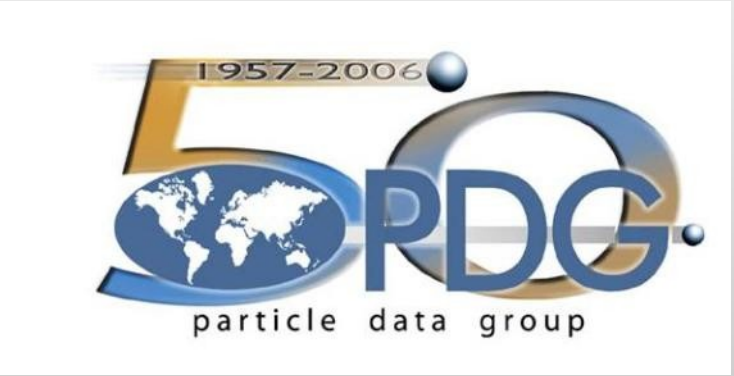
Particle Data Group



Now 53 years

November 2010

The 2010 edition is smaller in all dimensions than the 2006 edition, but…

	Pages /kg	Pages per kg
RPP10: 1422 pages 2.9 kg	490	490
RPP08: 1339 pages 2.3 kg	580	580
RPP06: 1231 pages 2.5 kg	490	490
RPP04:1109 pages 1.65 kg	670	670
RPP02: 974 pages 1.5 kg	650	650
RPP00: 878 pages 1.7 kg	520	520
RPP98: 794 pages 1.5 kg	530	530

DOE Review of PDG

on September 12, 2008 (all day) in Washington DC

- **Extremely successful.**
- **New resources are a game-changer.**
- **Addressed many issues.**
- **Solved many problems.**

Item	Requested	Funded
Additional physicist	1	2
Computing upgrade	4 FTE	6 FTE
Programmer	0	0.5

The PDG Empire

Collaboration

Particle Data Group collaboration

of 176 authors

from 21 countries and 108 institutions

+ 700 consultants in the HEP community

Review of Particle Physics

551 new papers with **2158** measurements

108 Reviews written or edited by PDG

RPP: **1422** pages

Booklet: **306** pages

Listings and Reviews

The Web allows us to see what most interest our readers.

The hits (page views) on

Data Listings = Reviews

almost exactly equal.

Clearly people care about both.

Astrophysics & Cosmology

12 years ago: Very little

Now:

Astrophysical Constants
Big Bang Cosmology
Cosmological Parameters:
H_0, Λ, Ω, etc.
Experimental Tests of Gravitational Theory
Dark Matter
Cosmic Background Radiation
Cosmic Rays

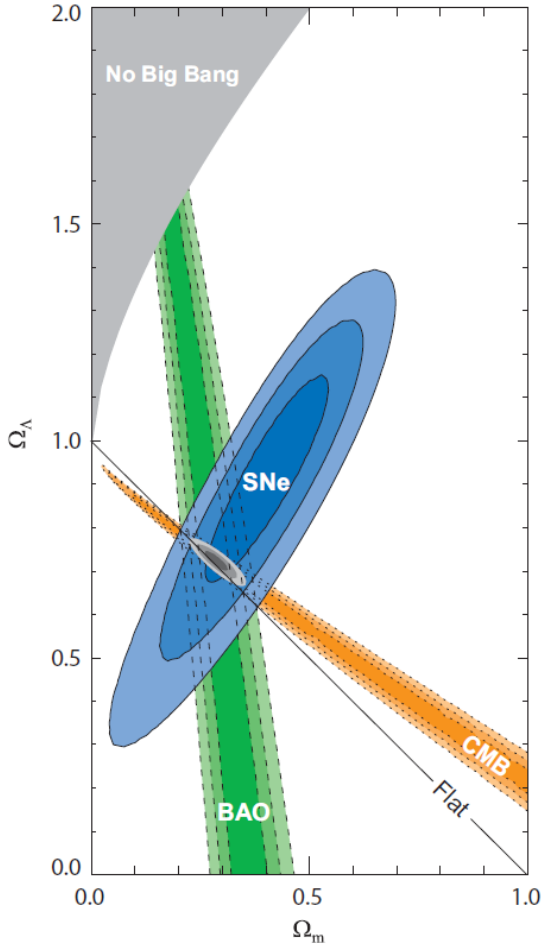


Figure 21.1: Confidence level contours of 68.3%, 95.4% and 99.7% in the Ω_Λ–Ω_m plane from the Cosmic Microwave Background, Baryonic Acoustic Oscillations and the Union SNe Ia set, as well as their combination (assuming $w = -1$). [Courtesy

B Meson Section 1984

Entire section was <u>one</u> page

$B^{\pm}$, B^0, B

$B^{\pm}$

41 CHARGED B(5271, JP=) I=

SEE ALSO THE LISTING FOR THE B (FOLLOWING THE ENTRY FOR THE NEUTRAL B) FOR MEASUREMENTS WHICH DO NOT IDENTIFY THE CHARGE STATE.

41 CHARGED B MASS (MEV)

M A 6 5270.8 3.0 BEHRENDS 83 CLEO +- D*- PI+ PI+ + CC 4/83*
M A STATISTICAL (2.3 MEV) AND SYSTEMATICAL (2.0 MEV) ERRORS COMBINED. 4/83*

41 CHARGED B PARTIAL DECAY MODES

		DECAY MASSES
P1	B+ INTO DOBAR PI+	1865+ 140
P2	B+ INTO D*(2010)- PI+ PI+	2007+ 140+ 140

B- MODES ARE CHARGE CONJUGATES OF THE ABOVE MODES.

41 CHARGED B BRANCHING RATIOS

R1 B+ INTO DOBAR PI+ (P1)
R1 2 0.042 0.042 BEHRENDS 83 CLEO +- E+ E-, UPSIL(4S) 4/83*

R2 B+ INTO D*(2010)- PI+ PI+ (P2)
R2 6 0.048 0.030 BEHRENDS 83 CLEO +- E+ E-, UPSIL(4S) 4/83*

REFERENCES FOR CHARGED B

BEHRENDS 83 PRL 50 881 + (ROCH+RUTG+SYRA+VAND+CORN+ITHA+HARV+OSU)

B^0

42 NEUTRAL B(5274, JP=) I=

SEE ALSO THE LISTING FOR THE B (FOLLOWING THIS ENTRY) FOR MEASUREMENTS WHICH DO NOT IDENTIFY THE CHARGE STATE.

