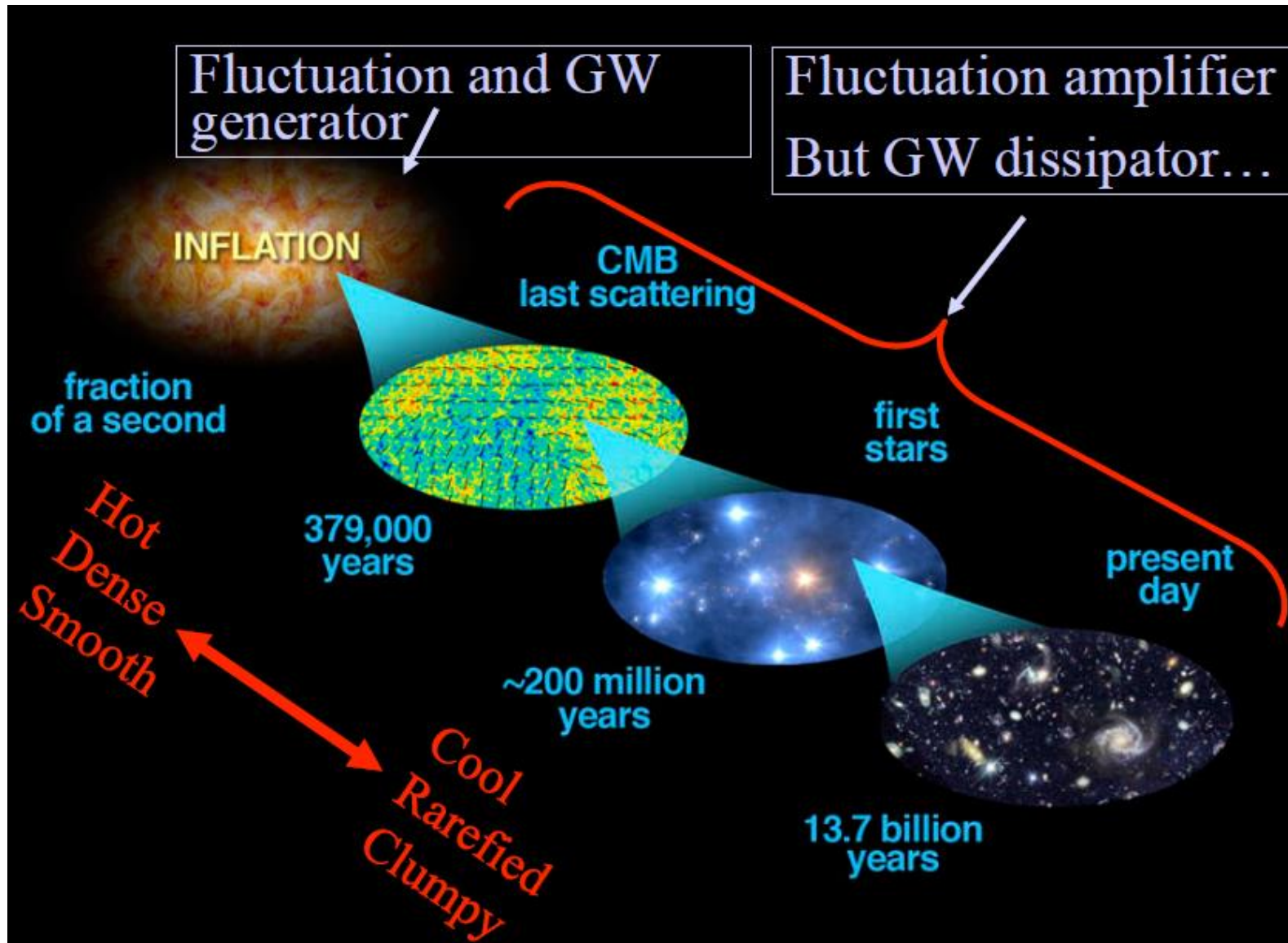


Alcuni highlights da LT

Sommario breve

- ☞ Novità più interessanti nel settore dell'astroparticle
- ☞ Gli esperimenti di DM hanno dei risultati che lasciano perplessi
- ☞ Gli esperimenti di neutrini sono oramai lanciati (o prevedono upgrade) in misure di precisione di θ_{13}/δ_{CP}
- ☞ Il programma di fisica agli acceleratori è dominato da LHC
 - ⇒ Tevatron riesce ancora a sorprendere
- ☞ Le prospettive teoriche...

Da Planck-I



Cosmic Microwave Background Radiation Overview

1965



Penzias and Wilson



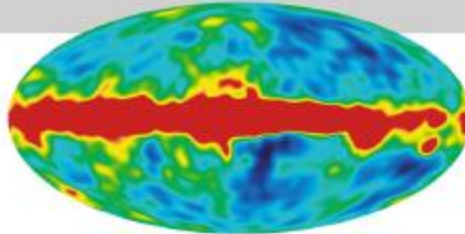
The oldest light or the first light of the Universe

Discovered the remnant afterglow from the **Big Bang**.
→ 2.7 K

1992

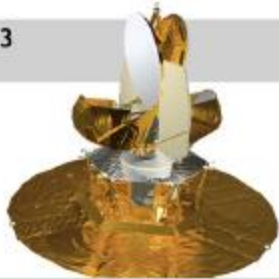


COBE

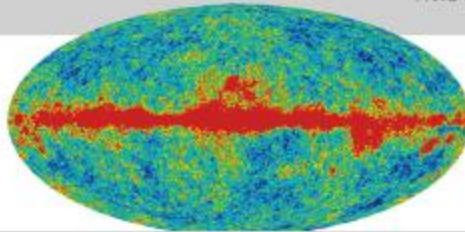


Blackbody radiation,
Discovered the patterns (**anisotropy**) in the afterglow.
→ angular scale ~ 7° at a level $\Delta T/T$ of 10^{-5}

2003



WMAP

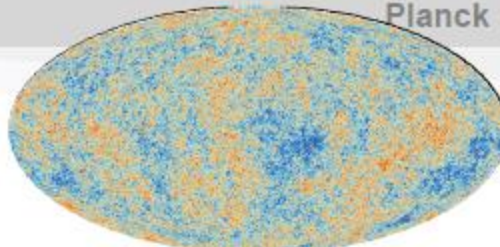


(Wilkinson Microwave Anisotropy Probe):
→ angular scale ~ 15'

