A che punto siamo

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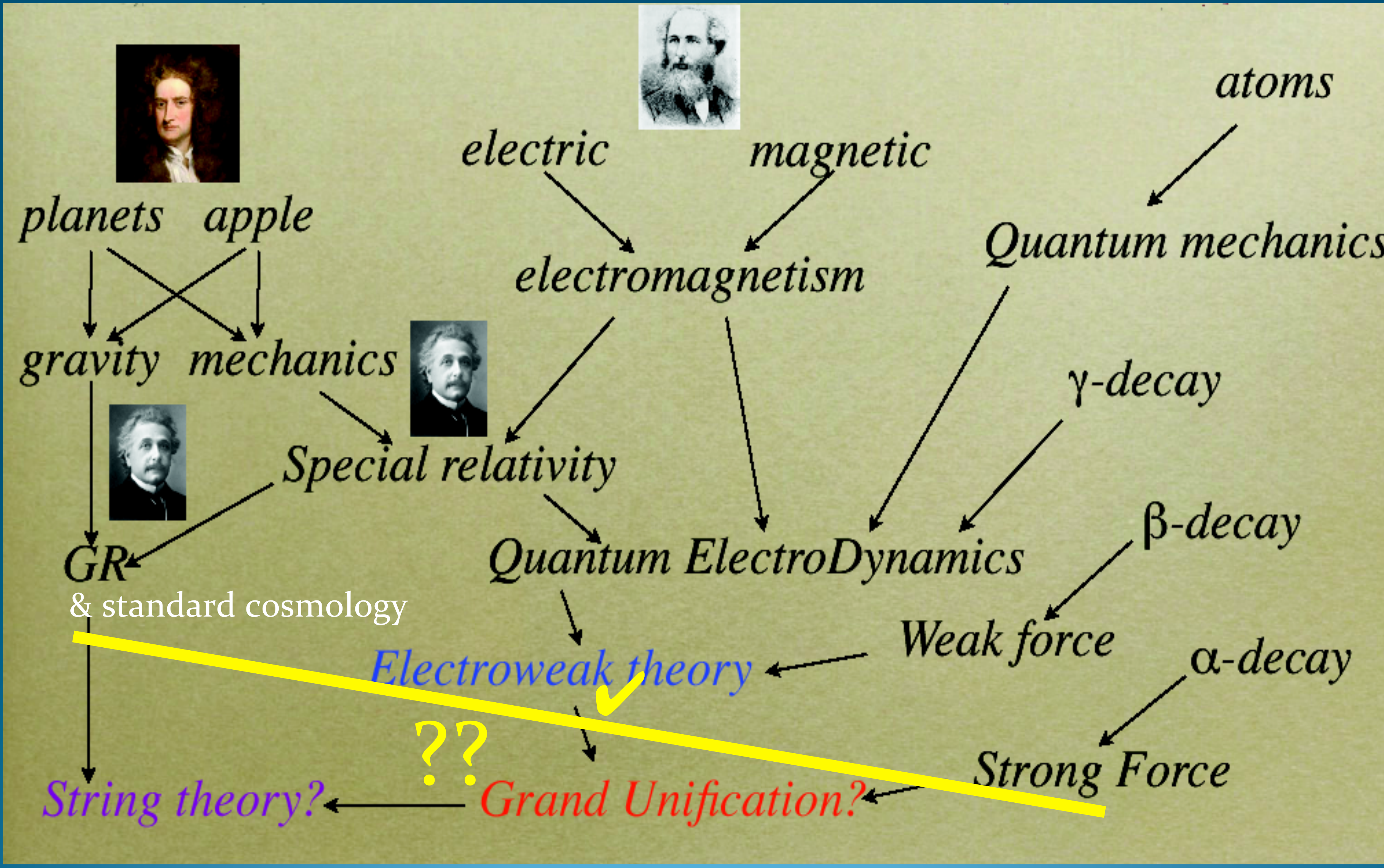
Giornate di Studio sul
Piano Triennale 2015-2017 dell’INFN
Trento, 7-8 novembre 2014

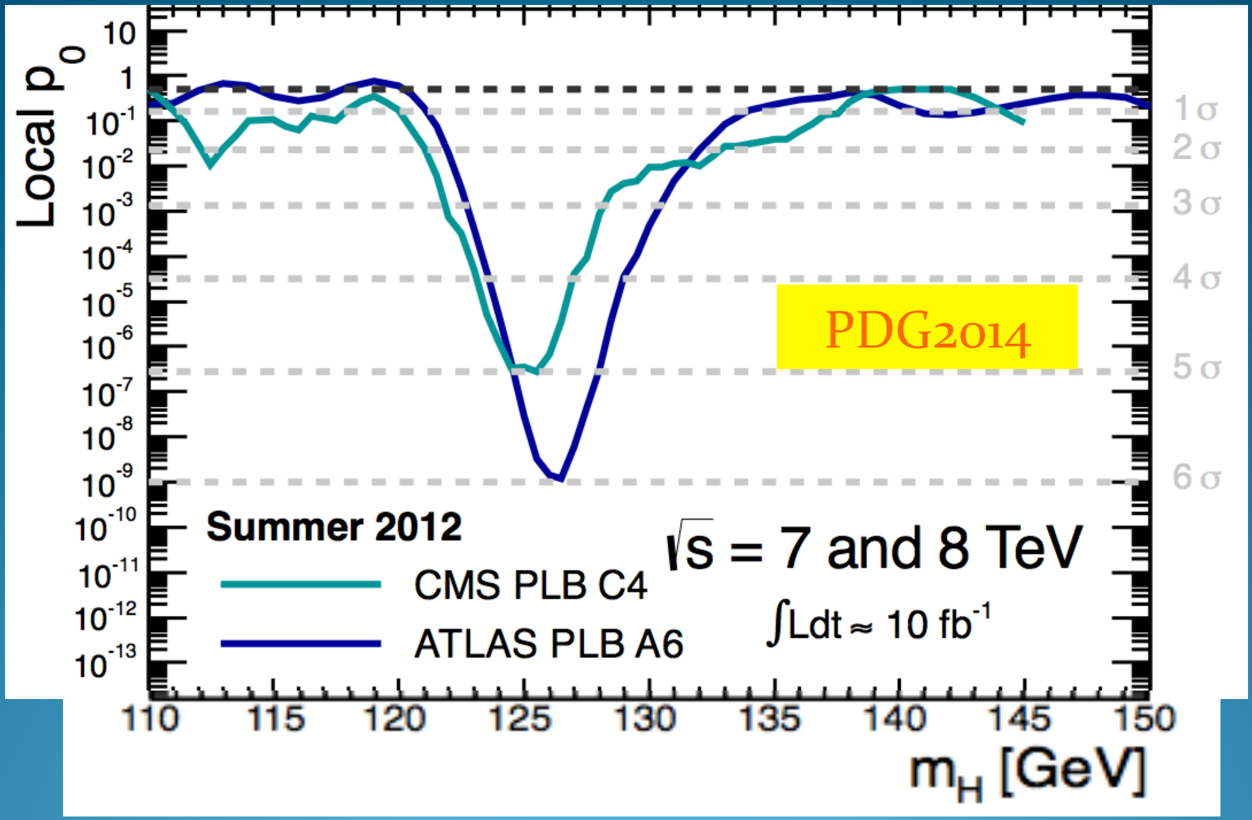
In prospettiva storica



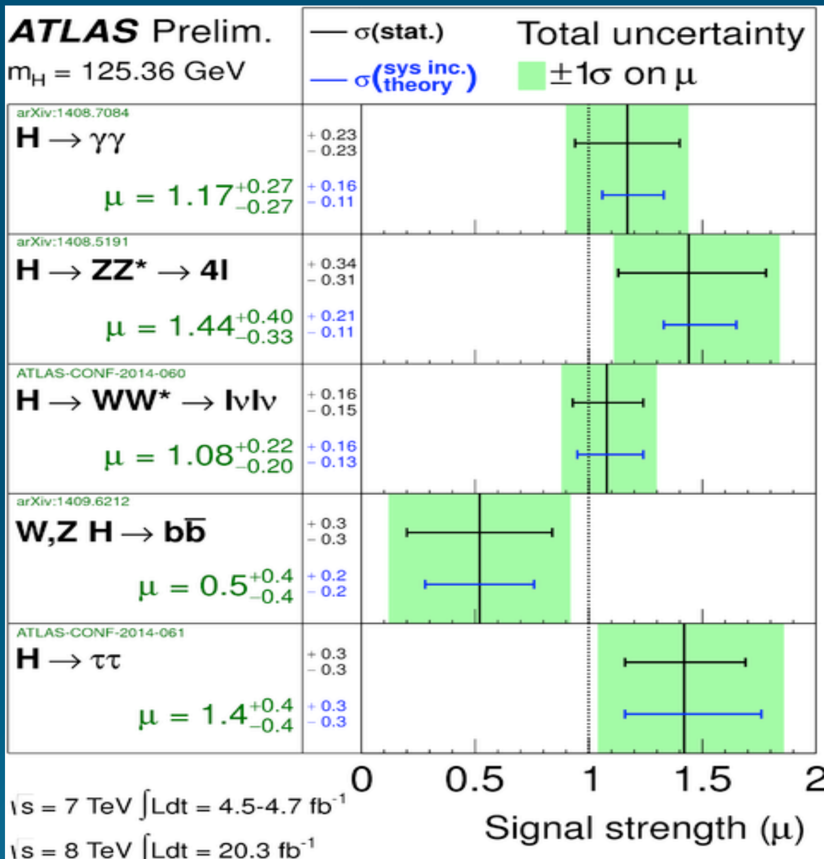
Siamo entrati in pieno nell'era dell'Higgs

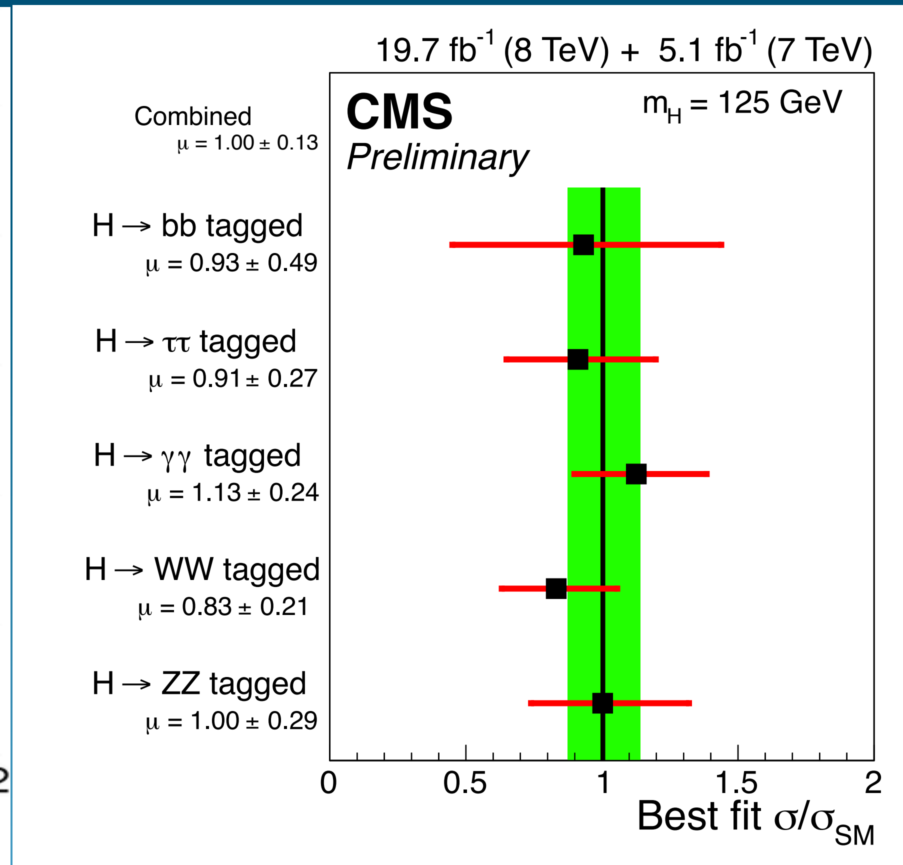
- Un grosso investimento di lungo termine sta pagando
- L'imperativo scientifico è sfruttare questa opportunità

Dalla scoperta



all’attuale preliminare identikit (“SM-like”)





$$\mu = 1.30 \pm 0.18$$

$$\mu = 1.00 \pm 0.13$$

ad uno studio sistematico appena iniziato

Landscape Redefined

Expansion of the Higgs Physics Program!

Precision
- Mass and width
- Coupling properties
- Quantum numbers (Spin, CP)
- Differential cross sections
- Off Shell couplings and width
- Interferometry

Rare decays
- $Z\gamma$
- Muons $\mu\mu$
- LFV $\mu\tau$, $e\tau$
- $J/\Psi\gamma$, $Z\Upsilon$, etc…

$$H^0$$

Tool for discovery
- Portal to DM (invisible Higgs)
- Portal to hidden sectors
- Portal to BSM physics with H^0 in the final state (ZH^0, WH^0, H^0H^0)

Is the SM minimal?
- 2 HDM searches
- MSSM, NMSSM searches
- Doubly charged Higgs bosons

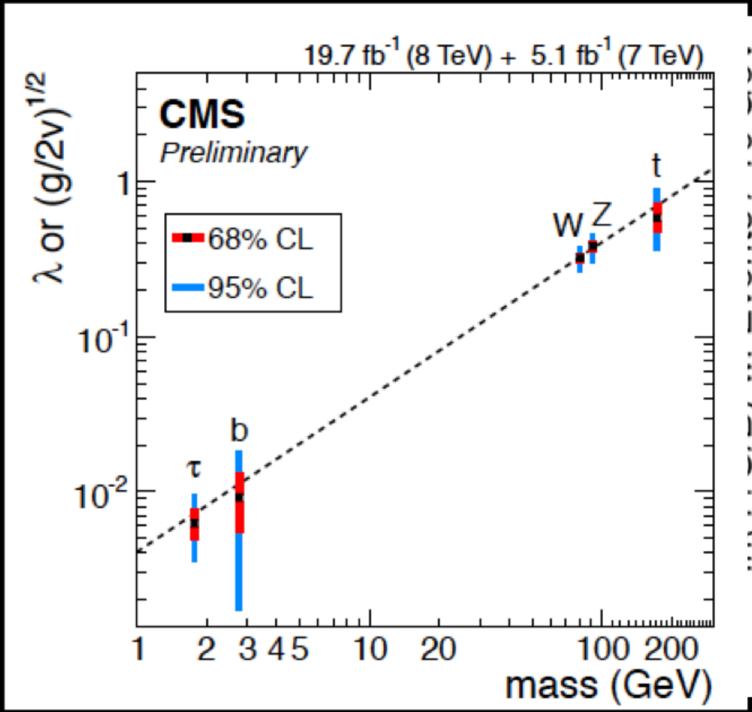
…and More!
- FCNC top decays
- Di-Higgs production
- Trilinear couplings prospects
- Etc…

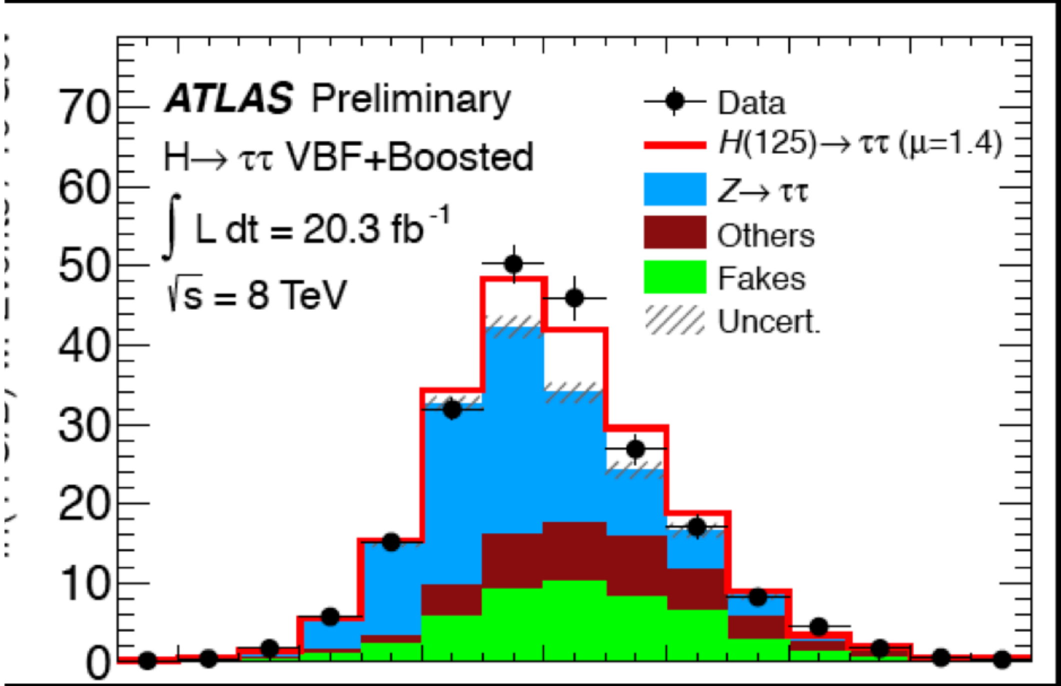
Kado ICHEP2014

Nonostante l'assenza di nuovi dati da Feb 2013, progressi nelle analisi dei dati di LHC – Run I:

❖ Measuring Higgs parameters

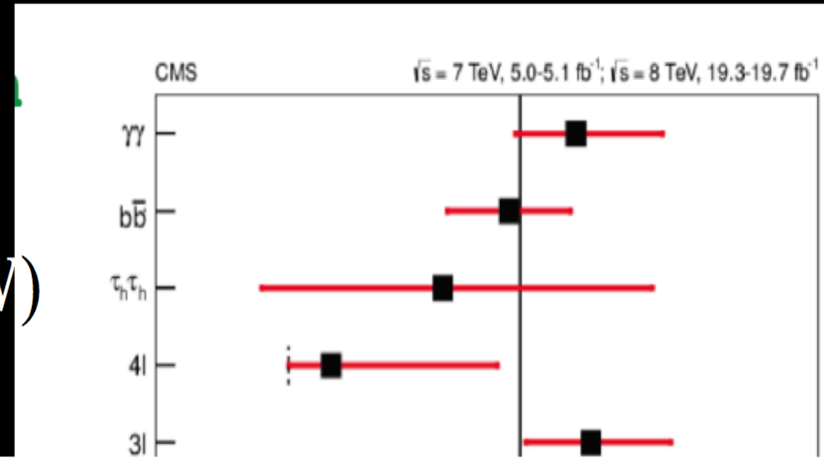
- ➢ Mass resolution ~ 0.2% with improved consistency
- ➢ Improved b and tau fermion analyses
- ➢ Improved couplings

