- Pour expliquer la dynamique des grandes structures (galaxies. . .)
- Pour décrire l'évolution de l'Univers
  (ray. de fond cosmologique, nucléosynthèse primordiale)

Matière "noire"

- lourde, stable, neutre, interagissant peu avec son environnement, hormis par interaction gravitationnelle
- particule nouvelle χ, hors du Modèle Standard ?

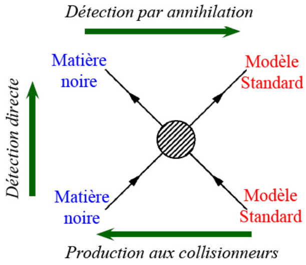
Observer la matière noire



Une coopération entre infiniment petit et infiniment grand

- La produire en accélérateur (si assez "légère")

Observer la matière noire

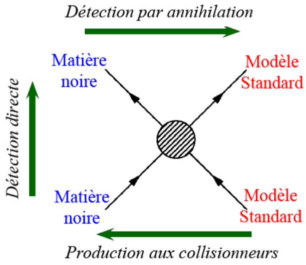


Une coopération entre infiniment petit et infiniment grand

- La produire en accélérateur (si assez "légère")
- La détecter lors de son passage sur Terre

  $\Longrightarrow$interaction avec noyau, qui recule

Observer la matière noire



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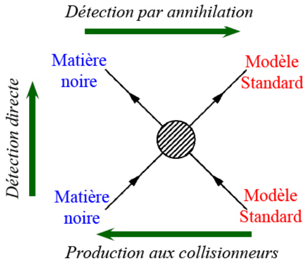
- Voir son annihilation en observant le ciel
  $\Longrightarrow$rayons gamma monochromatiques ($E_\gamma = M_\chi c^2$)
  $\Longrightarrow$excès de rayons cosmiques de haute énergie

Observer la matière noire



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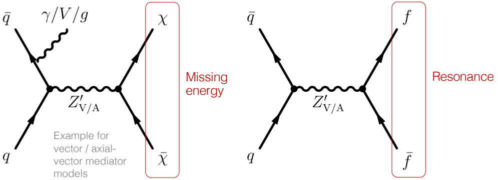
  $\Longrightarrow$rayons gamma monochromatiques ($E_\gamma = M_\chi c^2$)
  $\Longrightarrow$excès de rayons cosmiques de haute énergie
- Détecter sa présence par observations astronomiques
  $\Longrightarrow$déformation d’images par lentilles gravitationnelles
  $\Longrightarrow$informations cosmologiques (CMB)

En collisionneur

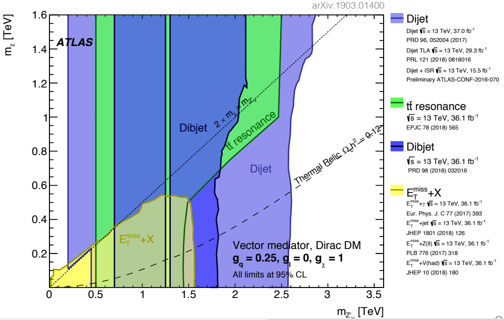
Dark Matter (DM)

If produced at the LHC, DM interactions will be mediated by particles that can also be directly searched for
— complementarity



ATLAS released combination of $E_{T,\mathrm{miss}}$ based DM searches involving $E_{T,\mathrm{miss}}$ + X, X = jet, γ, W, Z, H, b(b), t(t) using large number of models

arXiv:1903.01400, up to 37 fb^{-1}

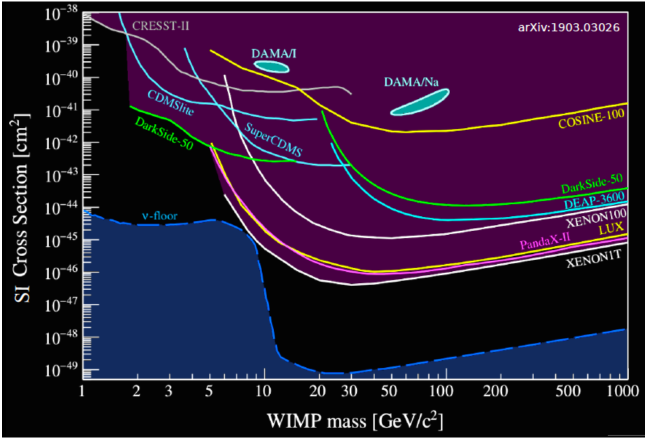


If light enough, Higgs boson can decay to DM (H $\to$ invisible)
ATLAS combination:
BR(H $\to$ invisible) < 0.26
(0.17 expected)