2009



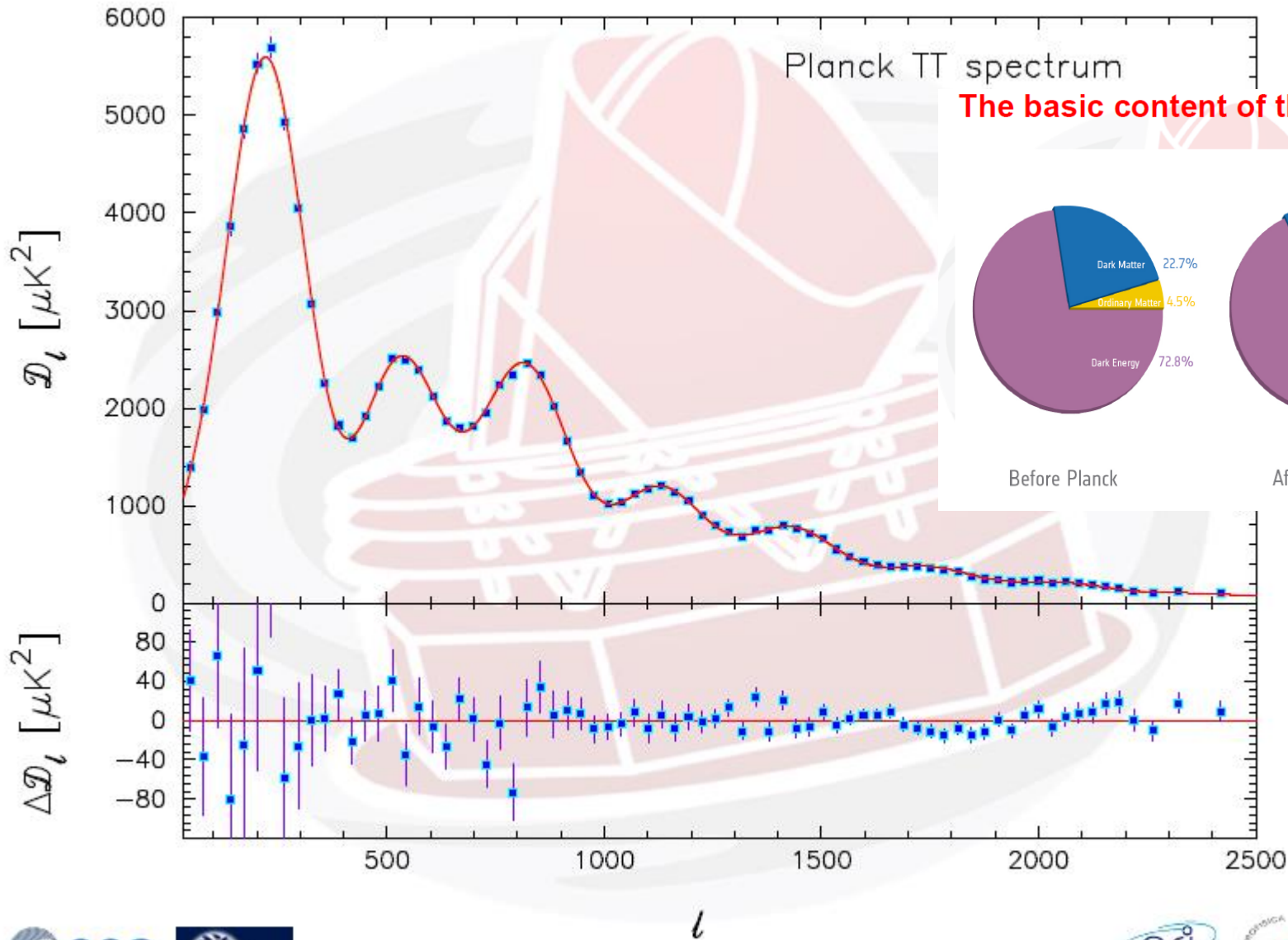
Planck



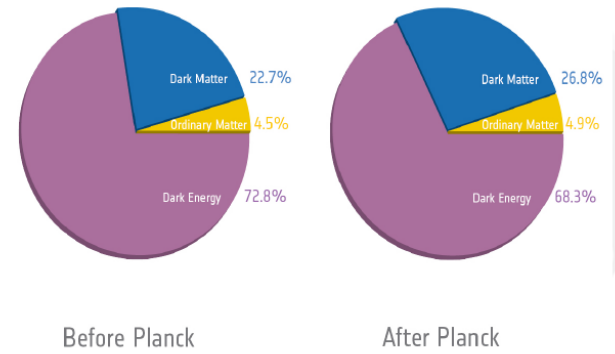
→ angular scale ~ 5',
 $\Delta T/T \sim 2 \times 10^{-6}$, 30~867 Hz