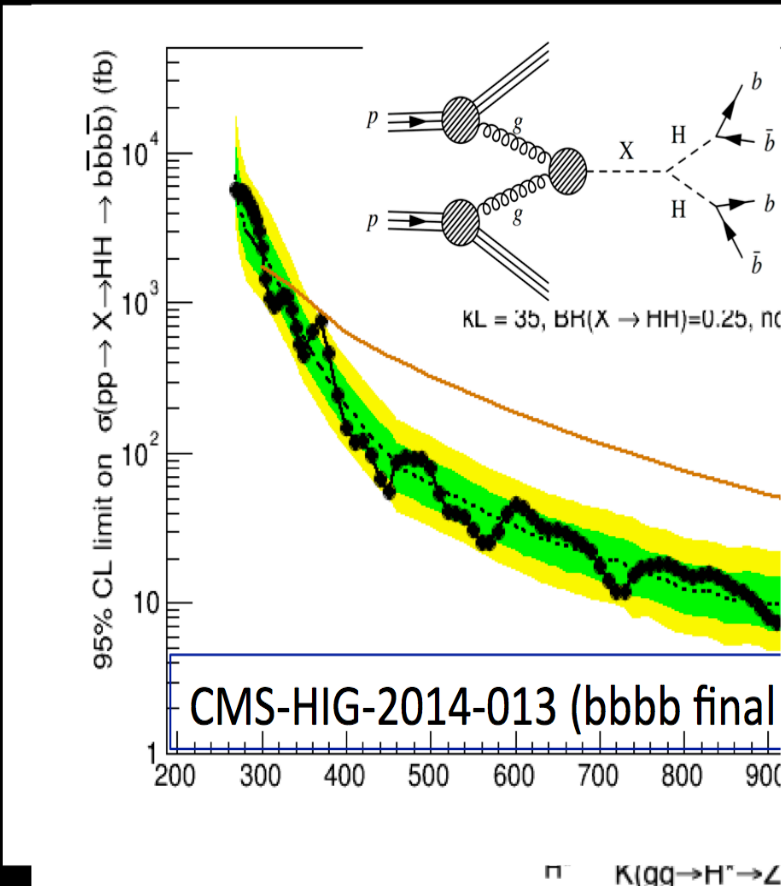


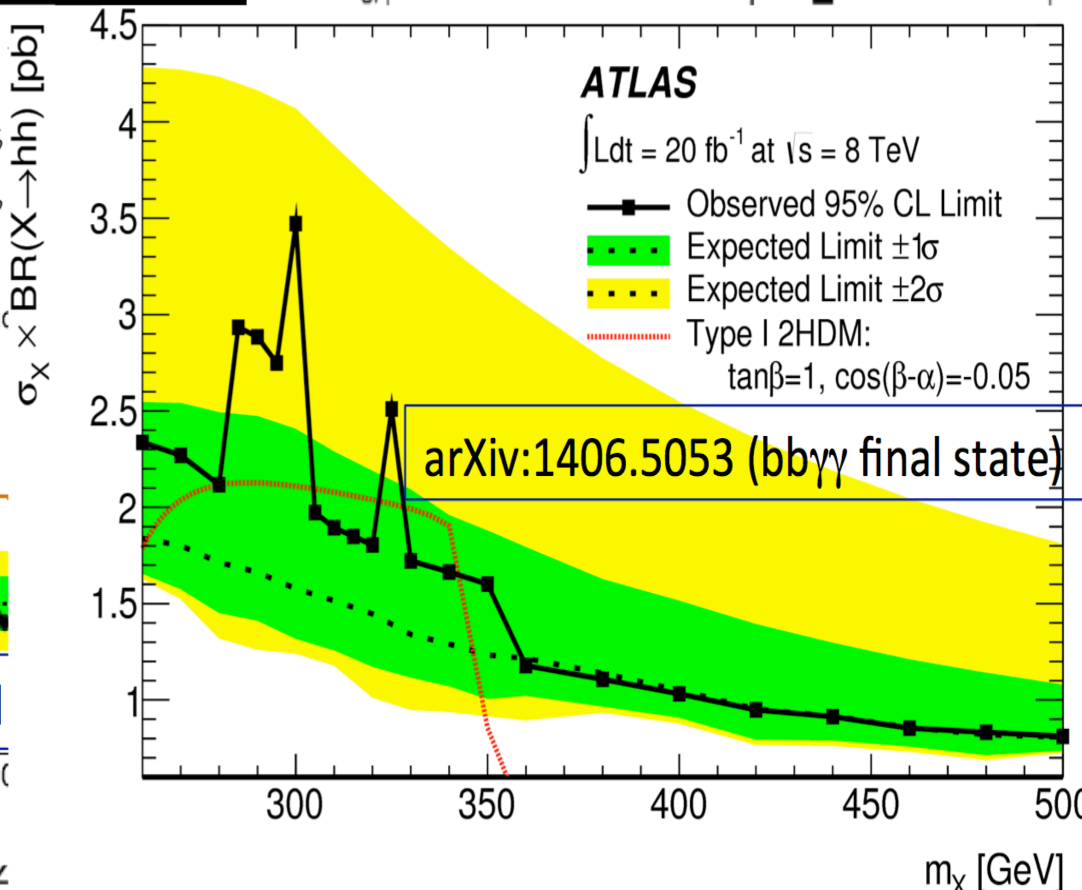


❖ New ideas for more luminosity:

- ttH in many final states ➡
- H width via interference (ZZ, WW)
- HH final states (X→ HH, 3H)







Perché insistere sull'Higgs?

- Nuove interazioni "fondamentali" vanno studiate (accoppiamenti ai fermioni, auto-accoppiamenti,...)
- Una deviazione confermata dall'Higgs del MS sarebbe ancora più importante della scoperta di luglio 2012!
- Una delle possibili porte di accesso (non garantita) a molte domande fondamentali ancora senza risposta:
  - -origine delle gerarchie tra diverse scale di massa
  - -origine di masse e mescolamenti dei fermioni
  - -natura della materia oscura
  - -modello microscopico per l'inflazione cosmica

Importanza del dialogo teoria/esperimento nella fase "matura" dello studio dell'Higgs

- Calcoli (e generatori MonteCarlo) raffinati per segnali e fondi nel contesto del Modello Standard

- Parametrizzazione delle deviazioni dal MS entro opportune Teorie Efficaci : inclusione dei test di precisione, individuazione di direzioni inesplorate.

Scuola italiana di fenomenologia (in Italia e all'estero) in prima linea su questo fronte

Esempi: effetti di Higgs off-shell, vertice top-antitop-H

Tools for Higgs Physics

Clickable Link

Cross Section

ggF
HIGLU (NNLO QCD+NLO EW)
iHixs (NNLO QCD+NLO EW)
FeHiPro (NNLO QCD+NLO EW)
HNNLO, HRes (NNLO+NNLL QCD)
SusHi (NNLO QCD)
RGHiggs (NNLO+NNNLL QCD)
ggHiggs (approx. NNNLO QCD)

VBF
VV2H (NLO QCD)
VBFNLO (NLO QCD)
HAWK (NLO QCD+EW)
VBF@NNLO (NNLO QCD)

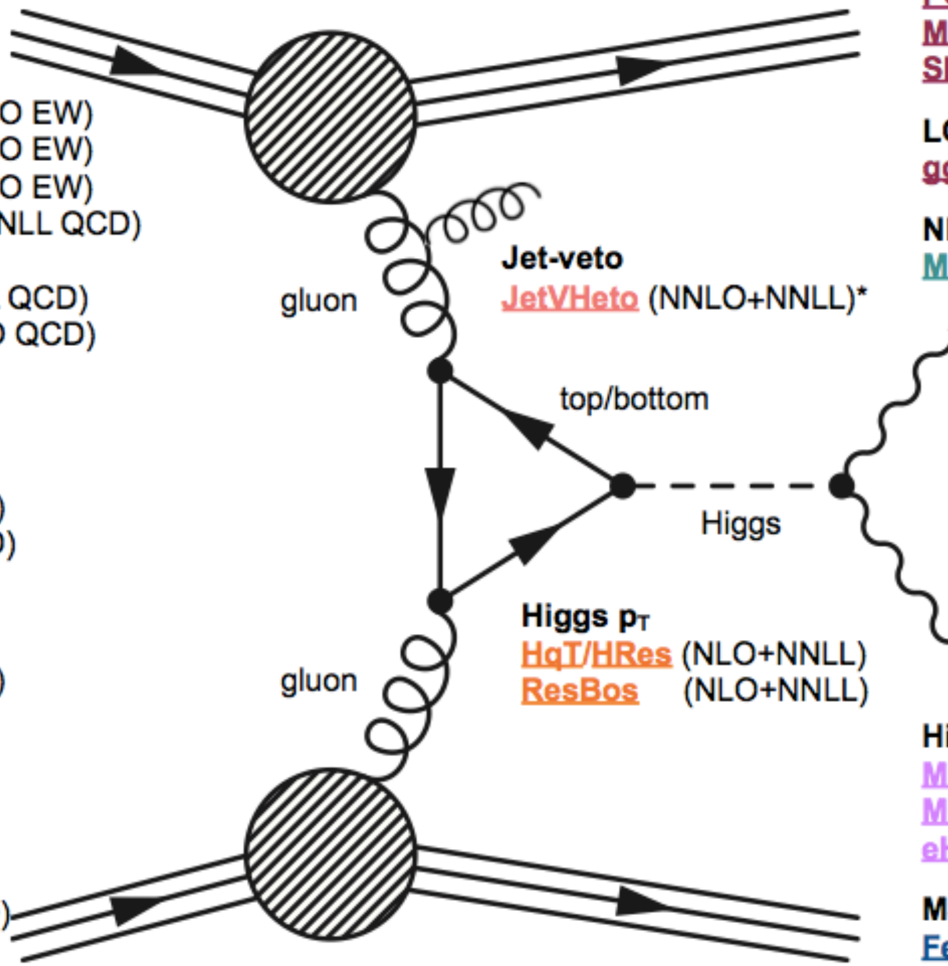
WH/ZH
V2HV (NLO QCD)
HAWK (NLO QCD+EW)
VH@NNLO (NNLO)

ttH
HQQ (LO QCD)

bbH
bbh@NNLO (NNLO QCD)

HH
HPAIR (NLO QCD)

+ private codes.



Jet-veto
JetVHeto (NNLO+NNLL)*

Higgs p_T
HqT/HRes (NLO+NNLL)
ResBos (NLO+NNLL)

PDF: MSTW, CTEQ, NNPDF, etc.
LHAPDF, HOPPET, APFEL

NLO MC
POWHEG MiNLO
MadGrapn5_aMC@NLO
SHERPA MEPS@NLO

LO MC
gg2VV

NLO ME
MCFM, MG5_aMC@NLO

Higgs Decay
HDECAY (NLO++)
Prophecy4f (NLO)

Higgs Properties
MELA/JHU, MEKD
MG5_aMC@NLO (HC)
eHDECAY

MSSM/2HDM
FeynHiggs, CPSuperH
SusHi+2HDMC
HIGLU+HDECAY

* NLO+NNLL in differential

Compiled by R. Tanaka, Jan. 2014

Q: Which operators are constrained by Higgs searches only ?

Contino ICHEP 2014

In total: 59 dim-6 operators

17+4 involve the Higgs

8+3 affect Higgs physics only

Elias-Miro, Espinosa, Masso, Pomarol
JHEP 1311 (2013) 066

Pomarol, Riva JHEP 01 (2014) 151

All other operators already constrained by:

EW observables at LEP1	stronger
Electric dipole moments (EDMs)	
$b \to s\gamma$	
Triple gauge couplings (TGC)	
$e^+e^- \to f\bar{f}$ at LEP2	
CKM unitarity by KLOE and β-decay	
$t\bar{t}$, top decays	
Muon, electron (g-2)	weaker

See:

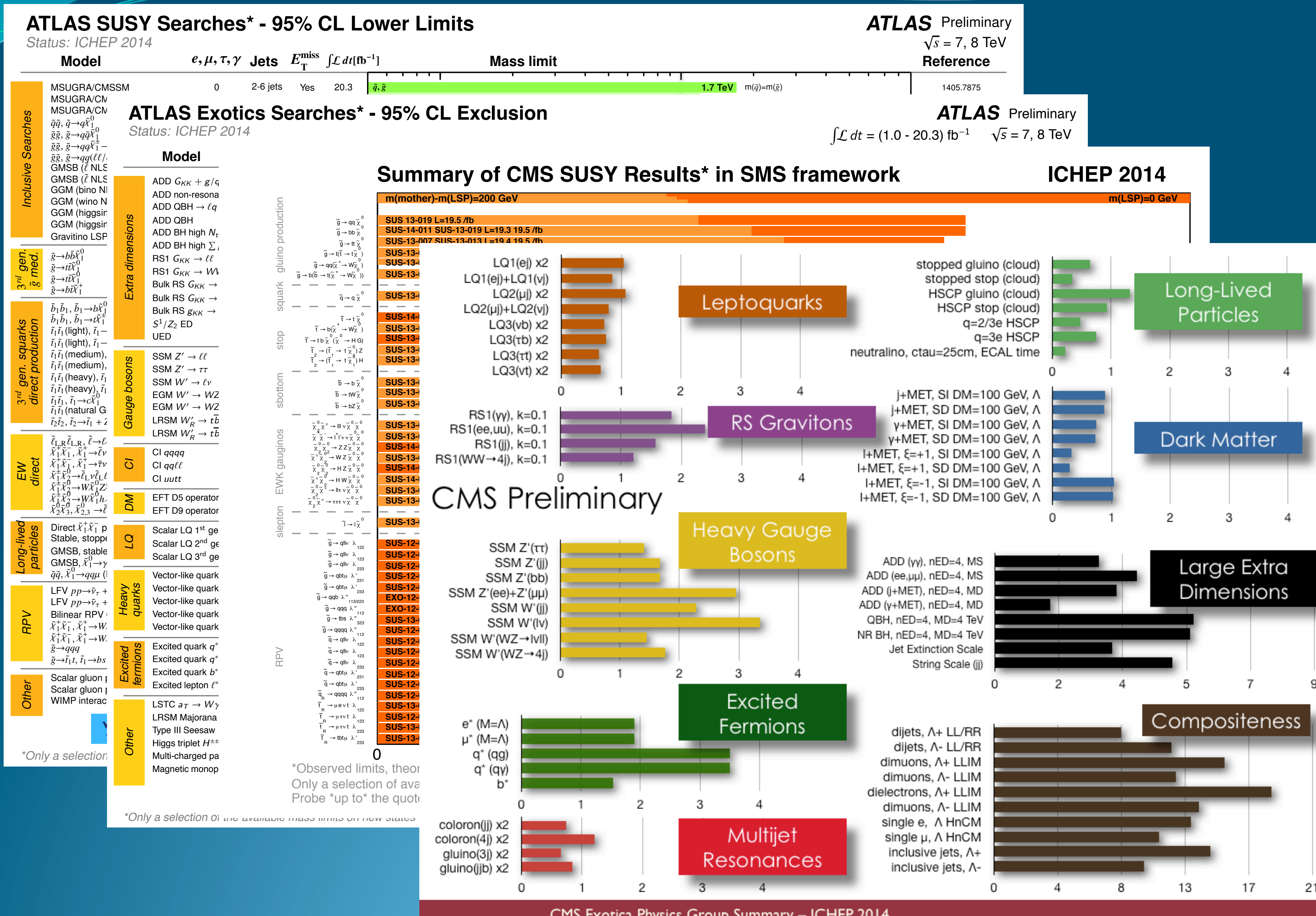
Pomarol, Riva JHEP 01 (2014) 151

RC, Ghezzi, Grojean, Muhlleitner, Spira JHEP 07 (2013) 035

and references therein

- 1 yet un-probed direction to New Physics (Higgs trilinear coupling)

Nessuna nuova particella trovata *finora*



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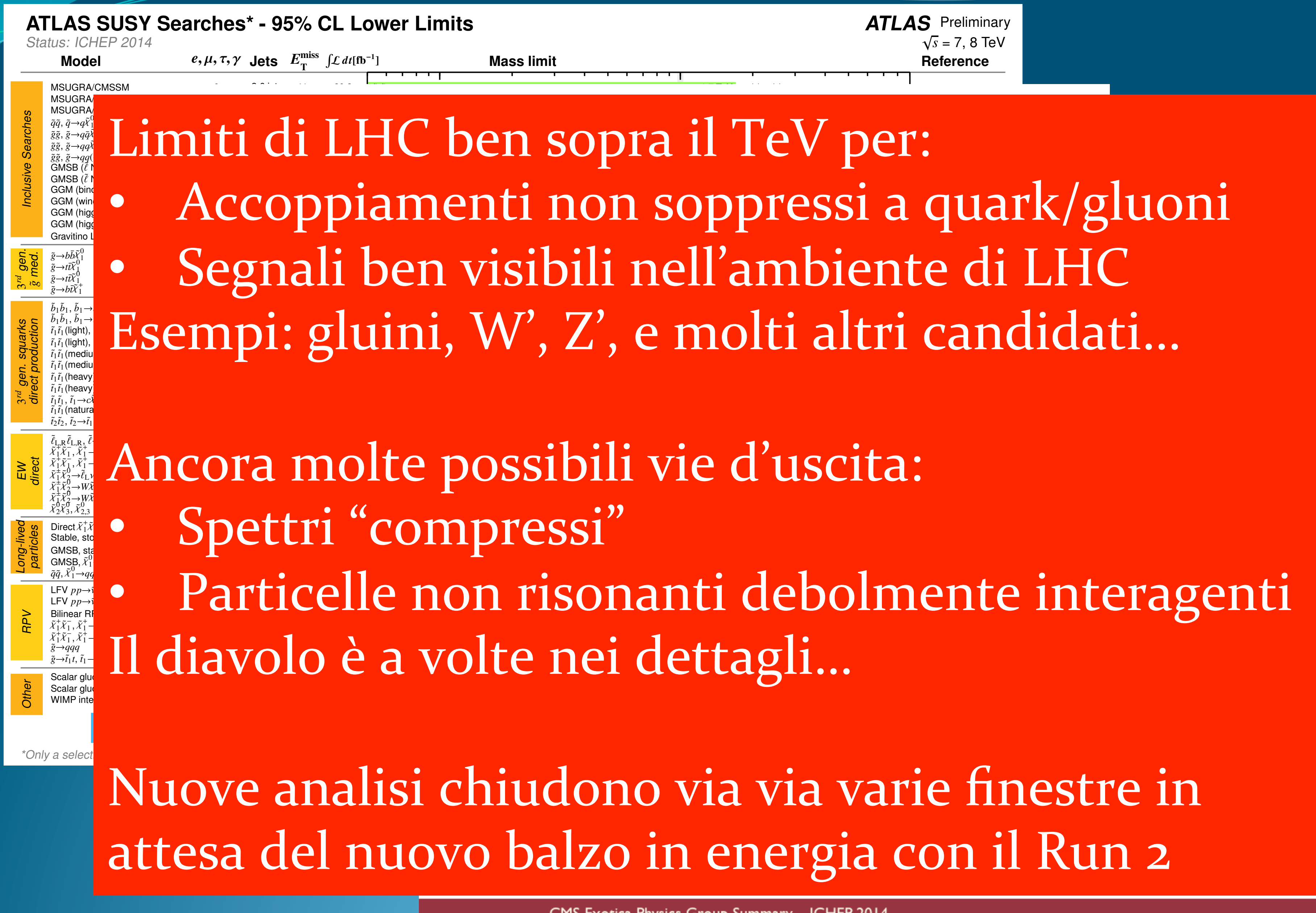


Limiti di LHC ben sopra il TeV per:

- Accoppiamenti non soppressi a quark/gluoni
- Segnali ben visibili nell'ambiente di LHC

Esempi: gluini, W', Z', e molti altri candidati…

Ancora molte possibili vie d'uscita:

- Spettri "compressi"
- Particelle non risonanti debolmente interagenti

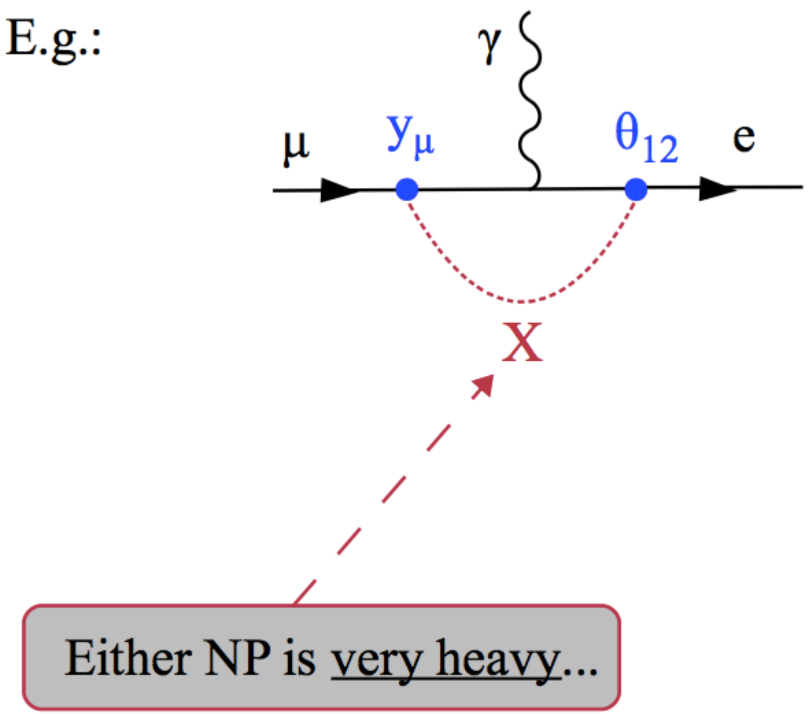
Il diavolo è a volte nei dettagli…

Nuove analisi chiudono via via varie finestre in attesa del nuovo balzo in energia con il Run 2

Fisica del sapore (a LHC ma non solo!)

