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The PDG Manual

Policies and Procedures of the Particle Data Group

Abstract

This manual discusses the organization, procedures, and policies of the Particle Data Group (PDG). It summarizes the roles and responsibilities for updating Particle Listings and review articles, provides style guidelines for PDG authors and gives an overview of the tools available for working effectively in the PDG collaboration.

Contents

TL;DR (what you really need to read)

This manual serves both as a reference guide for PDG work and as an overview for new PDG collaborators. All PDG authors need to be familiar with the sections relevant for their responsibilities, namely:

- Section 4 if working on the Particle Listings.
- Section 5 if working on review articles.
- Appendix A for links to the online tools and documentation needed to carry out PDG work.
- Appendix F for important style and other conventions to be followed by all collaborators.

New authors joining PDG should start with the checklist for new authors in Appendix B and may want to browse through the Introduction (Section 1) and the discussion of PDG organization (Section 2).

1 Introduction

The Particle Data Group (PDG) is an international collaboration whose goal is to provide a concise, accurate, clear and authoritative summary of particle physics as well as related areas of cosmology and astrophysics. The primary publication produced by PDG is the *Review of Particle Physics* (aka as the *Review*).[1] [2]

This manual discusses how PDG operates and how the *Review* is produced. It provides information necessary to work effectively in the PDG collaboration, including PDG schedule, an overview of available tools, pointers to online documentation, and style guidelines.

The remainder of this introduction gives an overview of the *Review*, discusses how the *Review* should be cited, and provides some statistics on the PDG collaboration, the *Review*, and its impact. The organization of the PDG Collaboration is discussed in Section 2. Section 3 gives an overview of the PDG computing infrastructure. Sections 4 and 5 describe how Particle Listings and review articles are updated and describes the corresponding roles and responsibilities. Several appendices provide additional reference material, including in particular a list of online references essential for PDG work in Appendix A.

1.1 The Review of Particle Physics

The *Review of Particle Physics* consists of three main parts:

- The **Summary Tables** give PDG's best values and limits (as derived in the Particle Listings) for particle masses, widths or lifetimes, branching fractions, and for many other quantities included in the Particle Listings. The Summary Tables also include a summary of searches for hypothetical particles and a compilation of experimental tests of conservation laws.

- **Reviews, Tables, and Plots** contain review articles covering a wide variety of theoretical and experimental topics from particle physics, cosmology and astrophysics. Many review articles discuss topics directly related to the data presented in the Particle Listings.

- The **Particle Listings** (aka Data Listings or Listings) summarize published measurements and limits, provide PDG's best values and limits for the corresponding quantities, and give details on how these results were derived.

Starting with the 2018 edition, the *Review* is divided into 2 volumes. Volume 1 includes the Summary Tables and Reviews, Tables, and Plots. Volume 2 consists of the Particle Listings. Review articles that were previously part of the Listings are now included in Reviews, Tables, and Plots in volume 1.

[1] PDG started in 1957 with the publication of tables of particle masses and lifetimes and the corresponding wallet cards by A. Rosenfeld and M. Gell-Mann. An account of the beginnings of PDG can be found in [1, 2].

[2] In this manual "*Review*" (note upper case and italic font) refers to the whole *Review of Particle Physics*, while "review" refers to an individual article included in the *Review*.

The *Review* is updated and published on the PDG web site [3] each year. In even-numbered years, the *Review* is also published in a dedicated issue of a particle physics journal and volume 1 is made available in print as the *PDG Book* and the abridged *Particle Physics Booklet*. Prior to the 2016 edition, the PDG Book contained the complete *Review*. Since the 2016 edition, the Listings are no longer printed in order to limit the size of the book.

The Summary Tables and Particle Listings are updated each year. Review articles are mostly revised in odd years with minor updates to synchronize with the Listings in even years.

1.2 How to cite the *Review*

The *Review* is considered to be a single, comprehensive review of particle physics and related areas. Therefore it should be cited as a whole, rather than citing e.g. individual review articles that are part of the *Review*. For example, the proper citation of the 2018 edition is:

> M. Tanabashi *et al.* (Particle Data Group), Phys. Rev. D **98**, 030001 (2018)

Should it be necessary to refer to a specific part of the *Review* such as for instance the Quark Model review, the following form should be used:

> *"Quark Model"* in M. Tanabashi *et al.* (Particle Data Group), Phys. Rev. D **98**, 030001 (2018)

1.3 PDG in numbers

The 2018 edition of the *Review* was published by 227 authors and 4 technical associates from 159 institutions in 24 countries. Most authors are volunteers who devote a fraction of their time to a single review article or section in the Listings. Hundreds of "consultants" contribute their expertise as referees, verify new entries in the Listings, provide fit results or give advice on specific topics.

The *Review* is the all-time most highly cited publication in particle physics. Each edition continues to be cited for many years after its publication. According to INSPIRE, recent editions of the *Review* have received over 6,000 citations each.

Here are some further statistics for the 2018 edition:

- 1,898 pages in the online journal publication, 880 pages in the printed book (which does not include the Particle Listings), 256 pages in the Booklet.
- 118 review articles.
- 2,873 new measurements from 758 papers, in addition to 38,498 measurements from 10,564 papers that first appeared in previous editions.
- 10,000 PDG Books and 25,000 Booklets printed that will be distributed world-wide.

- ∼9 million hits/year on the PDG web site (excluding external web sites mirroring the PDG web site and downloads from the journal web site).
- All review articles from the 2016 edition were downloaded more than 1,000 times, and many more than 10,000 times (excluding downloads from mirrors and from the journal web site).
- Based on download statistics, Listings and review articles are accessed at similar rates.

2 Organization

2.1 Coordination

The PDG Collaboration has its headquarters at Lawrence Berkeley National Laboratory (LBNL). The LBNL PDG group provides scientific leadership, central coordination and the technical expertise and infrastructure for the production of the *Review*, in addition to contributing to its contents. The staff scientists in the LBNL PDG group typically work half-time on PDG and are supported by a full-time editor and a small support staff. The group leader of the LBNL PDG group is Head of the PDG Collaboration.

In fall 2017, the team providing central PDG coordination was expanded beyond the LBNL staff to include a scientist supported by INFN. In the following, all scientists involved in the central coordination of PDG will be referred to as "PDG Coordination Team ".

Each topic in the *Review* has a designated contact person within the PDG Coordination Team. The primary responsibility of this contact person is to ensure that the topic is appropriately covered and the corresponding updates to review articles and Listings are completed on schedule. If the contact person participates directly in the updates in this area, that person is called an overseer. In some cases scientific oversight is delegated to an overseer outside of the PDG Coordination Team. In this case the contact person within the coordination team is referred to as coordinator.

The organization of the PDG Collaboration is shown in Figure 1.

2.2 Committees

2.2.1 Representative Board

The PDG Representative Board consists of members of the PDG Collaboration and includes representatives from CERN, Japan, the Meson Team, the Baryon Team, other non-LBNL PDG collaborators, collaborators working on cosmology, and a member of the LBNL PDG group. The Representative Board provides advice to the Head of the PDG Collaboration and is involved in important scientific decisions concerning the *Review*. Examples of such decisions include the addition of new PDG authors or the commissioning of new review articles.

The members of the Representative Board are chosen by the PDG Group Leader in consultation with the corresponding team or group of collaborators being represented.

The current membership of the Representative Board is given in Appendix C.

