Computing Upgrade

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- Introduction
- Plans and funding
- Current system and shortcomings
- Requirements for planned system
- Project plan
- Conclusions

PDG Computing System

- **The presently used system dates back to late eighties**
  - NB: This is before the web was born
  - At that time it was an extremely modern system that held up amazingly well over such a long period of time
- **Yet in spite of hardware upgrades from original VAX to now Linux PCs, software philosophy still dates back to single-user data entry on an ASCII terminal**

Upgrade is Urgent

- **We can no longer handle current requirements w/o great risk to data integrity and availability**
  - Amount of data, number of papers covered, and number of reviews more than tripled since current system was created
  - Complexity of data (often involving searches) has grown greatly
  - PDG collaboration was very small, but has now grown to 170 physicists worldwide (all volunteers except in Berkeley)
  - Giving the HEP community electronic access to the information in the PDG database requires a new system
- **Several upgrade attempts since mid 1990s did not converge**
- **Urgency of completing at least a partial upgrade increasingly evident by 2004**
  - Risk of hardware failure (no replacement system)

Plan in 2004

- **Lacking the necessary resources to carry out full upgrade, we decided on a pragmatic (albeit not ideal) approach that would ensure our ability to continue producing the RPP**
- **Upgrade in 3 phases:**
  - **Phase 1**: Switch to partially upgraded system for RPP 2006
    - Switch to modern hardware (Linux servers)
    - Reimplementation of existing Oracle/FORMS editor interface
    - Provide database viewer and initial version of encoder interface
  - **Phase 2**: Improve partially upgraded system
    - Address technology choices, long-term maintainability, documentation
    - Improve or replace existing interfaces as necessary
    - Add new tools (e.g. for handling of Reviews)
  - **Phase 3** (if deemed necessary): Redesign database structure

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    - Address
    - Improve
    - Add new tools (e.g. for handling of Reviews)
  - **Phase 3** (if

Completed end of 2005

terface

Starting now

term maintainability, documentation

ces as necessary

Not needed Redesign database structure

Contributors to Phase 1 of the Upgrade

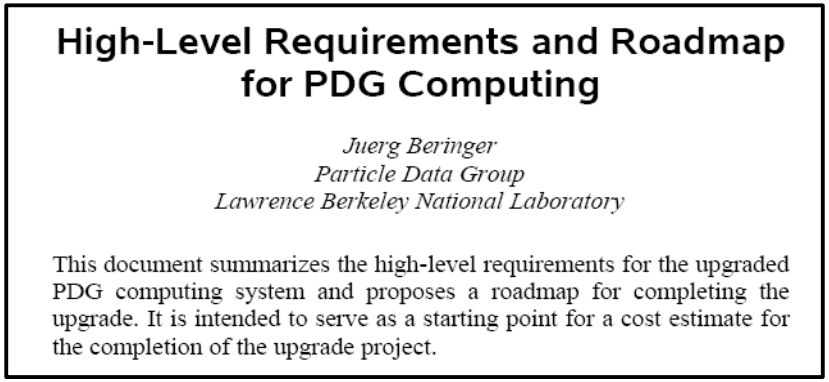
- **From COMPAS group, IHEP Protvino:**
  - Kirill Lugovsky (web interfaces)
  - Slava Lugovsky (web interfaces)
  - Vitaly Lugovsky (core libraries, database, left 2004)
  - Lyudmila Lugovskaya (documentation, left 2004)
  - Vladimir Ezhela (group leader, retired)
  - Oleg Zenin (group leader, new)
- **From LBNL:**
  - Juerg Beringer (project leader, since March 2004)
  - Orin Dahl (auxiliary programs, Oracle/FORMS related work, retired)
  - Piotr Zyla (daily operation, production tasks, editor interface)

All part-time contributors, mostly at the 10% to 70% level

Starting with Phase 2

- **Phase 1 completed in time for RPP 2006 production**
  - Reviewed in December 2005
- **Proceeded to planning for phase 2**
  - Estimated effort of 4 FTE-years

Written in 2006



High-Level Requirements and Roadmap for PDG Computing

Juerg Beringer
Particle Data Group
Lawrence Berkeley National Laboratory

This document summarizes the high-level requirements for the upgraded PDG computing system and proposes a roadmap for completing the upgrade. It is intended to serve as a starting point for a cost estimate for the completion of the upgrade project.

- **Funding from NSF and DOE has started ...**
  - Supplement of 0.2 FTE/year from NSF (PHY-0652989, April 2007)
  - In May got 0.3 FTE supplement from DOE for remainder of FY08
  - DOE review in Washington D.C. on September 12, 2008
    - Review went extremely well; continued significance of PDG affirmed
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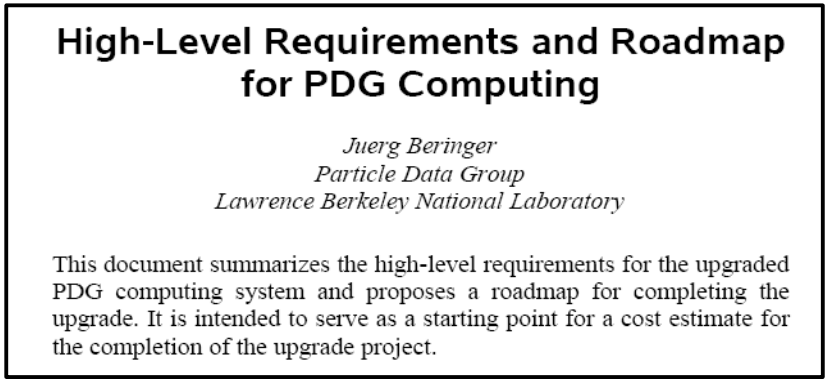