Accesso indiretto a possibile nuova fisica

Fino a che scale? Attenzione a non sovrastimare…



$BR(\mu \rightarrow e\gamma)^{exp} < 5.7\times10^{-13}$

MEG '13

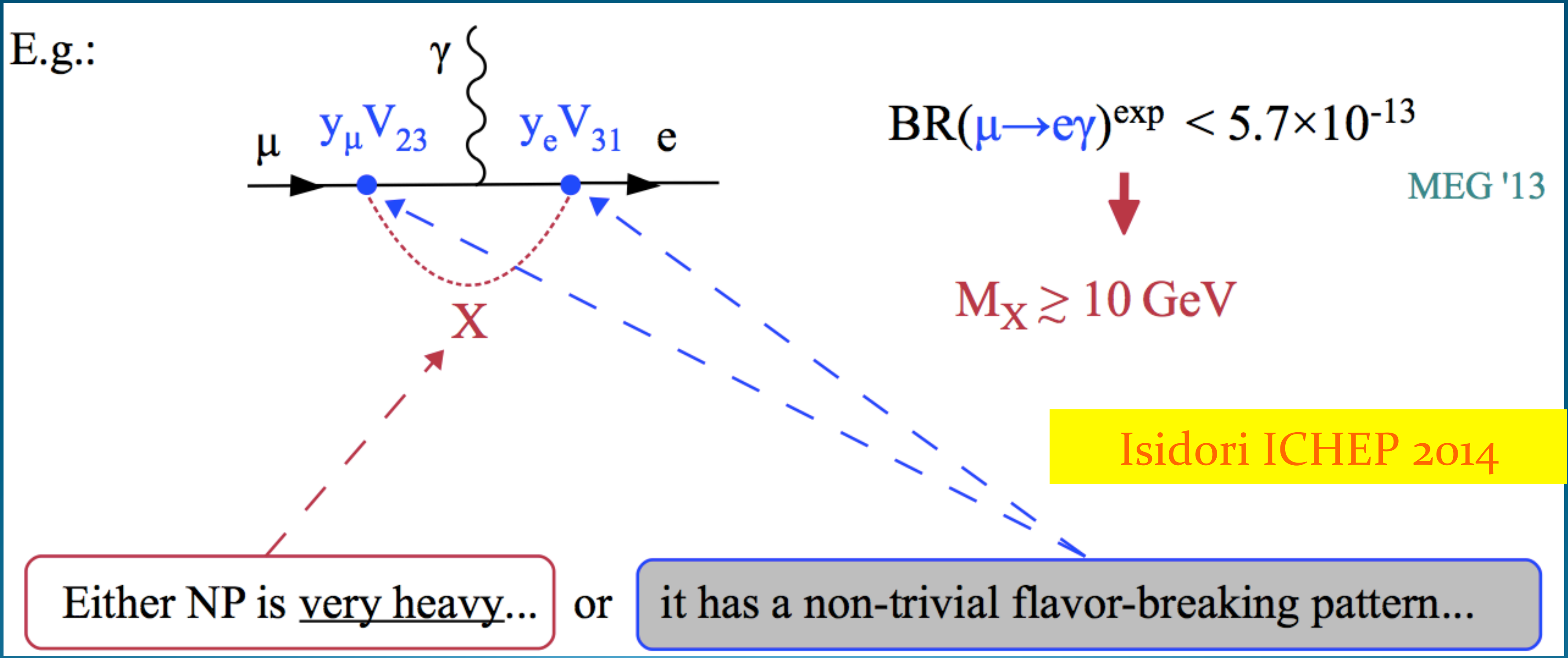
$M_X \gtrsim 200$ TeV

Isidori ICHEP 2014

Fisica del sapore (a LHC ma non solo)

Accesso indiretto a possibile nuova fisica

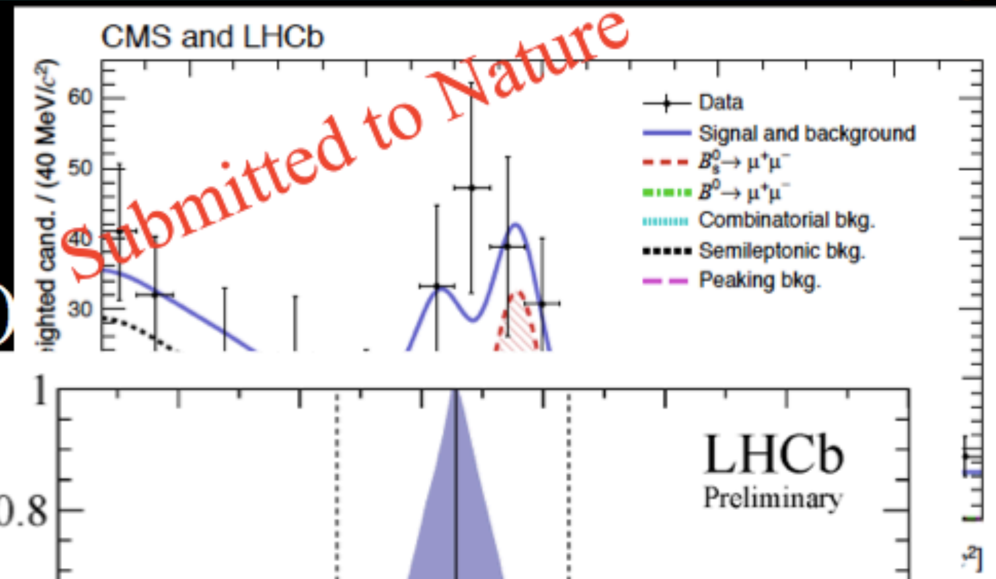
Fino a che scale? Attenzione a non sovrastimare...

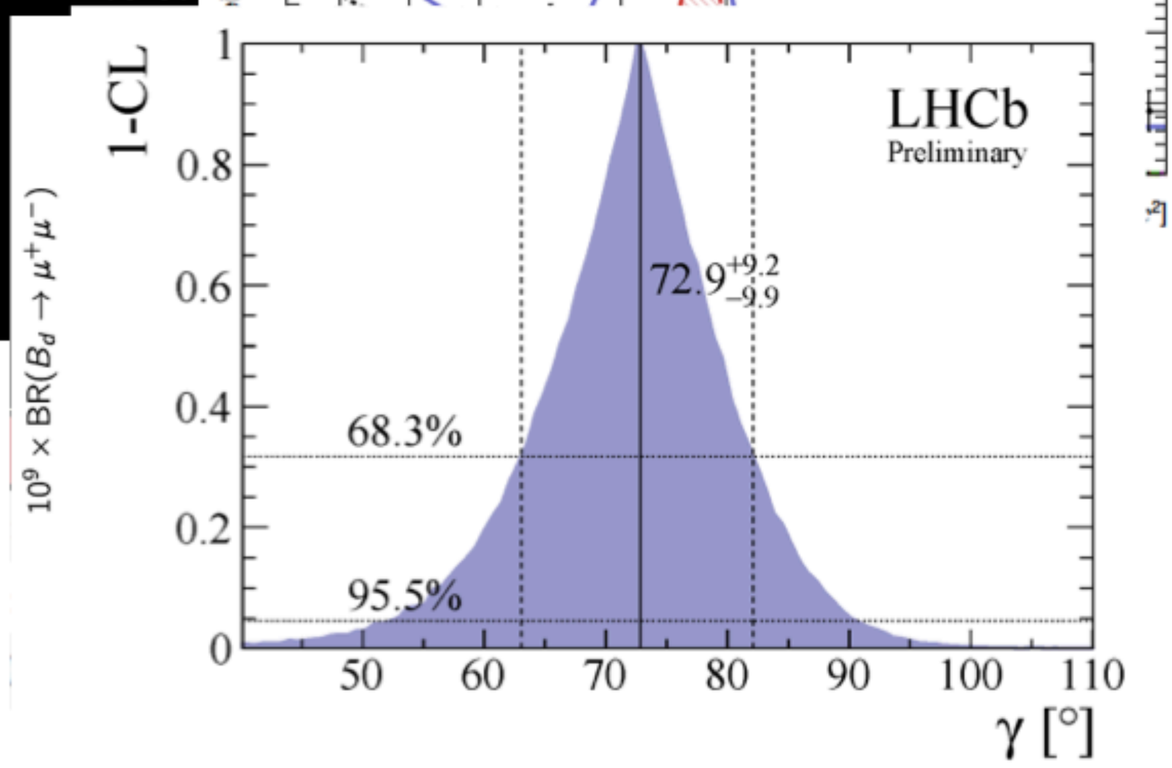


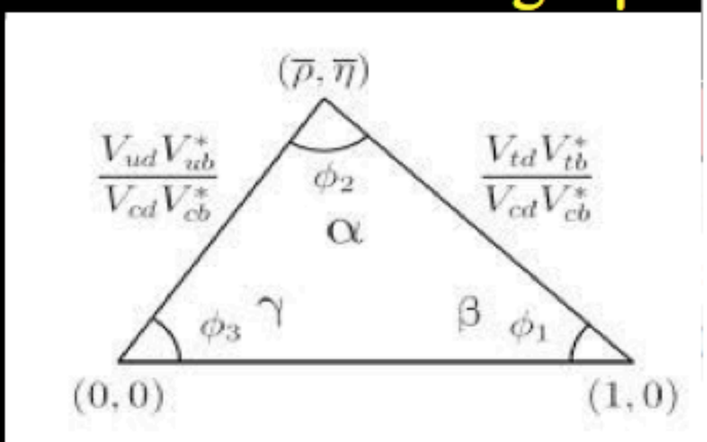
Isidori ICHEP 2014

Flavor physics

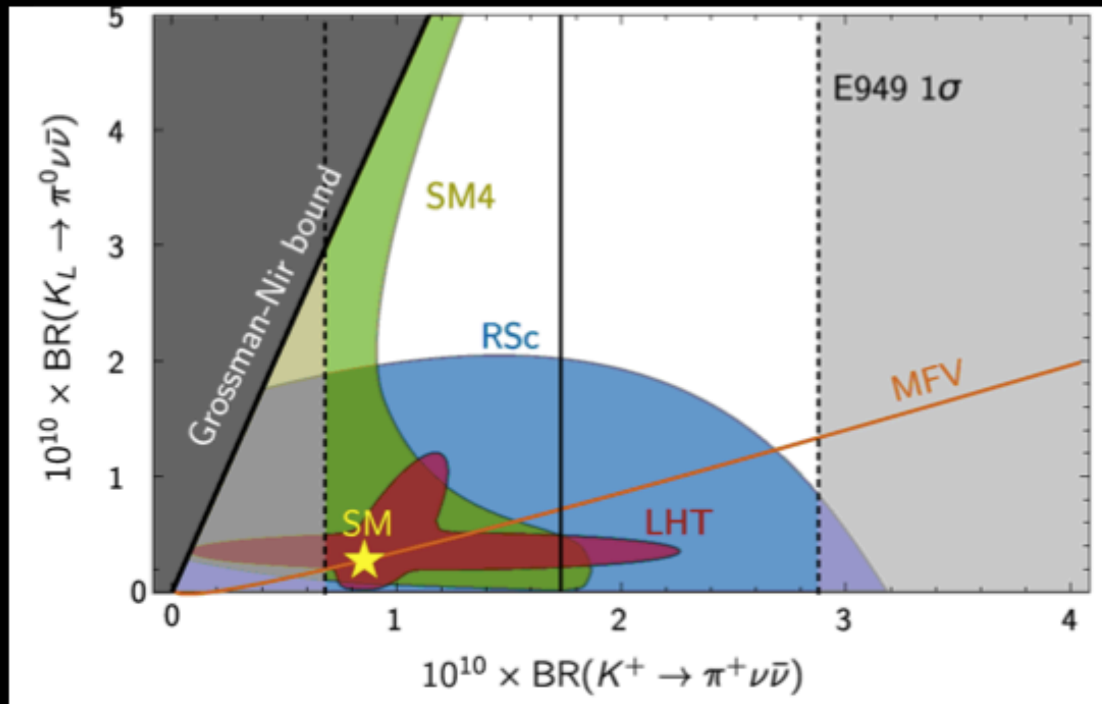
- Mostly from LHCb
  - Data set 3 fb^{-1}
- Bs mixing
  - ϕ_s tree ($\psi\phi$) and penguin ($\phi\phi$)
  - a_{sl}
- Rare decays
  - BR($B \rightarrow \mu\mu$)
- New results on angle γ



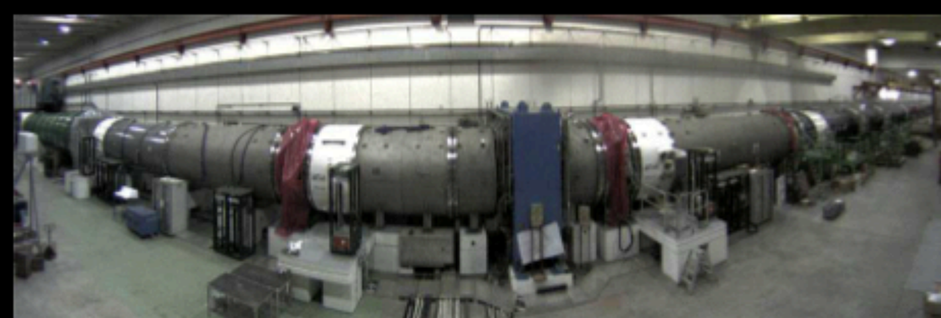




Kaon sector

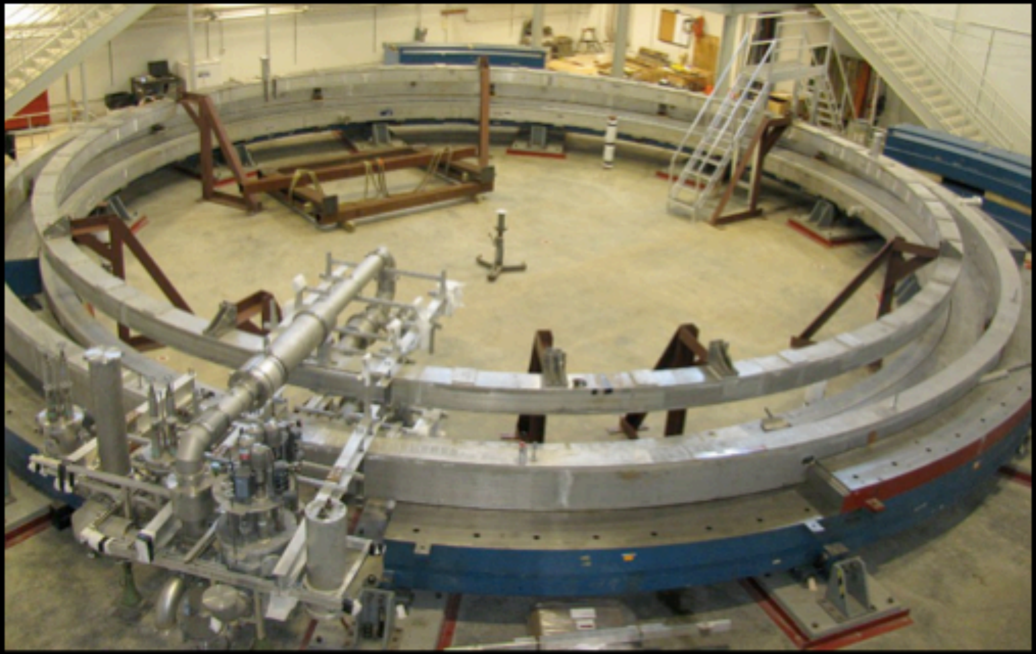


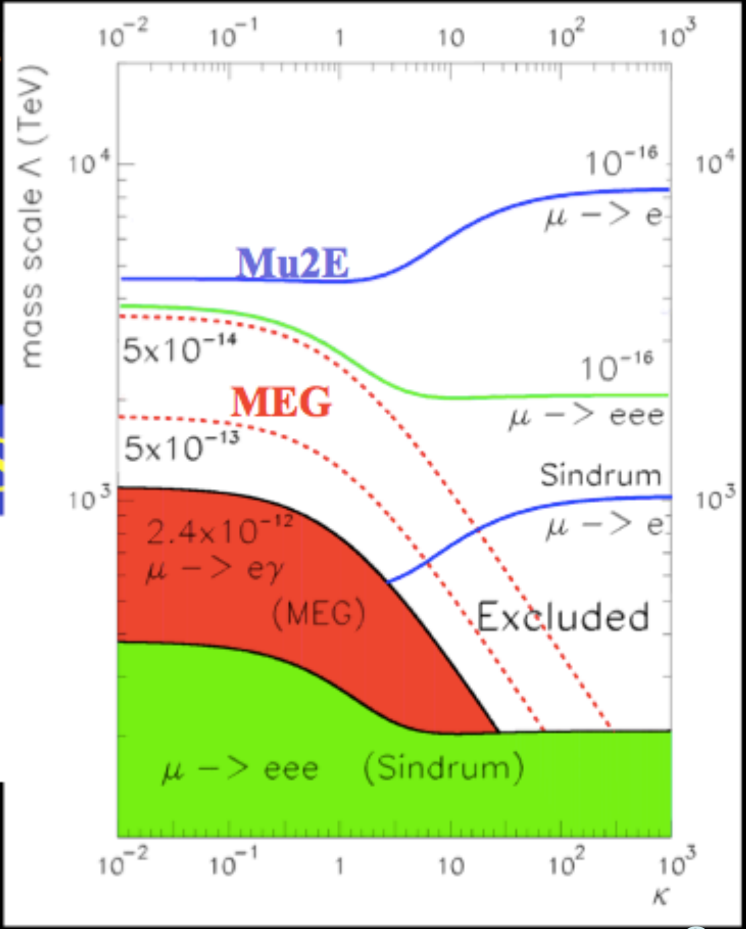
- NA62 expects O(100) events $K^+ \rightarrow \pi^+\nu\nu$ in the next few years



Charged lepton physics

- Searches for μ→e γ (MEG: real γ, Mu2E: virtual γ)
  - MEG improved limit (2010) → 5.7×10^{-13} obtained
  - MEG upgrade in progress → 6×10^{-14}
  - Mu2E (CD2 in progress now)
  - g-2 (CD2/3 ok if magnet works)





Ultra-relativistic Heavy Ions at LHC (ALICE, but also other experiments)

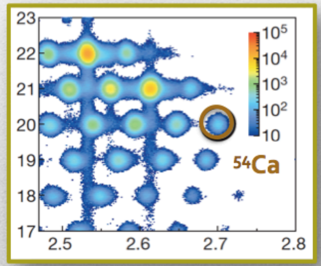
Field of hot and dense QCD matter is entering a new era of precision measurements:

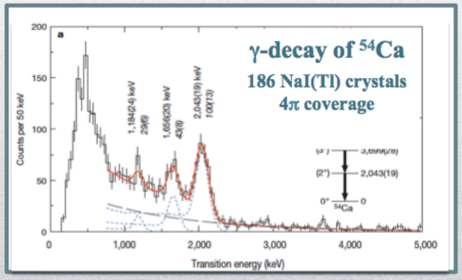
- High statistics at LHC in Pb-Pb, p-Pb, pp and the Beam Energy Scan at RHIC along with pending upgrades exploring characteristics of the phase diagram
- pinning down initial conditions
- their evolution via relativistic viscous hydrodynamics (η/s)
- quantitative determination of the energy loss of various flavors
- determination of nuclear PDFs

Wessels ICHEP 2014

Fisica nucleare di bassa energia

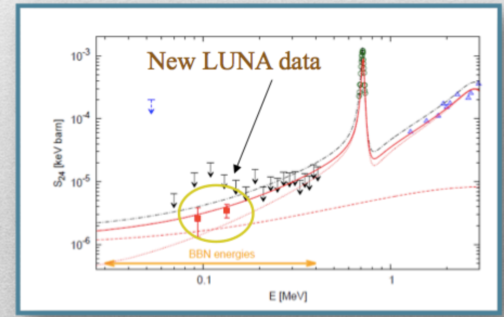
- GAMMA Spectroscopy Study of ^{54}Ca shows evidence for a New Magic Number: N=34
- Produced from fragmentation of ^{70}Zn @345 MeV





GAMMA@RIKEN

- The new LUNA data on the $^{2}H(\alpha,\gamma)^{6}Li$ reaction at Big Bang energies confirm validity of standard BBN theory for ^{6}Li abundance prediction
- To explain the excess of ^{6}Li found in metal poor stars non-standard physics solutions are requested!



LUNA3

Taiuti@CVI

Cosa abbiamo imparato *finora*?