2.2.2 International Advisory Committee

The PDG International Advisory Committee meets every two years in person for a full-day meeting with the PDG Collaboration in order to review PDG operations and products, and to make detailed recommendations. The committee's conclusions are provided in a written report that is distributed within the collaboration.

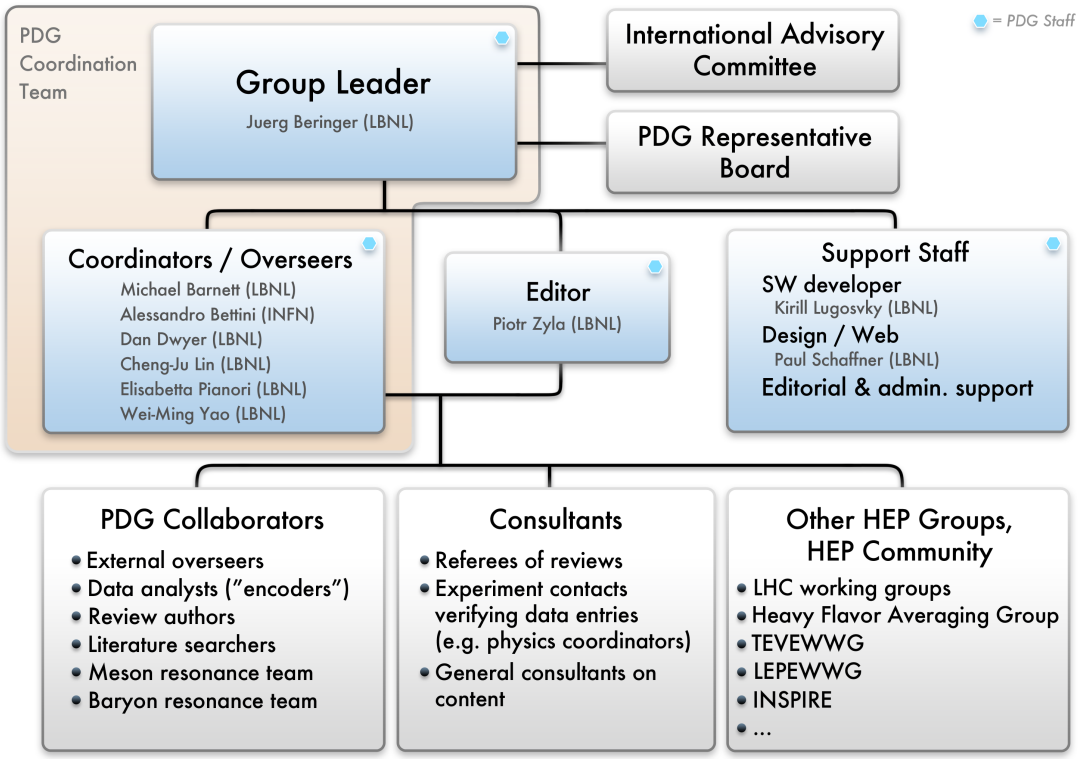

Figure 1: PDG organization.

The members of the Advisory Committee are nominated by the Director of the LBNL Physics Division with the exception of a member representing CERN, who is nominated by the CERN Director General.

The current membership of the Advisory Committee is given in appendix D.

2.3 Meetings

PDG's primary meetings are the Collaboration meeting and the meeting with the Advisory Committee. Both are full-day meetings that take place on successive days every two years in fall, after the publication of the *Review*.

Meetings of the PDG Coordination Team take place as needed.

2.4 Subgroups

2.4.1 Meson resonance team

The meson resonance team (or meson team) is a European-based subgroup of PDG that is responsible for strongly decaying mesons (termed "unstable mesons"). The meson team has about a dozen members and holds regular meetings at CERN.

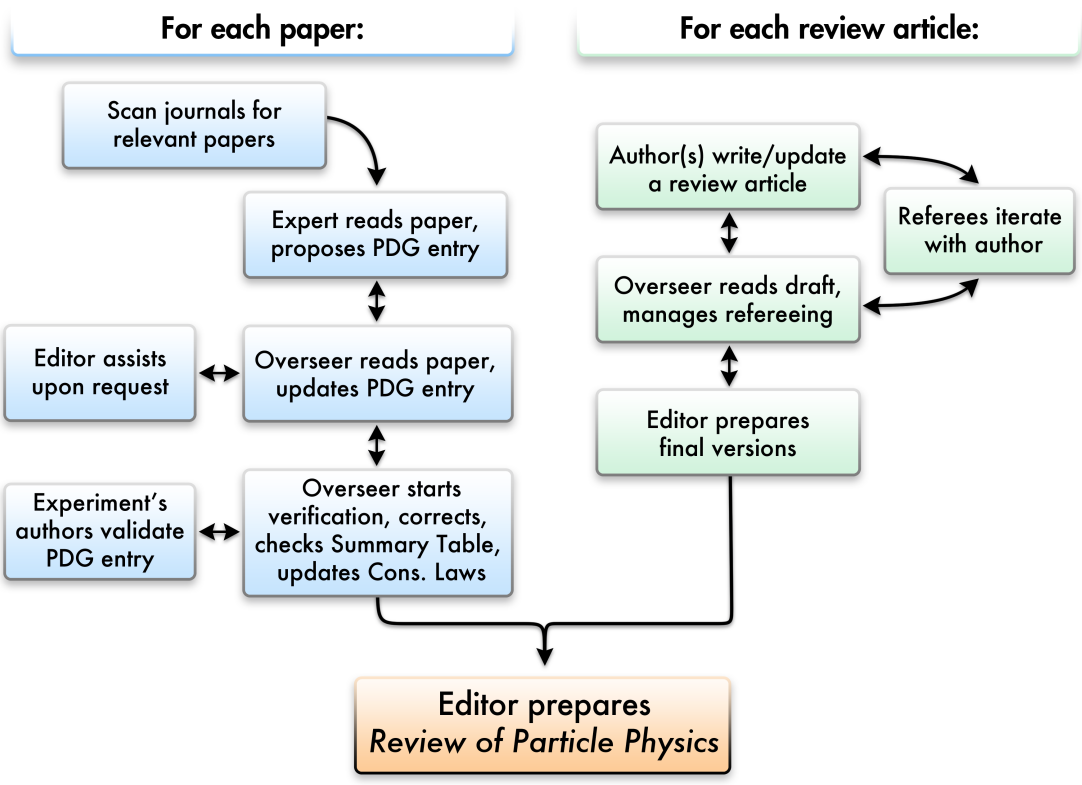

Figure 2: Overview of the process for updating the *Review*.

2.4.2 Baryon resonance team

The baryon resonance team (or baryon team) is responsible for baryon resonances except charmed and bottom baryons.

2.5 Process and schedule for updating the *Review*

The process for updating the *Review* is driven by the publication schedule (see below) and designed to minimize the necessary editorial and coordination work while ensuring quality, accuracy and timeliness. Figure 2 gives an overview of the current process.

Separate workflows are defined to update Listings (Figure 2 left) and review articles (Figure 2 right). The updated Listings and reviews are merged into the complete *Review* by the editor. The Summary Tables are (mostly) automatically generated based on the Listings. PDG averages, fit results and best limits are generally automatically transferred from the Listings into the Summary Tables. Some special entries are added manually. A more detailed discussion of how Listings and review articles are updated is given in Sections 4 and 5, respectively.