42 NEUTRAL B MASS (MEV)

M A 5 5274.2 2.8 BEHRENDS 83 CLEO 0 D*- PI+ + CC 4/83*
M A STATISTICAL (1.9 MEV) AND SYSTEMATICAL (2.0 MEV) ERRORS COMBINED. 4/83*

42 (B0) - (B+) MASS DIFFERENCE (MEV)

DM A 3.4 3.6 BEHRENDS 83 CLEO E+E-, UPSIL(4S) 3/84*
DM A STATISTICAL (3.0) AND SYSTEMATICAL (2.0) ERRORS COMBINED. 3/84*

39 B PARTIAL DECAY M

P1 B INTO ELECTRON NEUTRINO HADRONS
P2 B INTO MUON NEUTRINO HADRONS
P3 B INTO E+ E- ANYTHING
P4 B INTO MU+ MU- ANYTHING
P5 B INTO KAON ANYTHING
P6 B INTO J/PSI ANYTHING
P7 B INTO D0 ANYTHING
P8 B INTO PROTON ANYTHING
P9 B INTO LAMBDA ANYTHING

39 B BRANCHING RATIO

R1 B INTO (ELECTRON NEUTRINO HADRONS)
R1 A (0.13) (0.042) BEB
R1 B (0.136) (0.039) SPE
R1 C 0.127 0.021 CHA
R1 D 0.132 0.016 KLO
R1 E (0.116) (0.027) NEL
R1 A THE STATISTICAL AND SYSTEMATIC ER
R1 B THE STATISTICAL AND SYSTEMATIC ER
R1 AB THE ELECTRON ENERGY SPECTRA IN BO
R1 AB B-TO-C OVER B-TO-U QUARK TRANSITI
R1 C THE STATISTICAL AND SYSTEMATIC ER
R1 D STATISTICAL AND SYSTEMATIC ERRORS
R1 D RATIO CS(B-->E NU UP)/CS(B-->E NU
R1 E THE STATISTICAL AND SYSTEMATIC ER
R1
R1 ONLY THE EXPERIMENTS AT THE UPSIL
R1
R1
R1 AVG 0.130 0.013 AVERAGE

R2 B INTO (MUON NEUTRINO HADRONS)/TOT
R2 (0.094) (0.036) CHA
R2 A (0.105) (0.020) ADE
R2 B 0.124 0.035 CHA
R2 (0.155) (0.054) (0.029) FER
R2 (0.117) (0.028) ALT
R2 A THE STATISTICAL AND SYSTEMATIC ER
R2 B THE STATISTICAL AND SYSTEMATIC ER
R2
R2 THE AVERAGE OF THE THREE HIGH-ENE
R2 THESE EXPERIMENTS PRODUCE OTHER B
R2 THE B MESON.

R3 B INTO (E+ E- ANYTHING)/TOTAL
R3 (0.05) OR LESS CL=.90 BEB

R4 B INTO (MU+ MU- ANYTHING)/TOTAL
R4 (0.017)OR LESS CL=.90 CHA
R4 0.007 OR LESS CL=.95 ADE
R4 0.007 OR LESS CL=.95 BAR
R4 (0.02) OR LESS CL=.95 ALT

R5 B INTO (DILEPTON ANYTHING)

B Meson Section 2010

Section is 163 pages.

In 2008 was 144 pages

BOTTOM, CHARMED MESONS ($B = C = \pm 1$)

$B_c^+ = c\bar{b}$, $B_c^- = \bar{c}b$, similarly for B_c^*'s

$B_c^\pm$

$I(J^P) = 0(0^-)$

I, J, P need confirmation.

Quantum numbers shown are quark-model predictions.

$B_c^\pm$ MASS

VALUE (GeV)		DOCUMENT ID		TECN	COMMENT
6.277 ±0.006 OUR AVERAGE		Error includes scale factor of 1.6.			
6.2756 ±0.0029 ±0.0025		[1] AALTONEN	08M	CDF	$p\bar{p}$ at 1.96 TeV
6.300 ±0.014 ±0.005		[1] ABAZOV	08T	D0	$p\bar{p}$ at 1.96 TeV
6.4 ±0.39 ±0.13		[2] ABE	98M	CDF	$p\bar{p}$ at 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
6.2857 ±0.0053 ±0.0012		[1] ABULENCIA	06C	CDF	Repl. by AALTONEN 08M
6.32 ±0.06		[3] ACKERSTAFF	98O	OPAL	$e^+e^- \to Z$

[1] Measured using a fully reconstructed decay mode of $B_c \to J/\psi\pi$.

[2] ABE 98M observed $20.4^{+6.2}_{-5.5}$ events in the $B_c^+ \to J/\psi(1s)\ell\nu_\ell$ with a significance of > 4.8 standard deviations. The mass value is estimated from $m(J/\psi(1S)\ell)$.

[3] ACKERSTAFF 98O observed 2 candidate events in the $B_c \to J/\psi(1S)\pi^+$ channel with an estimated background of 0.63 ± 0.20 events.

$B_c^\pm$ MEAN LIFE

"OUR EVALUATION" is an average using rescaled values of the data listed below. The average and rescaling were performed by the Heavy Flavor Averaging Group (HFAG) and are described at

[6] ABE 98M result is derived from the measurement $[\sigma(B^+)\times B(B^+ \to J/\psi(1S)K^+)] = 0.132^{+0.}_{-0.}$ by using PDG 98 values of $B(b \to B^+)$ and B(.

[7] ACKERSTAFF 98O reports $B(Z \to B_c X)/B(Z$ 6.95×10^{-5} at 90%CL. We rescale to our PDG

[8] ABREU 97E value listed is for an assumed τ_{B_c} = $\tau_{B_c} = 1.4$ ps.