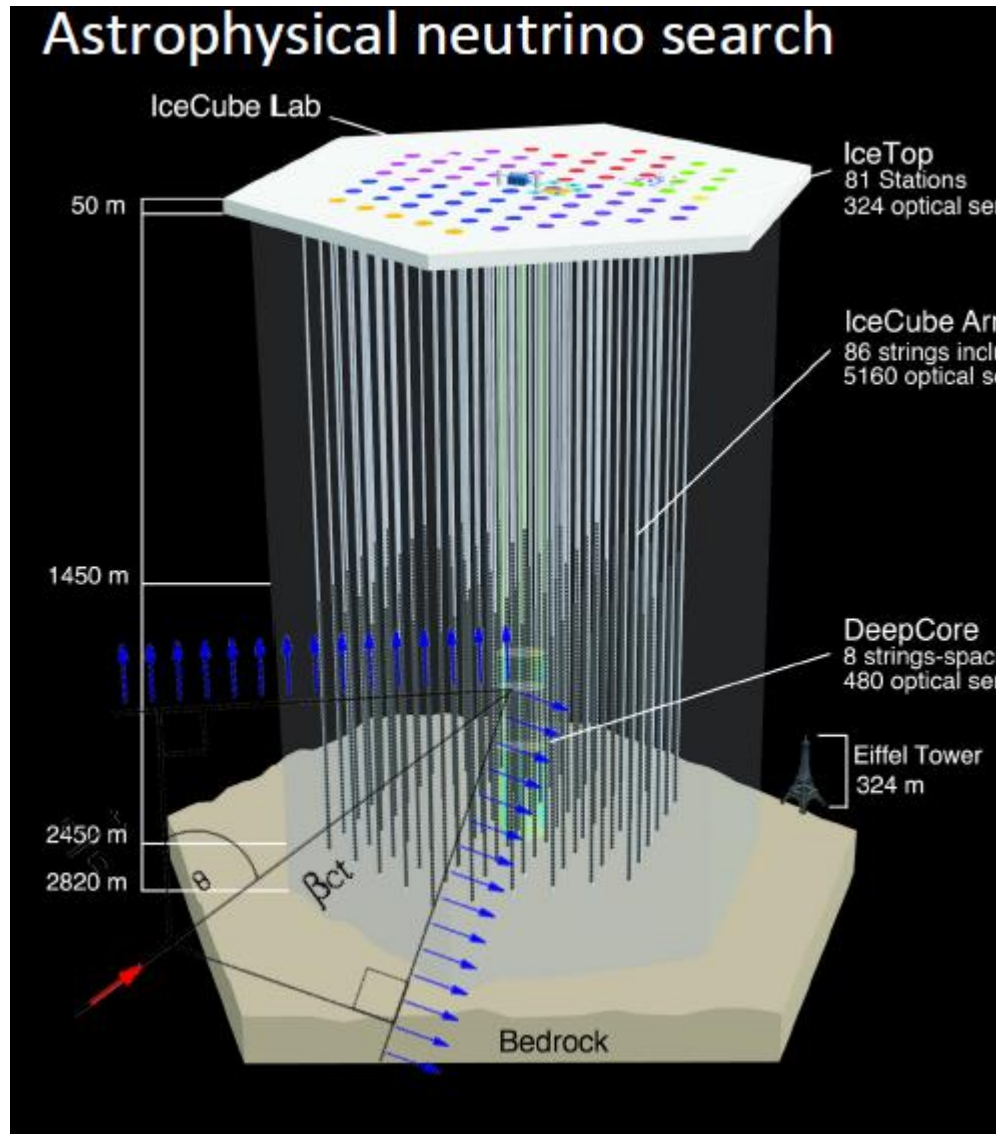
Il risultato finale



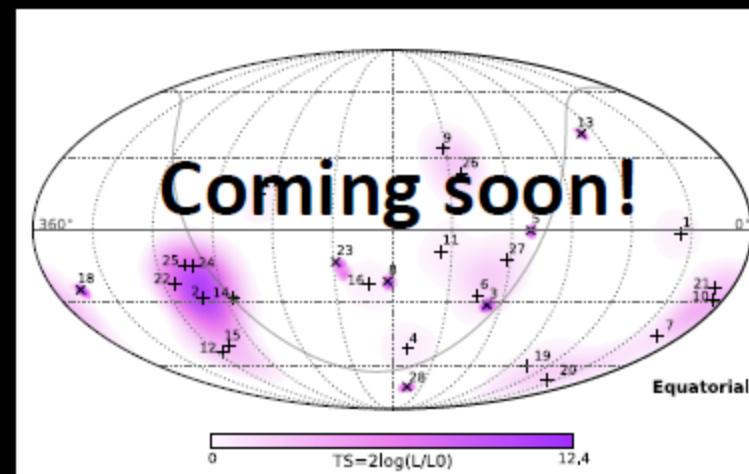
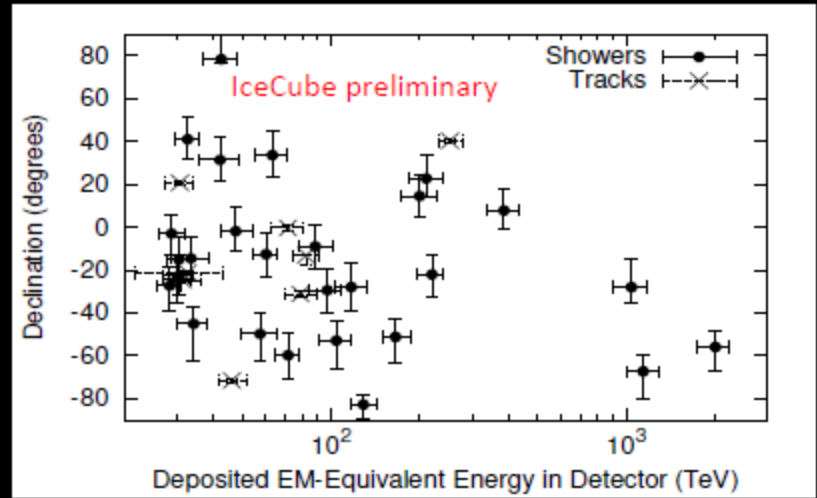
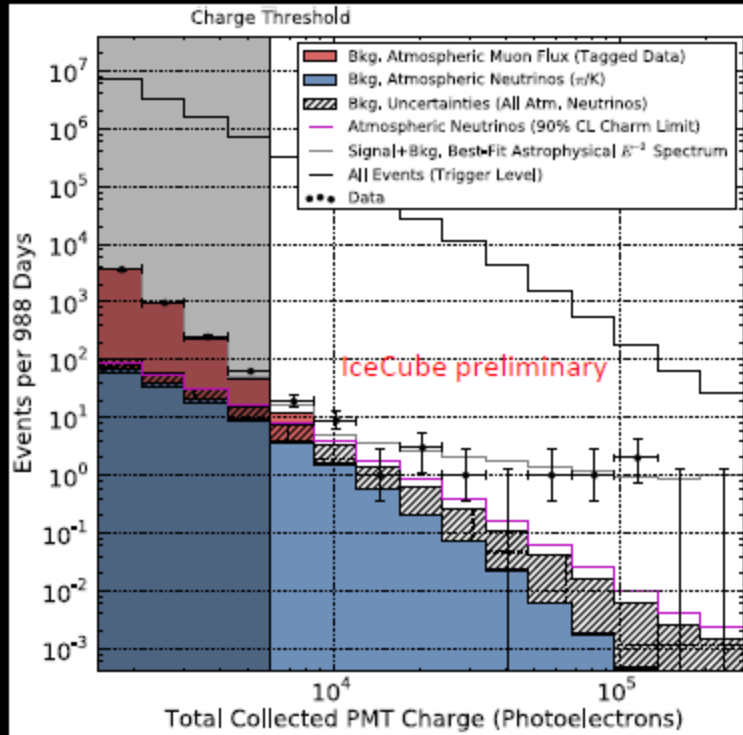
The basic content of the Universe



ICE3



Summary 3 year data:



Science article

Davide Meloni

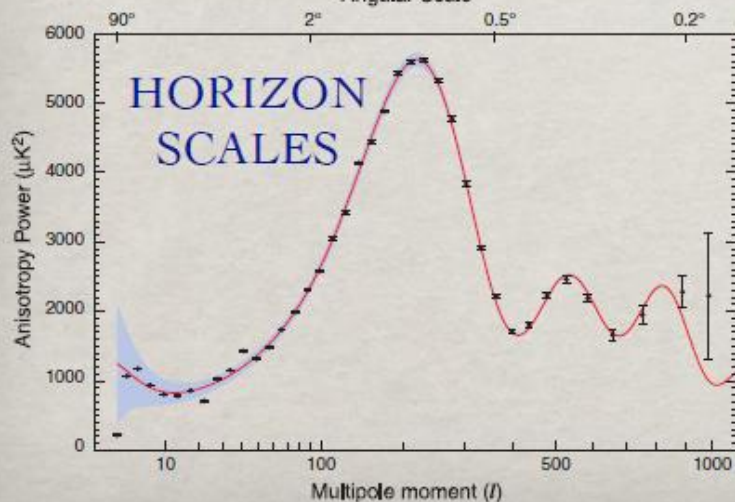
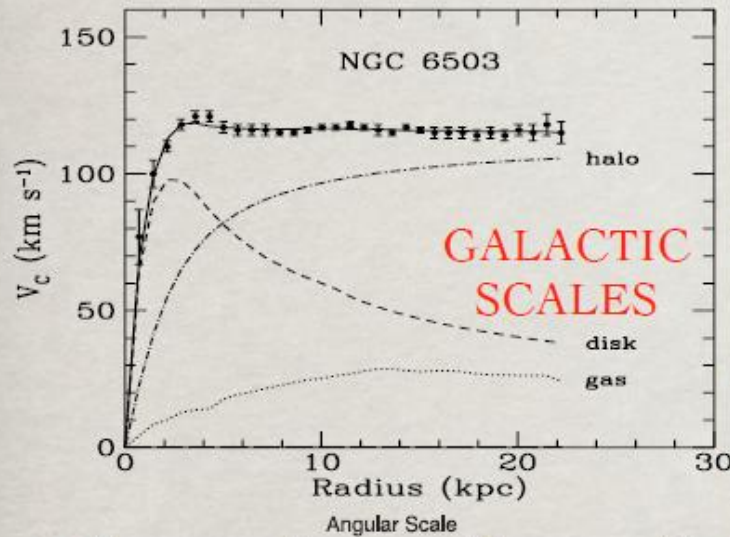
Conclusions

- Neutrino physics is an active field, from both experimental and theoretical point of views
- Many data are now available, which point toward a pattern with two large mixing angles and a smaller θ_{13}
- No clear theoretical explanation is on the market for the understanding of all neutrino properties
- The mystery is a "deformed replica" of what we have in the quark sector →

Possible common origin...

Dark Matter-Laura Covi

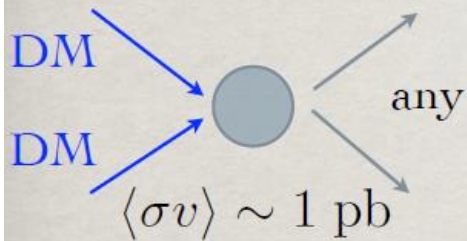
DARK MATTER EVIDENCE



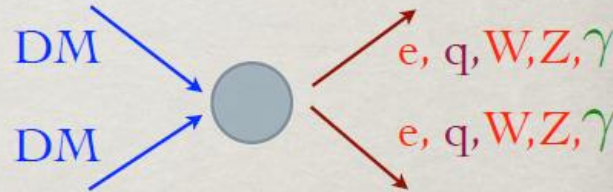
Particles	Ωh^2	Type
Baryons	0.0224	Cold
Neutrinos	< 0.01	Hot
Dark Matter	~ 0.11	Cold