To minimize the required staffing level and flatten out the workload of the PDG editor, Listings and review articles are updated at different times:

- Listings are updated yearly in two consecutive update cycles from mid-September to December and from mid-January to March, respectively.

- Review articles are updated in the fall of odd years. Minor updates to synchronize numbers and figures with the updated Listings are made in March of even years prior to publication.

Because of the large scope and the number of persons and tasks involved, the process of updating the *Review* can only work smoothly and on schedule if everyone strictly adheres to the deadlines for their own contributions. These deadlines are communicated to all collaborators well in advance of the start of a new update cycle as part of the PDG schedule. Figure 3 shows a summary of the PDG schedule. The detailed current schedule is available from the PDG web site [4].

2.6 Roles

Hundreds of physicists contribute in different roles to the *Review*. Some physicists can have more than one role. A role can be a long-term responsibility, such as being author of a review, or it may be limited to a specific task (e.g. the verification of a specific new entry in the Listings). The responsibilities associated with each role will be discussed in the sections on updating Listings (Section 4) and review articles (Section 5).

2.6.1 Roles for Listings

For updating the Listings, the following roles are defined:

- **Literature Searchers** scan about 25 relevant journals (see list in Appendix E) and select papers that should be evaluated for possible inclusion into the Listings. Based on the papers title and possibly abstract, each selected paper is assigned to at least one topic (a specific particle or group of particles). This assignment is preliminary and may change later after careful reading of the paper by the encoder to whom it was assigned.

- An **encoder** (or **data analyst**) reads and analyzes papers in his or her area of expertise and suggests if and how the results presented in the paper should be included into the Listings.

- An **overseer** also reads the paper and cross-checks the suggestions made by the encoder for a given paper, iterates with the encoder if necessary until agreement is reached, and finalizes the suggested entries.

- For topics with large numbers of papers, several encoders and/or overseers may work as a **team of encoders and/or overseers**. Each paper still gets assigned to a single encoder and a single overseer, but the different papers are divided up among the team members. Some teams have multiple encoders and a single overseer, while in other teams each member can assume the role of either encoder or overseer for a given paper.

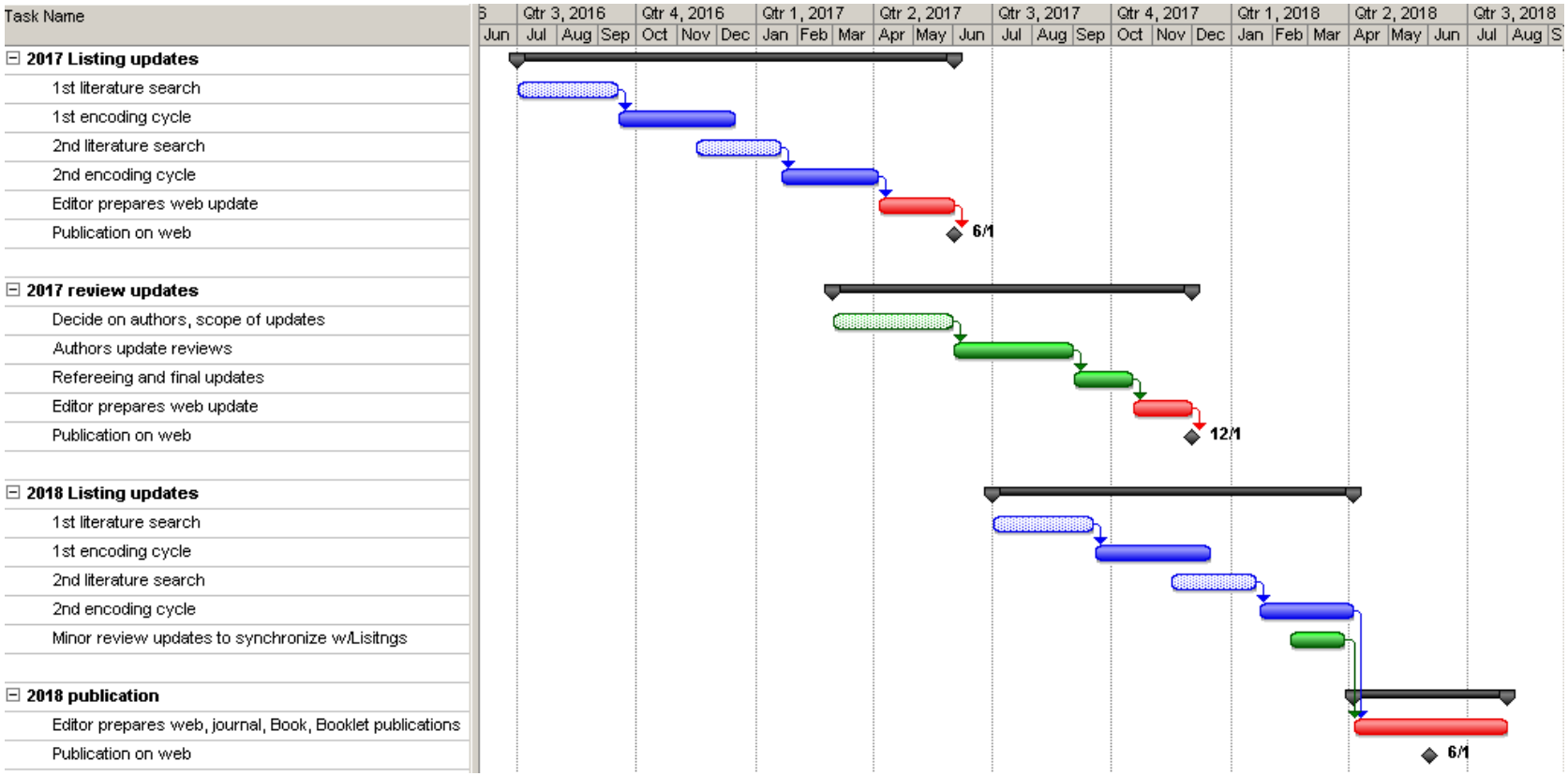

Figure 3: A simplified summary of a 2-year PDG schedule for updating the *Review*. Work on the Listings is shown in blue colors, work on the review articles in green. The time required by the editor to prepare versions of the Listings and reviews for publication on the web, online, and for the Book and Booklet is shown in red.

- **Coordinator**: If the overseer for a given section of the Listings is not a member of the PDG Coordination Team, someone from the PDG Coordination Team will act as coordinator for that section in order to provide help to the overseer, communicate important information, and ensure that updates are completed on schedule.

- The **editor** assists encoders and overseers when needed, checks all new data entries (as well as changes to older ones) for consistency with PDG standards, corrects (or asks overseers to correct) mistakes, runs programs to update fits and averages, and produces the complete Listings and Summary Tables in the different formats for web, journal, book and Booklet as needed.

- A **verifier** is a contact person among the authors of a given publication who is asked to verify and, if necessary, suggest corrections to the draft PDG entry for that publication.

2.6.2 Roles for review articles

For preparing review articles the following roles are defined:

- A **Review author** is an author or co-author of a review article. Review authors are generally world-experts on the corresponding topic who are chosen and invited by PDG to write a given review article. Because authors are expected to maintain and update their review for multiple editions of the *Review*, they should have a tenured (or equivalent) position.

- **Review referees** are invited to referee a specific PDG review article. Refereeing is open (by name) and carried out as a friendly discussion amongst experts. PDG strives to have each review article refereed by 3 to 5 referees. In general these referees should come from outside of the PDG Collaboration.