[9] BARATE 97H reports $B(Z \to B_c X)/B(Z \to qq$ at 90%CL. We rescale to our PDG 96 values of B candidate event is found, compared to all the which gives $m_{B_c} = 5.96^{+0.25}_{-0.19}$ GeV and τ_{B_c} =

$\Gamma(J/\psi(1S)\pi^+)/\Gamma_{\text{total}} \times B(\bar{b} \to B_c)$

VALUE	CL%	DOCUMENT ID
$<8.2 \times 10^{-5}$	90	[10] BARATE
• • • We do not use the following data for averages		
$<2.4 \times 10^{-4}$	90	[11] ACKERSTAFF
$<3.4 \times 10^{-4}$	90	[12] ABREU
$<2.0 \times 10^{-5}$	95	[13] ABE

[10] BARATE 97H reports $B(Z \to B_c X)/B(Z \to q$ at 90%CL. We rescale to our PDG 96 values of

[11] ACKERSTAFF 98O reports $B(Z \to B_c X)/B(Z$ 1.06×10^{-4} at 90%CL. We rescale to our PDG

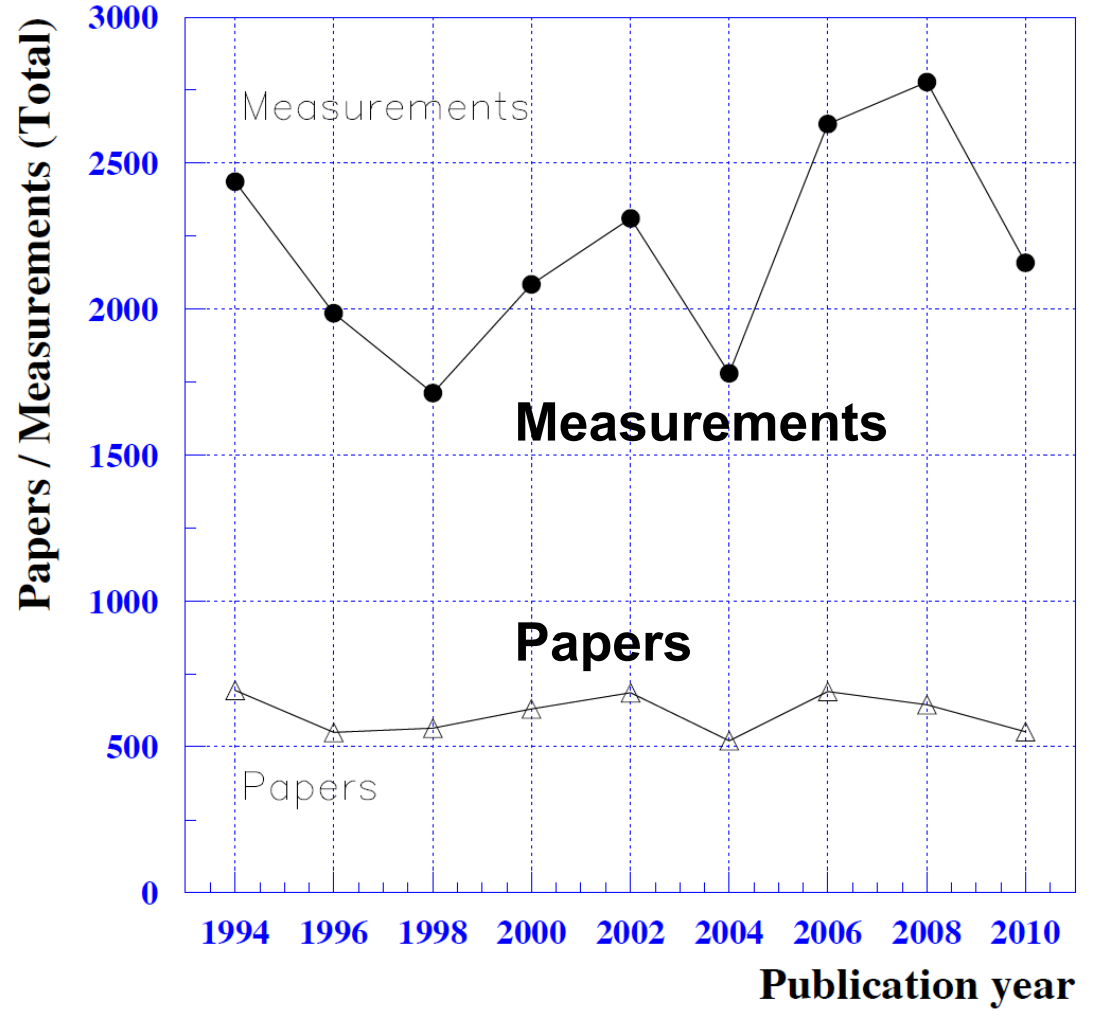
[12] ABREU 97E value listed is for an assumed τ_{B_c} = $\tau_{B_c} = 1.4$ ps.

[13] ABE 96R reports $B(b \to B_c X)/B(b \to B^+$ $J/\psi(1S)K^+) < 0.053$ at 95%CL for $\tau_{B_c} = 0.$ 0.17 ps$< \tau_{B_c} < 1.6$ ps. We rescale to our PDG 96 and $B(B^+ \to J/\psi(1S)K^+) = 0.00101 \pm 0.00$

$\Gamma(J/\psi(1S)\pi^+\pi^+\pi^-)/\Gamma_{\text{total}} \times B(\bar{b} \to B_c)$