Per LHC *finora* significa:

4/7 dell'energia di progetto
< 1/10 della luminosità integrata di progetto
< 1/100 della luminosità integrata possibile

ma questo si aggiunge a precedenti lezioni

LEPI, LEPII, Tevatron, B-factories, ed altri esperimenti di precisione nella fisica del sapore

La naturalezza *finora* ha fallito

Nessuna simmetria quantistica nel MS per $m_H \rightarrow 0$
Rapporto tra m_H e scale $M >> m_H$ non protetto

MS innaturale se non c'è Nuova Fisica al TeV

't Hooft Cargese 1979

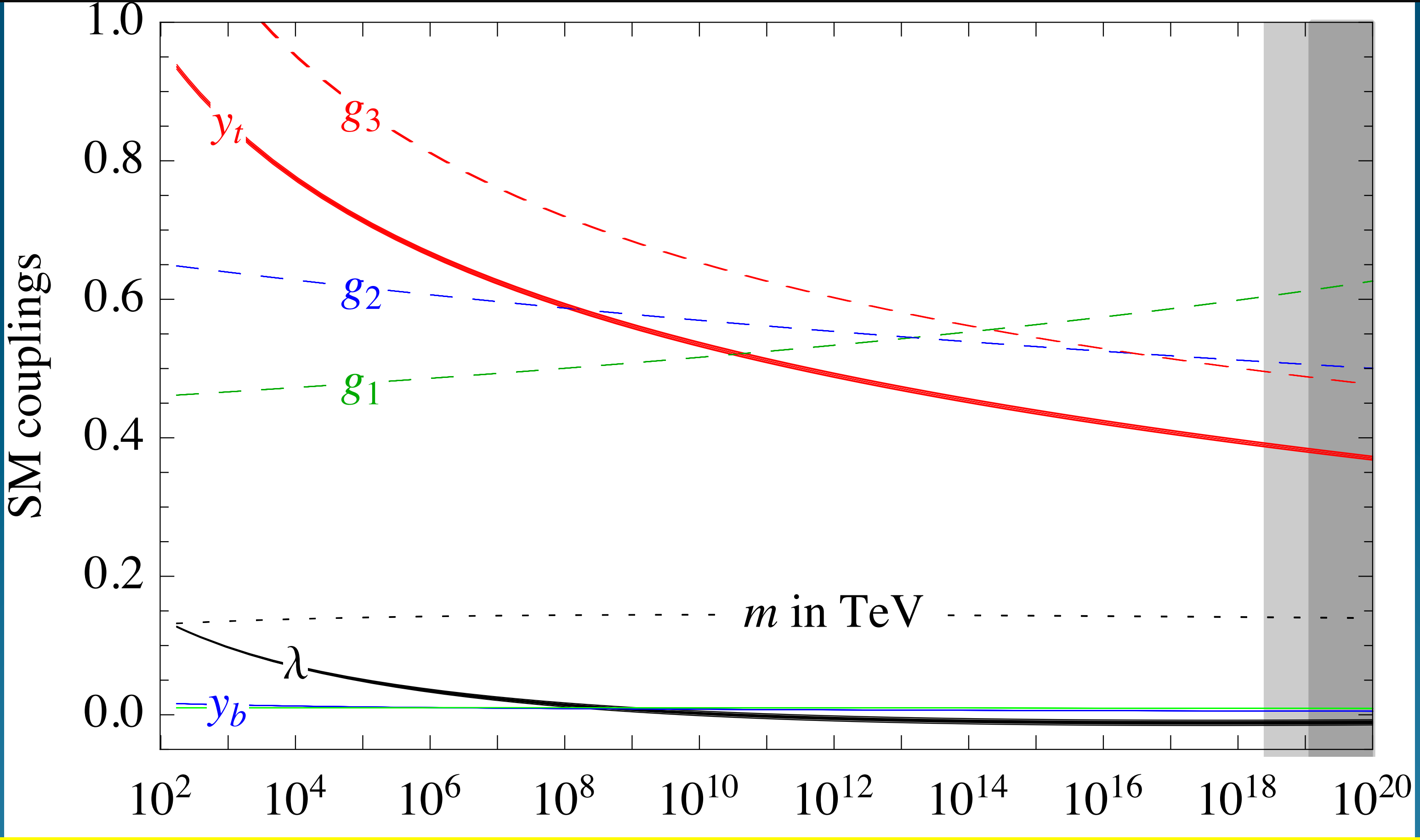
Superficialmente (troppo?):

$$\delta m_H^2 \sim -\frac{3\, h_t^2}{8\, \pi^2}\, \Lambda^2 < O(m_H^2) \quad \rightarrow$$

$\Lambda < O(500)$ GeV

Ci aspettavamo nuove particelle e non si sono ancora manifestate, né direttamente né indirettamente!
Scala Λ significativamente al di sopra del TeV ?

Tecnicamente, nulla ci obbliga a modificare il MS prima di 10^{10} GeV o giù di lì (forse niente tra M_{top} e M_P secondo un modello "minimale" per ν masses, DM, BAU e inflazione) [νMSM di Shaposhnikov et al.]



Buttazzo-Degrassi-Giardino-Giudice-Sala-Salvio-Strumia arXiv:1307.3536

[Linde, Weinberg, Cabibbo-Maiani-Parisi-Petronzio, Froggatt-Nielsen, Sher ...]

Naturalezza questione centrale per la fisica delle particelle nei prossimi anni

I teorici si sono sbagliati finora ➔ la risposta sarà sperimentale

Delle due l'una:

- Errore di dettaglio ➔ nuove particelle a LHC14 (o FCC?) che ci faranno capire quale dettaglio ci era sfuggito finora

- Errore grossolano ➔ lo deve confermare in modo molto forte l'esperimento per poter ricominciare su basi nuove

In entrambi i casi c'è una lezione importante da apprendere.

Quale fisica oltre il Modello Standard
è allora sperimentalmente accessibile?

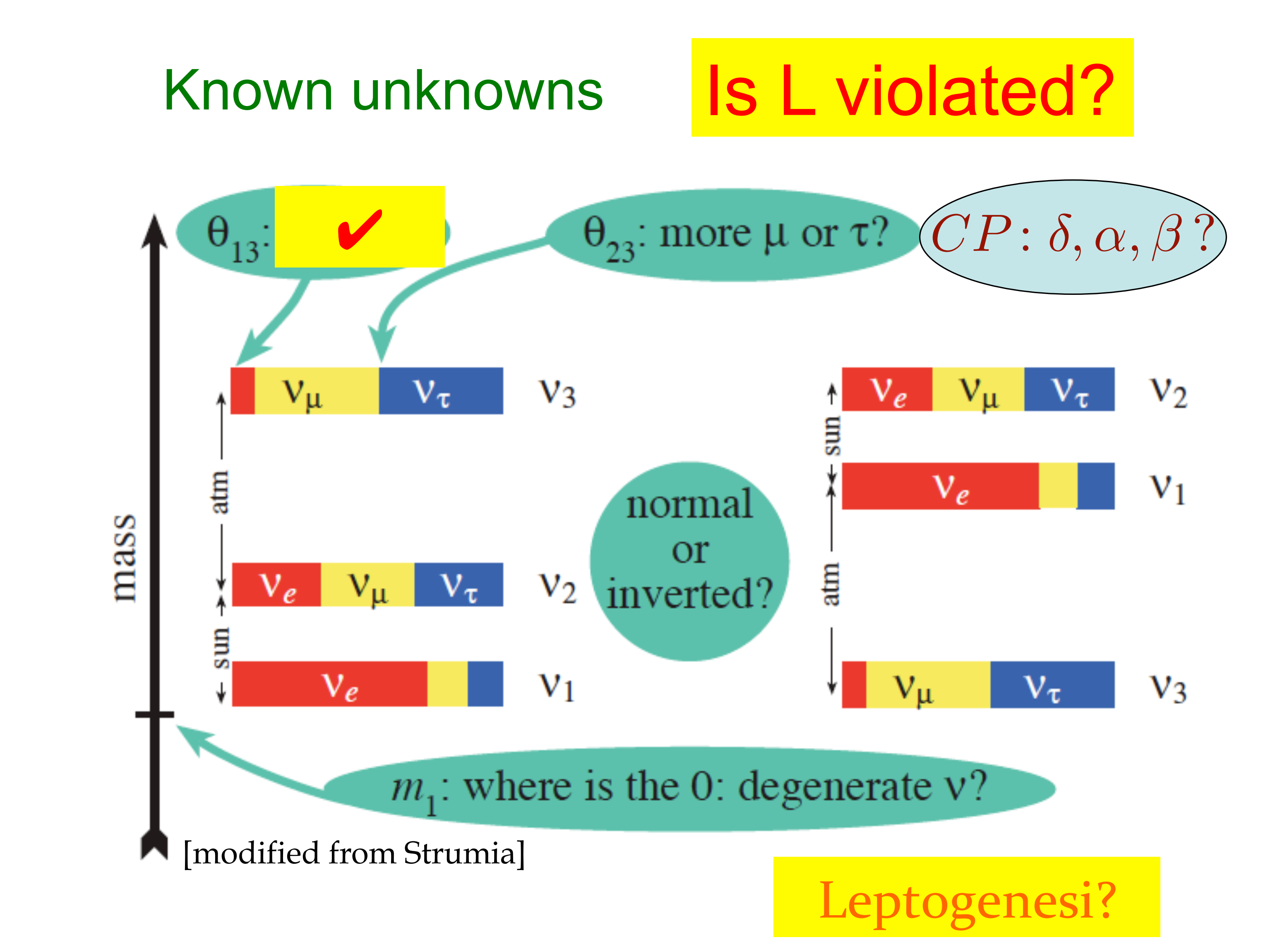
LHC-8 ha usato il famoso no-lose theorem

"Higgs del MS o Nuova Fisica al TeV"

Non saremo più in una tale botte di ferro in futuro
ma ci possiamo far guidare dalle evidenze attuali

Neutrini?
Materia Oscura
La Connessione Cosmica

Oltre il MS con i neutrini?



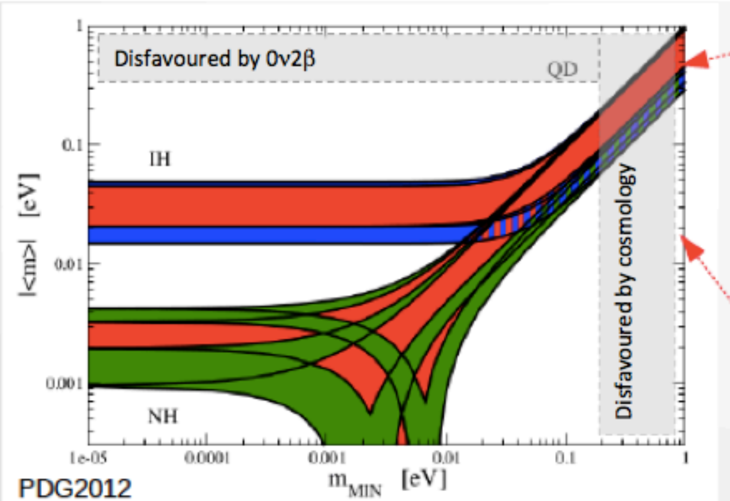
$(\beta\beta)_{0\nu}$ e masse dei neutrini

The absolute mass scale of neutrinos

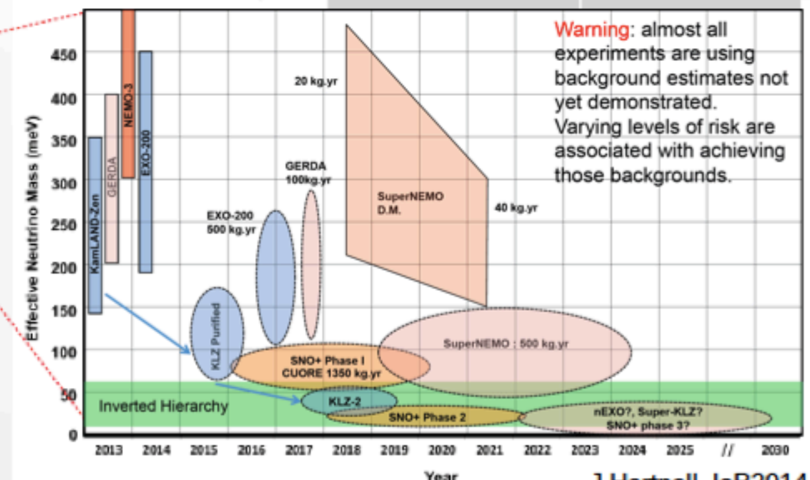
Dirac or Majorana

Are neutrinos their own antiparticles

Results at ICHEP2014	Future
CUORE-0	CUORE
EXO-200	LUCIFER
GERDA	LUMINEU
KamLAND-Zen	NEXT
Majorana Demonstrator	SNO+
NEMO-3	SuperNEMO



PDG2012



J.Hartnell, IoP2014

Neutrino Properties from Cosmology

$$N_{\rm eff} = 3.32 \pm 0.27 \ (68\% CL)$$

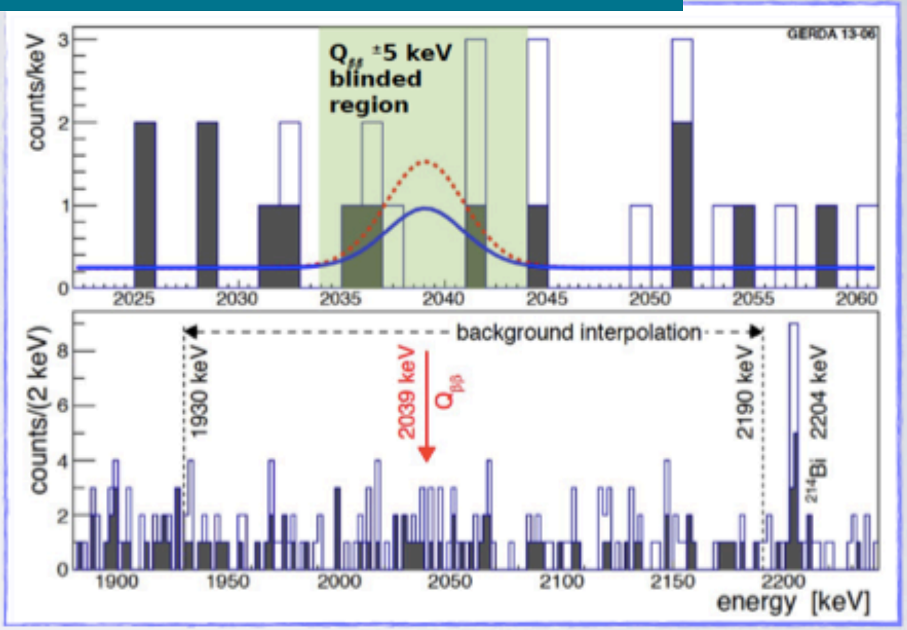
$$\sum m_\nu < 0.28 \text{ eV} \ (95\% CL)$$

T. Rodrigo - SPC September 2014 18

$(\beta\beta)_{0\nu}$ decay of ^{76}Ge: GERDA

Line 2

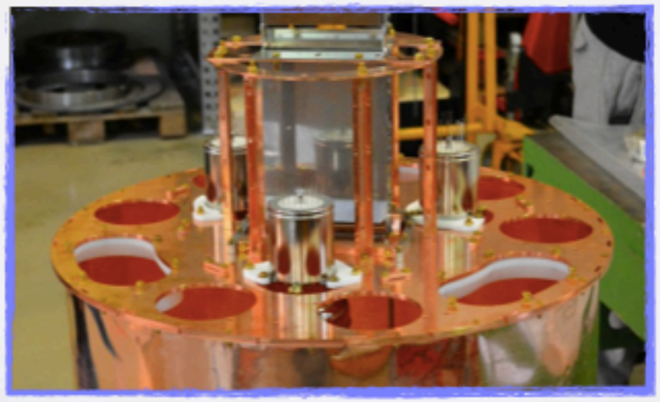
- Successful completion of Phase I
  - end data taking 21-05-2013
  - Combined with HdM + IGEX
    - p_value = $2. 10^{-4}$
    - Klapdor's claim strongly disfavoured



$T_{1/2}^{0\nu} > 2.1\ 10^{25}$ y frequentist

$T_{1/2}^{0\nu} > 1.9\ 10^{25}$ y bayesian

- Phase 2 under construction
  - More mass (detectors done!)
  - Less background (10 times)
  - Improvements in LAr veto

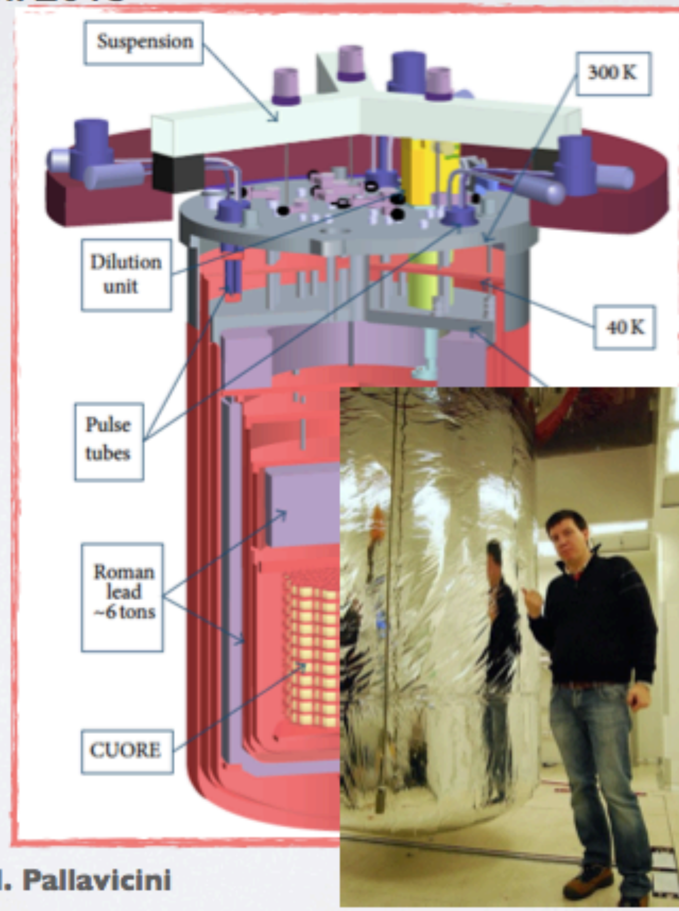


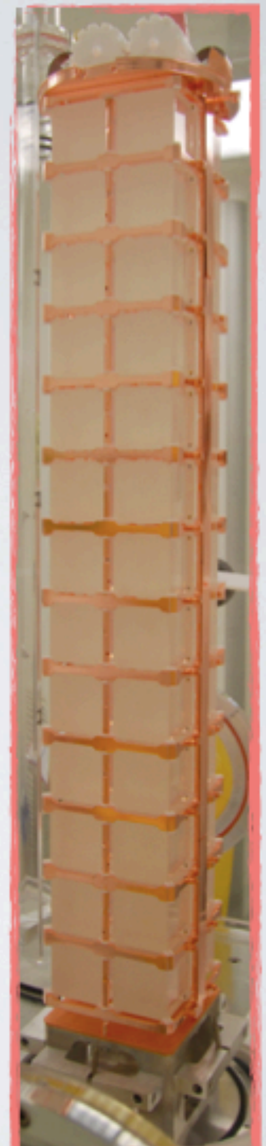
M. Pallavicini

HIGHLIGHTS: 0νββ - CUORE

Line 2

- Cuore
  - Cuore-0 started data taking in 2013 !
    - Background very significantly reduced compared to Cuoricino
    - Physics results expected by Jan. 2015
  - Cuore cryostat
    - Successfully commissioned!
      - 4.9 mK lower peak
      - 8 mK stable
    - The largest mass ever cooled down below 10 mK
      - "The coldest cubic m^3 of the Universe"