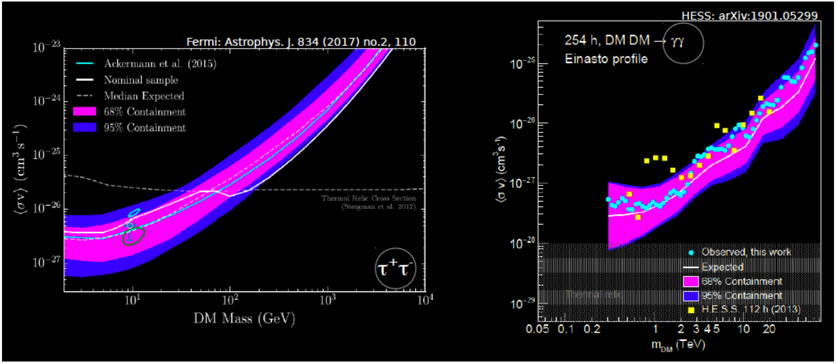
arXiv:1904.05105, 36 fb^{-1}

En détection directe

- Matière noire interagissant avec cible
- Recul des noyaux, détection par ionisation/lumière/chaleur
- Contrainte sur masse et probabilité d'interaction
- Etudes actuelles à basse masse (mais bruit de fond des ν)

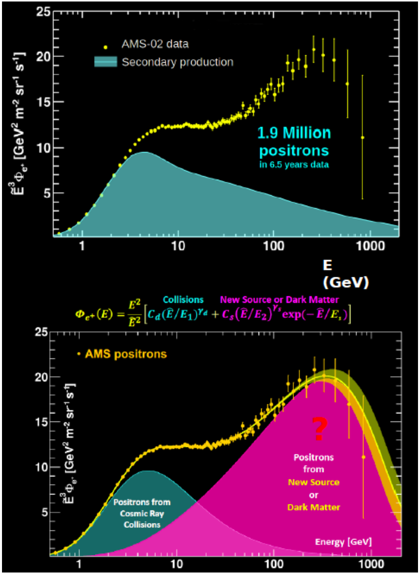


En annhilation dans le ciel: photons



- Annihilation de particules de matière noire ?
- En photons: raies monochromatiques ($E = 2m_\chi c^2$)
- En leptons: composition des rayons cosmiques
- Contraintes sur la masse et la probabilité d'interaction

En annhilation dans le ciel: positrons



- AMS installé sur station spatiale pour étudier rayons cosmiques
- flux e^+ sur domaine d'énergie étendu jusqu'à 1 TeV, compatible avec rayons cosmiques + matière noire
- mais d'autres origines (astrophysiques) envisageables (restes de supernova, pulsars, propagation rayons cosmiques)
- difficile de rendre compte de toutes les infos sur les rayons cosmiques

Naissance d'une nouvelle astronomie

Multi-messenger astrophysics

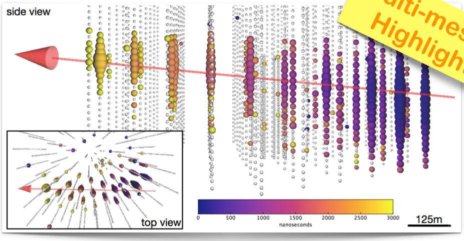
Exploring the Universe by combining information from a multitude of cosmic messengers: electromagnetic radiation, gravitational waves, neutrinos and cosmic rays

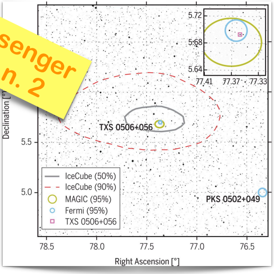
EPS-HEP Conference 2019 — Ghent — Elisa Bernardini — University of Padova (Italy) & DESY (Germany) 2

IceCube-170922A

Compelling evidence for neutrino emission from the **Blazar TXS 0506+056.**
Identification of a cosmic hadron accelerator with >PeV energies!

