Outlook …

B. Filippone
PSI 2016
Oct. 20, 2016

Outlook …

- Wie ist das wetter?

Outlook …

- Wie ist das wetter?

→ Mostly sunny with a chance for Discovery!

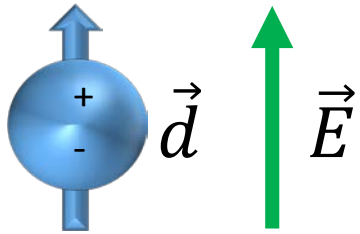
Outlook …

- Bernhard Lauss email:

"I don't want to bother you with a summary of the workshop or similar, but an outlook where low-energy fundamental physics will go in the next, say up to 10 years might be something you would also find exciting [ ] boring [ ] impossible [ ] great, and I want to do [ ]"

→ **much easier than a workshop summary …**

Physics at different Energy Scales



$$E = \vec{d} \cdot \vec{E}$$

"Next LHC" Collision Energy

10^{14} eV

LHC Collision Energy

10^{13} eV

Higgs Boson

Proton Rest Mass Energy

10^{9} eV

Muon Decay Energy

10^{8} eV

Neutron Beta Decay Energy

10^{6} eV

Neutrino Rest Mass Energy

10^{-1} eV

Electron Electric Dipole Moment

10^{-19} eV

Neutron Electric Dipole Moment

10^{-23} eV

First a look at the Past → Present

“We hold these conferences every 3 years which allows time for new results to be available” **K. Kirch**

What’s the scorecard:

First a look at the Past → Present

"We hold these conferences every 3 years which allows time for new results to be available" **K. Kirch**

What's the scorecard:

Based on Titles of Talks:

Status	Results
6	4

First a look at the Past → Present

"We hold these conferences every 3 years which allows time for new results to be available" **K. Kirch**

What's the scorecard:

Based on Abstracts and actual Talks:

Status	Results
48	6

Hard Experiments often take TIME

Results:

Order of Magnitude Smaller Limit on the Electric Dipole Moment of the Electron

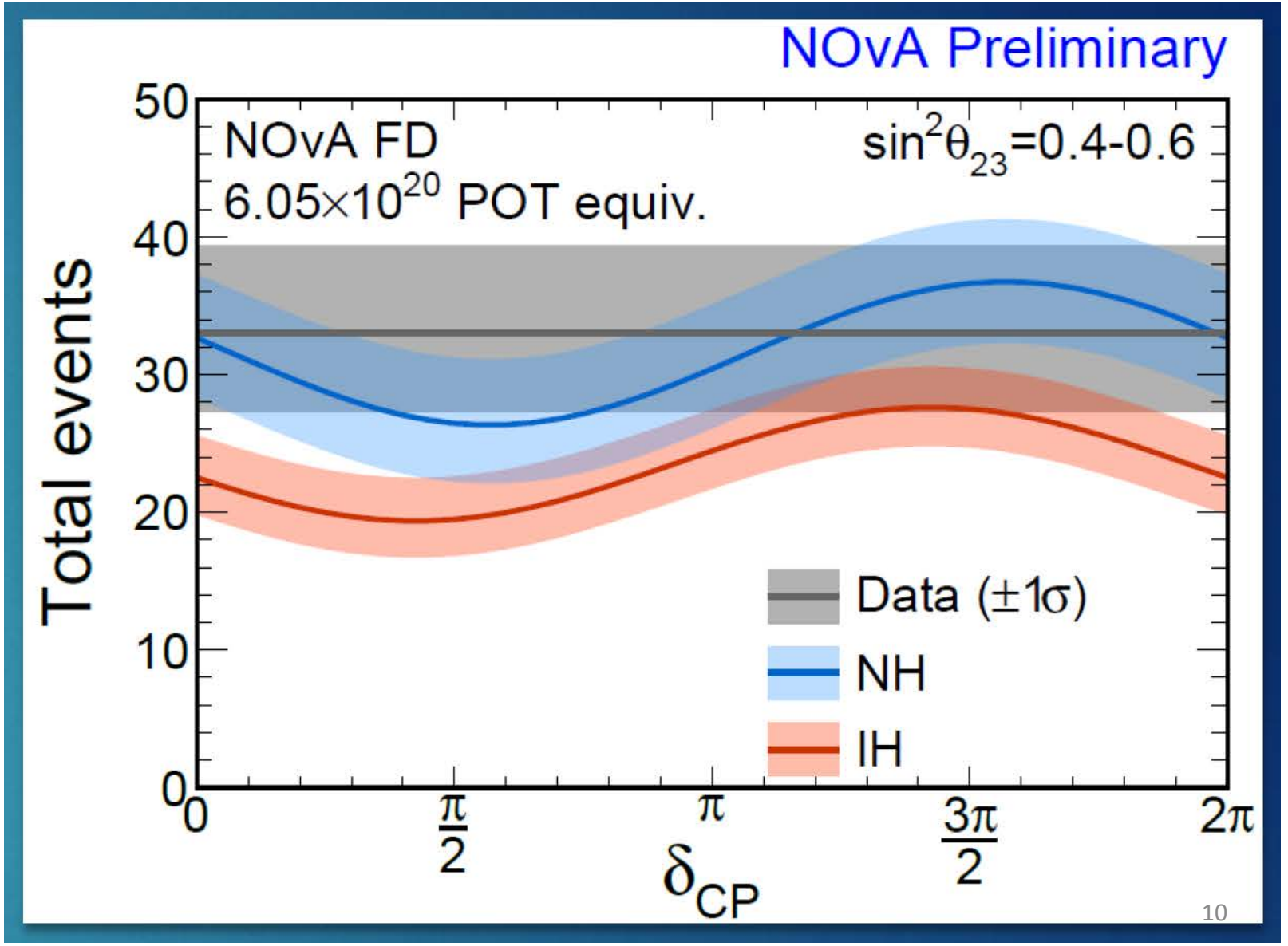
The ACME Collaboration,* J. Baron,[1] W. C. Campbell,[2] D. DeMille,[3]† J. M. Doyle,[1]† G. Gabrielse,[1]† Y. V. Gurevich,[1]‡ P. W. Hess,[1] N. R. Hutzler,[1] E. Kirilov,[3]§ I. Kozyryev,[3]‖ B. R. O'Leary,[3] C. D. Panda,[1] M. F. Parsons,[1] E. S. Petrik,[1] B. Spaun,[1] A. C. Vutha,[4] A. D. West[3]

The Standard Model of particle physics is known to be incomplete. Extensions to the Standard Model, such as weak-scale supersymmetry, posit the existence of new particles and interactions that are asymmetric under time reversal (T) and nearly always predict a small yet potentially measurable electron electric dipole moment (EDM), d_e, in the range of 10^{-27} to 10^{-30} $e\cdot$cm. The EDM is an asymmetric charge distribution along the electron spin ($\vec{S}$) that is also asymmetric under T. Using the polar molecule thorium monoxide, we measured $d_e = (-2.1 \pm 3.7_{stat} \pm 2.5_{syst}) \times 10^{-29}$ $e\cdot$cm. This corresponds to an upper limit of $|d_e| < 8.7 \times 10^{-29}$ $e\cdot$cm with 90% confidence, an order of magnitude improvement in sensitivity relative to the previous best limit. Our result constrains T-violating physics at the TeV energy scale.

- PSI 2013: Oct. 16 – 20, 2013
- Submitted Nov. 7, 2013

Presentation by Jerry Gabrielse

Results:

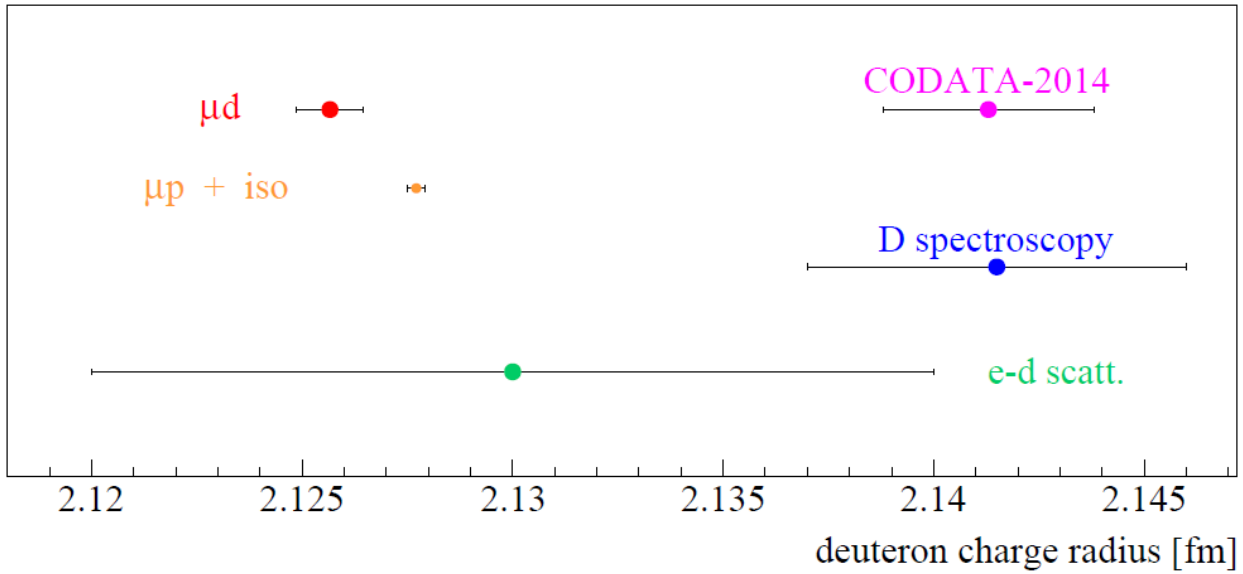


Presentation by Giulia Brunetti

Results:

muonic deuterium

the size of the deuteron



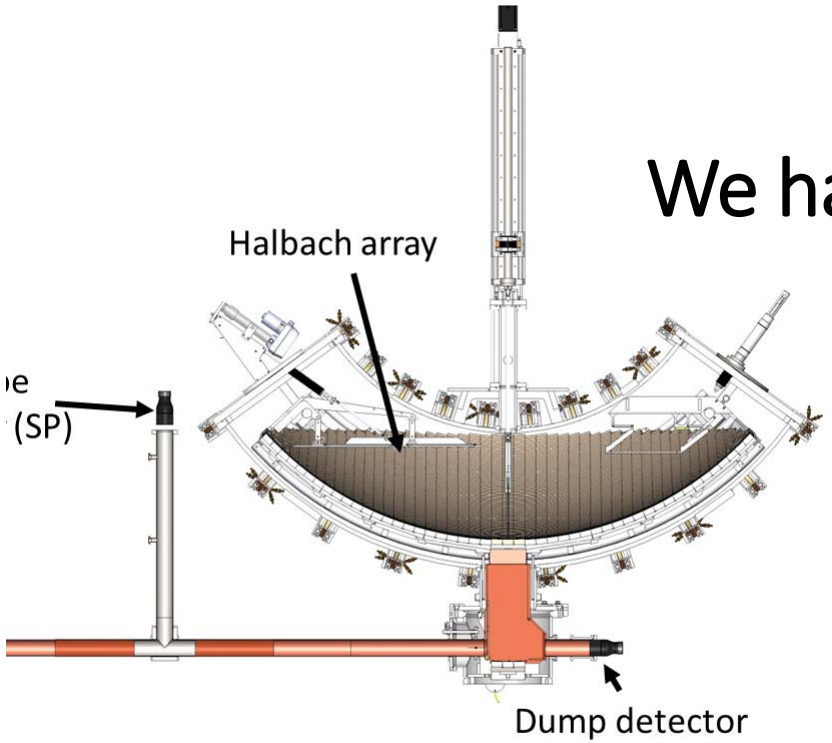
$\rightarrow$ 5.9σ discrepancy between $r_d(\mu d)$ and CODATA-2014.