- **Review overseers** coordinate the process of updating a set of reviews. This includes, when needed, finding and inviting new authors (after they were endorsed by the Representative Board), discussing the scope of needed updates with review authors, requesting new reviews or updates from the authors, selecting referees and managing the refereeing.

- **Review Coordinator**: If the overseer for a given review article is not a member of the PDG Coordination Team, someone from the PDG Coordination Team will act as coordinator for that review in order to provide help to the overseer, communicate important information, and ensure that the review is updated on schedule.

- The **editor** assists when needed, finalizes the source files for each review (including final formatting and typesetting), prepares different versions for web, journal, book and Booklet as needed, and merges the individual reviews into the final manuscript of the *Review*.

2.6.3 Head of PDG

The group leader of the LBNL PDG group, who is chosen by the LBNL Physics Division Director, is Head of the PDG Collaboration. He or she acts as spokesperson of the collaboration and organizes and manages the work needed to update and publish the *Review*.

2.6.4 Other roles

In addition to the scientific roles described above, there are many other essential tasks that are mostly carried out by members of the LBNL PDG group. These include software development, maintenance of the PDG computing system, and web/graphic design.

2.7 Authorship of the *Review*

The PDG Collaboration consists of the authors of the *Review* and includes both the scientific authors and Technical Associates.

The scientific authors of the *Review* include:

- Literature searchers
- Encoders
- Overseers and coordinators of the Listings
- Active authors of PDG review articles. An author is considered active if he or she actively maintains a review article, even if this does not result in substantial changes to that review. Authors who wrote a review article that continues to be included with essentially no changes but are no longer active in maintaining their review remain on the author list of the *Review* for one more edition after becoming inactive.
- Overseers and coordinators of reviews
- PDG editor
- Head of PDG

Technical Associates are PDG authors who make substantial contributions to the software, production or publication of the *Review* but are not scientific authors. This includes software developers, system managers, web/graphic designers, and administrative support. Technical Associates are expected to devote a significant fraction of their time to PDG tasks over an extended period of time.

The contributions of referees, verifiers, and anybody else who provided advice and expertise in specific areas but is not a scientific author or Technical Associate are acknowledged in the list of Consultants that is published in the Introduction of the *Review*.

2.7.1 Becoming a PDG author

Becoming a PDG author is by invitation only.

All new scientific authors must be vetted by the PDG Representative Board (see Section 2.2.1) before they can be invited to contribute to PDG. Technical Associates must be endorsed by the Head of PDG.

2.7.2 Termination of authorship

PDG authorship (and therefore membership in the PDG Collaboration) may end due to several reasons, including:

- An author wishes to retire from her or his PDG duties. Whenever possible, authors should communicate their decision at least 3 months before the start of a new encoding or review update cycle in order to allow finding a replacement before the start of the new cycle.
- In order to ensure that review articles remain up-to-date and incorporate new developments in the corresponding area, review authors are normally changed after a few editions.
- In rare cases, authors may be dismissed from PDG if their contributions do not meet PDG quality standards, if they fail to complete their assignments, or if they complete them only with substantial delays that jeopardize the PDG schedule.

Authors who contributed to the previous edition of the Review but are no longer active in PDG remain on the author list for one more edition (unless they were dismissed because they failed to fulfill their PDG duties).

2.7.3 Publication of the PDG author list

The PDG author list is published on the PDG web site, in the journal publication of the *Review*, and in the PDG Book. The Booklet includes an abridged version of the author list that does not include affiliations.

The PDG author list is updated both when the *Review* is published in a journal and when partial updates of Listings or review articles are posted on the PDG web site. For partial updates, all authors of the last journal publication remain on the author list.

Except for the first author, the PDG author list is ordered alphabetically by author name[3]. The first author is generally chosen by alternating among authors from CERN and the meson team, Japan, LBNL and authors from other institutions. Special consideration for becoming first author is given to long-time PDG authors who have made extraordinary contributions to PDG. The first author changes only in even years for the journal publications and stays the same for partial updates in intermediate years.

[3]Some or all members of the first author's group are sometimes listed immediately after the first author and before the other authors.

2.8 Collaboration with other groups

PDG collaborates extensively with other HEP groups and organizations, including:

- LHC working groups
- Heavy Flavor Averaging Group (HFLAV)
- Tevatron Electroweak Working Group (TEVEWWG)
- LEP Electroweak Working Group (LEPEWWG)
- INSPIRE

If an established working group exists in a given area, PDG works together with this group to derive the corresponding averages and fit results quoted in the *Review*. Typically this means that the working group is asked to run their fits using exactly the results included in the Listings while excluding any (preliminary) results that might otherwise be included in their fits.

3 Computing infrastructure

The PDG computing infrastructure consists of:

- A web-based computing platform known as `PdgWorkspace` that provides each collaborator with a set of tools for updating the *Review* that is tailored to his/her responsibilities. Most PDG work is done in `PdgWorkspace` or, in the case of writing reviews, on the collaborator's own laptop or PC.
- The PDG main server hosts the PDG production database, `PdgWorkspace` and other web-based services and tools. The editor uses this server to run fits, averages, and to produce the *Review* in different formats. Most collaborators do not need to access the main server directly as they can use all necessary tools via `PdgWorkspace` (see above).
- The PDG web server hosts the public PDG web site [3] with static web pages and pdgLive [5] as well as the ordering system.

The PDG computing infrastructure is illustrated in Figure 4. A more detailed and still mostly up-to-date description can be found in the Proceedings of the CHEP 2010 conference [6].

All PDG Collaborators have access to `PdgWorkspace`. The checklist in Appendix B provides instructions for setting up your `PdgWorkspace` account. Appendix A gives the necessary references to access the PDG computing tools.

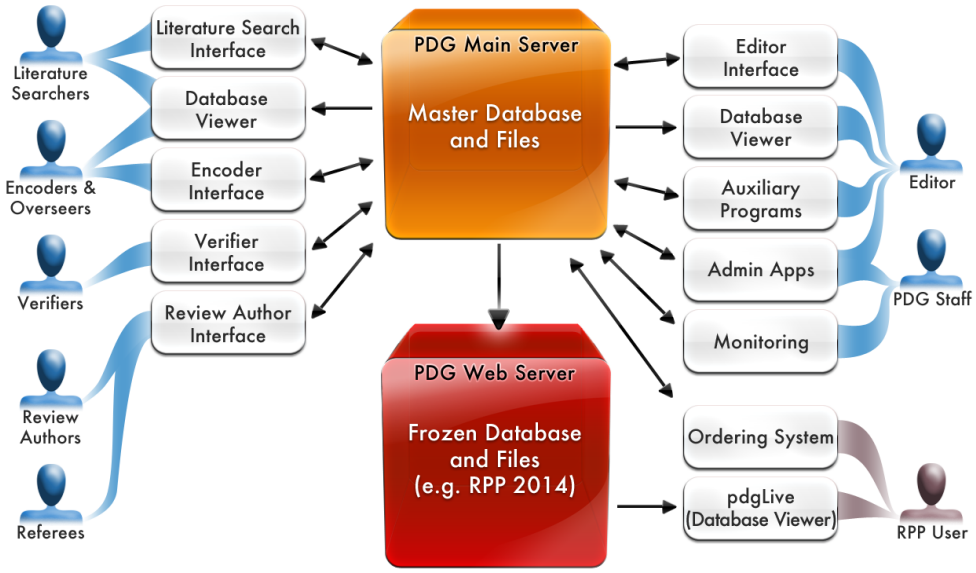

Figure 4: Overview of the PDG computing infrastructure.