Open questions for Oscillation experiments

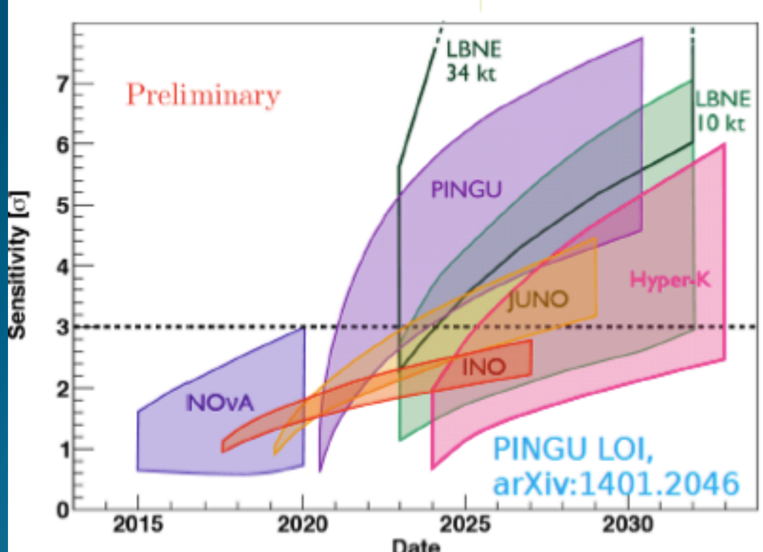
- The neutrino mass hierarchy
- The octant of the 2-3 mixing angle
- CP violation in the lepton sector
- Are there sterile neutrinos

Major efforts towards answering the remaining questions and to increase precision

Some of the emerging pillars of the neutrino program:

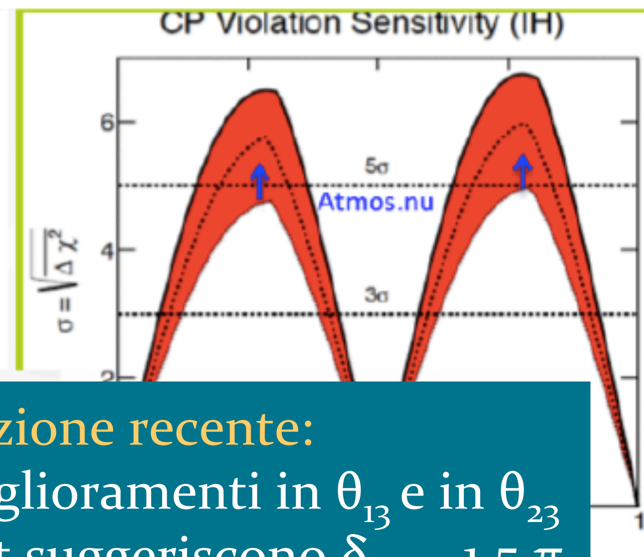
- ✓ A platform at CERN for detector R&D
- ✓ The proposed upgrade of the J-PARC beam and the proposal to construct Hyper-Kamiokande
- ✓ The P5 recommendations to host an international facility for short and long-baseline neutrino oscillations at FNAL

Sensitivity to mass hierarchy



LBNE

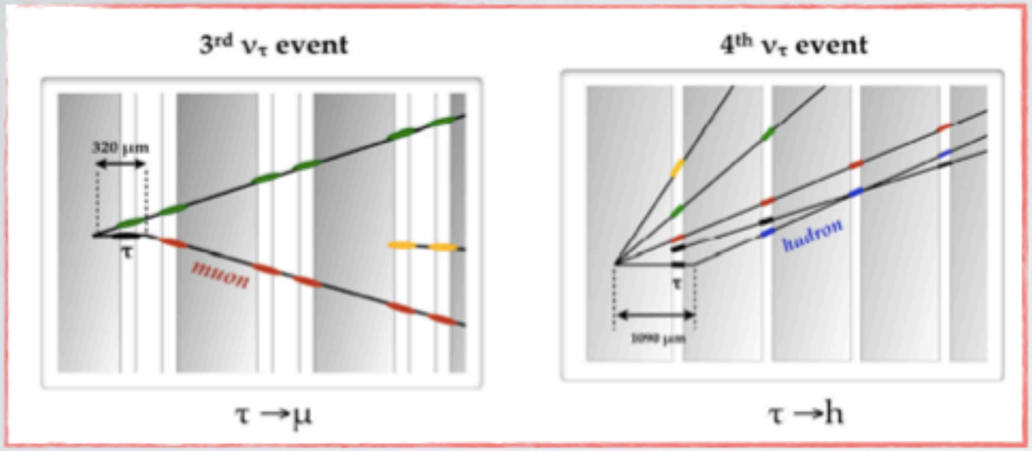
Exposure 2…
34kt × 1.2M…



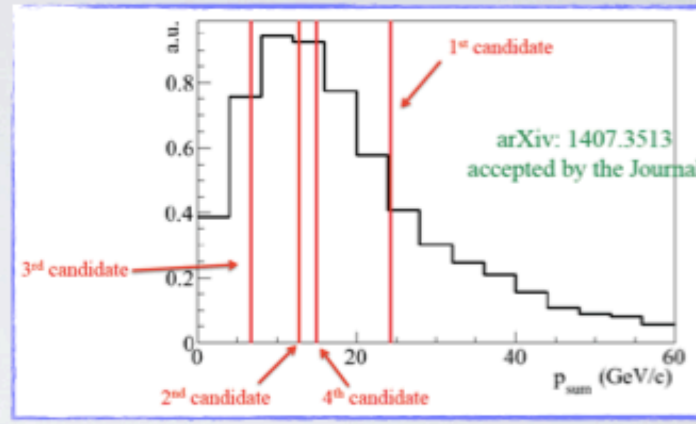
Evoluzione recente:

- Miglioramenti in θ_{13} e in θ_{23}
- I fit suggeriscono $\delta_{CP} \sim 1.5\,\pi$
- Nulla su gerarchia di massa

Raffinamenti recenti nella fisica delle oscillazioni



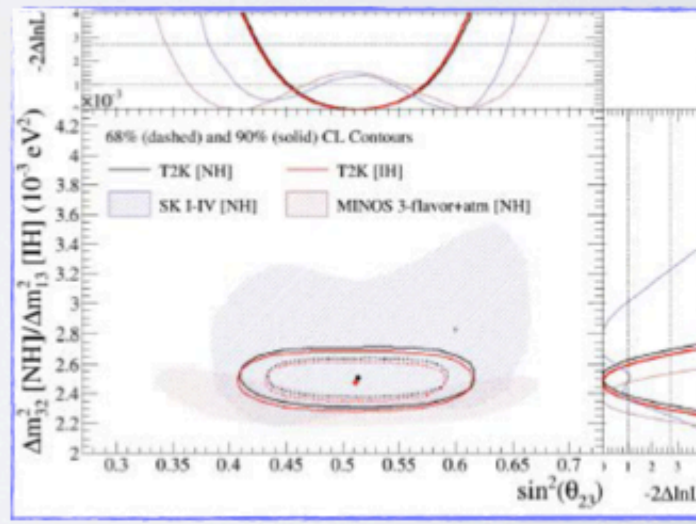
Opera: visible energy 4 candidates



- **Opera** has now 4 events
  - Close to 5σ discovery claim (**now 4.2 σ**)

Decay channel	Expected signal	Observed	Expected background			
			Total	Charm decays	Hadronic re-interactions	Large-angle muon scattering
$\tau \to 1h$	0.41 ± 0.08	2	0.033 ± 0.006	0.015 ± 0.003	0.018 ± 0.005	/
$\tau \to 3h$	0.57 ± 0.11	1	0.155 ± 0.030	0.152 ± 0.030	0.002 ± 0.001	/
$\tau \to \mu$	0.52 ± 0.10	1	0.018 ± 0.007	0.003 ± 0.001	/	0.014 ± 0.007
$\tau \to e$	0.62 ± 0.12	0	0.027 ± 0.005	0.027 ± 0.005	/	/
Total	2.11 ± 0.42	4	0.233 ± 0.041	0.198 ± 0.040	0.021 ± 0.006	0.014 ± 0.007

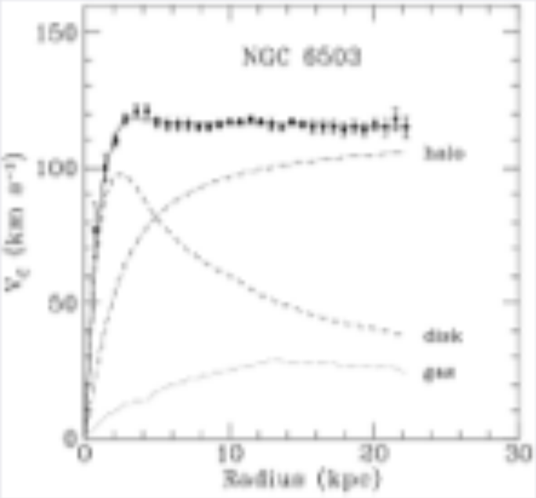
T2K: 3% measurement of ϑ_{23}



PRL 112, 18180 (2014)

- **T2K** is continuing data taking
  - Most precise measurement of ϑ_{23}

Oltre il MS con la Materia Oscura

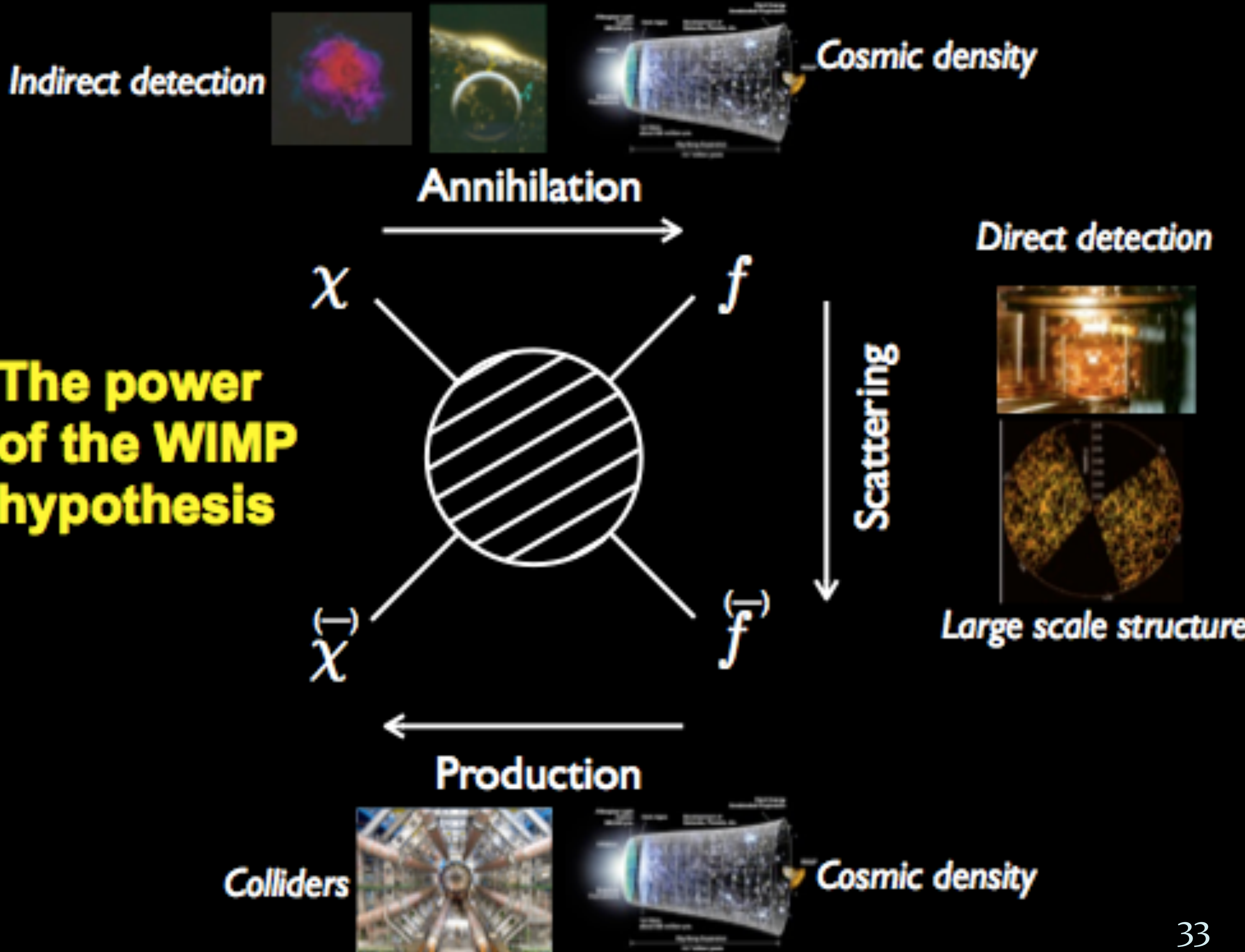


Chiara evidenza per la Materia Oscura
Spiegazione migliore: nuova particella

Ma quale particella?
WIMP? Assione? Neutrino sterile? Altro?

Cambiamento di prospettiva dopo il Run 1 di LHC: svincolarsi dai modelli, esplorare senza pregiudizi

The power of the WIMP hypothesis

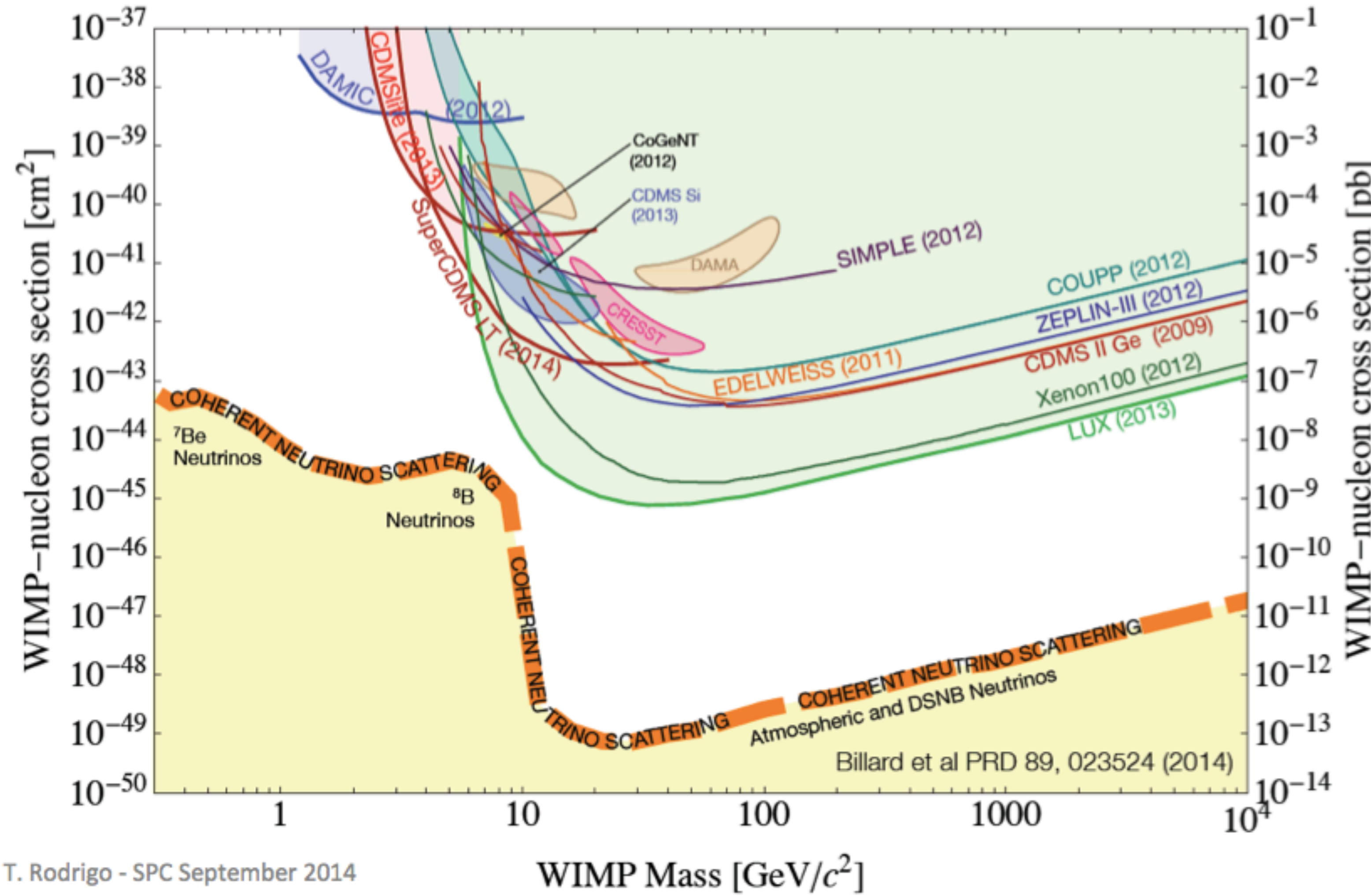


Ricerche dirette di Materia Oscura (WIMP)

- **Dama-Libra: NaI crystals**
  - model independent, annual modulation
  - running in steady state. well known claim
- **Xenon: search for nuclear recoils in 2-phase xenon TPC**
  - 100 kg: running. No signal of nuclear recoil.
  - 1 ton: under construction
- **DarkSide: search for nuclear recoils in 2-phase low argon-39 TPC**
  - Technical run with natural argon successfully completed in 2014
  - Physics run expected for 2015 with depleted argon
- **CRESST**
  - Long existing small INFN participation officially approved this year

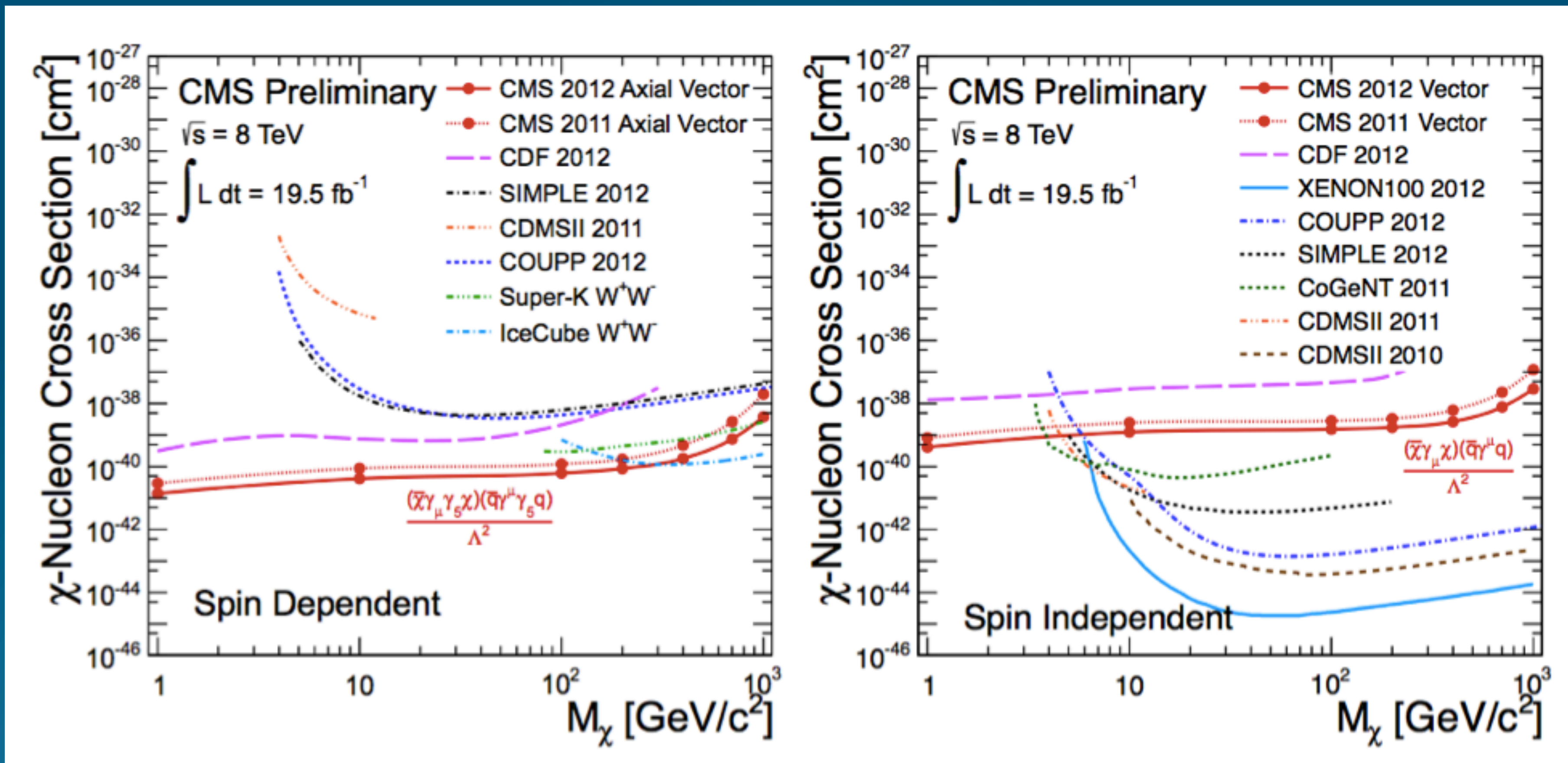
DM Direct detection searches - Present status