VALUE	CL%	DOCUMENT ID

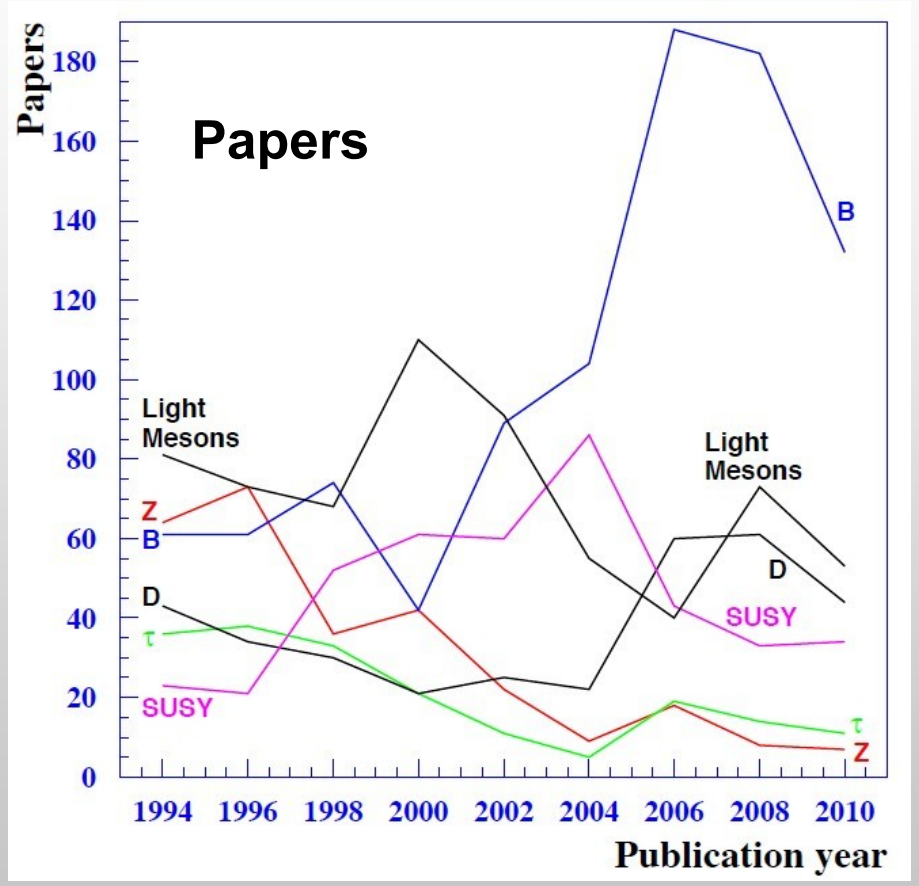
Trends

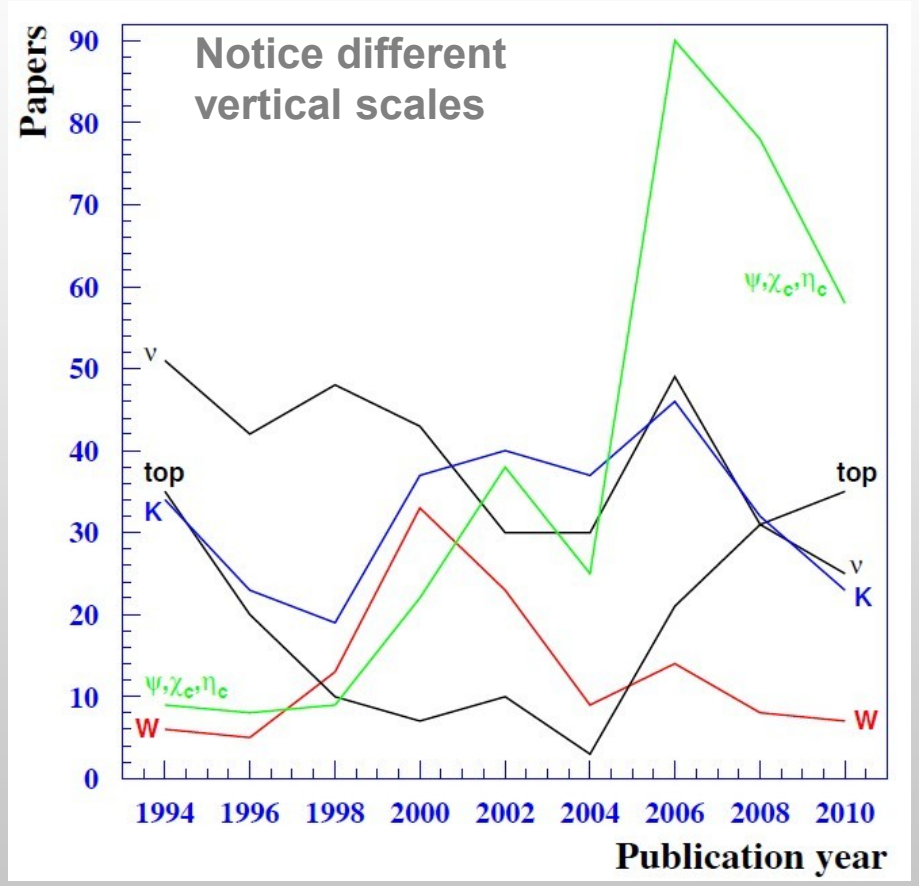


Some editions are more or less than 24 months, yielding fluctuations in graph.

Trends in coverage

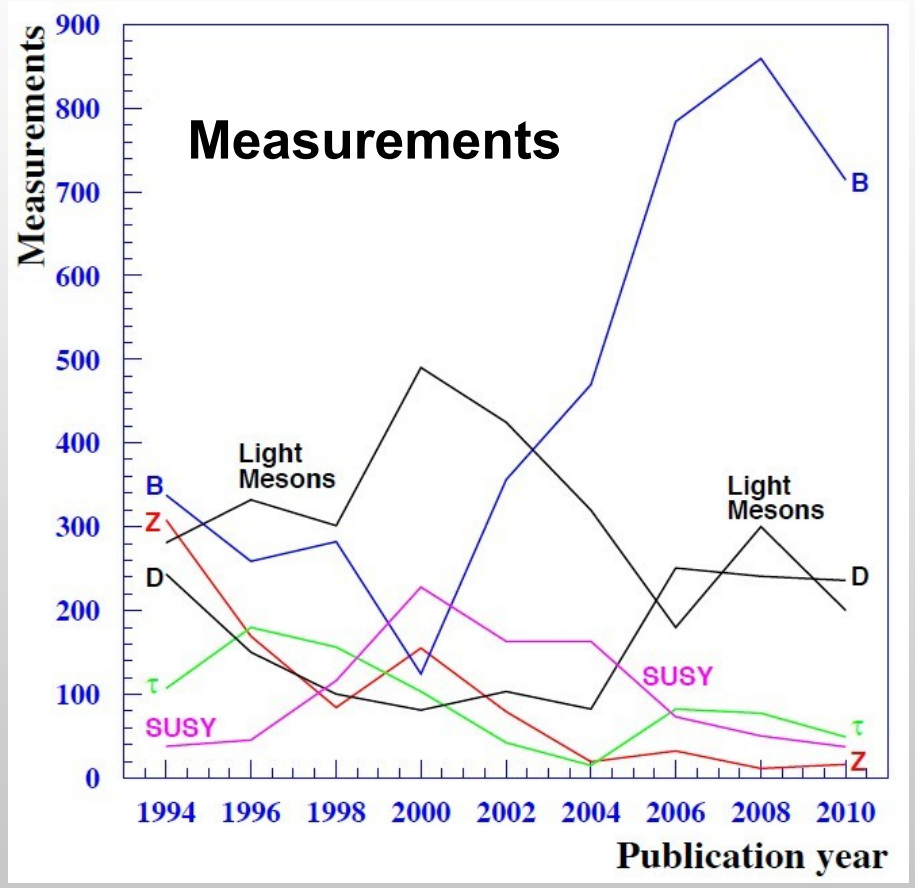
188/182/132 B papers in 2006/2008/2010 editions

