Particle Data Group

57 years of service

Where PDG is now, and where our community wishes us to be in the future
PDG Collaboration

206 authors from 24 countries and 140 institutions

Institutions: 57 US, 66 Europe, 15 Other
What is the PDG Collaboration?

PDG at LBNL  (Central coordination and production)
  Physics:  3 FTE’s  (6 physicists: half PDG and half research)
  Editor:   physicist
  Software developer:  physicist

PDG Collaborators outside of LBNL PDG
  196 Physicists from 24 countries  (volunteers at 5-10% level).
  • Most coordinated directly by LBNL  (incl. Japanese Team)
  • Meson Resonances Team (Europe) – 13 physicists – semi-indep.
  • Baryon Resonances Team (JLab) – 5 physicists – semi-indep.

PDG Consultants – 700 physicists
  • Experiments’ Physics Coordinators (etc.) – verifying data listings
  • Referees of reviews (3-5 for each review)
  • General consultants on content

PDG Users -- tens of thousands

Clearly this cannot work without vital central coordination.
Central Leadership is Essential
Quality control has to be the critical path. The community relies on us.

This requires central coordination.

With 206 authors, there are many points of failure. LBNL’s job is to oversee all and make sure there is no failure.
PDG leadership group at LBNL coordinates the entire effort

• Produce and publish the Review
• Handle all of the final checking, editing
• Major contributor to the content
• Choose the authors and the content
• Maintain & drive the schedule
• Coordinate the input of 700 consultants from HEP community
• Assure quality.

Essential for
• High-quality
• Timely publication
Very successful Computing Upgrade completed in Dec. 2011

Enabled many roles:

- **Literature searcher:** 20 journals.
- **Encoder** is world-class expert who interprets papers.
- **Overseer** edits work of encoders.
- **Verifier** is given experiment’s physics coordinator (or equiv.).
- **Review authors.**
- **Referees.**
- **Editor.**
- **Etc.**
PDG Advisory Committee

- Appointed by LBNL Physics Division Director.
- Meets to discuss all aspects of PDG operations.
- Issues detailed report with many recommendations.
- Current committee:
  - Deborah Harris – Chair (Fermilab)
  - James Olsen (Princeton)
  - Junichi Tanaka (U. of Tokyo)
  - Tancredi Carli (CERN)
  - Anze Slosar (BNL - cosmology)
  - Yasunori Nomura (UC Berkeley)
“The leadership of the PDG has done an excellent job of maintaining and expanding the relevance of the project…

The new PDG software has been very successful at producing the data analysis and the web-based interfaces that keep the effort timely, productive and efficient.

This is a laudable accomplishment in light of the recent growth in data coming from the new Cosmic Frontier efforts in the field as well as the success of the LHC.”
PDG Products
What PDG Produces

Review of Particle Physics

Formats:

Printed
- Book – 1675 pages  14k copies
- Booklet – 328 pages  32k copies

Online
- Full content of the book (PDF)
- pdgLive – Interactive database

Detailed and Summarized versions

Schedule:
- Printed updated in even years.
- Online (including pdgLive) updated once a year.
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.
A Highlight

Latest plot shows large mixing of neutrinos

Hitoshi Murayama
Astrophysical Constants 6091
Big Bang Cosmology  7799
Cosmological Parameters: $H_0$, $\Lambda$, $\Omega$, etc. 13769
Experimental Tests of Gravitational Theory 4234
Dark Matter 8591
Dark Energy 7627
Cosmic Background Rad. 5587
Big Bang Nucleosynthesis 4343
Total Cosmology Downloads 58,041 (9.4%)
A Highlight: Higgs coverage

138 new papers in 2014 edition (50 in 2012)

Data Listings split into 3 sections:
- The $H^0$ at 125 GeV (mass, spin, $\sigma_B$)
- Neutral $H^0$ searches
  (incl. MSSM $H_1^0$, $A^0$, general two-doublet models, fermiophobic, invisible, light $A^0$, others)
- Charged $H^\pm$ (doublet) and $H^{\pm\pm}$ (triplet/singlet)

Review article on Higgs
- 53 double-column pages
- 32 figures
- 18 tables
- 500 references
Amazing Diversity of Topics
Interest Our Community

- Higgs boson
- Passage of particles through matter
- Plots of cross sections and related quantities
- Neutrino mass, mixing, and oscillations
- Electroweak model and constraints on new physics
- Particle detectors at accelerators
- Cosmic rays
- QCD
- Statistics
- Quark model
- Cosmological parameters
- Physical constants
- Kinematics
- CKM quark-mixing matrix
- Cross-section formulae
- Dark matter
- Dark energy
- Top quark
- Big bang cosmology

Downloads of PDG reviews in 2014 edition (in past year)

plus 90 more reviews

Downloads

0 10,000 20,000 30,000 40,000 50,000
Covered by PDG

From DOE HEP homepage
IMPACT
The Review is the all-time top cited article in High Energy Physics with more than 51,000 citations (INSPIRE)

Citations increase for years after an edition is published.
Is this just citation inflation?