(Spin independent cross section)



Ricerche di Materia Oscura a LHC

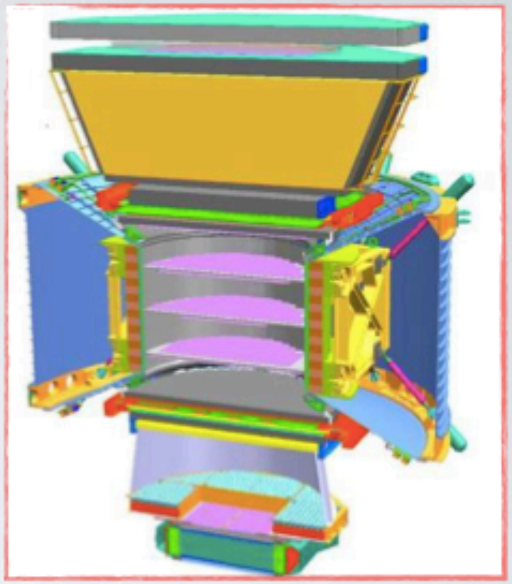
Ricerche di Mono-X ($X+E_{T,miss}$ con X=jet, γ, Z, …)
Tema di fisica già dominante in vista del Run 2



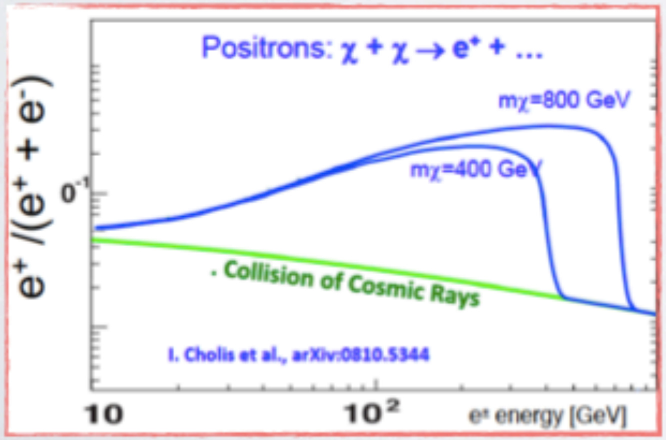
Risultati simili, come è ovvio, anche da ATLAS

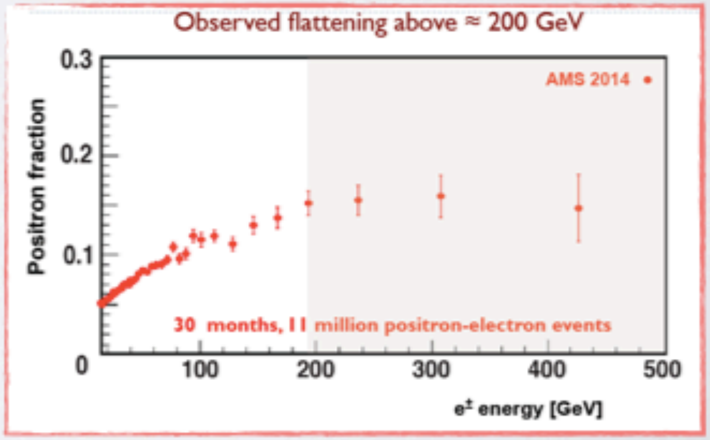
Complementarietà delle ricerche indirette

- An "accelerator-like" particle detector in space
  - Tracker, TOF, TRD, Calorimeter, Magnet and RICH
  - Smooth data taking in progress
    - Events: 55 billions collected, 41 billions analysed
    - Man-power demanding operations: tracker alignment is done every minute because of constant temperature changes



- Most recent result: precise measurement of positron fraction
  - Main motivation: search for dark matter

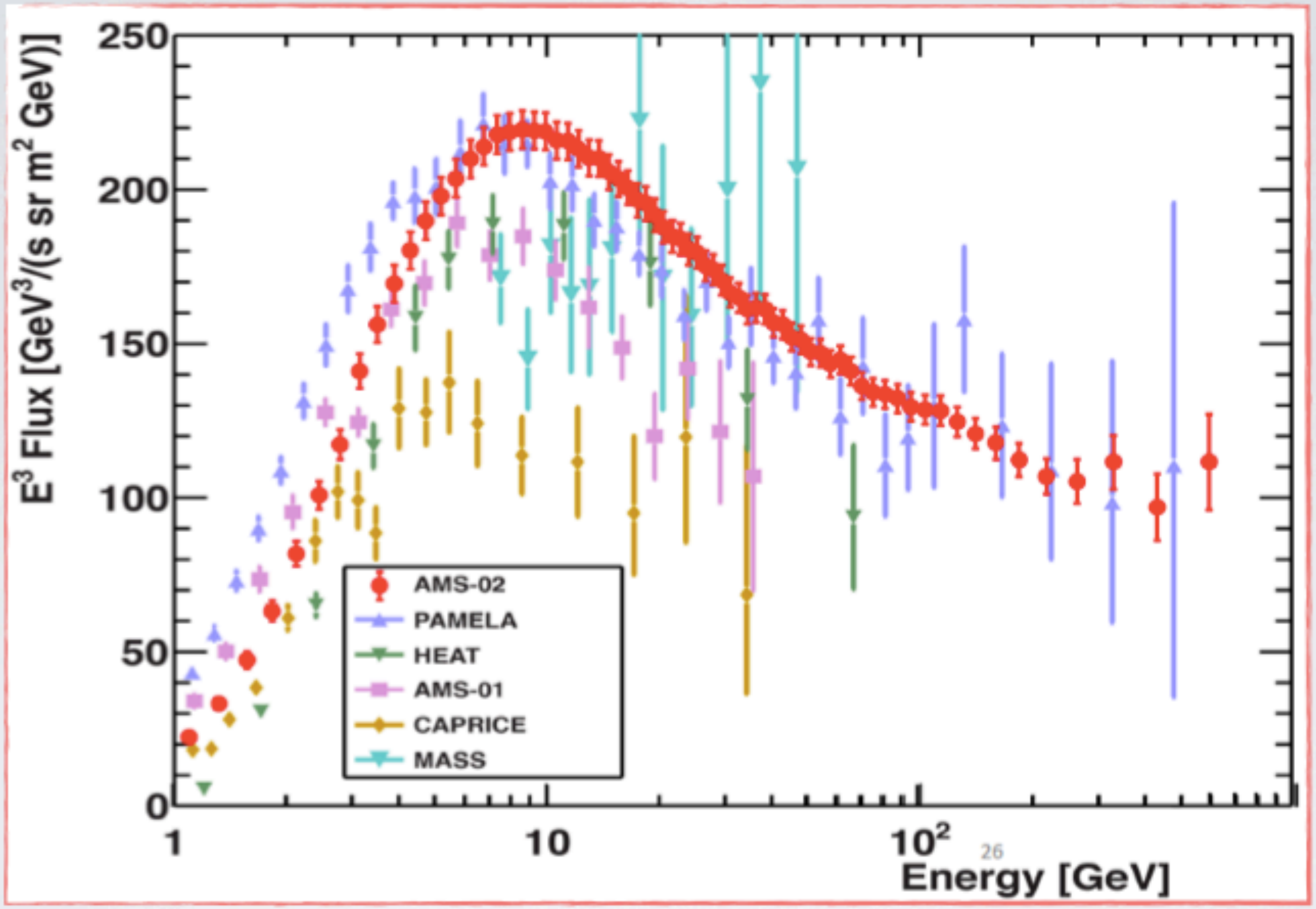




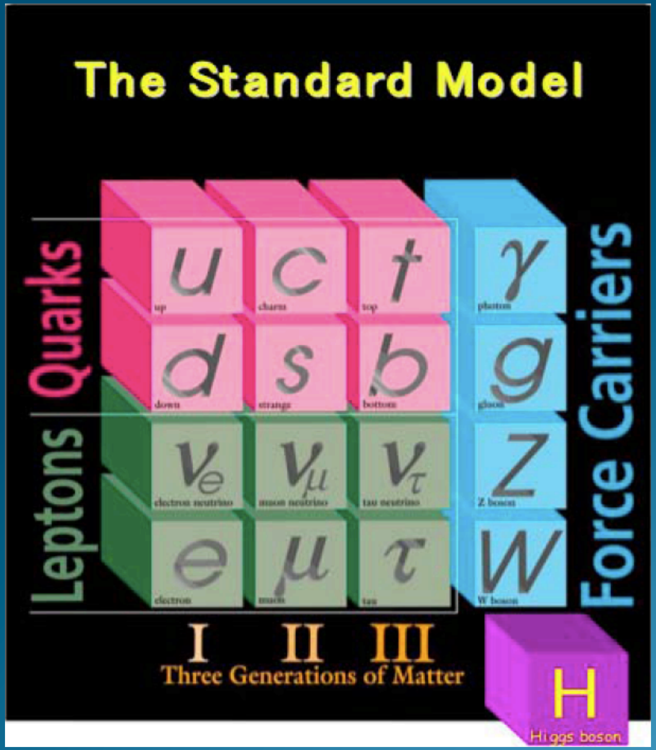
IMPACT OF AMS02 ON e⁻ FLUX KNOWLEDGE

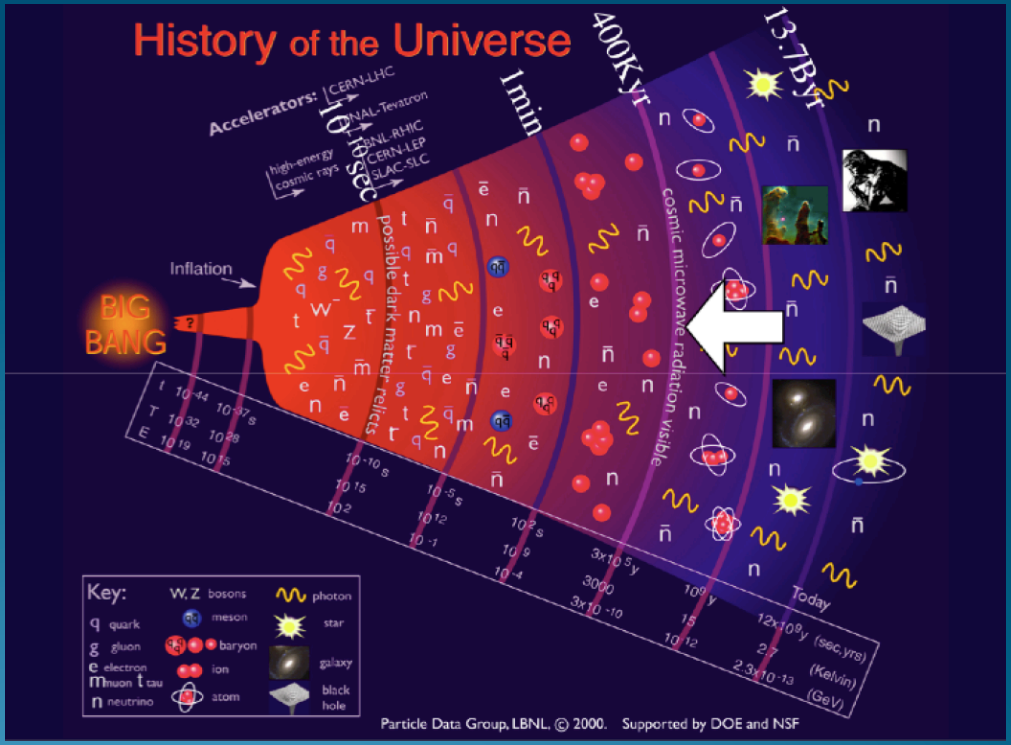
Line 4

Electron flux after AMS02



La connessione cosmica

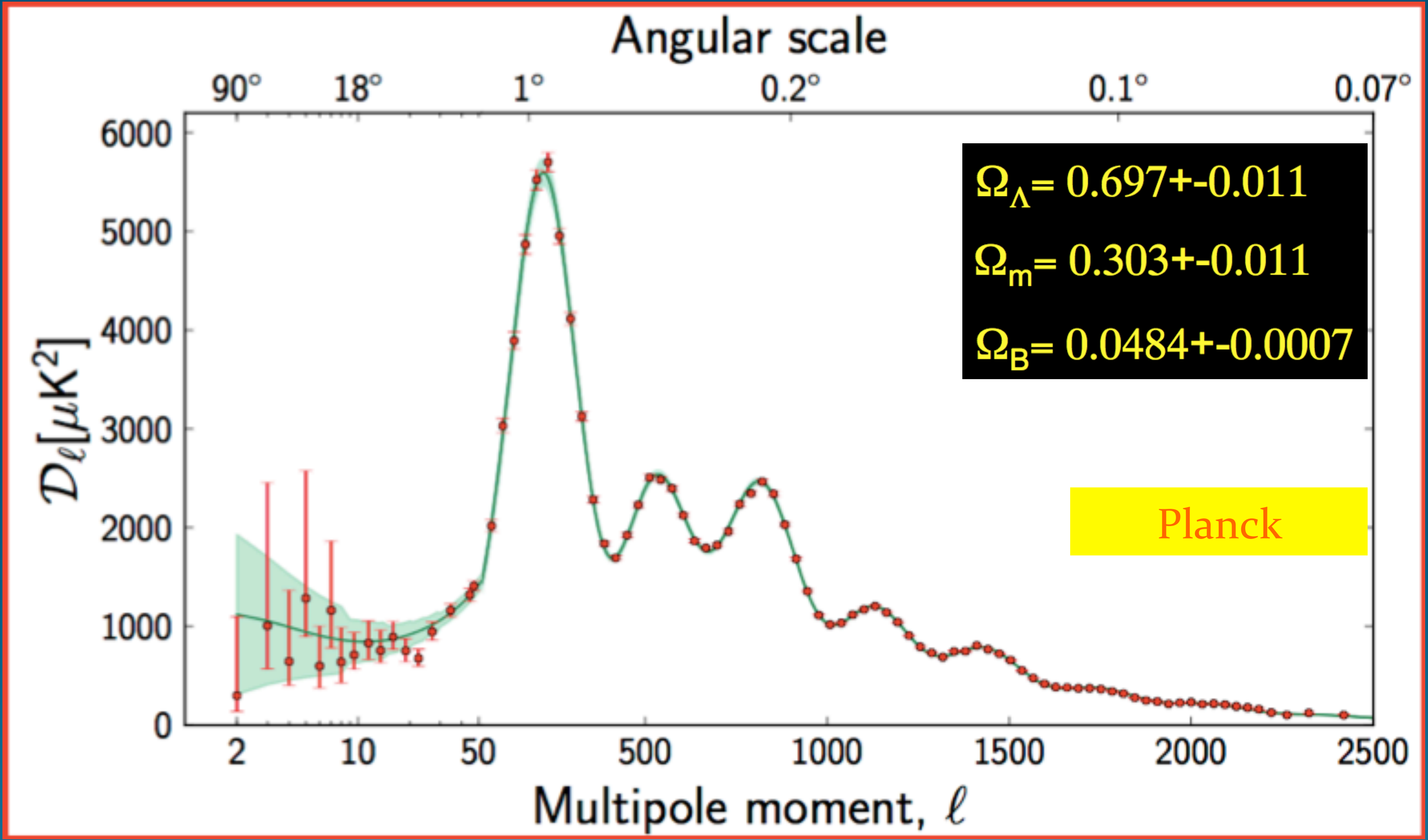




+ gravity!

Con la maturazione della cosmologia osservativa avvicinamento irreversibile tra le due scienze

L' inflazione con il giusto cocktail di parametri funziona bene!



La storia di BICEP2/Planck

Marzo 2014: entusiasmante annuncio di BICEP2

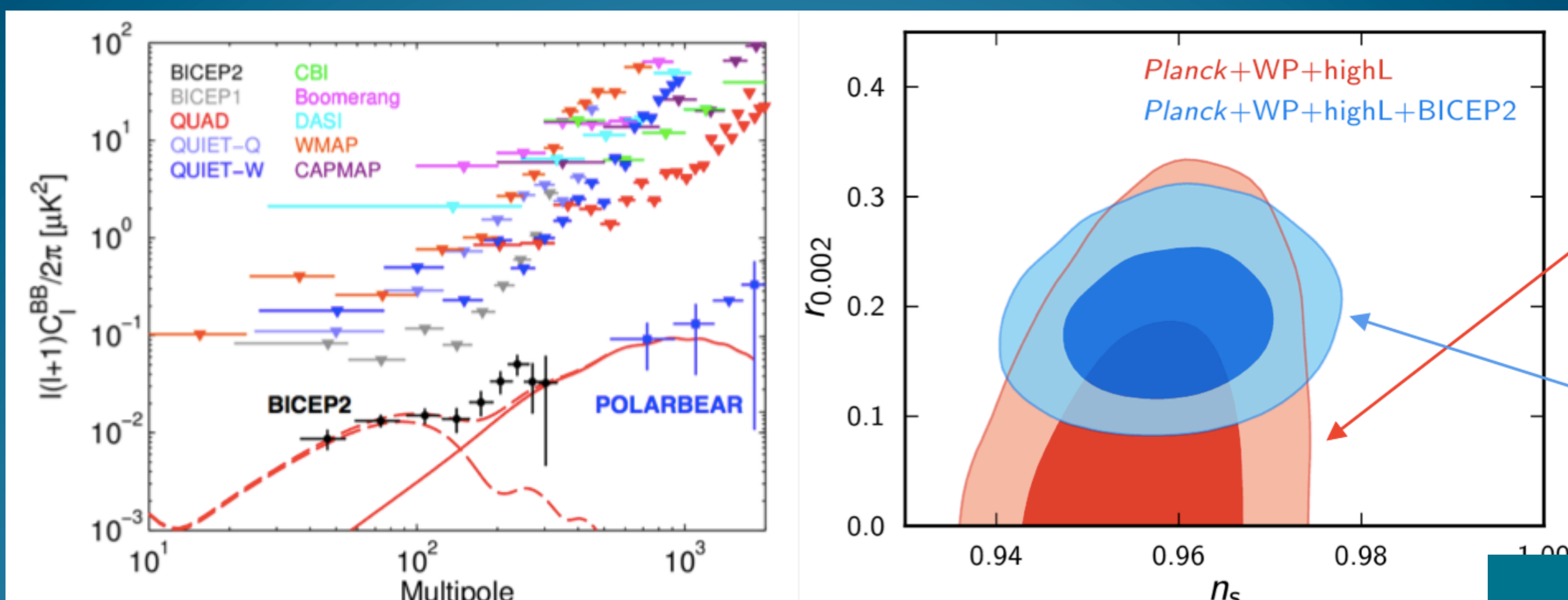
1) Rivelato il B-mode nella polarizzazione della RCF

2) Possibile intepretarlo come traccia dell'inflazione

$$r = 0.20^{+0.07}_{-0.05}$$

$$r \approx \frac{V[\phi]}{(4 \times 10^{16}\mathrm{GeV})^4}$$

GUT-scale physics!?



La storia di BICEP2/Planck

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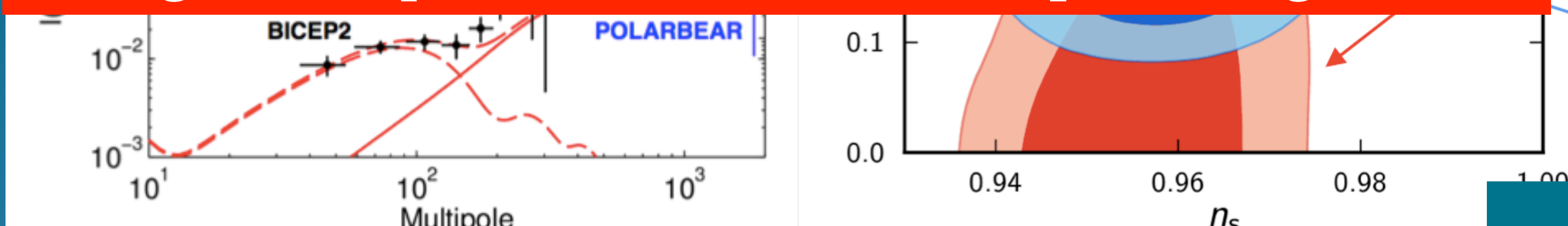
1) Rivelato il B-mode nella polarizzazione della RCF

2) Possibile intepretarlo come traccia dell'inflazione

Perchè così tanto entusiasmo?
(soprattutto dei teorici non-specialisti)

Dando per buona l'intepretazione si sarebbe aperta una finestra (insperata!) su una nuova scala fisica altrimenti inaccessibile, rilevante per fisica dei campi scalari, grande unificazione, gravità quantistica, assioni, superstrings…



La storia di BICEP2/Planck (continua)

Settembre 2014 (dopo vari segnali premonitori di esperti):

Planck intermediate results. XXX.
The angular power spectrum of polarized dust emission at intermediate and high Galactic latitudes

We investigate the level of dust polarization in the specific field recently targeted by the BICEP2 experiment. … This level is the same magnitude as reported by BICEP2 over this l range, which highlights the need for assessment of the polarized dust signal even in the cleanest windows of the sky. The present uncertainties are large and will be reduced through an ongoing, joint analysis of the *Planck* and BICEP2 data sets.