[R. Pohl *et al.* (CREMA-coll.), Laser spectroscopy of muonic deuterium, Science 353, 669 (2016)]

Presentations by Aldo Antognini & Julian Krauth

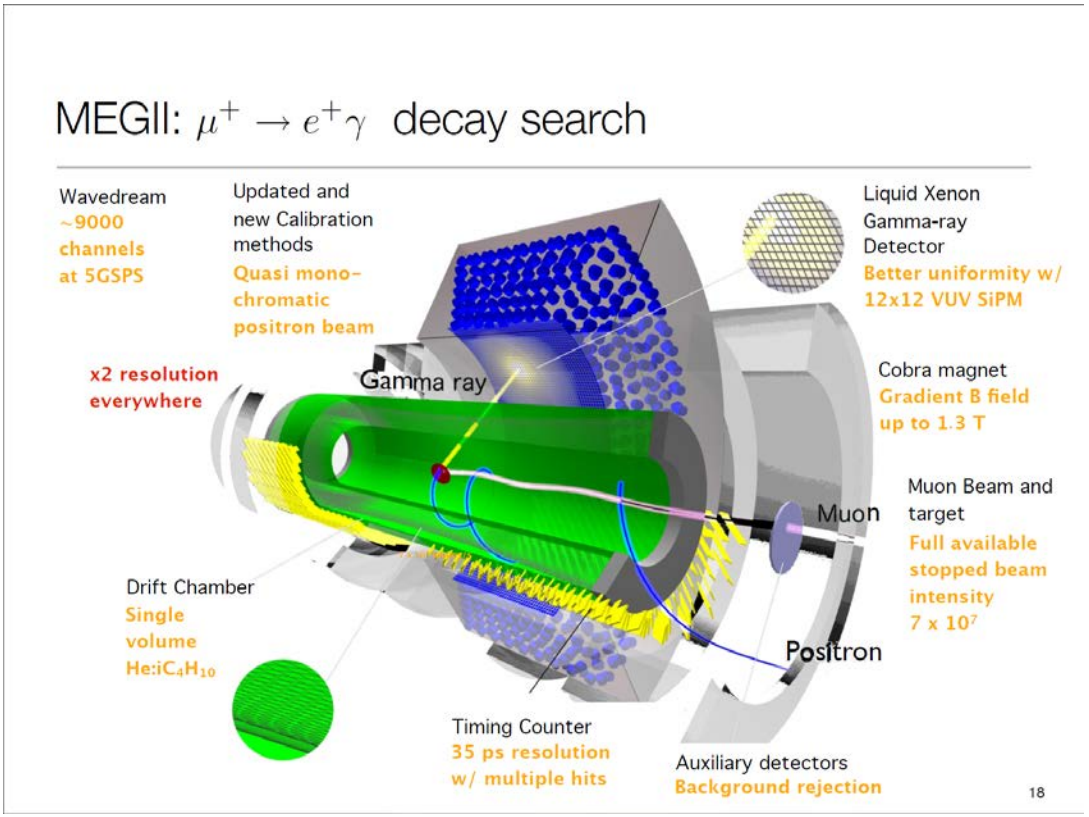
Results:

We have developed a new method for measuring the neutron lifetime



- We have demonstrated an *in situ* active neutron detector that allows for many systematic tests and enables the measurement of corrections for cleaning effectiveness and phase space evolution
- We have made a measurement of τ_n for the first time with no extrapolation: $878.8 \pm 2.6_{stat} \pm 0.6_{sys}$

Results:



- a new upper limit for the branching ratio of $B(\mu^+ \to e^+ \gamma) < 4.2 \times 10^{-13}$ *at 90% C.L.* has been established (a factor 30 improvement with respect to the previous MEGA experiment and also the strongest bound on any forbidden decay particle)

Results:

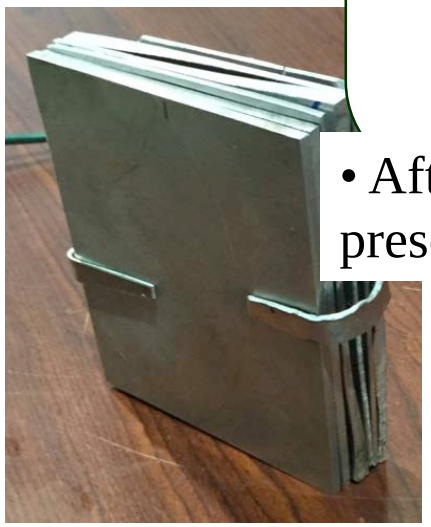
Presentation by

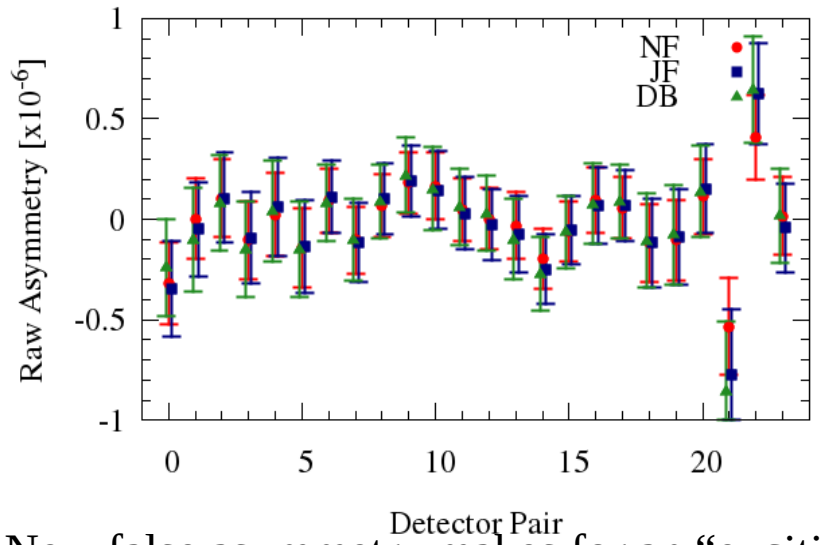
– **Anita Govaerts-Van Loon + Stefan Ritt**

Almost Results:

NPDGAMMA (AGAIN)

- Determine pieces of cryostat that came from single pour and assume independent
- Cut up LH_2 cryostat
- Design targets to replicate background with parahydrogen vessel full
- Composite target to mimic neutron capture on original LH_2 vessel





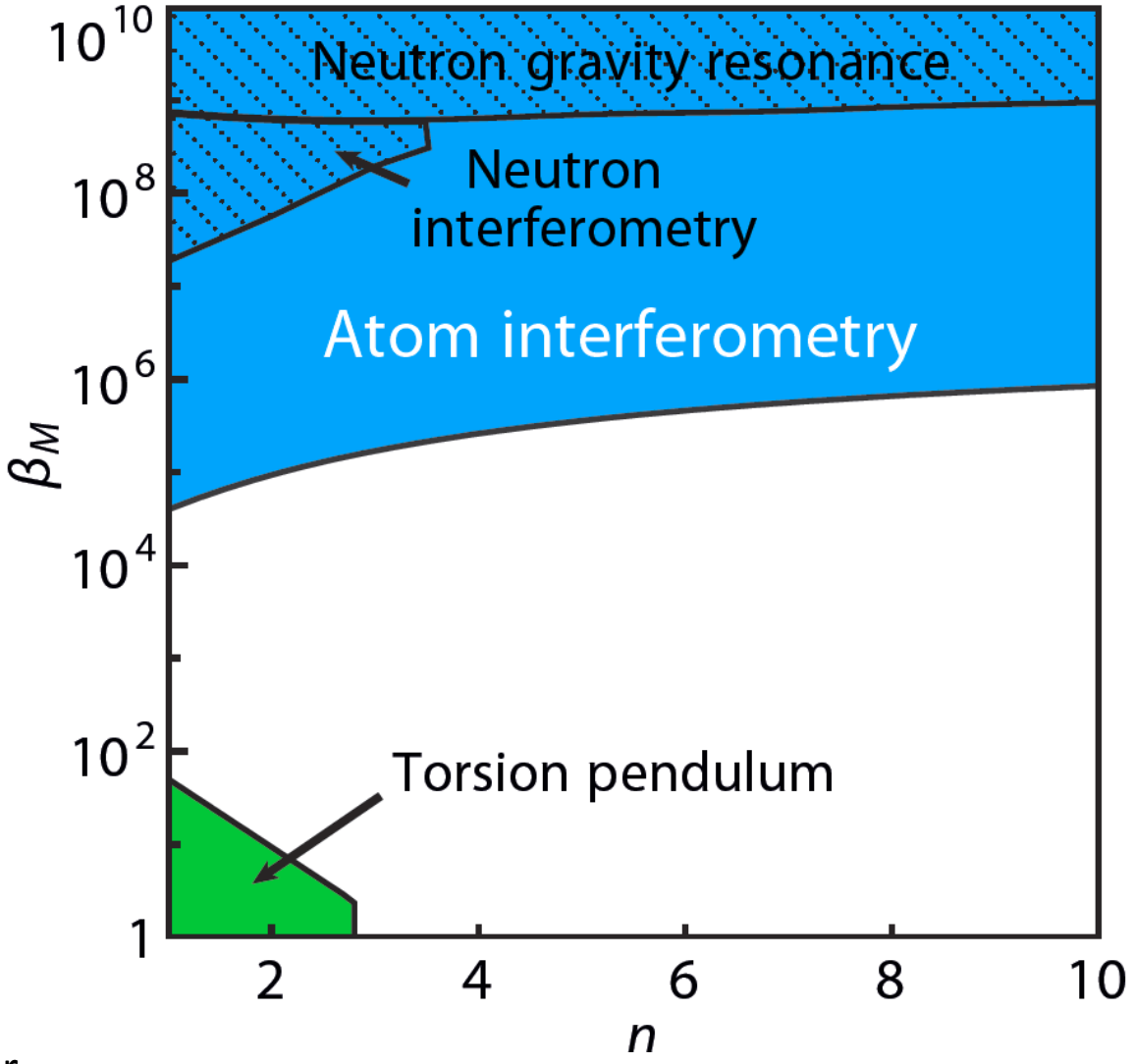
- New false asymmetry makes for an "exciting" data analysis