THE WIMP CONNECTION

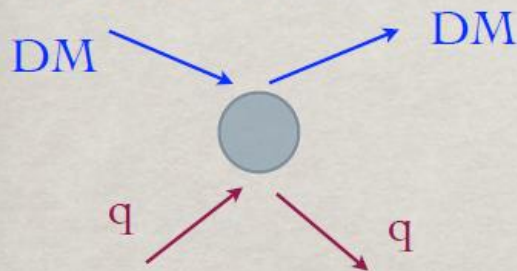
Early Universe: $\Omega_{CDM}h^2$



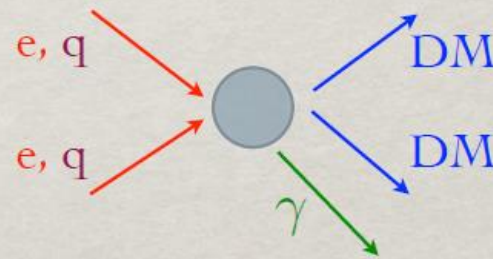
Indirect Detection:



Direct Detection:



Colliders: LHC/ILC

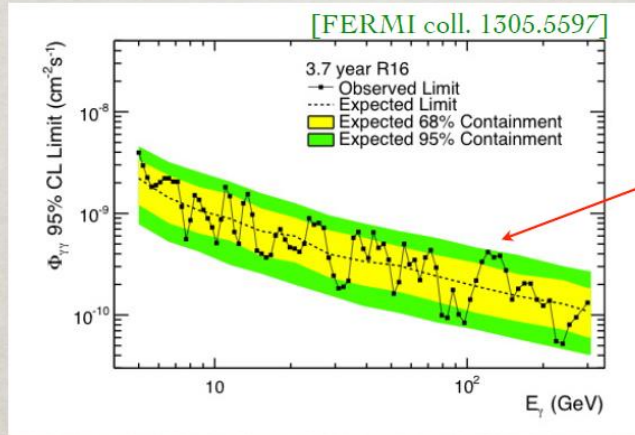


3 different ways to check this hypothesis !!!

E se non fossero wimp??

Risultati

New analysis by the FERMI collaboration sees only an excess of 3.2σ (local) and 1.5σ (global)

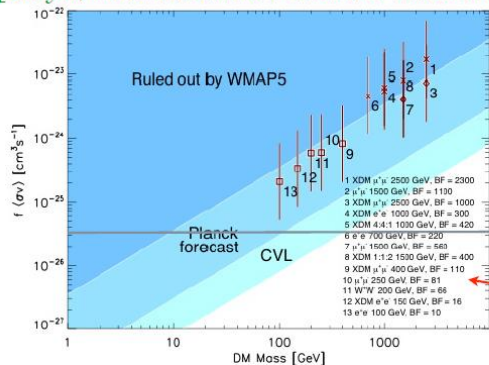


Possibly a statistical fluctuation...

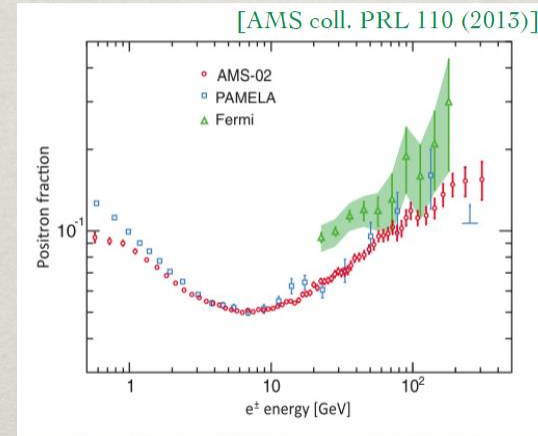
PLANCK: DM ANNIHILATION

WIMP annihilation also modifies the epoch of recombination due to the release of energy in the primordial plasma and leave imprints into the CMB ! WMAP already puts some constraints, but Planck will reach cross sections needed by PAMELA

[Slatyer, Padmanabhan & Finkbeiner 0906.1197]



AMS-02 CONFIRMS PAMELA

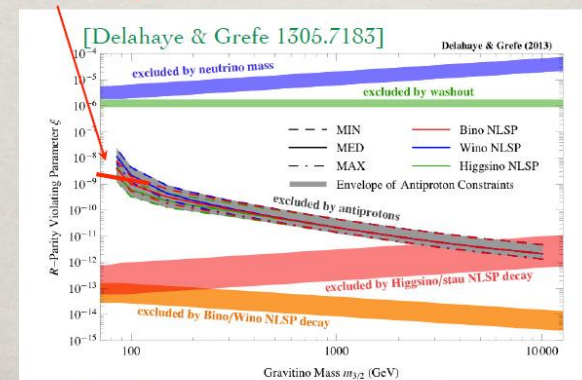


Spectrum fits well with PAMELA and extends to 350 GeV: flattening ? turning point ? Pulsar or DM ?

ANTI-PROTON CONSTRAINTS

Very important also the AMS-02 expected antiproton data ! E.g. see a recent analysis of the antiproton constraints for decaying gravitino DM limiting the R-parity breaking coupling.

From the FERMI gamma-line search: $\tau < 1 - 4 \times 10^{29} \text{ s}$ 95% CL

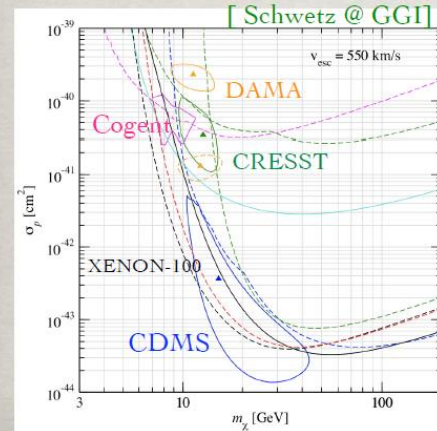
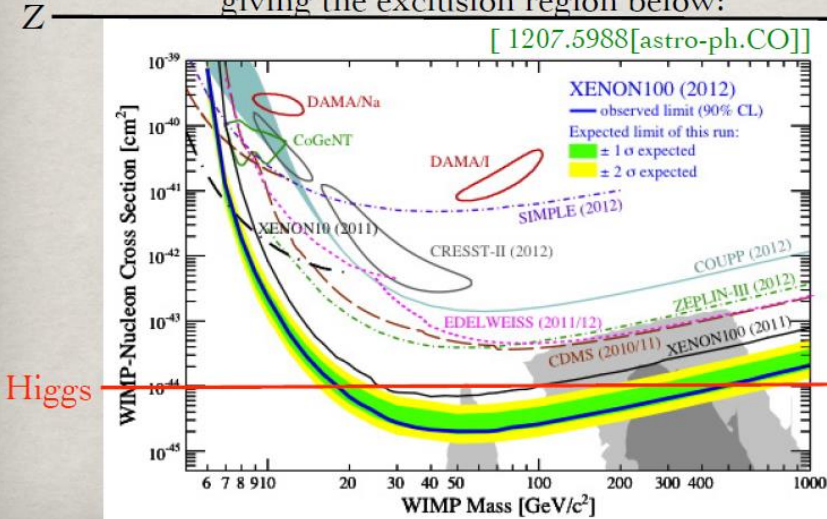


Direct detection?

NEWS: SIGNAL(S) OF DM ? NEWS: SIGNAL(S) OF DM ?