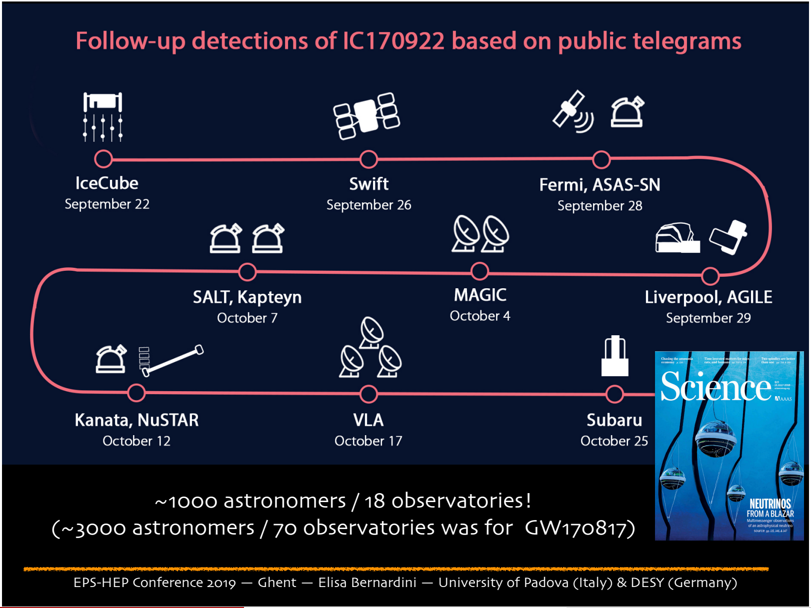
Multi-messenger Highlight n. 2





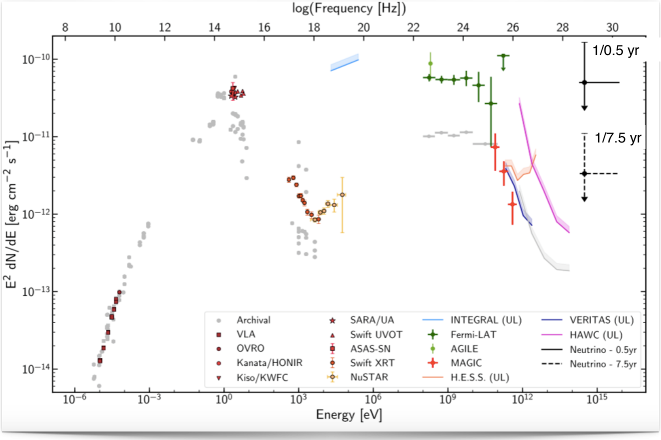
- Publicly distributed 43 seconds after trigger, refined direction 4 hr later
- At 6 arc-minutes from the direction of TXS 0506+056
- Most probable energy between 250 and 300 TeV and probability of astrophysical origin 56.6%

. . . relayée par de nombreux observatoires



Does it all fit together?

IceCube, FERMI, MAGIC, ++., Science 361, 146 (2018)



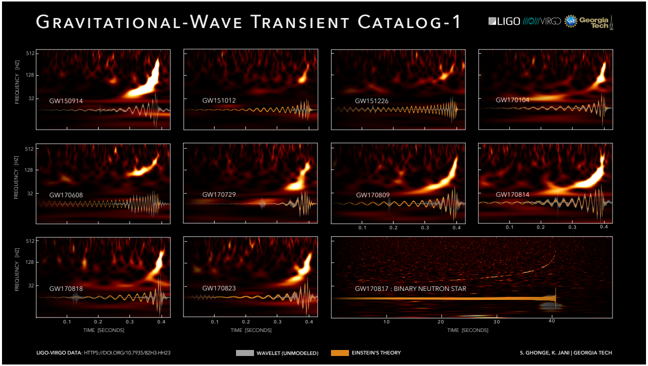
EPS-HEP Conference 2019 — Ghent — Elisa Bernardini — University of Padova (Italy) & DESY (Germany) 25

LIGO/Virgo voit des ondes gravitationnelles

DETECTIONS: GWTC-1 8

GW DETECTIONS IN O1&O2 – GWTC-1

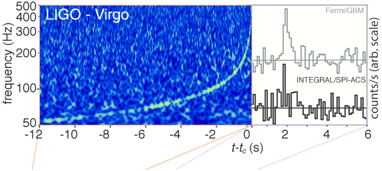
- 11 confident GW detection from compact binaries:
  - FAR ≤ ~1 per month & probability of astrophysical origin > 50%
  - **10 binary black holes & 1 binary neutron star**

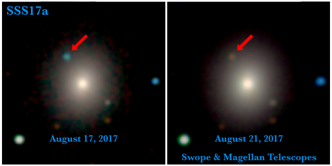


Avec des contreparties électromagnétiques

GW170817: A NEW ERA IS BORN

- On **August 17, 2017** at 12:41:04 UTC the signal from a **binary neutron star** was detected
- Fermi detects sGRB 1.7s after the GW
- GCN alert sent ~27 minutes after GW detection
  - Localised to ~30deg^2
- First observation of an optical counterpart ~11h later by the Swope telescope





First GW + EM observation!!