• After 15 years in the making, NPDGamma will be presenting the final result soon

Graphics by D. Blyth

Presentation by Nadia Fomin

Almost Results:



Presentation by Holger Müller

In Addition …

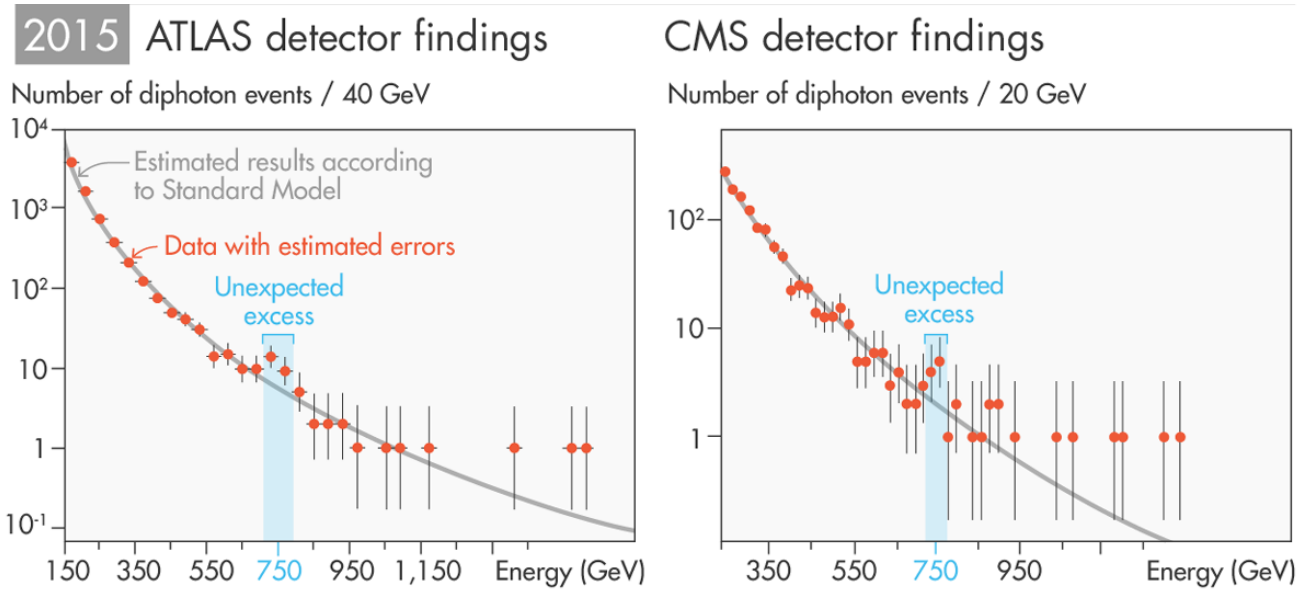
- Many beautiful (experimentally) technical talks and posters on exciting developments of hardware and techniques