Recent new results by XENON-100 appeared, with two events in the signal region compatible with background, giving the exclusion region below:

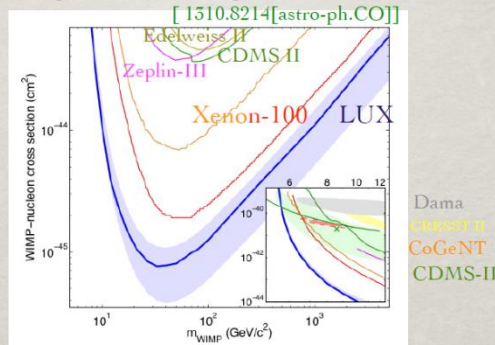
In the last couple of years quite a number of hints appeared in the low mass region... Unfortunately difficult to fit all together, moreover the region is excluded by XENON100 & LUX



DAMA: annual modulation @ ~9 sigma
 Cogent: excess+ann. mod.
 CRESST: 67 events vs 38 bg
 CDMS: 2 events vs 0.8 bg no annual modulation

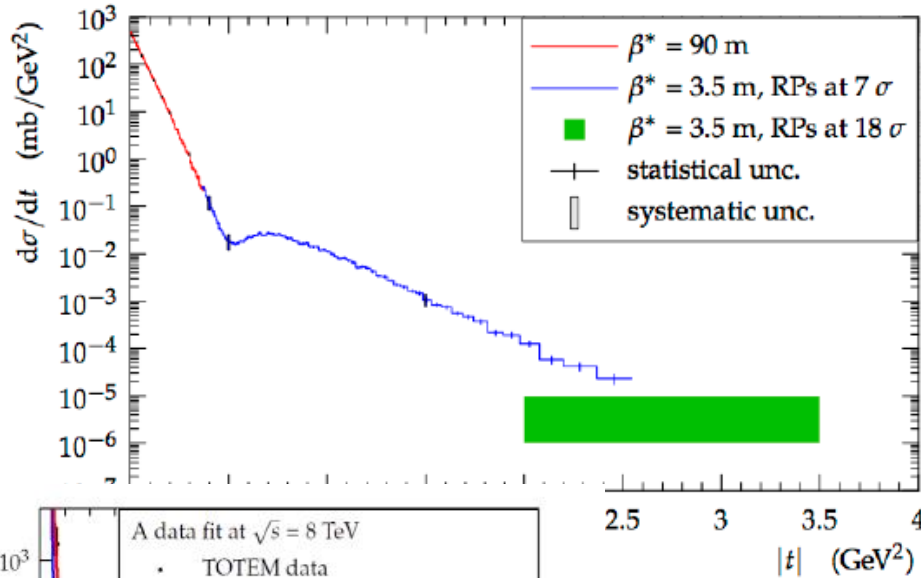
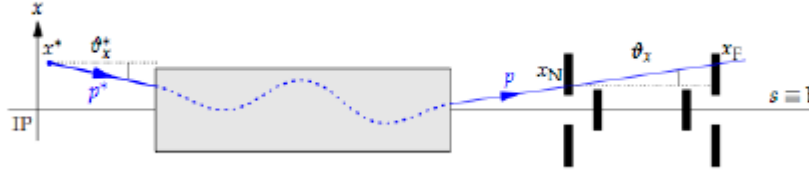
NEWS: SIGNAL(S) OF DM ?

Latest results by LUX with lowest threshold ever !
 Again excludes all previous hints

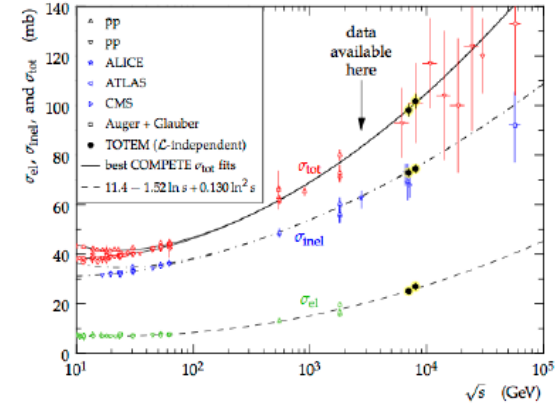


Colliders...

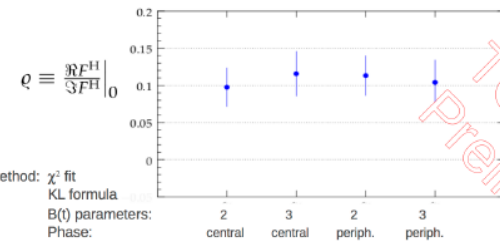
- proton transport IP5 → RP detectors:



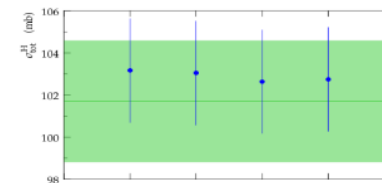
$$\sigma_{\text{tot}} = \frac{16\pi}{1 + q^2} \frac{dN_{\text{el}}/dt|_0}{N_{\text{el}} + N_{\text{inel}}}$$



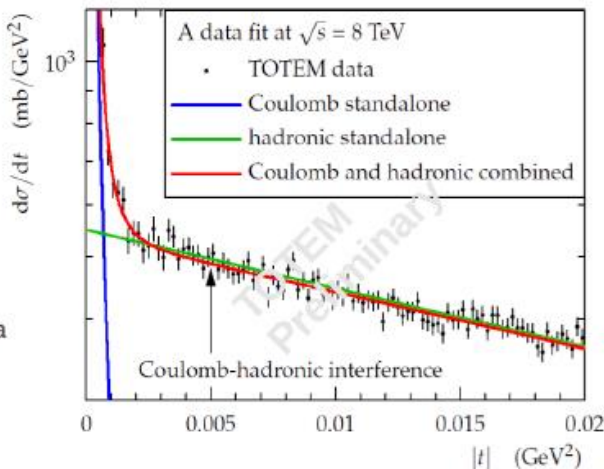
Elastic pp scattering : ρ measurement



$$\rho = 0.104 \pm 0.027(\text{stat}) \pm 0.010(\text{syst}) + 0.012(\text{model}) - 0.006$$



$\sigma_{\text{tot}} = 101.7 \pm 2.9 \text{ mb}$
 Measured by TOTEM
 (CERN-PH-EP-2012-354)

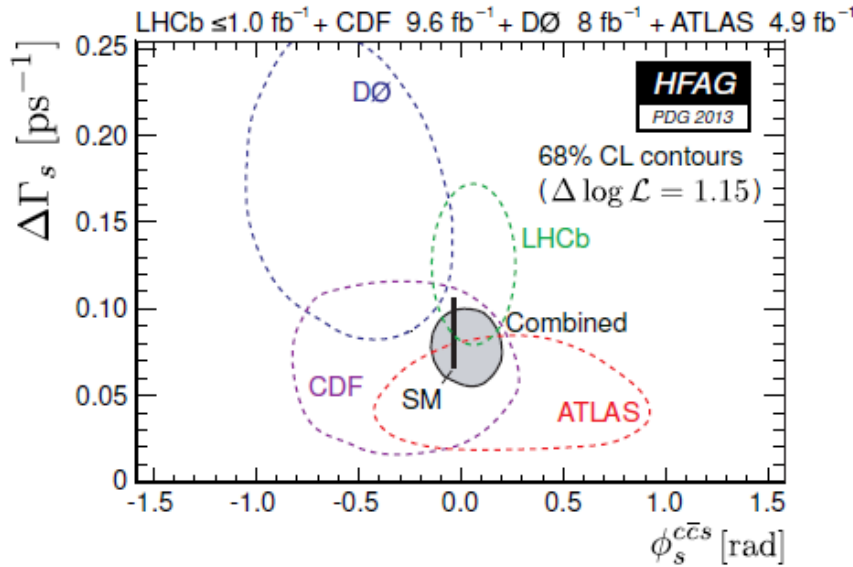


$$\rho \equiv \frac{\Re A_{\text{el}}}{\Im A_{\text{el}}}|_{t=0}$$

David Straub: NP in flavor

B_s mixing phase

Photon polarization in $B^+ \rightarrow K^+ \pi^- \pi^+ \gamma$

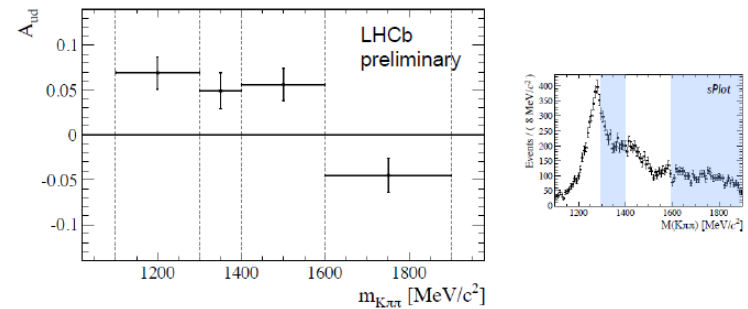


NEW!