4 Updating the Listings

4.1 Overview

The workflow for updating the Listings is illustrated in the left-hand side of Figure 2. It consists of the following steps that are repeated for each published paper:

1. Literature searchers look through journals (see Appendix E for the list of journals being scanned) for published articles with results potentially relevant for PDG. These articles are tagged with so-called particle code(s)[4]. At the start of the encoding cycle, the editor releases the lists of tagged articles to the encoders responsible for the corresponding particle codes. The released lists of articles are available in `PdgWorkspace`.

2. Each paper is carefully read by the encoder(s) responsible for the particle code(s) it was tagged with. The encoder decides which (if any) results should be included in the Listings and enters a draft entry (a so-called encoding) into the PDG database using `PdgWorkspace`. If needed, other entries are modified, for example an earlier publication using part of the same data might be superseded and is no longer included in averages and fits. If the paper was tagged incorrectly, and thus assigned to the wrong encoder, the encoder needs to add the correct code(s) so that the corresponding encoder will pick up the paper. Articles that have no relevant results for the encoder's responsibilities are automatically marked as "empty" with respect to these areas by `PdgWorkspace`. When an encoder completes the initial encoding, she or he signs the paper off to the overseer.

3. The overseer reads the paper and examines the draft entry prepared by the encoder. He or she may discuss with the encoder until both agree on the new entry. The overseer ensures that the entry is consistent with the style and level of detail of other entries, updates the corresponding section as needed in view of the new result, and finally signs off the new entry.

4. Whenever a new entry is signed off, it becomes available for verification. Requests to check new entries are e-mailed automatically once per week to the corresponding verifiers. Any comments or requests for changes submitted by the verifier will be e-mailed to the corresponding overseer, and the corresponding paper will re-appear in the overseer's list of pending papers in `PdgWorkspace`. If needed, the overseer corrects the encoding. All encodings that received comments from verifiers need to be signed off again by the overseer, even if no corrections were made.

5. Finally, the editor checks each new entry to make sure that the information was correctly added to the PDG database. His focus is on technical correctness; he does not check the scientific accuracy of the entry.

[4]For example, the code "Q007" denotes the top quark. The list of all particle codes is available within `PdgWorkspace`.

This workflow is supported by `PdgWorkspace`, which takes care of maintaining for each paper what needs to be done next and by whom.

The Listings are updated each year during two consecutive update cycles:

- **First cycle**: The literature search becomes available mid-September. Encoders complete their work in October. Overseers need to sign off all papers before the end of November. Verification starts automatically whenever a paper is signed off.

- **Second cycle**: The literature search becomes available mid-January. Encoders complete their work by mid-February. Overseers need to sign off all papers early in March. Verification starts automatically whenever a paper is signed off. Fit results from external groups, checks of the Summary Tables, and the update of the Conservation Law entries must be completed by early April, when the second cycle finishes and the editor starts preparing the manuscript of the complete *Review*.

A typical but simplified schedule for updating the Listings is shown as part of Figure 3. The actual schedule is e-mailed to all PDG collaborators and can be found on the PDG-internal web site [4].

4.2 General guidelines for updating the Listings

The following guidelines apply for deciding what and how new results are added to the Listings:

- Only published results are included in the data tables of the Listings.

- PDG fits and averages can only include published results. This applies both to averages and fits produced by PDG and to combinations requested from external groups.

- In special cases that must be well justified, unpublished preliminary results may be mentioned in footnotes or header text in the Listings if doing so provides substantial additional information. Unpublished results are never used in PDG averages or fits, nor can they be included in the data tables themselves.

- A result is considered published if it has been accepted for publication by a journal and the reference for its publication is known. The published version does not need to have appeared before the cut-off date for including results.

- Results published in a refereed journal are in general included into the Listings. They are or are not used in averages and fits based on the judgment of the corresponding encoder and overseer.

- Occasionally an encoder or overseer may have serious concerns about the validity of a published result. Such concerns may be noted in a footnote but should in all cases first be discussed with the authors of the publication to avoid unnecessary misunderstandings. Only in very rare cases should a newly published result be omitted from the

Listings, e.g. when the authors retract a result or indicate otherwise that it might not be reliable.

- The Listings do not aim to be a complete, archival record of all published results. On the contrary, obsolete results should periodically be removed.

- When adding newly discovered particles to the Listings, the corresponding data is typically only included in the Summary Tables if the new particle or state was seen by at least 2 experiments.

4.3 Responsibilities

4.3.1 Literature searchers

- Scan the standard set of journals (see Appendix E) for articles with results that should be included into the *Review*.

- Using the Literature Search tool in `PdgWorkspace`, enter the list of found articles, tagged with the corresponding particle codes, into the PDG database.

- Make sure that the literature search is completed by the relevant deadline (see Appendix A.3). This is extremely important, because the encoding cycle cannot start before the literature search is completed.

4.3.2 Encoders

- Carefully read each paper. If there are results that deserve inclusion into the Listings decide on an appropriate tentative encoding and enter it into the PDG database using `PdgWorkspace`.

- If necessary for understanding the result (e.g. in the case of model-dependent limits from searches), provide additional details on the result in a brief footnote.

- Decide whether the new result should be included in PDG averages and fits ("used") or whether it is the "best limit". Results marked as "not used" will appear "below the line" shown in the corresponding data block.

- Update older measurements, footnotes, header text etc as needed to include the new result. In particular, make sure to mark any older, now superseded, results as "not used", so that they will no longer be included into PDG averages and fits.

- If help from the editor or discussion with the overseer are needed to complete the encoding, use the messaging system in `PdgWorkspace` rather than e-mail for any interactions that don't require discussion in person or by phone. This makes it much easier for the editor to help and keeps a record of discussions during the encoding process.

- Sign off all your papers to the overseer at the latest by the corresponding deadline.

4.3.3 Overseers

- When needed, identify new encoders in consultation with the PDG group leader, then have them vetted as new PDG authors by the PDG Representative Board (see Section 2.2.1). Tentative new encoders must not be contacted before they are vetted by the PDG Representative Board.

- Review and, if appropriate, incorporate any recommendations made by the PDG Advisory Commmittee (The Advisory Committee provides a written report with their recommendations. The report is distributed to the PDG Collaboration within a few months after each Advisory Committee meeting).

- Periodically examine the current version of your sections of the Listings to see if any overall reorganization, updates or corrections are needed. If so, plan ahead and discuss with the editor (especially if he needs to carry out larger changes), then choose an appropriate time to carry out the changes.

- Carefully read each paper assigned to your section(s) and validate any tentative encodings entered by the encoder. Discuss as needed with the encoder to arrive at the final encoding.

- Make sure older measurements, footnotes, header text etc are updated as needed to reflect new results.

- Make sure the correct verifier and collaboration was entered.

- To the extent possible, make sure that the encoding was entered following PDG standards by using PDG macros, etc.

- Once the encoding is complete, sign off in `PdgWorkspace`. This will initiate the verification process and allow the editor to finalize the encoding.

- If there are any comments or requests for corrections from the verifier, make the necessary updates, then sign off the encoding again. If you disagree with any requested changes, reach out to the verifier to try to resolve the disagreement.

- To allow on-time publication of the *Review*, it is essential to complete all encodings by the deadline. To make this possible, although automatic reminders are sent to the encoder, it is important to communicate with the encoder early to make sure he or she completes their assigned papers on schedule.