La prossima puntata alla fine del mese
importante insistere con altri esperimenti
la questione è di primaria importanza

E infine il punto (per ora)

Nei prossimi anni possiamo affrontare concretamente, su più fronti di attacco, molte domande fondamentali

Naturalezza (nuova fisica al TeV si o no?)
Materia oscura: WIMP, assione, o altro?
Nuove scale in fisica: numero leptonico, inflazione

Progresso importante è certo, soluzioni definitive meno
(il caso dell'Higgs a LHC è l'eccezione, non la regola)

Quel che è pure certo è che l'INFN deve continuare a giocare un ruolo di primo piano, il capitale umano e tecnologico a disposizione sono una garanzia, vanno accompagnati da scelte sagge e finanziamenti adeguati

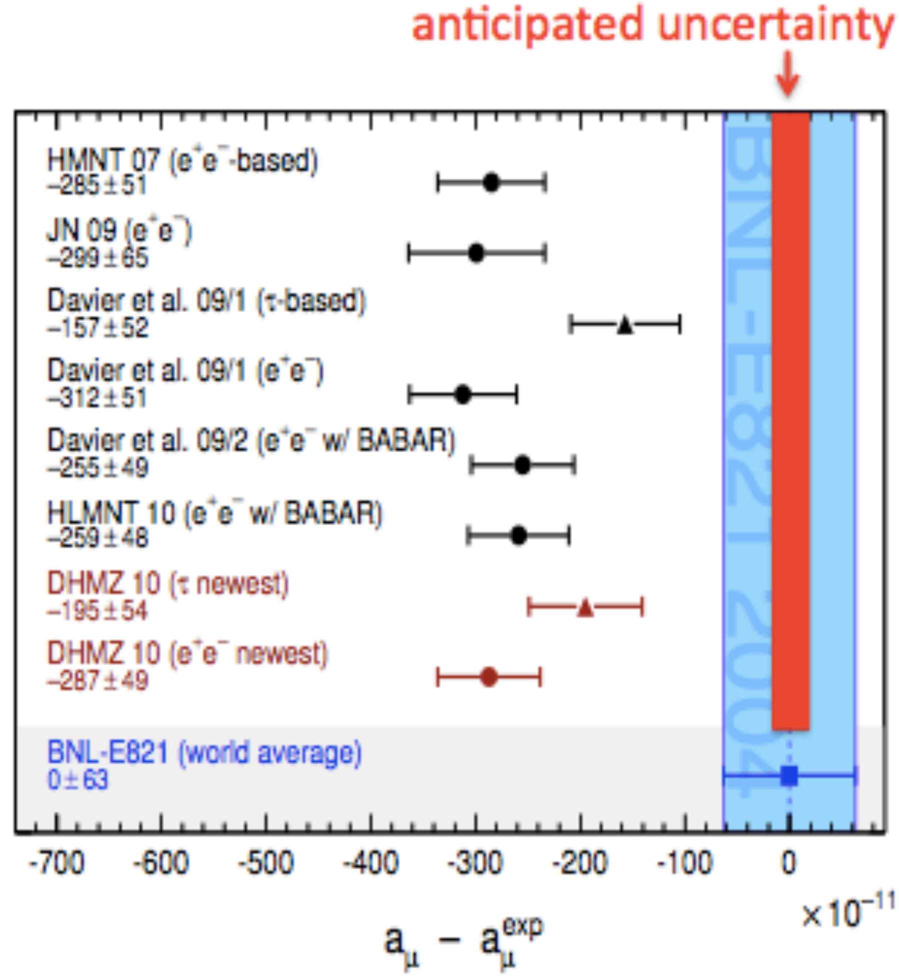
Grazie

Spare slides

New generation of muon experiments (g-2)

Muon g-2 experiments
at Fermilab
at J-PARC

Fermilab g-2: Data taking 2016



Oltre il MS con i neutrini

$$\mathcal{L}_{eff} = \mathcal{L}_{SM} + \delta\mathcal{L}(m_\nu) + \ldots$$

$\mathcal{L}_{SM}$:

Renormalizable minimal SM Lagrangian

3 families with ν_L but no ν_R

Accidental (B, L_e, L_{mu}, L_{tau}) [(B+L) anomalous]

$\delta\mathcal{L}(m_\nu)$: experimentally needed, still undetermined

Simplest solutions

1. Dirac [add 3 right-handed ν_R, assume (B-L)]
2. Majorana [Broken (B-L)], favoured because of

- Unique d=5 op in L_{eff}, Λ as large as almost M_{GUT}
- Simplest see-saw mechanism with heavy ν_R
- Makes possible baryogenesis via leptogenesis

Clear th bias for 2., but exp open question: $(\beta\beta)_{0\nu}$

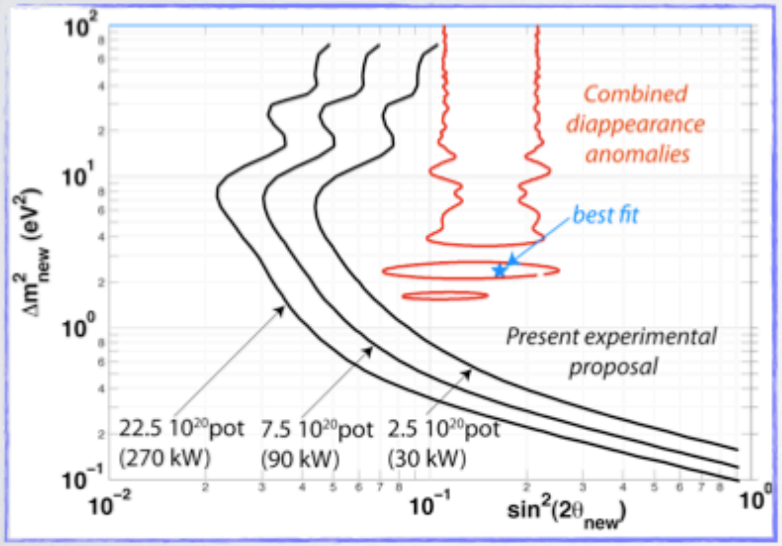
Neither 1. nor 2. affect the success of L_{SM} until Λ

SEARCH FOR STERILE NEUTRINOS

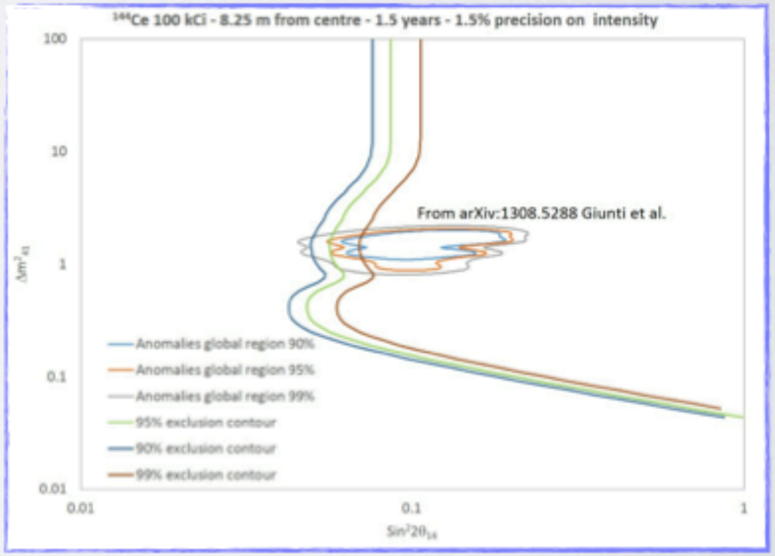
Line 1

- The topic is hot and two main efforts are in progress
  - **SOX:** re-use of Borexino as detector of neutrinos emitted by a source
  - **SBL-ICARUS:** re-use of Icarus on Short Base Line program at Fermilab
    - Possible third actor: **Nessie**

SBL-Icarus sensitivity @ CERN
FNAL sensitivity still under study



SOX sensitivity with Ce-144 source



HIGHLIGHTS: SOLAR NEUTRINOS

Line 1

- First direct and real time detection of pp solar neutrinos by Borexino
  - Nature, 512, 28-Aug-2014
    - pp rate: 144±13± 10 cpd/100 t
    - expected: 131±2 cpd/100 t

ARTICLE

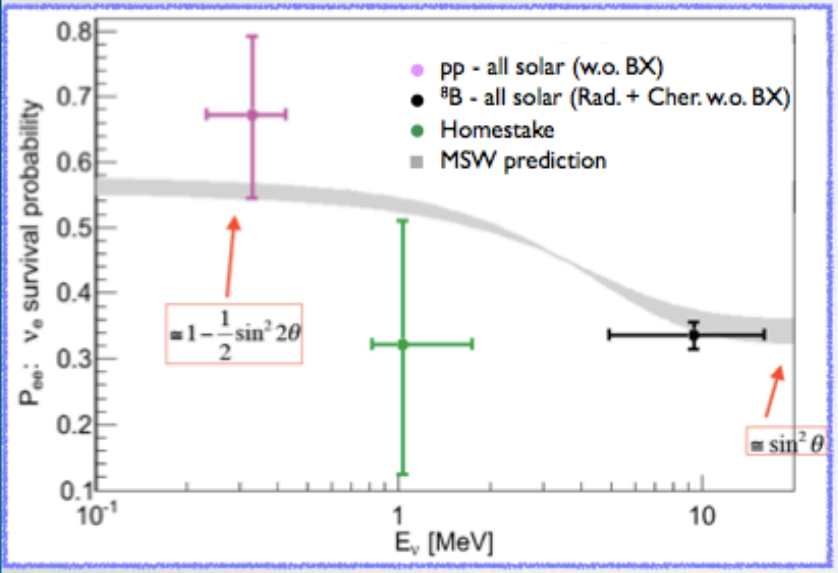
doi:10.1038/nature13702

Neutrinos from the primary proton–proton fusion process in the Sun

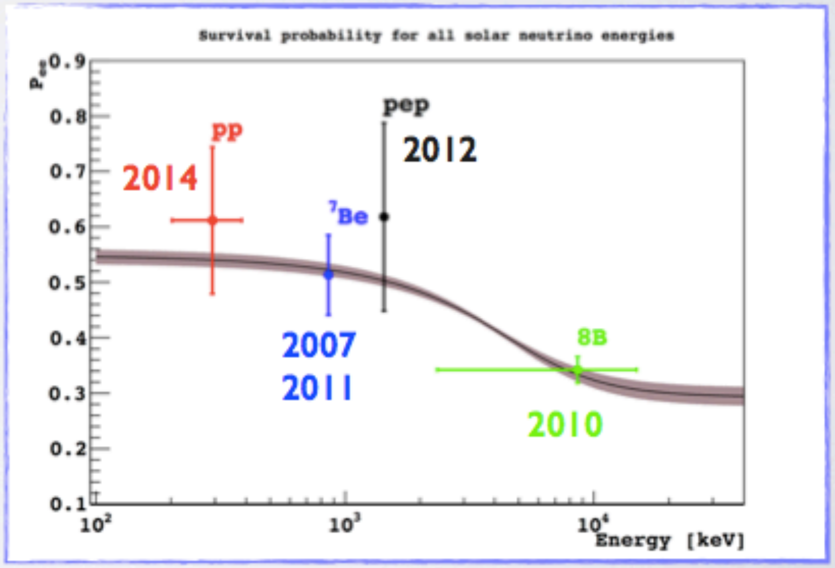
Borexino Collaboration*

In the core of the Sun, energy is released through sequences of nuclear reactions that convert hydrogen into helium. The primary reaction is thought to be the fusion of two protons with the emission of a low-energy neutrino. These so-called *pp* neutrinos constitute nearly the entirety of the solar neutrino flux, vastly outnumbering those emitted in the reactions that follow. Although solar neutrinos from secondary processes have been observed, proving the nuclear origin of the Sun's energy and contributing to the discovery of neutrino oscillations, those from proton–proton fusion have hitherto eluded direct detection. Here we report spectral observations of *pp* neutrinos, demonstrating that about 99 per cent of the power of the Sun, 3.84×10^{33} ergs per second, is generated by the proton–proton fusion process.

Before Borexino



Borexino 2014



Il miracolo WIMP

WIMP = Weakly Interacting Massive Particle

For WIMPs in thermal equilibrium after inflation

$$\langle \sigma_{\rm ann} v \rangle \simeq 3 \times 10^{-26} {\rm cm}^3 {\rm s}^{-1}$$

EW x-section for particle with $M \sim 10^{2-3}$ GeV

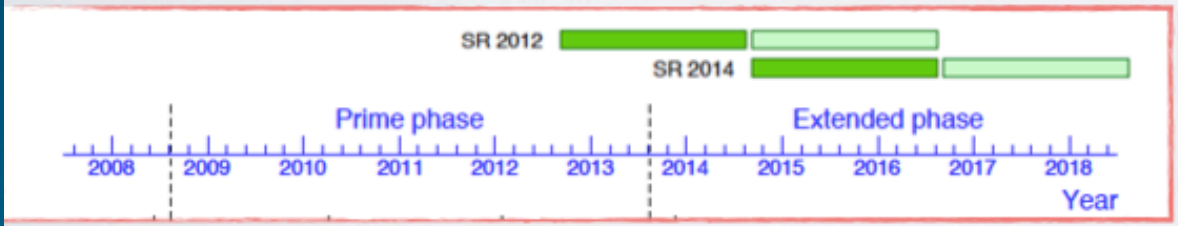
HIGHLIGHTS: FERMI RESULTS

Line 4

- Fermi has changed our knowledge of the γ sky
  - Very broad science scope
  - Very successful mission
  - Very significant role of INFN

Science group	Coordinators
AGN and Blazars	Denis Bastieri
	Jeremy Perkins
Calibration and analysis	Carmelo Sgrò
	Matthew Wood
Catalogs	Elisabetta Cavazzuti
	Isabelle Grenier
Dark matter and new Physics	Luca Baldini
	Miguel A. Sànchez-Conde
Diffuse emission	Elena Orlando
	Johann Cohen-Tanugi
Galactic sources	Massimiliano Razzano
	Marianne Lemoine-Goumard
GRBs	Elisabetta Bissaldi
	Magnus Axelsson
Sources in the solar system	Melissa Pesce-Rollins
	Eric Grove

- The mission is currently expected to continue until **2018**
  - Might be extended. Review in 2016.



- 315 papers, 22 of which in Science/Nature
  - h_index of the experiment is 50

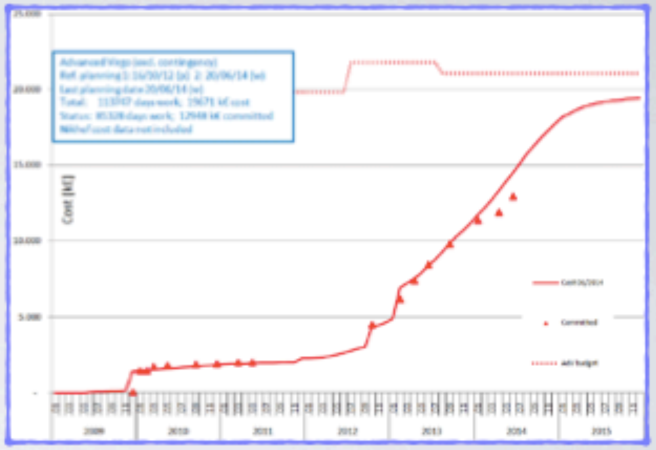
Category I and II papers in refereed journals

Journal	Published	In press	Total
Advances in Space Research	0+1=1	-	1
Astronomy and Astrophysics	6+29=35	0+3=3	38
Astroparticle Physics	2+6=8	-	8
Astrophysical Journal	81+59=140	0+2=2	142
Astrophysical Journal Letters	22+20=42	-	42
Astrophysical Journal Supplement	8+2=10	-	10
Journal of Cosmology and Astroparticle Physics	3+4=7	-	7
Journal of Geophysical Reserch	0+1=1	-	1
Monthly Notices of the RAS	0+25=25	-	25
Nature	2+1=3	-	3
Nuclear Instruments and Methods	0+1=1	-	1
Physical Review D	8+2=10	-	10
Physical Review Letters	7+0=7	-	7
Publications of the ASJ	0+1=1	-	1
Science	18+0=18	1+0=1	19
Total	157+152=309	1+5=6	315

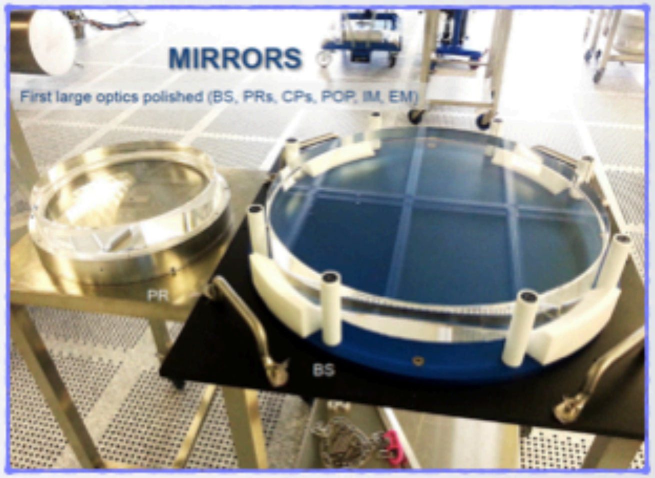
HIGHLIGHTS: STATUS OF VIRGO-ADV

Line 5

- Very hard work in progress
  - GOAL: Start data taking at the end of 2015 - early 2016
  - On-time and on-budget so far
    - **Very tight and risky approach to match Ligo with MUCH smaller resources**



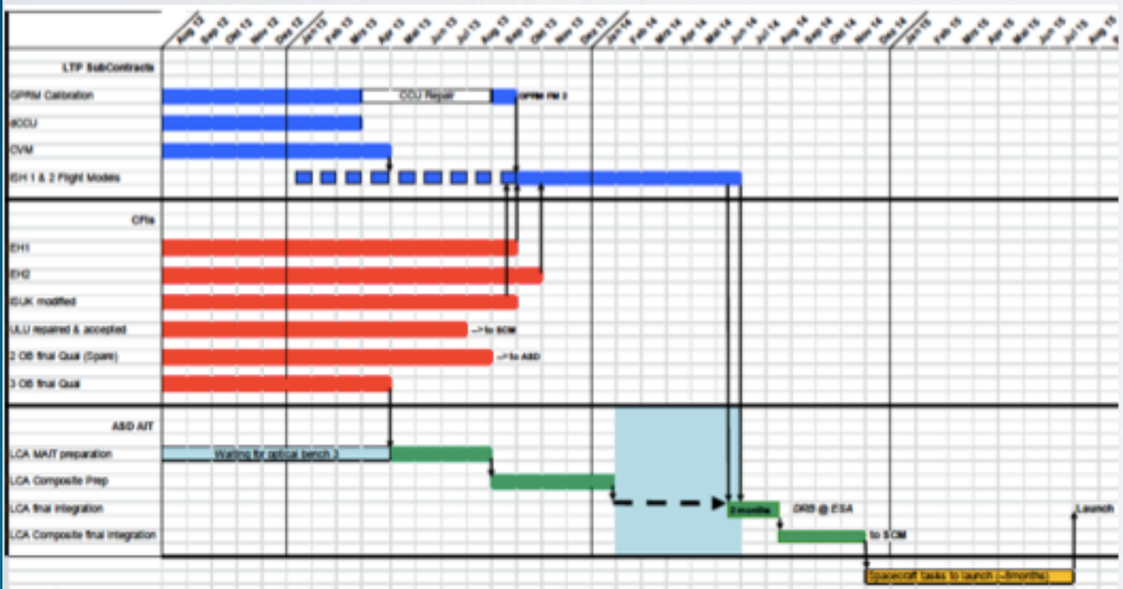
- July 2014: commissioning of IMC ***started
- October 2104: SIB2 installed, finish commissioning of INJ
- Early 2015: mirrors in the central building installed ➡ lock of the CIFT
- Summer 2015: first end mirror installed ➡ 1-arm test
- Fall 2015: full interferometer ➡ lock in the power recycling configuration
- 2016: commissioning of the full interferometer ➡ noise hunting and science run