No

From inSPIRE for all papers

Average number of citations

Year

PDG Citations

1980 1990 2000 2010

0 10 20 30

40 50

1000 5000
Excluding mirror sites and excluding education webpages

Web Usage

Hits per Year on PDG Website in 2000-2014

Year

Hits per Year (in Millions)
Quality Assurance
Quality Assurance

PDG Advisory Committee
PDG Workshops
Collaboration with Working Groups
PDG Research
Workshops lead to improved coverage

- Searches
- Neutrino
- CKM
- D Meson
- \( \tau \) lepton
- Extra-dimensions
- Statistics
Coordination with working groups at LHC, Tevatron, B-factories, LEP on:

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

Many of these provide fits to our data using PDG guidelines.
Research by LBNL PDG members has been recognized as the secret to the success (and quality) of PDG.

It is assures that the book is produced by highly qualified active physicists.

All are only 50% PDG

**LBNL Physicists** (ATLAS, Daya Bay, Theory)

- Juerg Beringer
- Dan Dywer
- Cheng-Ju Lin
- Simone Pagan Griso
- Weiming Yao
- Michael Barnett
“The PDG’s authoritative nature has developed out of a dedication to comprehensive study and evaluation, pursued according to the highest scientific standards.

It's modern, immediate, online character has made it an essential daily tool for students and more senior physicists alike.

Several reviewers remarked that HEP would be a qualitatively weaker field if the PDG were not there as a current, growing resource.”
Issues for PDG
Moving into electronic era of laptops, tablets and smartphones.

People are not always online (travel, planes, etc.). Need apps.

The book is growing too big.

Booklet is big for shirt pockets.

Computing system was built for publishing printed products.

Computing system still needs to enable new features beyond printed products.

Is having a copy of the full-sized book (booklet) essential to your work or study?

Is a Book without Data Listings OK? (45% as big)
Is a Booklet without the condensed reviews OK?

How important is an App?

An amazing **6172** readers responded, demonstrating the very high value our community places on PDG products (and **1491** comments).

(We sent out one email; no reminders).
### PDG Survey on Book, Booklet and APP

<table>
<thead>
<tr>
<th>BOOK</th>
<th>BOOKLET</th>
<th>PREFERENCE (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>32.1</td>
<td>18.5</td>
<td>Not needed</td>
</tr>
<tr>
<td>23.5</td>
<td>18.4</td>
<td>Like but could do without</td>
</tr>
<tr>
<td>26.1</td>
<td>29.9</td>
<td>Satisfied with reduced book(let)</td>
</tr>
<tr>
<td>18.4</td>
<td>33.2</td>
<td>I need the book(let)</td>
</tr>
</tbody>
</table>

Only 18% say they need full-size book.

82% want the booklet in some form.
Two thirds said app was either: Important or Very important.

Comments from survey were emphatic:

Reduced printed products are dependent on producing replacement app(s).
• **Summary Tables**
  Basically easy; just formatting for readability

• **Review articles**
  Even easier except for formatting tables

• **pdgLive**
  Not easy. Major programming to connect to database and to present on-the-fly. Proposal to DOE to do this.
Issue with Book is **cost** and the size and eventual binding issues. (Summary Tables, Reviews and Listings grow every edition).


This year, with essentially no funds to pay for them, one publisher bid on RPP and Booklet: **Chinese Physics C**, at about 8% of their actual cost.
Slow boat from China
Future of Book

Discussed by Collaboration and Advisory Committee

Book:

a) Keep book as is  (Where is funding?  How control size to avoid binding issues?)

b) Discontinue  (Not the preference of 68%)

Conclusion:

c) Reduce content & size to 40-45%  (no data listings)  
   Still some cost, perhaps $80,000 (LBNL share).
Issue with Booklet is **not** cost (paid by CERN)

It is: **the number of pages and eventual binding issues.**

Summary Tables grow every edition
Future of Book and Booklet

Booklet:

a) **Discontinue**  (Not the preference of 82%)

b) **Reduce content & size**  (Which content?  How satisfy readers?).

Conclusion:

c) **Keep booklet as is** – Not urgent decision, so postpone decision for two years (when app is available).
Assuring the Future
“... the age of ink marks on dead tree carcasses is over.”

(Comment from 2014 PDG Survey)
“Nevertheless, keep some hard copies around for after the next big solar flare....”

- Books and booklet will still be in demand for some time

- Demand increasing for electronic distribution, including:
  - Static web pages and PDF files
  - Dynamic web pages (pdgLive - many extensions possible)
  - E-books
  - App(s) for smartphones and tablets (all platforms)
  - API (access to PDG database by programs)
  - Downloadable PDG data (use of our data by others in their apps etc)
  - ...