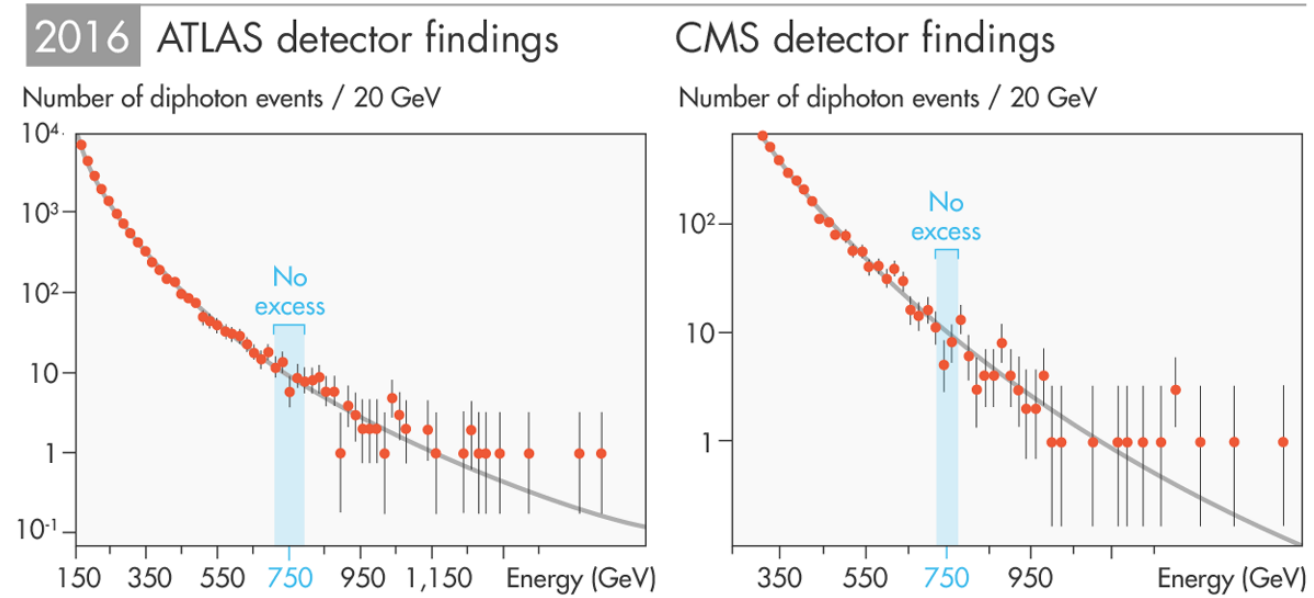
- Now to the Outlook …

Good News & Bad News …

- First the Bad News:

Good News & Bad News …





Good News & Bad News …

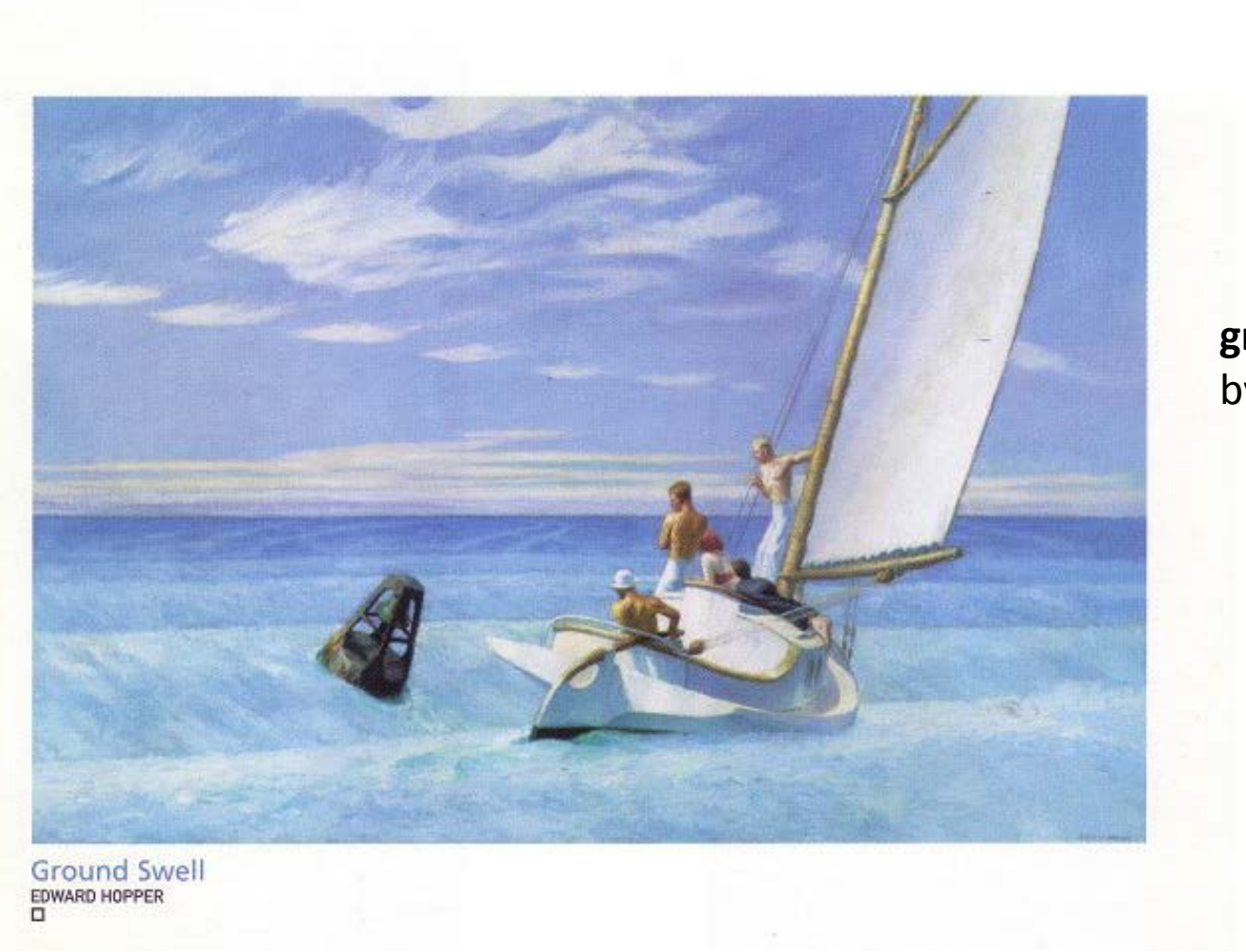
- Now the Good News:

Good News & Bad News …

- Now the Good News:
  - Last time (2013) – Precision, Intensity, Low energy Frontier was a ripple …

Good News & Bad News …

–At Present (2016) – Precision, Intensity, Low energy Frontier is more of a ground swell …



Ground Swell
EDWARD HOPPER

ground swell : a broad deep undulation of the ocean caused by an often distant gale or seismic disturbance

Merriam-Webster

Good News & Bad News …

–Next time (2019) – Precision, Intensity, Low energy Frontier WILL be more of a serious California wave:

Predictions:

- There will be 3 major intriguing BSM results:

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- There will be 3 major intriguing BSM results:
    1. One will be a statistical fluctuation

Predictions:

- There will be 3 major intriguing BSM results:
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  2. One will be a new systematic effect

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  1. One will be a statistical fluctuation
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  3. One will be a **Discovery !**

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- There will be 3 major intriguing BSM results:
  1. One will be a statistical fluctuation
  2. One will be a new systematic effect
  3. One will be a **Discovery !**

Of course any decent theoretical prediction should include an error bar: = ± 1

“There’s plenty of room at the bottom!”