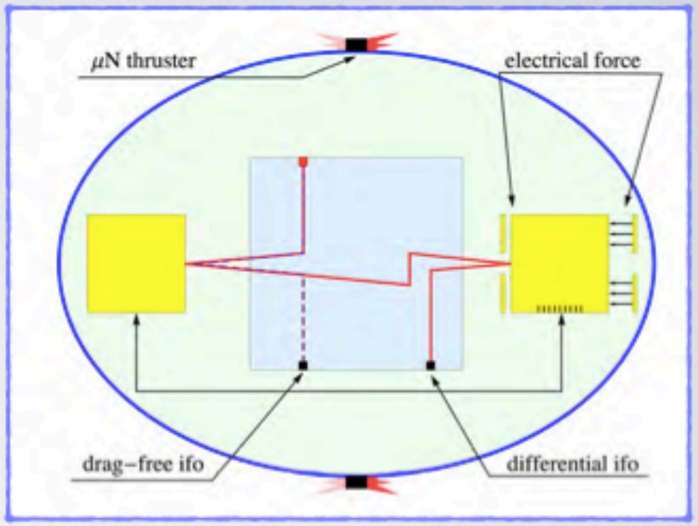


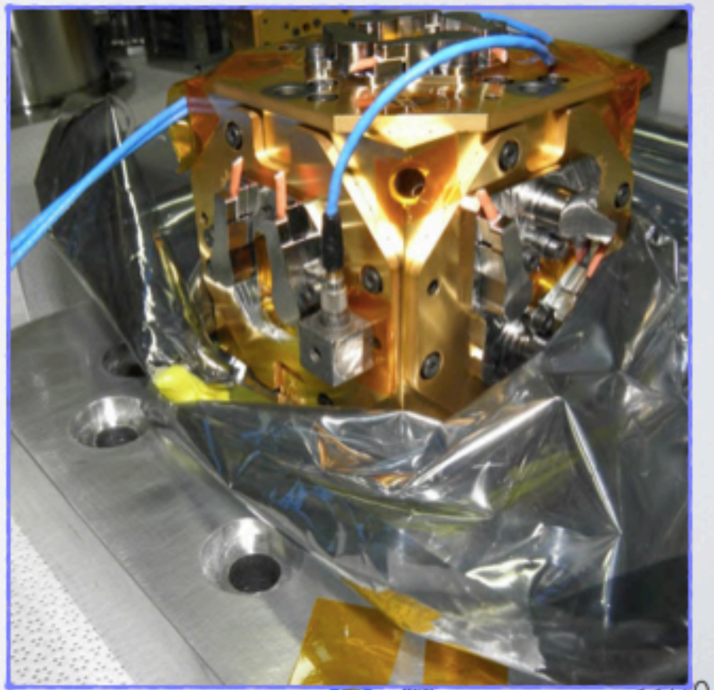
HIGHLIGHTS: LISA-PF ALMOST READY TO GO

Line 5

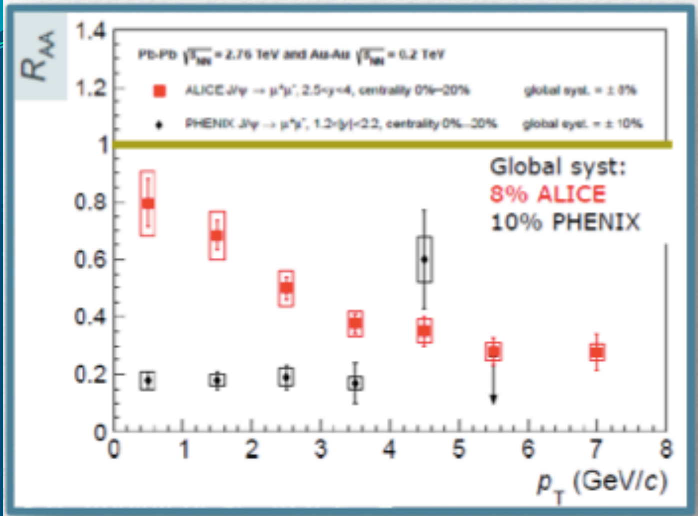
- **GOAL**
  - Test the concept of non-contacting satellite
  - Two Au-Pt masses in the same space-craft
    - One in true free falling, another one controlled at low frequency by electrostatic force
    - One Lisa arm in one satellite
  - **Launch: July 15, 2015**





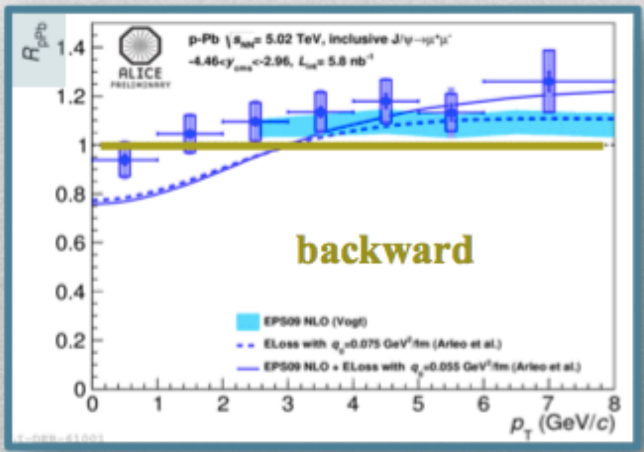


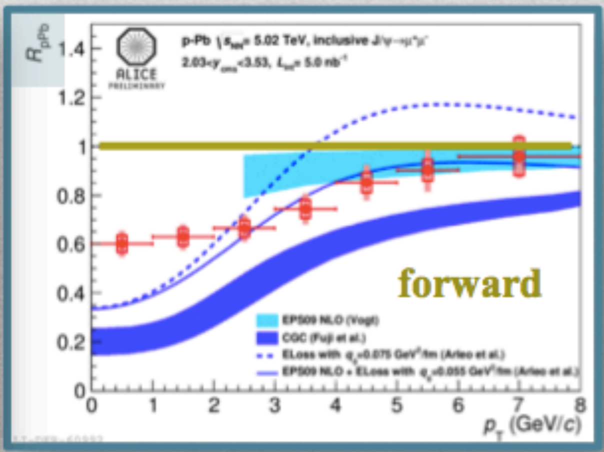
J/ψ



- Suppression in PbPb
- pPb: No suppression at backward, suppression at forward
- nuclear shadowing and/or partonic energy-loss models in fair agreement with data

ALICE

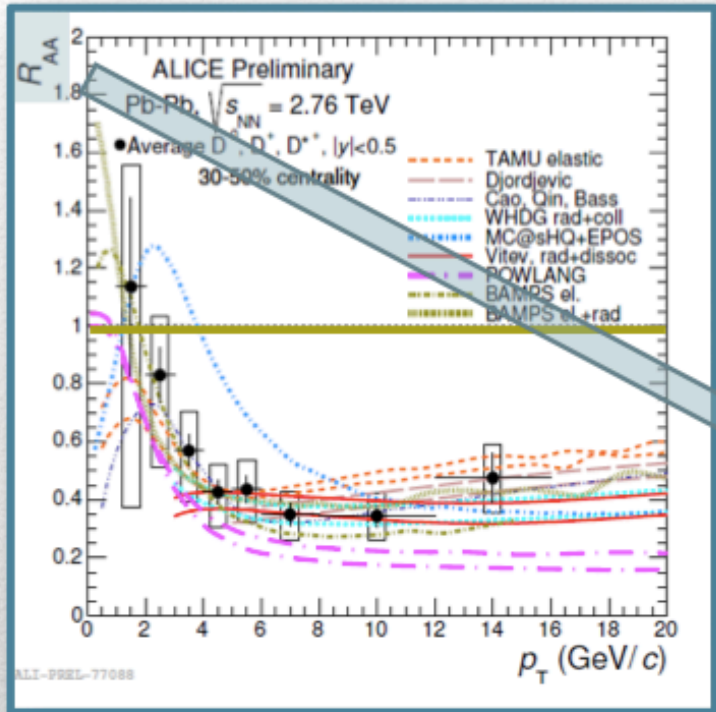


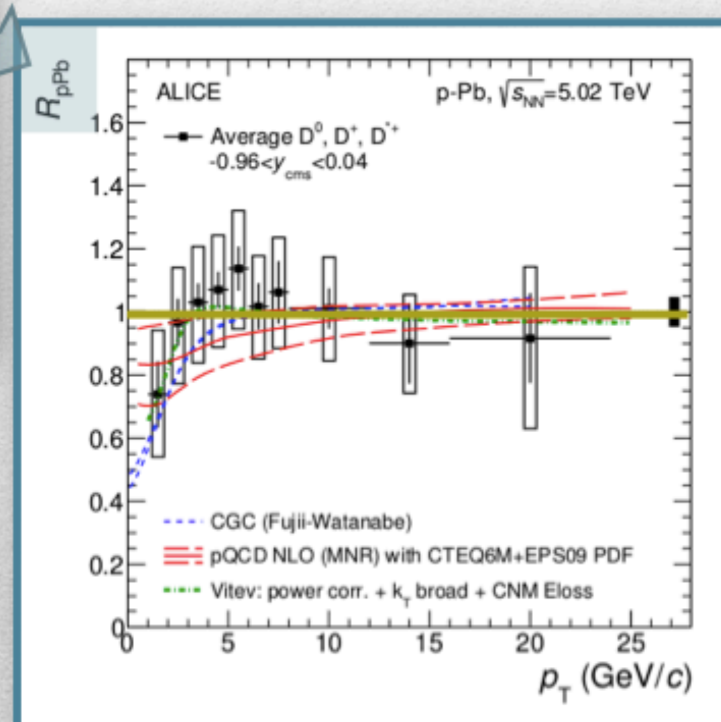


Taiuti@CVI

Heavy Flavour

- CNM effects cannot explain HF suppression in Pb-Pb



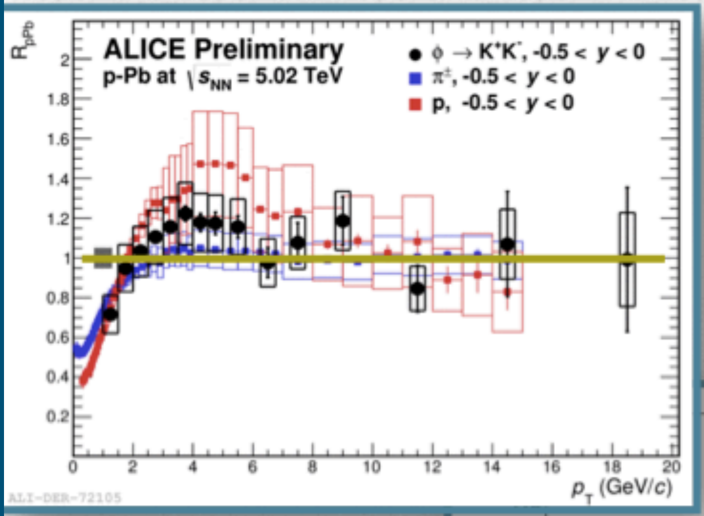


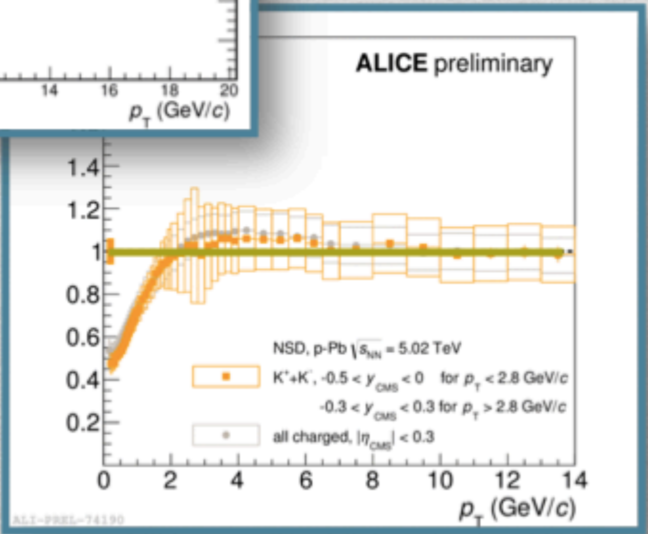
ALICE

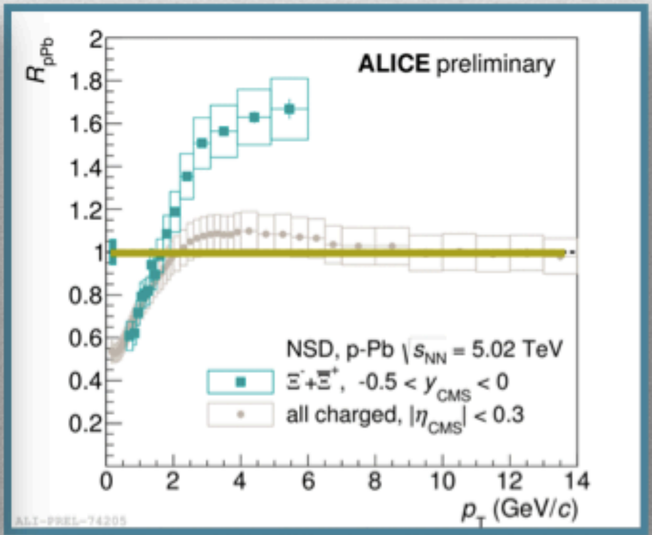
Taiuti@CVI

R_{pPb} reveals Cold Nuclear Matter (CNM) Effects

- CNM effects cannot explain Pb-Pb R_{AA} suppression
- At low p_t interesting Cronin peak, with mass ordering
- At high p_t $R_{pPb} \sim 1$







ALICE

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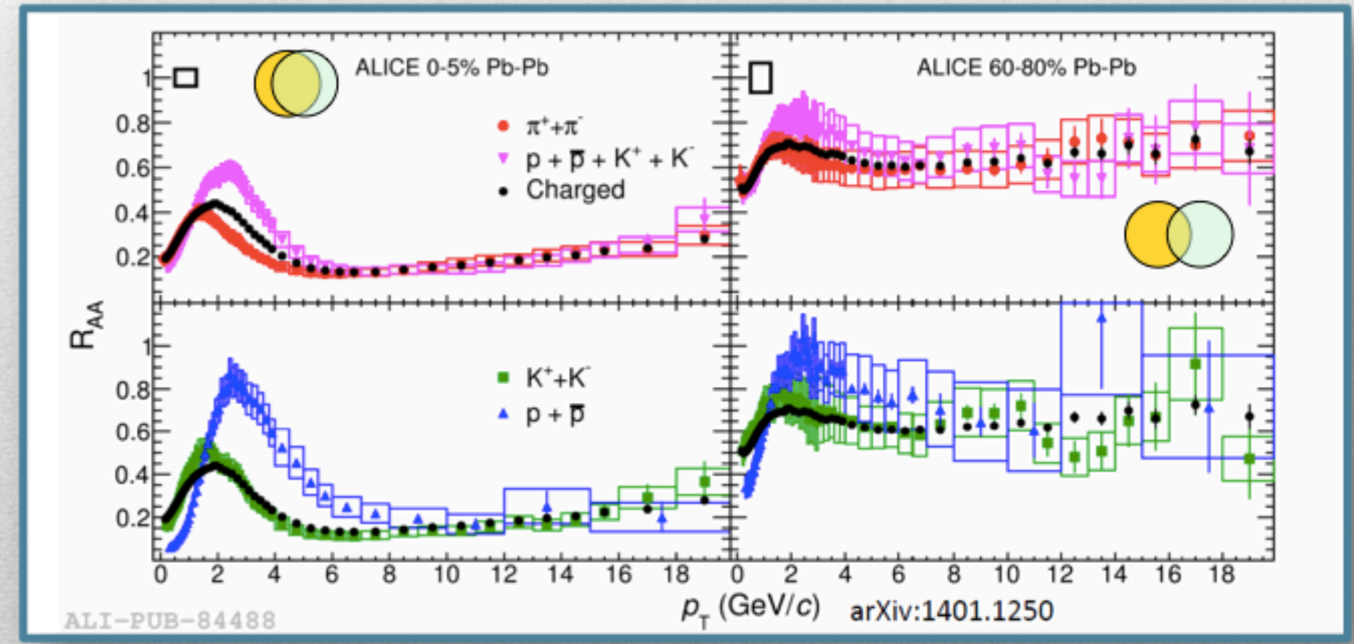
R_{AA} with particle ID

- Strong suppression for all hadrons

At low $p_t \rightarrow$ mass ordering

At high $p_t \rightarrow$ independent of mass

Importance of production mechanism (coalescence ….)



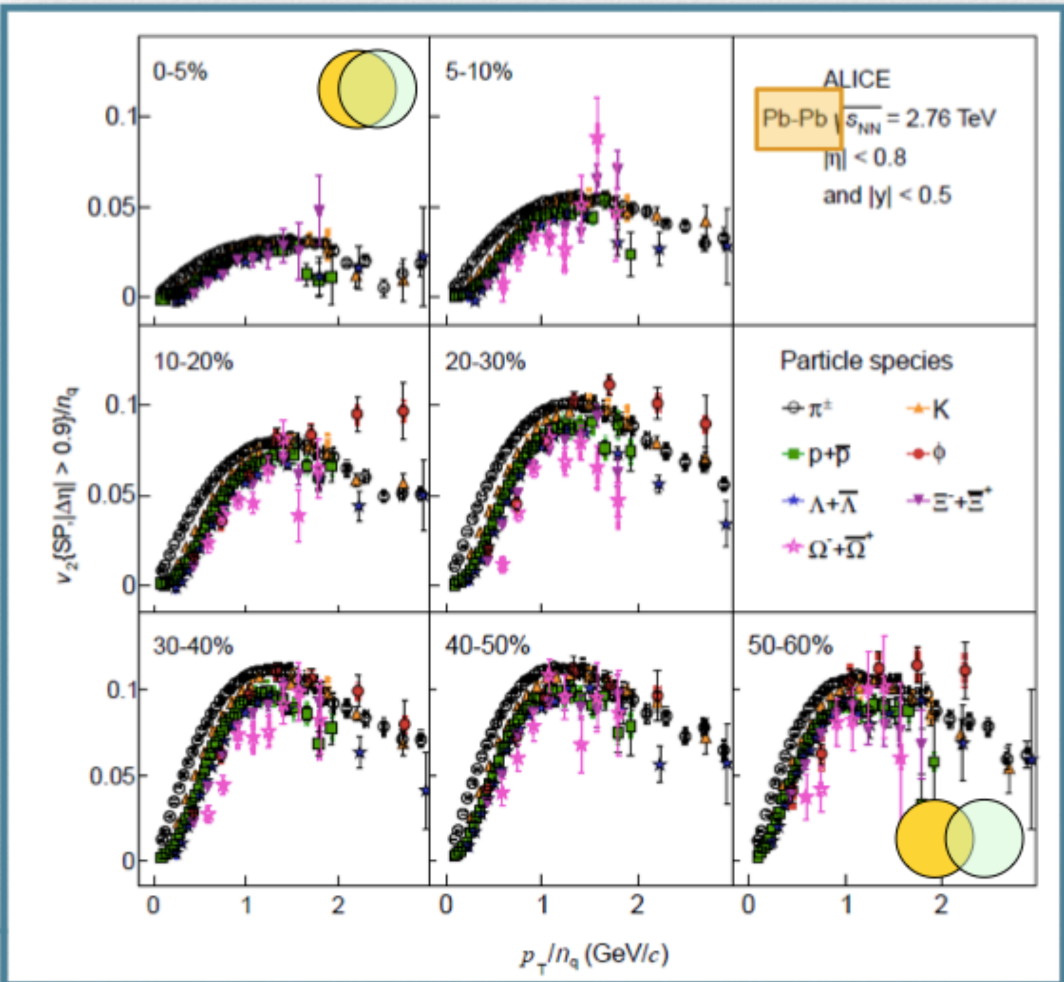
ALICE

Taiuti@CVI

Exhaustive analysis of Pb-Pb data

- V_2 DOES NOT scale with the number of quarks (RHIC initial observation)

ALICE



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