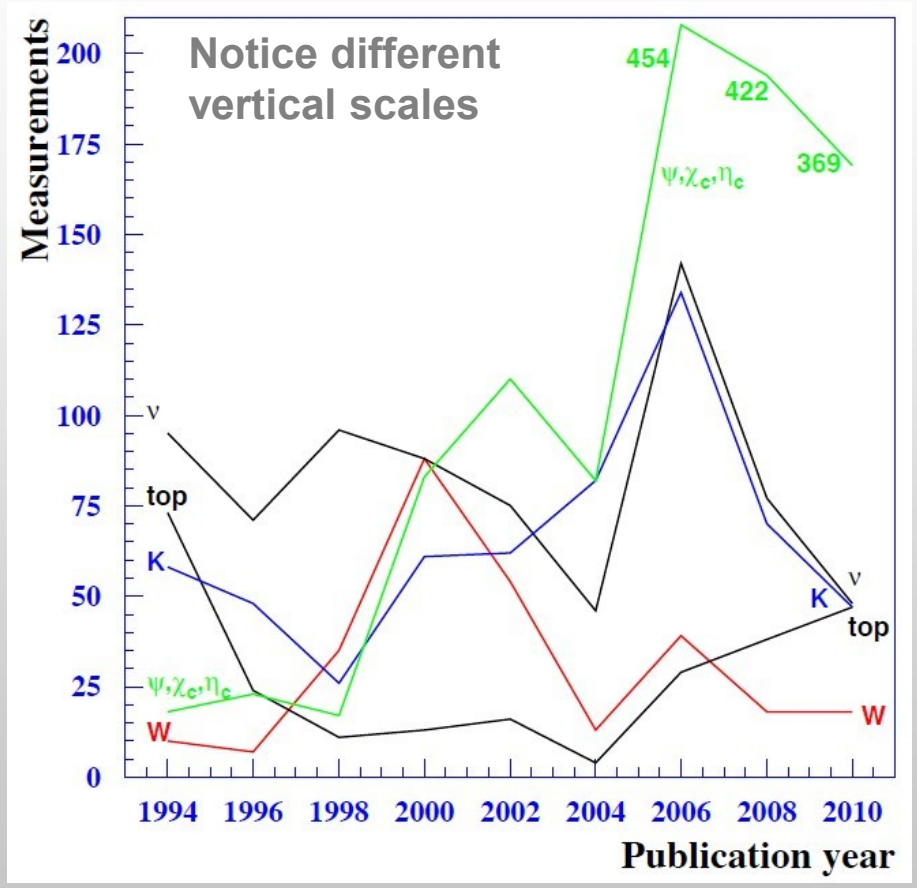




Trends in coverage

784/862/714 B measurements in 2006/2008/2010 editions





New Papers in RPP-2010

Papers	2006	2008	2010
W Boson	14	8	7
Z Boson	18	8	7
τ Lepton	19	14	11
Neutrinos and mixing	49	31	25
Charged hvy leptons	0	0	0
Quarks (u,d,c,s,b)	14	18	17
Top quark	21	31	35
b', t' quarks	0	3	1
γ, e, μ, π, η	20	22	20
K mesons	46	32	23
D and D_s mesons	60	61	44
B and B_s mesons	188	179	132
Supersymmetry	43	33	34
Axions	11	18	21
Higgs	23	12	34
W', Z'	13	18	16
Compositeness	6	6	5
Extra dimensions	11	11	10
Other searches	11	4	12
Free q, monopoles	3	1	3
Baryons	46	33	
ψ, η_c, χ_c, χ_b, upsilon	90	78	
Other unstable mesons	42	66	58
TOTAL	689	645	553

Measurements	2006	2008	2010
W Boson	39	18	18
Z Boson	32	11	16
τ lepton	82	77	49
Neutrinos and mixing	142	77	48
Charged hvy leptons	0	0	0
Quarks (u,d,c,s,b)	24	42	33
Top quark	29	38	47
b', t' quarks	0	3	1
γ, e, μ, π, η	32	44	40
K mesons	134	70	47
D and D_s mesons	251	241	236
B and B_s mesons	784	862	714
Supersymmetry	73	50	37
Axions	13	18	22
Higgs	30	15	45
W', Z'	24	32	29
Compositeness	12	15	5
Extra dimensions	15	12	14
Other searches	23	10	22
Free q, monopoles	10	1	4
Baryons	206	362	
ψ, η_c, χ_c, χ_b, upsilon	454	422	
Other unstable mesons	221	355	369
TOTAL	2633	2778	2167