Results

LHCb-PAPER-2014-001

- We obtain 4 independent measurements of the asymmetry:

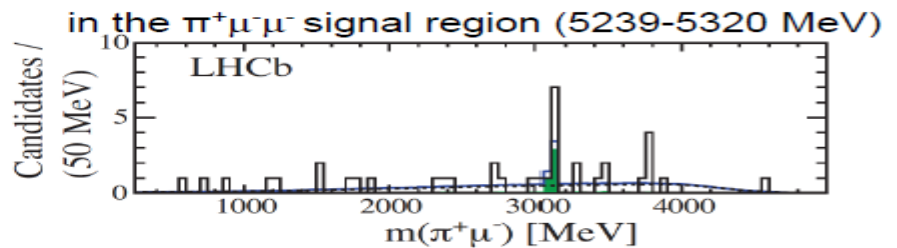
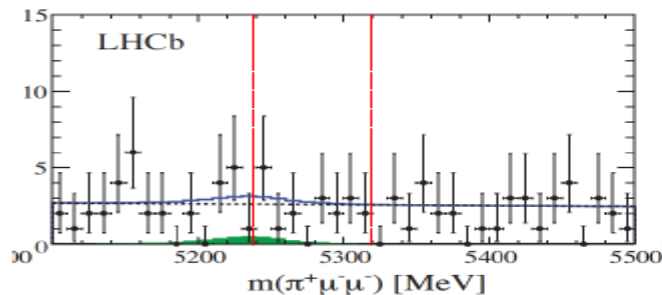


- This translates into a **5.2 σ significance** for a non zero up-down asymmetry
 \Rightarrow first observation of photon polarization in $b \rightarrow s\gamma$ transition

NEW!

$B^- \rightarrow \pi^+ \mu^- \mu^-$, short neutrino lifetime

arXiv:1401.5361



- Peaking background : $B^+ \rightarrow J/\Psi K^+(\pi^+)$, $B^+ \rightarrow \Psi(2S) K^+$
- No signal found, $\text{BR}(B^- \rightarrow \pi^+ \mu^- \mu^-) < 4.0 \times 10^{-9}$ at 95% CL

LHC...EWK

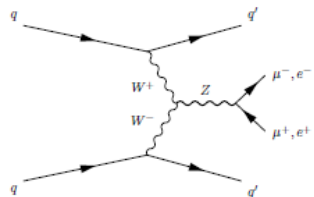
Electroweak Zjj production

Electroweak Zjj production **new!**

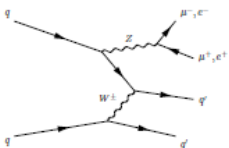
arXiv:1401.7610

- EW Zjj production, $\sqrt{s} = 8$ TeV, $\int L dt = 20.3 \text{ fb}^{-1}$

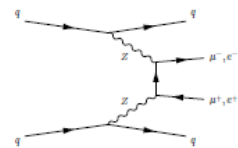
vector boson fusion (VBF):
similar to VBF Higgs production
sensitive to aTGC



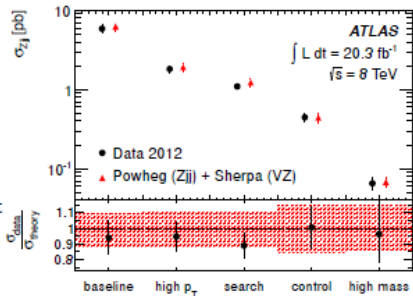
Z bremsstrahlung:



non-resonant l^+l^-jj production:



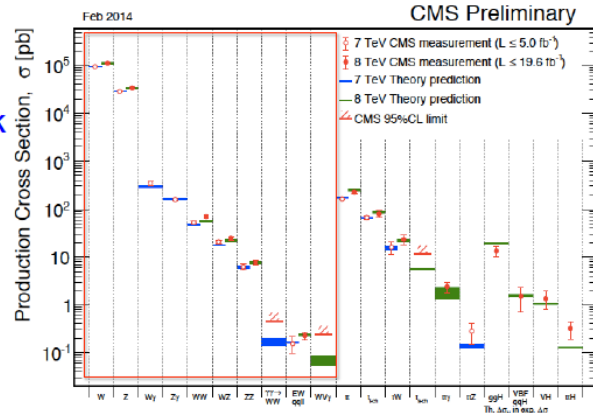
- opposite-sign same-flavor lepton pair within $81 \text{ GeV} < m_Z < 101 \text{ GeV}$
- ≥ 2 high p_T jets
- inclusive Zjj production: measurement of fiducial cross sections in 5 phase space regions with different sensitivity to the EW component
- search regions: $m_{jj} > 250 \text{ GeV}$ & 1 TeV and jet veto on additional jets in the rapidity interval between the two tag jets



Summary

Impressive amount of EWK results from the LHC

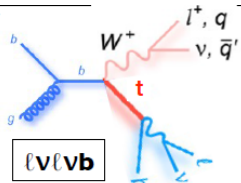
- Precise test of the Standard Model at TeV scale
- Agreement with theory across orders of magnitude
- Starting to set serious constraints on PDFs**
- The LHC is now the leading laboratory for exploring the gauge boson self-interactions.



Top

Inclusive σ_t : Wt-channel - $\sqrt{s} = 8$ TeV

ATLAS-CONF-2013-100 $[L_{dt} = 20.3 \text{ fb}^{-1} (2012)]$



- OS $e\mu$, 1 or 2 central high p_T jets, ≥ 1 b-tag,
- Bkg: $t\bar{t}$, diboson, Z+jets, data-driven (matrix method) fake lept.

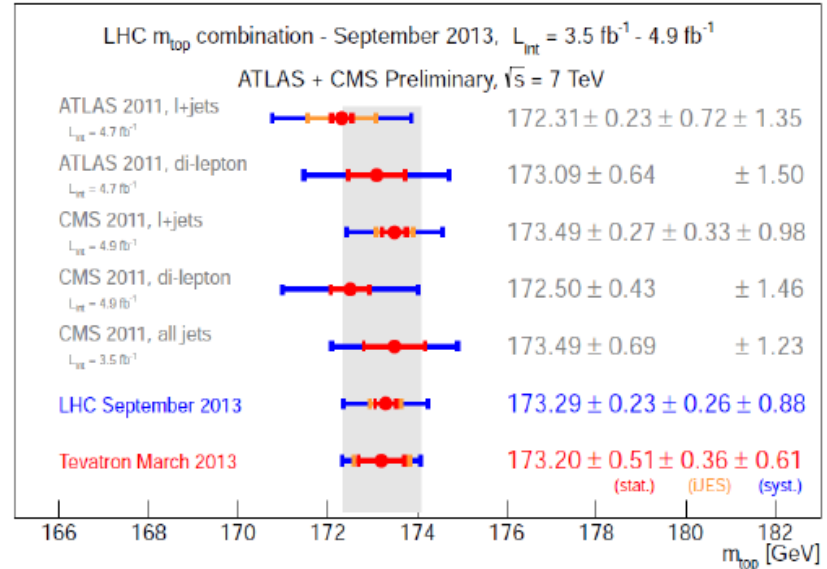
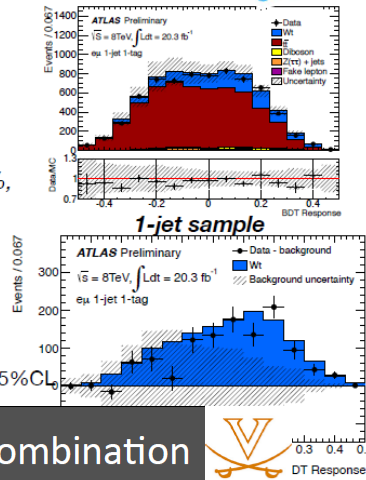
- Extract σ_{Wt} and bkg norm by simultaneous binned max. likelihood fit of Boosted Decision Tree outputs in 1 and 2-jet bin (with 19 and 20 kine vars)