- Once the Summary Tables are ready, the editor will request that you check the Summary Tables and make sure the Conservation Laws section is updated with any new results. When checking the Summary Tables, it is especially important to check all quantities flagged for manual updating, as well as any entries corresponding to new quantities added to the Listings.

4.3.4 Coordinators

The responsibility of a coordinator is to ensure that overseers who are not part of the PDG Coordination Team are properly informed about their duties and deadlines. If an overseer (or encoder) does not fulfill his or her responsibilities on time, it is the responsibility of the coordinator to step in and take the necessary measures to ensure timely completion of the corresponding work. In order to allow this, the coordinator has access in `PdgWorkspace` to all papers of his overseer(s) and can, if needed, make any necessary updates.

4.3.5 Editor

The editor is available to help with adding or updating entries in the Listings, especially in the case of complicated entries. He maintains the contents of the PDG database and eventually checks each new or modified entry for technical correctness. He also runs averages and fits. Ultimately he prepares the final versions of Listings and Summary Tables in the different formats for the web, the online journal publication, and for the book and booklet (Summary Tables only). Before releasing the web edition or manuscript for the publishers, he asks all overseers to check the final version of the *Review*.

5 Updating review articles

5.1 Overview

The workflow for updating review articles is illustrated in the right-hand side of Figure 2. For each review, it consists of the following steps:

0. Well before the start of a review update cycle, the overseer determines if the past author(s) of the review should be kept and are still available to update their review, or if author changes are needed. In the latter case, the overseer, with help from the PDG Coordination Team and the Head of PDG, and after consulting with experts in the corresponding area, proposes new author(s) to the Representative Board. After they are vetted, the overseer invites the new author(s) to become responsible for the corresponding PDG review. New authors may choose to revise an existing review, or to rewrite it completely.

1. At the start of the review update cycle, the overseer discusses the planned scope of needed updates (or of a new review) with the review's authors. The authors then write or update their review article.

2. While the authors work on their review, the overseer identifies 3 to 5 referees who will be available to referee the updated review. It is important to identify referees in advance and make sure that they will be available in order to avoid delays between the time when the authors complete the draft and when refereeing starts. Occasionally, refereeing may not be necessary, but even if the authors deem no changes to be necessary, each review (with very few exceptions such as e.g. Clebsch-Gordon coefficients) should be refereed at least once every few editions.

3. When the authors complete their draft, the overseer reads it carefully to ensure it is ready for refereeing and then sends it to the referees.

4. Refereeing in PDG is an open process, so referees send their suggestions directly to the authors (the overseer must be CCed). Authors and referees iterate under the supervision of the overseer until all comments and suggestions are addressed. If an author disagrees with a suggestion, he or she does not need to implement it but should explain the decision to the corresponding referee.

5. Once the refereeing process is complete and the authors provide the final draft of the updated review, the editor takes care of the final formatting and produces the different versions (web, journal publication, book, booklet).

This workflow is supported by the review authoring tool in `PdgWorkspace`, which is used by the overseer to maintain the current status of each review as well as author and referee assignments. PDG uses Subversion (SVN) [7] for managing the different versions of the review. Authors have access to SVN and are encouraged to use it to submit their updates.

Alternatively, they can download review source files via `PdgWorkspace` and return the revised version by e-mail to the overseer, who needs to import the new version into SVN.

Reviews can be updated every two years (in odd years) during summer and fall. In addition, minor updates can be made in even years shortly before the publication of the *Review*. This can only be used to synchronize numbers and figures with the latest results presented in the Listings. The detailed timeline for review updates is given in the schedule e-mailed to all PDG collaborators and can be found on the PDG-internal web site [4].

Not all reviews need to be updated in each update cycle.

New reviews may be added or existing ones may be dropped based on recommendations from the PDG Advisory Committee or input from the community, or to take into account new developments.

5.2 General guidelines for updating reviews

The following general guidelines apply to all PDG review articles:

- PDG reviews are targeted at the level of graduate students.
- Reviews should be up-to-date and well-written. They should provide a **broad yet concise overview that is mostly free of personal biases**. Author(s) must not describe their own work above the work of others.
- Review authors must observe all applicable copyright laws. In particular, when reusing a figure from another publication, the review's author(s) must obtain permission to use the figure, and the origin of the figure must be properly acknowledged. The source of a slightly modified or adapted figure must also be cited.
- At the latest during the refereeing period, experiments whose results are quoted must be given an opportunity to check what is quoted in the review (typically this can be done by asking a representative of the experiment to be a referee).
- In contrast to the Listings, PDG review articles may refer to unpublished public results at the discretion of the review authors. This includes results or plots shown at a conference, independently of whether an accompanying written note or preprint is available (assuming that at least the corresponding slides with the result are available publicly). The threshold for inclusion should be set substantially higher if there is no accompanying documentation. Unpublished public results should only be included if the review authors are reasonably confident that an unpublished result is solid and will eventually be published. (Needless to say, non-public results can never be quoted by PDG.)
- PDG results, averages and fits given in reviews must be consistent with the values presented in the Listings. This is especially important for the journal publication of the *Review*. If necessary, minor updates to synchronize numbers and figures with the Listings can be made in the spring of even years, after the corresponding Listing updates and prior to publication.

- If review authors wish to make a version of their PDG review available as a preprint on arXiv [8], they are free to do so but only after the review article has been made public on the PDG web site or appeared in the journal publication of the *Review*.

5.3 Responsibilities

The following sections discuss the responsibilities of review authors, overseers, referees, and the editor.

One essential responsibility shared by everybody involved in the review update process is to meet the different deadlines. **Late reviews will be omitted from publication and postponed to a later edition if necessary for on-time publication of the *Review*.**

5.3.1 Review authors

- For existing reviews, revisit the published current version and think about what might be missing, needs to updated, or is no longer relevant. Consider any recommendations from the Advisory Committee. Think about how this review fits into the complete *Review* and whether there are any inconsistencies or duplications. Decide on needed updates and discuss them with the overseer early in the review update cycle.

- In order to constrain the size of the *Review*, each review is allocated a fixed number of pages. Any requests for extending this page allocation must be made and justified to both overseer and Head of PDG well in advance.

- For new reviews, discuss the scope, level of detail, and expected length with the overseer. Become familiar with related sections in the Listings or other reviews in the *Review*.

- **At the beginning of the review update cycle, obtain the latest version of the review source files from `PdgWorkspace`**. This is essential to avoid losing any final changes done by the editor prior to the last publication. Review authors must never resume their work based on a previous version of their own copy of the source files.

- Discuss with the overseer if the revised review will need to be refereed. All substantial changes must be refereed. Refereeing is not necessary if changes are minor and the version of the review published in a recent edition was refereed. Most reviews need to be refereed at least once every few editions, even if no substantial changes are made. This is necessary to ensure no new developments or results are missed.

- When reusing a figure from another publication, obtain the publisher's permission to reuse the figure (unless the figure is your own and you retained the copyright).

- Provide the draft version of the updated or new review to the overseer at the latest by the corresponding deadline (see current schedule, Section A.3). If no updates are needed, inform the overseer as early as possible.

- Respond to any comments or suggestions from referees in detail. Either address them by implementing the suggestion in the review, or explain the decision to disregard the suggestion. Provide the revised final draft of the review to the editor by the corresponding deadline. Refereeing in PDG is an open process, so please discuss directly with the referee(s) but make sure the overseer is copied on all discussions.