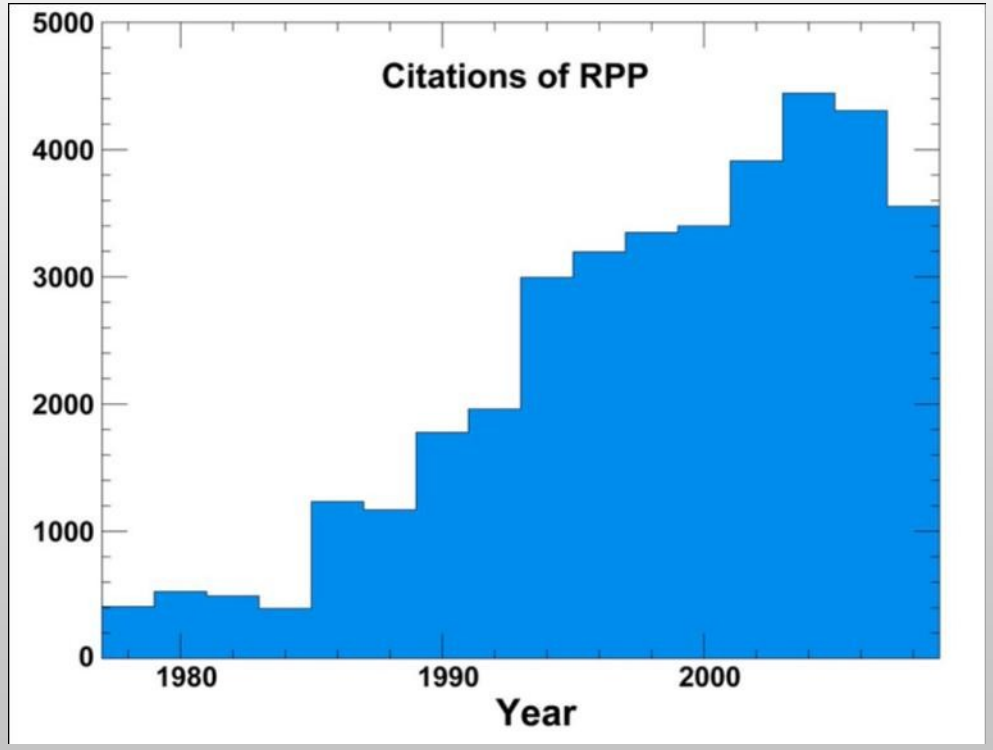
M. Barnett – November 2010

Impact

- 31,000 Booklets requested
- 15,000 RPP books requested
- 11 million hits/year on website (>180 countries)
- 38,000 citations of RPP
- Most cited publication in HEP

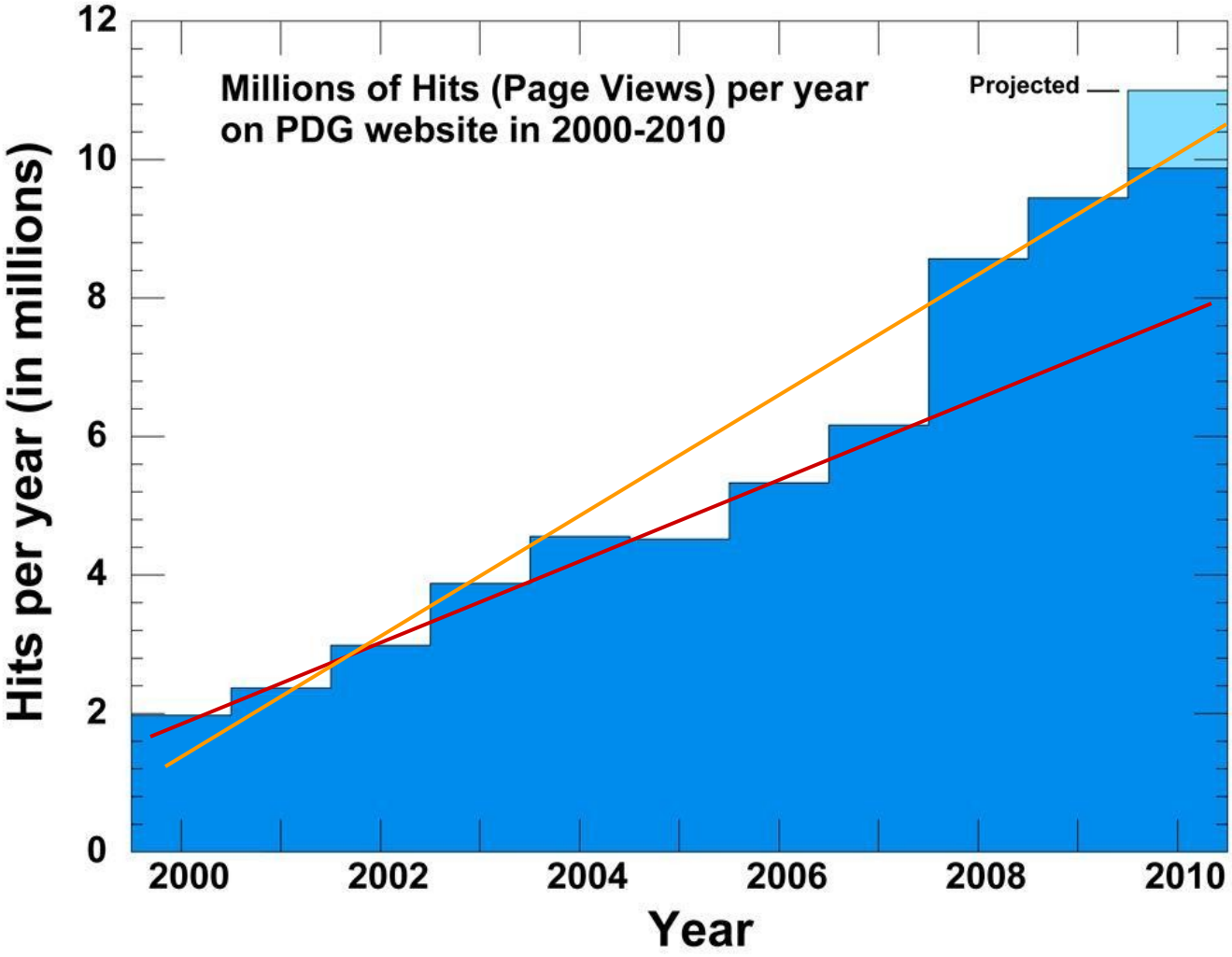
Top Cited

The Review is the all-time top cited article in High Energy Physics with 38,000 citations (SLAC-SPIRES)