Astrophys. J. 848 (2017) L12

Depuis le 1er avril 2019

O3 SO FAR: OPEN PUBLIC ALERTS

https://gracedb.ligo.org

- 21 public alerts: 15 BBH, 1 BNS, 1 NSBH candidates; 3 retractions, 1 glitch

GraceDB — Gravitational Wave Candidate Event Database

HOME | SEARCH | LATEST | DOCUMENTATION | LOGIN

Latest — as of 13 July 2019 14:28:24 UTC

Test and MDC events and superevents are not included in the search results by default; see the query help for information on how to search for events and superevents in those categories.

Query:

Search for: Superevent

Search

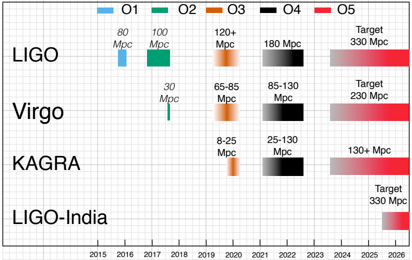
UID	Labels	t_start	t_0	t_end	FAR (Hz)	UTC Created
S190707q	ADVOK DQOK SKYMAP_READY PASTRO_READY EMBRIGHT_READY GCN_PRELIM_SENT PE_READY	1246527223.118398	1246527224.181226	1246527225.284180	5.265e-12	2019-07-07 09:33:44 UTC
S190706ai	ADVOK DQOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT PE_READY	1246487218.321541	1246487219.344727	1246487220.585938	1.901e-09	2019-07-06 22:26:57 UTC
S190701ah	ADVOK DQOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT PE_READY	1246048403.576563	1246048404.577637	1246048405.814941	1.916e-08	2019-07-01 20:33:24 UTC
S190630ag	ADVOK DQOK SKYMAP_READY PASTRO_READY EMBRIGHT_READY GCN_PRELIM_SENT PE_READY	1245955942.175325	1245955943.179550	1245955944.183184	1.435e-13	2019-06-30 18:52:28 UTC
S190602aq	DQOK ADVOK SKYMAP_READY PASTRO_READY EMBRIGHT_READY GCN_PRELIM_SENT PE_READY	1243533584.081266	1243533585.089355	1243533586.346191	1.901e-09	2019-06-02 17:59:51 UTC
S190524q	DQOK ADVNO SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT	1242708743.678669	1242708744.678669	1242708746.133301	6.971e-09	2019-05-24 04:52:30 UTC
S190521r	DQOK ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT PE_READY	1242459856.453418	1242459857.460739	1242459858.642090	3.168e-10	2019-05-21 07:44:22 UTC
S190521g	DQOK ADVOK SKYMAP_READY PASTRO_READY EMBRIGHT_READY GCN_PRELIM_SENT PE_READY	1242442966.447266	1242442967.606934	1242442968.888184	3.801e-09	2019-05-21 03:02:49 UTC
S190519bj	ADVOK DQOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT PE_READY	1242315361.378873	1242315362.655762	1242315363.676270	5.702e-09	2019-05-19 15:36:04 UTC
S190518bb	DQOK ADVNO SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT	1242242376.474609	1242242377.474609	1242242380.922655	1.004e-08	2019-05-18 19:19:39 UTC
S190517h	DQOK ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT PE_READY	1242107478.819517	1242107479.994141	1242107480.994141	2.373e-09	2019-05-17 05:51:23 UTC
S190513bm	DQOK ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT	1241816085.736106	1241816086.869141	1241816087.869141	3.734e-13	2019-05-13 20:54:48 UTC
S190512at	DQOK ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT PE_READY	1241719651.411441	1241719652.416286	1241719653.518066	1.901e-09	2019-05-12 18:07:42 UTC
S190510g	DQOK ADVOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY GCN_PRELIM_SENT	1241492396.291636	1241492397.291636	1241492398.293185	8.834e-09	2019-05-10 03:00:03 UTC
S190503bf	DQOK PASTRO_READY EMBRIGHT_READY SKYMAP_READY ADVOK GCN_PRELIM_SENT	1240944861.288574	1240944862.412598	1240944863.422852	1.636e-09	2019-05-03 18:54:26 UTC
S190426c	DQOK EMBRIGHT_READY PASTRO_READY SKYMAP_READY ADVOK GCN_PRELIM_SENT PE_READY	1240327332.331668	1240327333.348145	1240327334.353516	1.947e-08	2019-04-26 15:22:15 UTC
S190425z	DQOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY ADVOK	1240215502.011549	1240215503.011549	1240215504.018242	4.538e-13	2019-04-25 08:18:26 UTC
S190421ar	DQOK EMBRIGHT_READY PASTRO_READY SKYMAP_READY GCN_PRELIM_SENT ADVOK PE_READY	1239917953.250977	1239917954.409180	1239917955.409180	1.489e-08	2019-04-21 21:39:16 UTC
S190412m	DQOK SKYMAP_READY PASTRO_READY EMBRIGHT_READY ADVOK GCN_PRELIM_SENT PE_READY	1239082261.146717	1239082262.222168	1239082263.229492	1.683e-27	2019-04-12 05:31:03 UTC
S190408an	DQOK ADVOK SKYMAP_READY PASTRO_READY EMBRIGHT_READY GCN_PRELIM_SENT PE_READY	1238782699.268296	1238782700.287958	1238782701.359863	2.811e-18	2019-04-08 18:18:27 UTC
S190405ar	DQOK SKYMAP_READY EMBRIGHT_READY PASTRO_READY ADVNO	1238515307.863646	1238515308.863646	1238515309.863646	2.141e-04	2019-04-05 16:01:56 UTC