Syst dominated

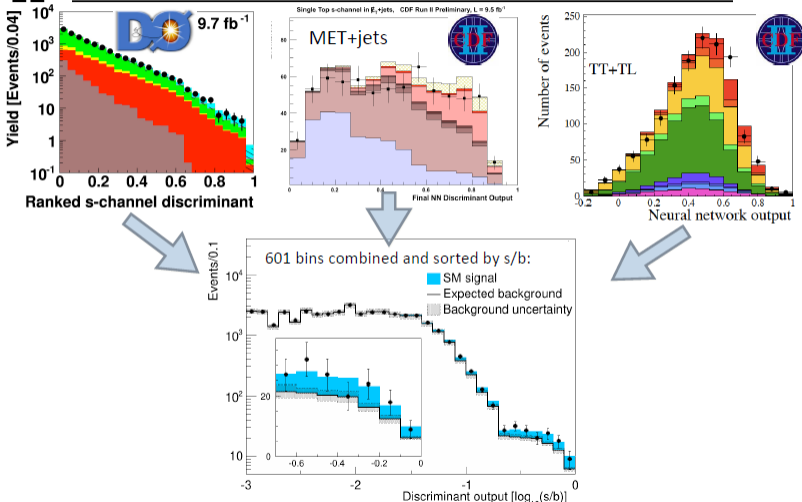
- Syst: Wt(tt) gen+ had 11% (~7.5%) b-tag eff. ~8%, ISR/FSR (~5.9%) and b-jet en. scale (~5.0%). Profile b-tag, 1 comp of JES and soft JES.

$\sigma_{Wt} = 27.2 \pm 2.8$ (stat) ± 5.4 (syst) pb
significance: 4.2 s.d. $\delta\sigma_{Wt}/\sigma_{Wt} \sim 22\%$

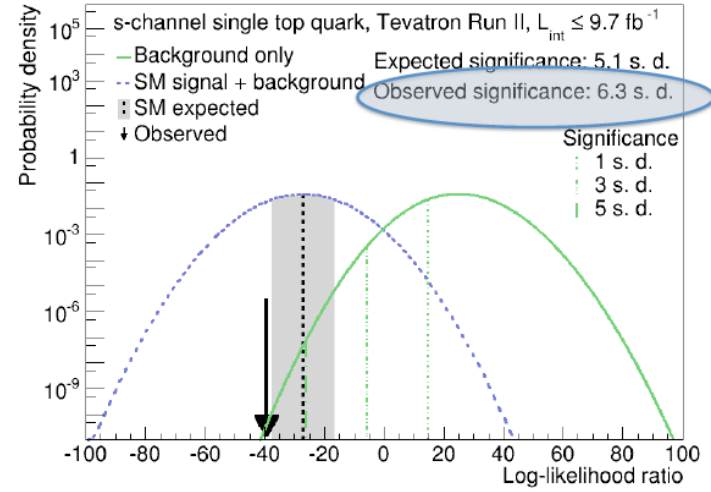
- Determine $|V_{tb}| = 1.10 \pm 0.12$ If $|V_{tb}| < 1$ $|V_{tb}| > 0.72$ at 95% CL



New Tevatron s-channel combination



+ = 1st observation of a new process!



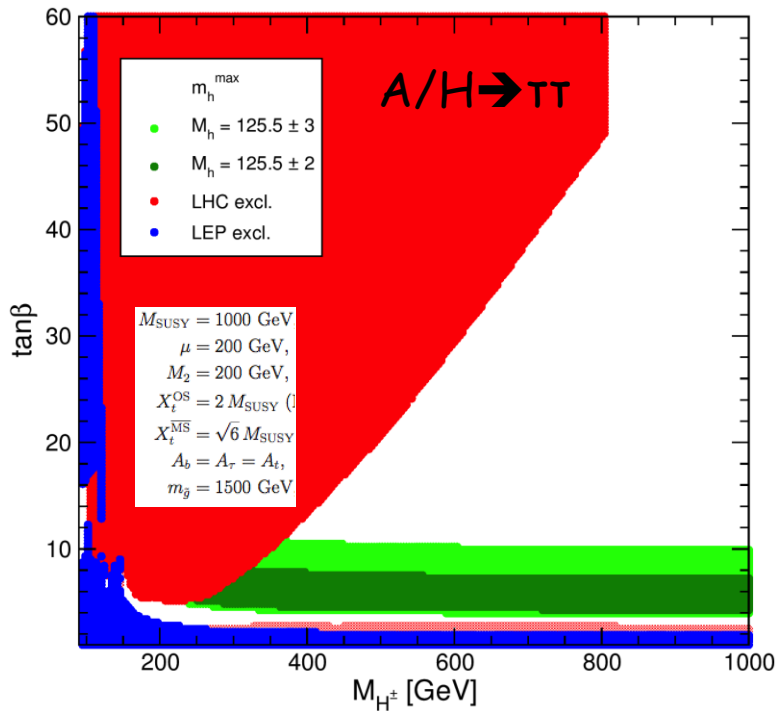
Benchmark Scenarios for the Search of MSSM Higgs Boson

With 125.5 GeV signal interpreted as h (H possibility excluded by H^\pm searches)

M.C., Heinemeyer, Stal, Wagner, Weiglein '13

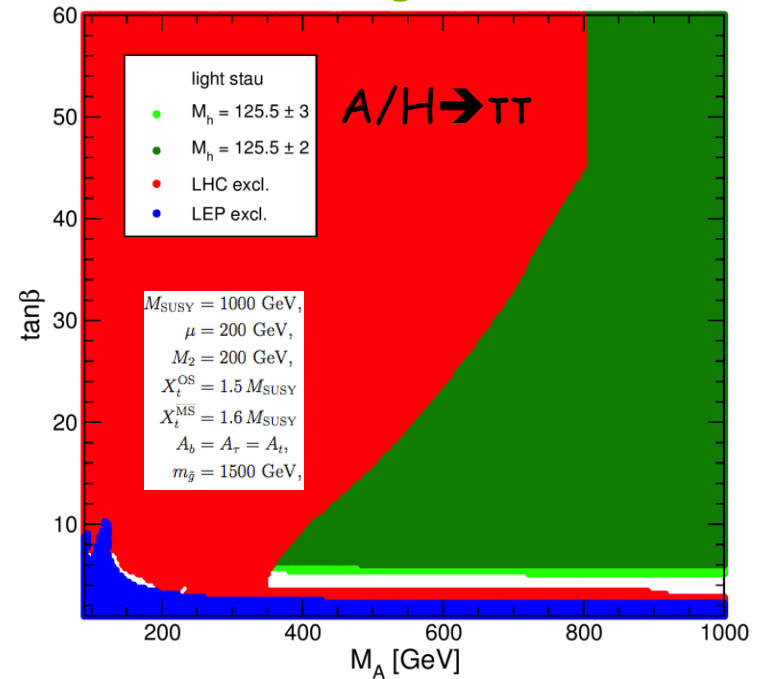
m_h^{\max} scenario

Lower bound on $\tan\beta$, M_A and M_{H^\pm}
(slightly relaxed if $M_{\text{SUSY}} \sim 2\text{TeV}$)