Major Web Presence

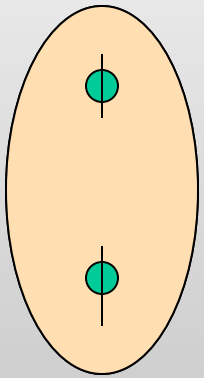
Excluding
Mirror sites
and
Education
webpages

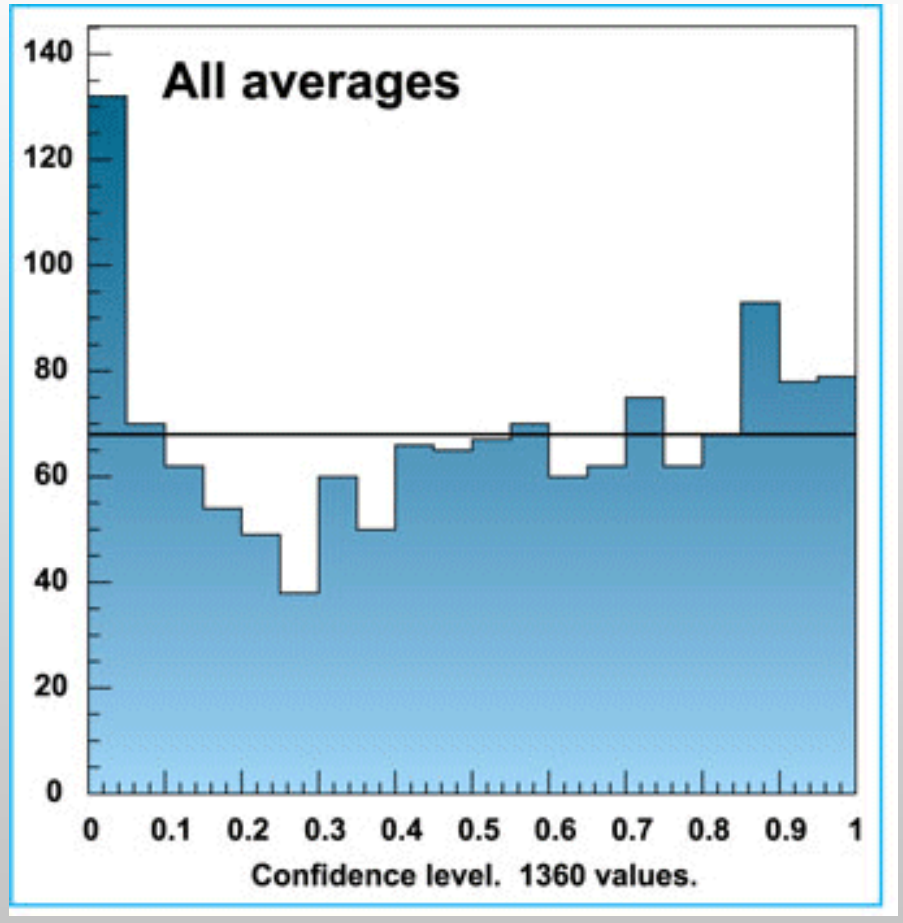


Confidence Levels of Averages

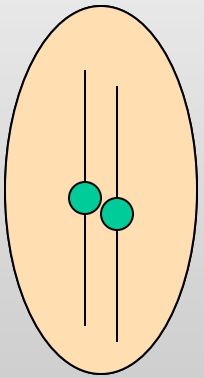
Each point is one average.

Peak at left due to conflicting measurements.





Broad peak at right due to conservative error bars.



Printing Costs

Four publishers bid on RPP and Booklet:

Physics Letters B (Elsevier)

Physical Review D (AIP)

Journal of Physics G (IoP)

European Physical Journal C (Springer)

Printing Costs

Confidential

The problems

Confidential

Vital roles of CERN, Japan, SLAC

CERN

50-year collaboration

Administration for CERN funding (Michael Doser).

Pays publisher directly for their copies (except this year).

Oversees support for the Meson Team (space, travel), which is mostly non-CERN people who meet at CERN.

Mirror website maintained.

Nine CERN members (as individuals):
Doser, Basaglia, Ceccucci, Giudice, Gurtu, Hoecker, Roesler, Sauli, and Silari.

Japan

24-year collaboration

Administration for Japanese funding (Ken-ichi Hikasa)

Oversees support for Japanese members (travel).

Mirror website maintained.

In charge of major sections.

Japan

Reviews and Data Sections

- Neutrinos
- CKM Quark Mixing
- Top quark
- Higgs bosons
- Supersymmetry
- Compositeness of quarks and leptons
- Axions
- Heavy bosons (W', Z', etc.)
- Even more exotic particles.

Japan

Leadership (past and present)

- Dr. Kasuke Takahashi
- Prof. Yoshio Oyanagi
- Prof. Ken-ichi Hikasa (current leader)

Seven Japanese physicists

- Dr. Kaoru Hagiwara (KEK)
- Prof. Ken-ichi Hikasa (Tohoku University)
- Dr. Kenzo Nakamura (KEK)
- Dr. Yoshihide Sakai (KEK)
- Prof. Takayuki Sumiyoshi (Tokyo Metropolitan U.)
- Prof. Masaharu Tanabashi (Nagoya University)
- Prof. Taizan Watari (Tokyo)
- Dr. Akira Yamamoto (KEK)
- Prof. Hitoshi Murayama (various)

SLAC

Many years collaboration (> 20)

Coordination with SLAC SPIRES database via the SLAC Library group.

Yields our ability to link to the papers from which the measurements come.

Many discussions of improved coverage for the HEP community.