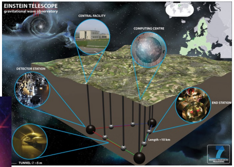
Et d’autres runs pour bientôt

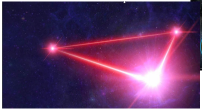
BEYOND O3

- O3 to last ~1 year
  - Kagra aims to join O3
- Possible 5 detector network ~2026
- LIGO A+ (and Advanced Virgo+)
- 3G: Einstein Telescope, Cosmic Explorer
- Space-based GW missions e.g. LISA

Credit: LVC, Living Reviews in Relativity; 21:3; 2018



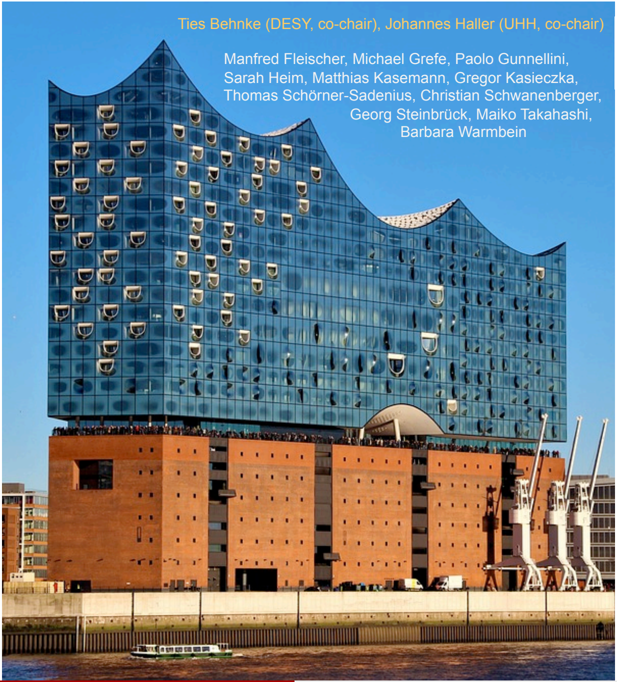




Credit: gwoptics

A dans un an,
pour ICHEP 2020
à Prague (Tchéquie)

ou dans deux ans
pour Lepton-Photon 2021
à Manchester (Grande-Bretagne),
ou
pour EPS-HEP 2021,
à Hambourg (Allemagne) !



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EPS HEP 2021

Hamburg

21.-28.July 2021