- If the review is directly related to a section of the Listings, make sure the review is consistent with the results and averages quoted there. If needed, minor updates to synchronize numbers and figures with the Listings can be made shortly before publication (see schedule, Section A.3).

5.3.2 Review referees

- Following the instructions from the overseer, carefully referee the draft version of a review and provide feedback by the deadline given by the overseer. Feedback received after the deadline may be incorporated only for a later edition of the *Review*.

- Note that refereeing is open (by name), therefore comments and suggestions should be sent directly to the authors, with CC to the overseer.

5.3.3 Review overseers

Overseers are responsible for making sure that the authors deliver a high-quality, refereed review to the editor by the corresponding deadline.

- Although the addition of a new review or removal of an existing one is quite rare, overseers need to periodically assess whether a given review is still useful and if its scope is appropriate for PDG. Obsolete reviews should be dropped. A good time to discuss the continued relevance of reviews is during the PDG Collaboration Meetings that take place every two years.

- Consider any recommendations from the PDG Advisory Committee on your reviews and make sure the authors are aware of all suggestions concerning their reviews. We do not have to agree with all recommendations and, after careful consideration, may occasionally disagree with a certain point. In such cases, the suggestion does not need to be implemented. However, at the following meeting with the Advisory Committee we need to be able to explain our decision.

- Well before the start of the review update cycle, ensure that qualified authors are available to update the review. If necessary, determine new author(s), propose them to the Representative Board to get them vetted, invite them to PDG and help them get started within PDG. Note that PDG generally rotates authors after a few editions in order to refresh the review.

- Discuss and agree on the scope of updates with the authors early in the update cycle. Make sure that reviews are updated when needed.

- If refereeing is necessary, make sure 3 to 5 suitable referees are available to start refereeing the revised review as soon as the author(s) provide their draft version. **It is essential to determine the referees well in advance of the author's deadline for submitting their draft review, so that refereeing can start immediately**. If the review quotes experimental data or averages obtained from external groups, make sure that the corresponding experiments or groups are represented by the chosen referees.

- Communicate clearly to all referees that refereeing in PDG is an open process and that their names will be known to the authors.

- Ensure that the authors meet their deadline for providing the draft of the revised version, and that the refereeing completes in time.

- Update the review's status in `PdgWorkspace` as it progresses through the update process and maintain up-to-date lists of authors and referees. The former is essential for monitoring progress on reviews, and the latter information is used for defining PDG mailing lists and for generating the *Review*'s author and consultant lists.

5.3.4 Review coordinators

The responsibility of a coordinator is to ensure that overseers who are not part of the PDG Coordination Team are properly informed about their duties and deadlines. If an overseer does not fulfill his or her responsibilities on time, it is the responsibility of the coordinator to step in and take the necessary measures to ensure timely completion of the corresponding review and its refereeing. In order to allow this, the coordinator has access in `PdgWorkspace` to all reviews of his overseer(s) and can, if needed, make any necessary updates.

5.3.5 Editor

The editor carries out the final formatting of each review and prepares the different versions for the web, online journal publication, book and booklet as needed.

References

[1] A.H. Rosenfeld, *The particle data group: growth and operations-eighteen years of particle physics*, Ann. Rev. Nucl. Part. Sci. 25 (1975) 555-598

[2] G. Roberts, *The physicist's guide to the universe*, CERN Courier, November 2017

[3] PDG web site, http://pdg.lbl.gov

[4] PDG-internal web site, https://pdgdoc.lbl.gov. Can be found from the public PDG web site (http://pdg.lbl.gov) via *PDG Authors* → *Encoder Tools*.

[5] pdgLive (interactive access to PDG data), http://pdglive.lbl.gov

[6] *Towards a New PDG Computing System*, J. Beringer et al., Proceedings of the 18th International Conference on Computing in High Energy and Nuclear Physics (Taipei, Taiwan, October 2010), published in J. Phys.: Conf. Ser. 331 082001

[7] Apache subversion, `https://subversion.apache.org/`

[8] `https://arxiv.org/`

Appendix

A Essential references

A.1 PdgWorkspace and other PDG web sites

- pdgworkspace.lbl.gov - `PdgWorkspace` is the PDG online portal for working on Listings and reviews. New PDG collaborators should complete the checklist in Appendix B to gain access to `PdgWorkspace`.
- pdgdoc.lbl.gov - The PDG TWiki includes public pages for collaborators and verifiers, and a protected part with the documentation for PDG software developers.
- pdgverify.lbl.gov - the index page for the PDG verification system (used to verify new entries in the Listings). For specific papers/encodings, all relevant information can be directly accessed from PdgWorkspace, so normally one doesn't need to use the index page directly. However, it may be useful for getting an overview of all pending verifies.
- pdg.lbl.gov/order - the PDG product ordering system. As a PDG collaborator, your login information is the same as for PdgWorkspace. Use it to order your free copy of the PDG Book and Booklet (you will not receive them unless you request a copy via the ordering system).
- pdg.lbl.gov - the main PDG web site. PDG-internal information for collaborators can be found under *PDG Authors* → *Encoder Tools*, which redirects to pdgdoc.lbl.gov.

A.2 Documentation

Detailed information on how to use `PdgWorkspace` and other PDG tools are available online. The top-level TWiki page pdgdoc.lbl.gov provides an index to the available documentation. It can be reached from the main PDG web site via *PDG Authors* → *Encoder Tools*. This documentation includes:

- Detailed instructions for using the encoding tool in `PdgWorkspace`, including a tutorial video and many HowTo guides illustrating different operations.
- Documentation of the PDG verification system, including many screen snapshots illustrating the verification process in detail.
- The PDG schedule and printable PDF files showing responsibilities for Listings and reviews (see Appendices A.3 and A.4).
- This PDG Manual.

A.3 PDG schedule

The current schedule for updating Listings and reviews is posted on the PDG TWiki (pdgdoc.lbl.gov). You can also find it from the main PDG web site (pdg.lbl.gov) via *PDG Authors* → *Encoder Tools*.

When the new schedule for the next update of the *Review* becomes available, it is e-mailed to all PDG collaborators.

A.4 PDG responsibilities

The responsibilities for both Listings and reviews are stored in the PDG database and can be seen in `PdgWorkspace`:

- You can view your own responsibilities under *Settings* → *Responsibilities*.
- The *Responsibility* tool allows you to browse responsibilities by author or by topic, you can see the list of other PDG authors with whom you collaborate, and you can display and update the list of consultants who have contributed to your sections or reviews.

In addition to the tools to view the current responsibilities in `PdgWorkspace`, PDF files with lists of responsibilities for Listings and reviews are periodically generated in case you wish to have a printed copy. These PDF files are posted on the PDG TWiki (pdgdoc.lbl.gov). Please note that for up-to-date responsibilities you should always check `PdgWorkspace` because responsibilities may change even during an encoding or review update cycle.

A.5 Contact information and mailing lists

- support@pdg.lbl.gov - mailing list to request technical support. For technical issues, please use this list rather than contacting the editor directly.
- PDG editor (P. Zyla): editor@pdg.lbl.gov or pazyla@lbl.gov.
- Head of PDG (J. Beringer): jberinger@lbl.gov.

B Checklist for new authors joining PDG

Welcome to PDG!