The End

Procedures

The process of producing the

Review of Particle Physics

See also organization charts in Summary talk

Procedures

Literature Search

Complete Literature Search by two people of 20 journals (600 papers per edition predominantly from PL, PRL, PR and EPJ)

Enter Literature search results in database

Distribute assignments of papers to Encoders and Overseers

Procedures

Encoding

Each Paper Read Carefully by Two People: by encoder and by overseer

Encoder and Overseer initiate data entry

Encoding data entered into database:
Sections have very different formats

Create new sections, delete sections, reorganize/combine sections

Procedures

Reviews

Write/edit Reviews describing content of and/or problems in a given section

Referee each review and note (3-5 referees)

Place reviews into system so can produce book and web versions

Procedures

Final processing

Edit all sections for consistency, errata, quality, etc.

Request Verification of every entry from each experiment

Enter corrections/changes from Verifications

Calculate Averages, Fits and Best Limits.
Many of these are unique by section

Prepare Summary Table

Prepare Conservation Laws table (with impact on Listings and Summary Table)

Procedures

Production

Post Listings and Reviews on web

Produce 1400-page book of Summary Tables, Listings, Reviews

Produce web versions of everything in book

Produce 308-page Booklet with Summary Tables and abridged version of reviews

Quality Assurance

The HEP Community and many others depend on us for accuracy and integrity

Quality Assurance

- All reviews have 3-5 referees.
- Every item of data that is entered is checked by the experiments (700 people help).
- PDG Advisory Committee reviews all PDG operations

We strive to only report what is a fair consensus of the community.
E.g.- For the growing B sections, the three encoders are from Belle, BaBar, and Tevatron.

We invite comments from the collaborations on many sections.

We organize mini-workshops when we need to consider expanded and improved coverage of a section (such as D mesons, B mesons, neutrinos, tau leptons, CKM, extra dimensions, ...)

PDG Advisory Committee

Hiroaki Aihara – Chair	**(U. of Tokyo)**
Gustaaf Brooijmans	**(Columbia)**
Patrick Janot	**(CERN)**
Deborah Harris	**(Fermilab)**
Gilad Perez	**(Weizmann/Stony Brook)**

Distinguished Members of Past Advisory Committees

Peter Zerwas

Taka Kondo

Michael Turner

Michel della Negra

Jonathan Dorfan

Ann Kernan

Lincoln Wolfenstein

Gary Feldman

Rudiger Voss

Persis Drell

Dieter Schlatter

Paul Langacker

Mark Wise

Stephen Ellis

Chris Quigg

Mike Whalley

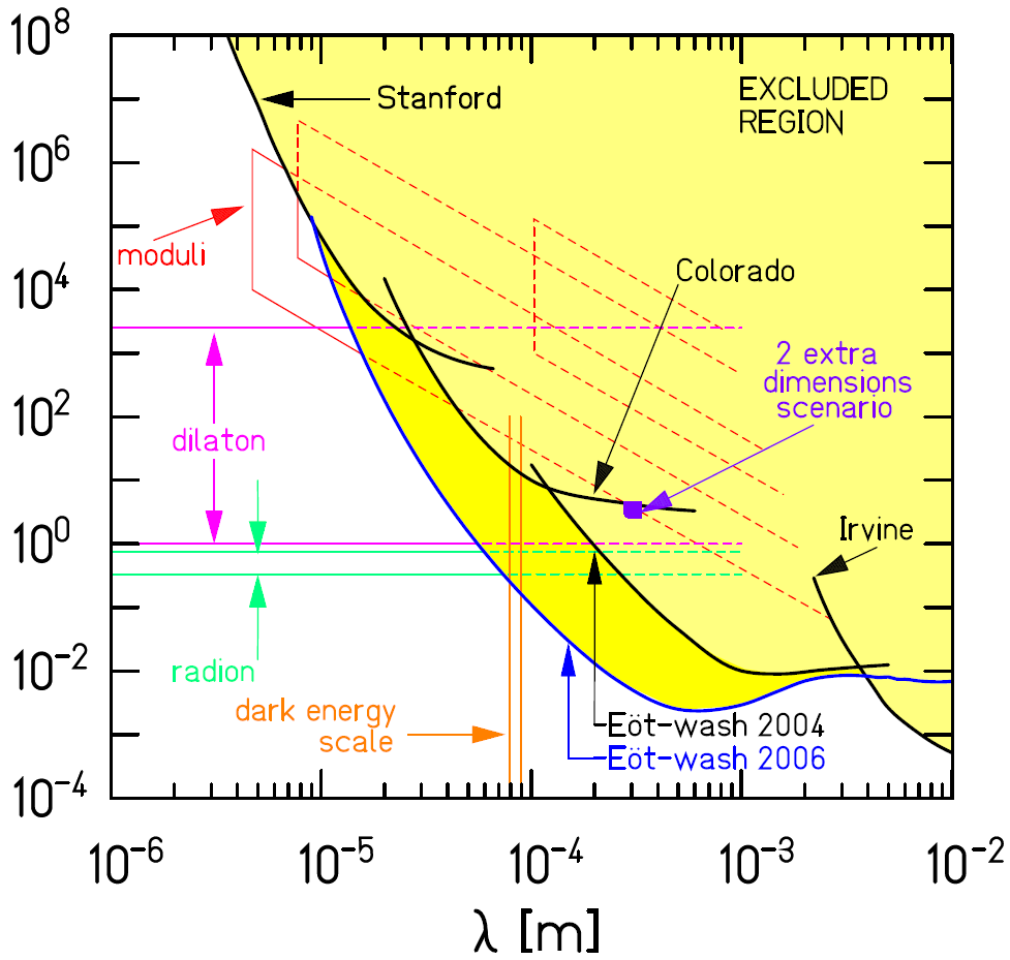
Jonathan Rosner

Fred Gilman

Vital PDG Workshops

Workshops lead to improved coverage

- Neutrino
- CKM
- D Meson
- τ lepton
- Extra-dimensions →
- Statistics



Constraints on deviations from Newton's gravitational force law

Collaboration with Working Groups

Coordination with working groups at

LEP, Tevatron and B-factory on:

- Electroweak fits,
- B lifetimes, B mixing,
- V_{cb} and V_{ub}
- top quark mass, etc.

PDG role in:

- CKM workshops (CERN 2002, Durham 2003, San Diego 2005)
- Statistics workshops, etc.

Looking forward to the new Higgs Working Group (LHC and Tevatron)