M. Barnett – December 2014
Long-term Possibilities

- Emphasis on searching and indexing, rather than navigation
- Cross-linking with other services (pdgLive ↔ INSPIRE available)
- pdgLive version for offline use (as an app)
- Interactive plotting, data selection and evaluation
- Interactive presentation of review articles
- User tagging or display of contributed content

Implementing some of these new features is a long-term effort given our very limited resources
Workload and Budget Issues
Some editions are more or less than 24 months, yielding fluctuations in graphs.

So there is an increasing burden on the LBNL group.
<table>
<thead>
<tr>
<th>Papers</th>
<th>2008</th>
<th>2010</th>
<th>2012</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supersymmetry</td>
<td>33</td>
<td>34</td>
<td>68</td>
<td>123</td>
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<tr>
<td>Axions</td>
<td>18</td>
<td>21</td>
<td>21</td>
<td>36</td>
</tr>
<tr>
<td>Higgs</td>
<td>12</td>
<td>34</td>
<td>51</td>
<td>138</td>
</tr>
<tr>
<td>W', Z'</td>
<td>18</td>
<td>16</td>
<td>36</td>
<td>50</td>
</tr>
<tr>
<td>Compositeness</td>
<td>6</td>
<td>5</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>Extra dimensions</td>
<td>11</td>
<td>10</td>
<td>17</td>
<td>32</td>
</tr>
<tr>
<td>Other searches</td>
<td>4</td>
<td>12</td>
<td>37</td>
<td>94</td>
</tr>
<tr>
<td>Free q, monopoles</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>103</td>
<td>135</td>
<td>244</td>
<td>496</td>
</tr>
</tbody>
</table>

132 → 120 → 183 B papers in 2010, 2012, 2014 editions
The success of PDG over many years has been due to the generous support of DOE, NSF, Japan and CERN.

Current funding from DOE + Japan (Japan 6%)

NSF grant (12% of budget) ended last year (after 30 years)

DOE initial guidance during CR, 11% budget cut.

CERN in-kind funding. Covers products shipped to CERN and distributed throughout Europe. Funds Meson Team expenses. Pays all printing costs for Booklet.

The ability of PDG to meet future needs depends on adequate funding.
The PDG budget is essentially salary only.

Handled recent budget cuts by:

- Phased out rehired-retirees.
- Replaced our full-time admin with a 10% admin.
- Pocket Diary for Physicists eliminated.
- All printed products are not currently in our budget. (One-time savings with Chinese publication).

Successful operation requires stable funding at constant level of effort.
Reduced book may be about $80,000 (every other year).
Not in current budget.

To develop interactive app (like pdgLive)
on one-time basis of about 0.25 FTE in FY15 and
0.25 FTE in FY16.

Then cost each year is about $80,000 per year.
Not in current budget.
Impact

- 32,000 Booklets requested
- 14,000 RPP books requested
- 10 million hits/year on website (>180 countries)
- 51,000 citations of RPP
- Most cited publication in HEP
PDG provides a vital, dynamic, innovative service to the HEP community.

The HEP community depends on PDG to provide standards and to assure integrity and quality in summarizing particle physics.
The End
899 new papers with 3283 new measurements.

330 LHC papers: ATLAS, CMS, and LHCb

Extensive Higgs boson coverage from 138 papers with 258 measurements.

Supersymmetry: 123 papers with major exclusions, many from LHC experiments.

Latest from B-meson physics: 183 papers with 803 measurements, including first observation of $B_s \rightarrow \mu^+\mu^-$ from LHCb and CMS.

Cosmology reviews updated to include 2013 Planck.

Updated and new results in neutrino mixing on $\Delta m^2$ and mixing angle measurements, including the first $\Delta m_{32}^2$ from reactor experiment.

72 new top results since 2012, many from LHC experiments.

Final assignment of $1^{++}$ quantum numbers to the $X(3872)$ by LHCb.

Observation of charmonium-like states $X(3900)$ and $X(4020)$ (BESIII and BES3). Observation of bottomonium-like states $X(10620)$ and $X(10650)$ (Belle).

Heavily revised Atomic- Nuclear Properties website.
New reviews on:
- Higgs Boson Physics
- Dark Energy
- Monte Carlo Neutrino Generators
- Resonances

Significant update/revision to reviews on:
- Top Quark
- Dynamical Electroweak Symmetry Breaking
- Astrophysical Constants
- Dark Matter
- Big-Bang Nucleosynthesis
- Neutrino Cross Section Measurements
- Accelerator Physics of Colliders
- High-Energy Collider Parameters
- Total Hadronic Cross Sections Plots
B Meson Section 1984

Entire section was one page