Here is a short list of things we ask you to do when joining the PDG Collaboration as a new author:

- Go to `https://pdgworkspace.lbl.gov/` and request the password to log into `PdgWorkspace`, the web-based system for updating the *Review*. Click on *Request new password...*, then enter your e-mail address on the following page. You will receive a temporary password by e-mail.
- Log into `PdgWorkspace` at `https://pdgworkspace.lbl.gov/`, using your temporary password. Immediately after logging in, you will have to change your password.
- In `PdgWorkspace`, go to *Settings*, then check and update your profile, including
  - Under *Account* check how your name will appear in the PDG author list. You can change it there if you like.
  - Under *Affiliations* choose the affiliation(s) that will be shown in the PDG author list.
  - Under *Author ID* follow the instructions to enter your INSPIRE ID. If you have an ORCID and it is known to INSPIRE, it will be retrieved automatically. You can also enter your ORCID manually. These IDs will be used when generating the PDG author list in order to ensure proper attribution of citations.
- Using the PDG-internal documentation page (you can find it from the PDG home page (pdg.lbl.gov) under *PDG Authors* → *Encoder Tools*), find out who the overseer is for your responsibilities. This person is your primary contact person whenever you need help with your PDG work. In general, if needed, feel free to contact the editor or the Head of PDG, but it is usually most efficient if you first seek help from your overseer and consult the available documentation.
- Take note of the essential references provided in Appendix A.
- Please read the sections in this document that are relevant for your responsibilities, i.e. in particular Section 4 (if you work on the Listings) or Section 5 (if you work on reviews), and become familiar with PDG style conventions (see Appendix F).

C Membership of the PDG Representative Board

As of 2018, the members of the PDG Representative Board are:

- M. Doser (CERN), representing CERN
- S. Eidelman (Novosibirsk State University and Budker Institute of Nuclear Physics, Russia), representing the Meson Team
- K. Hikasa (Tohoku University), representing Japan
- C.-J. Lin (LBNL), representing LBNL
- K. Olive (University of Minnesota), representing collaborators working on cosmology
- R. Workman (George Washington University), representing the Baryon Team
- ex officio: J. Beringer (group leader, LBNL)

D Membership of the PDG International Advisory Committee

As of 2018, the members of the PDG International Advisory Committee are:

- A. Seiden (UCSC), Chair
- T. Carli (CERN)
- L. Hall (UC Berkeley/LBNL)
- T. Nakada (EPFL)
- A. Slosar (BNL)
- M. Yokoyama (Tokyo)
- Q. Zhao (IHEP Beijing)

E List of journals scanned in literature search

Articles with results relevant for PDG that are published in the following journals will be included into the *Review* via the normal PDG procedures. Articles published elsewhere are not identified automatically and should be brought to PDG's attention in order to be considered.

The following journals, listed in alphabetical order, are scanned by the Literature Searchers:

- Astroparticle physics (ASP)
- Chinese Physics C (CP C)
- European Physics Journal A (EPJ A)
- European Physics Journal C (EPJ C)
- Europhysics Letters (EPL)
- International Journal of Modern Physics A (IJMP A)
- JETP Letters (JETPL)
- Journal of Cosmology and Astroparticle physics (JCAP)
- Journal of Experimental and Theoretical Physics (JETP)
- Journal of High Energy Physics (JHEP)
- Journal of Physics G (JP G)
- Modern Physics Letters A (MPL A)
- Nature (NAT)
- Nature Physics (NATP)
- New Journal of Physics (NJP)
- Nuclear Physics A (NP A)
- Nuclear Physics B (NP B)
- Physics Letters B (PL B)
- Physics of Atomic Nuclei (PAN)
- Physics of Particles and Nuclei (PPN)
- Physics of Particles and Nuclei Letters (PPNL)

- Physical Review C (PR C)
- Physical Review D (PR D)
- Physical Review Letters (PRL)
- Physics Reports (Physics Letters C) (PRPL)
- Progress of Theoretical and Experimental Physics (PTEP)
- Review of Modern Physics (RMP)
- Science (SCI)
- Soviet Physics Uspekhi (SPU)

F PDG Style Guide

The style guide below is just a starting point. It will be expanded with more details in the future.

F.1 General guidelines

- PDG reviews as well as any footnotes, comments and explanations in the Listings should be concise, well-written, and at a level where they can be understood by a graduate student.
- Where differences exist in spelling or vocabulary between British and American English, the latter should be used.

F.2 Listings

- The following guidelines should be followed for papers based on data from a given collaboration when the paper is authored only by a subset of authors from that collaboration and is not considered a result of (and has not been reviewed by) that collaboration. The example below is taken from CLEO-c, where this was explicitly agreed upon:
  - TECN should be left blank.
  - There should be a footnote similar to "Obtained by analyzing CLEO-c data but not authored by the CLEO Collaboration.
  - When giving the reference, if there's a suitable collaboration name for that specific group of authors it will be used (the name of the collaboration whose data was used should not be used). Otherwise the author's institutions will be listed, or else the collaboration column will be left blank.

F.3 Figures

- All figures need to be submitted to PDG in publication quality with easily readable and complete axis labels, tick marks, etc.
- Figures must be submitted in .eps format (a vector graphics format). Bitmap images (.png, .jpg) are not acceptable.
- Color figures are welcome but should be produced in such a way that they are legible when printed on a black-and-white printer.
- Data from others that is shown in figures must be clearly referenced in the figure or caption. This applies to both experimental results and work from theorists. Figures adapted with minor modification from other publications must include "Adapted from [reference]." in the figure caption.

F.4 References in reviews

- References should be given in the format

  S. AUTHOR *et al.*, JOURNAL VOLUME, PAGE (YEAR)

  including first author plus *et al.* (if there are more than three authors) and the journal reference with publication year in parenthesis at the end. Titles of publications are not included.

- For large collaborations such as ATLAS, CMS, etc., the collaboration name is put after the first author *et al.* in square brackets, e.g.

  M. Aaboud *et al.* [ATLAS Collab.] ...

  NOTE: in the future, we may change to the following format (to be decided):

  ATLAS Collab. (M. Aaboud *et al.*), ...

- For published articles where a preprint on arXiv exists, the preprint reference should be included in square brackets at the end of the reference. For preprints submitted after April 2007, the new arXiv reference format without subject area (such as hep-ex, hep-ph, etc) is used, for example "[arXiv:1310.0447]". Older references include the subject area but omit the word "arXiv" (e.g. "[hep-ph/9612433]").

F.5 Author list of review articles

- The author(s) of each review are listed at the beginning of the review. Depending on when the review was written or updated, one of the following forms is used:
  - **"Written (month) (year) by ..."** is used for new reviews and for reviews that were only updated in trivial ways since being written. Examples of trivial updates are correcting typos, updating the reference for a preprint that has since been published, rephrasing a sentence for clarity without changing its meaning, etc. The month and year given refer to the time of writing the original version of the review, even if trivial updates were made. For trivial updates, the author list of the specific review remains unchanged from the previous version. The contribution of the authors who checked the review and found it to still be accurate is acknowledged by including them in the list of authors of the *Review*.
  - **"Revised (month) (year) by ..."** is used for reviews that were updated in non-trivial ways. The authors listed include only the authors who participated in the current updating (so-called active authors). If the updates are relatively minor but don't fall into the trivial category above and the original authors are no longer active, the original authors may be acknowledged by using the combined form **"Revised (month) (year) by ..., written (month) (year) by ..."**. The decision on whether to do so is made by the active authors.