m_h^{mod} scenario

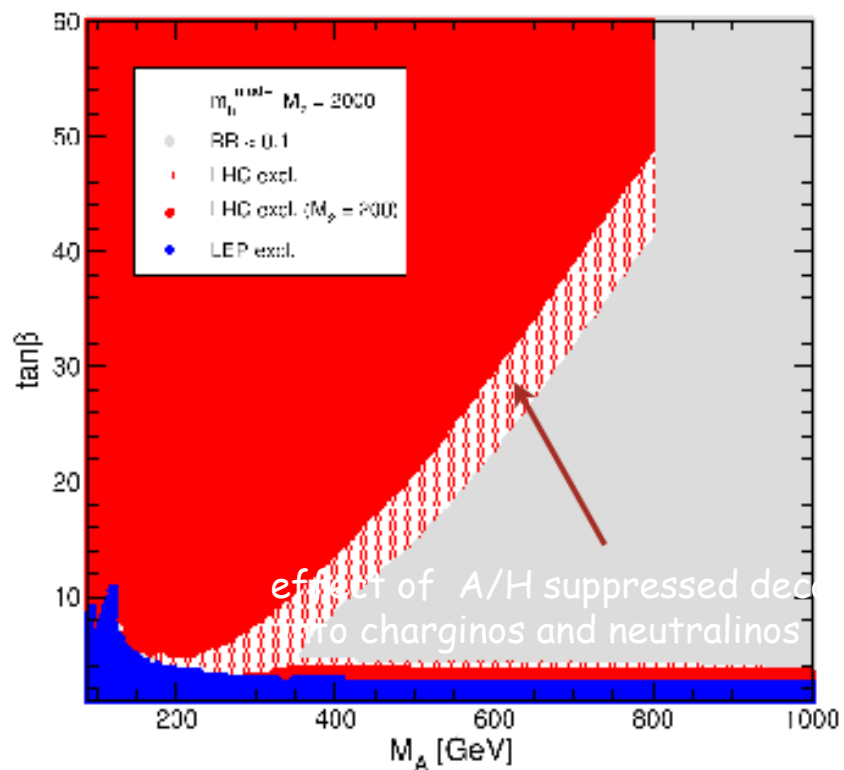
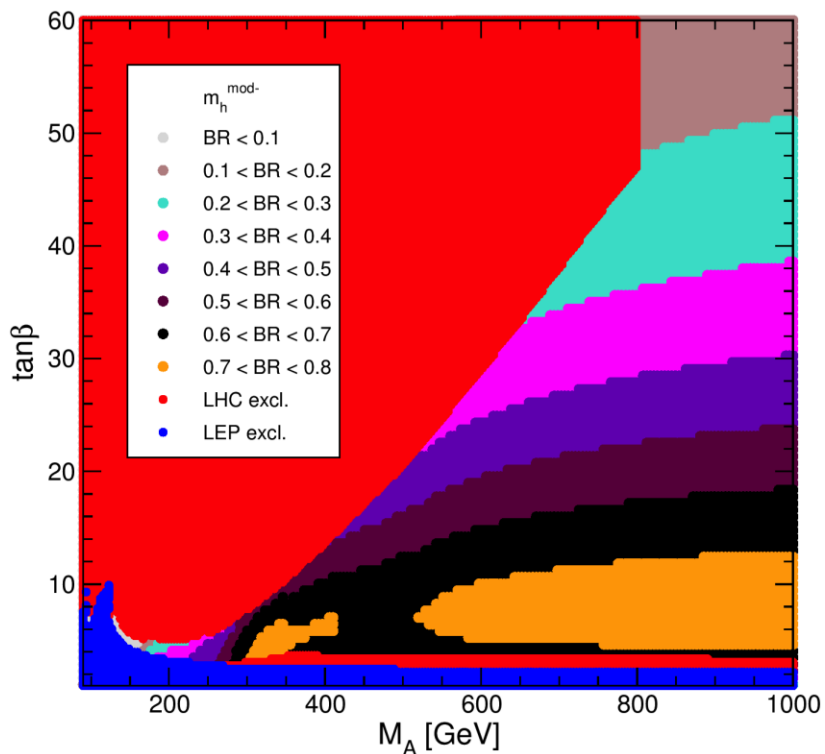
Moderate stop mixing: large region in $\tan\beta$ - m_A plane compatible with Higgs signal



Green region favored by LHC observation

Decay of Non Standard MSSM Higgs Bosons in electroweakinos

m_h^{mod} scenario



Reach of non-standard Higgs bosons in tau decays modified.
 Opportunity to search for these new decays
 Also $H \rightarrow hh$ relevant at low $\tan\beta$

Il futuro..MLM

Dark Matter

Our thinking has shifted K. Zurek, Aspen 2014

From a single, stable weakly interacting particle
(WIMP, axion)

Models: Supersymmetric light DM sectors, Secluded WIMPs, WIMPlless DM, Asymmetric DM ...
Production: freeze-in, freeze-out and decay, asymmetric abundance, non-thermal mechanisms ...

$M_p \sim 1 \text{ GeV}$

Standard Model

...to a hidden world with multiple states, new interactions

ASPEN 2014: <https://indico.cern.ch/event/276476/>
pp at 100 TeV opens three windows:

➔ Access to new particles in the few → 30 TeV mass range, beyond LHC reach

➔ Immense rates for phenomena in the sub-TeV mass range ⇒
increased precision w.r.t. LHC

➔ Access to very rare processes in the sub-TeV mass range ⇒

search for stealth phenomena, invisible at the LHC

80-100 km tunnel infrastructure in Geneva area –
design driven by pp-collider requirements
with possibility of e⁺e⁻ (TLEP) and p-e (VLHeC)

FCC (Future Circular Colliders)
CDR and cost review
for the next ESU (2018)
(Including Injectors)



Final remarks

- The days of “guaranteed” discoveries or of no-lose theorems in particle physics are over, at least for the time being
- but the big questions of our field remain wild open (hierarchy problem and naturalness, flavour, neutrinos, DM, BAU,)
- This simply implies that, more than for the past 30 years, future HEP's progress is to be driven by experimental exploration, possibly renouncing/reviewing deeply rooted theoretical bias
- It took 40 years to wrap up the SM, it may take as long to pin down the right scenario to move beyond the SM: the community must prepare itself, and find motivation, to face the challenge of such a long enterprise
- The thorough exploration of the TeV scale is essential, as it uniquely addresses key questions of our field, and provides the necessary landscape to interpret any other indication of new physics
- A whole spectrum of discoveries may be waiting for us at LHC@14 TeV or it may be years before the next big discovery !
- In either case, the LHC can meanwhile deliver a rich programme of measurements, from precision studies of Higgs and top properties, to QCD studies at extreme energies, to the search for very rare phenomena. Don't forget the Tevatron was about to deliver its biggest result, the Higgs discovery, over 25 years after start up !

Altri talks interessanti..

Molti, consiglio di andare sulla pagina web

- ☞ Terranova (misura di $g-2$ dell'elettrone)
- ☞ Crivellin (NP nel flavor?)
- ☞ Xenon 100/Lux
- ☞ Tavola rotonda sulle neutrino facilities
 - ⇒ Posizione di Ferroni
 - ⇒ Posizione CERN
 - ⇒ China as «the» player?
 - ⇒ Fermilab come l'unico luogo con un vero fascio
- ☞ Misure di QCD di precisione
- ☞ Misure di fisica dell'Higgs