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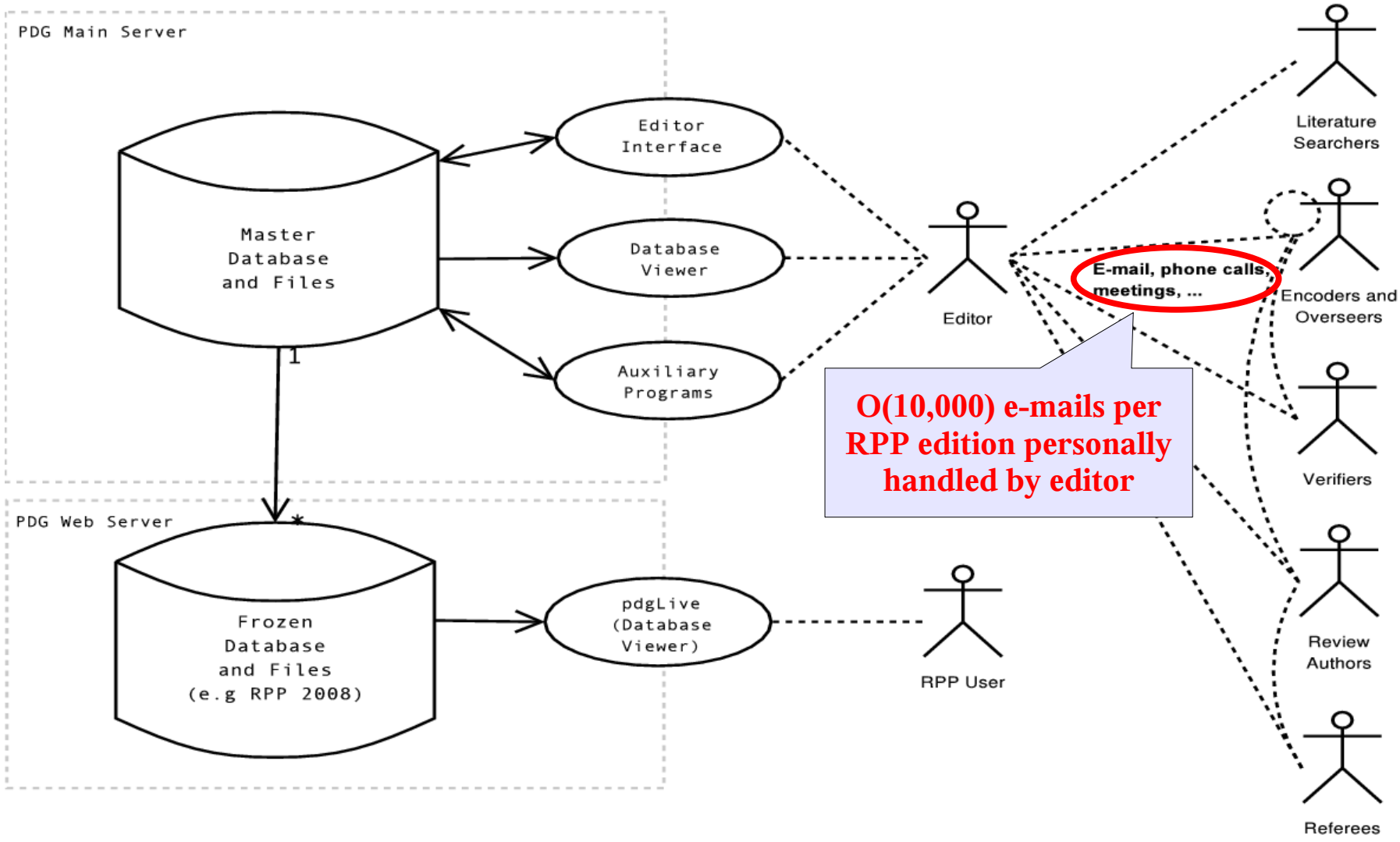
    - One major comment:

Even more money to make sure PDG succeeds!

Feedback from DOE

- **Have heard from DOE how pleased they are with the review**
  - Related to the computing plan, they will suggest we **plan for 2 FTE for 3 years rather than 2** as they were convinced by the reviewers that we will likely need that effort
  - Will propose **0.5 FTE for maintenance** when project is completed
  - Funding during next 6 months will be challenging due to "Continuing Resolution" in Congress
- **Based on positive outcome of DOE review, we are now starting with work on phase 2 of the upgrade**
- **Funding is not yet assured – we need help from the Advisory Committee to keep pushing until the money is in hand**

Current Production System



Technical Details

- **Hardware**
  - 2 Linux-based servers
- **Software**
  - PostgreSQL, Apache Tomcat, Apache web server
  - O(100k) lines of application code
    - Fortran and C for auxiliary programs
    - Kawa and BRL for user interfaces
    - HTML and JavaScript
  - Mimetex (tool to generate gif images from TeX snippets)
  - TeX and TeXsis
- **Database**
  - Small (ASCII dump is 40MB) but **very complex database**
  - ~100 database tables, about 2/3 storing scientific information

Shortcomings (I)

- **System designed as single-user system and doesn't scale**
  - No support for concurrent data entry by multiple users
  - No support for workflow management
- **All data entry must go through editor**
- **Arcane, inefficient and error prone data entry method**
  - Editor interface basically only graphical SQL editor
- **No support for producing Reviews**
  - Authors, referees and overseers communicate mostly by e-mail
  - Updated review source files are circulated by e-mail and must often be merged by overseer or editor
  - Review authors have to deal with TeXsis (a special TeX-based macro package used internally by PDG), or editor has to convert from other formats

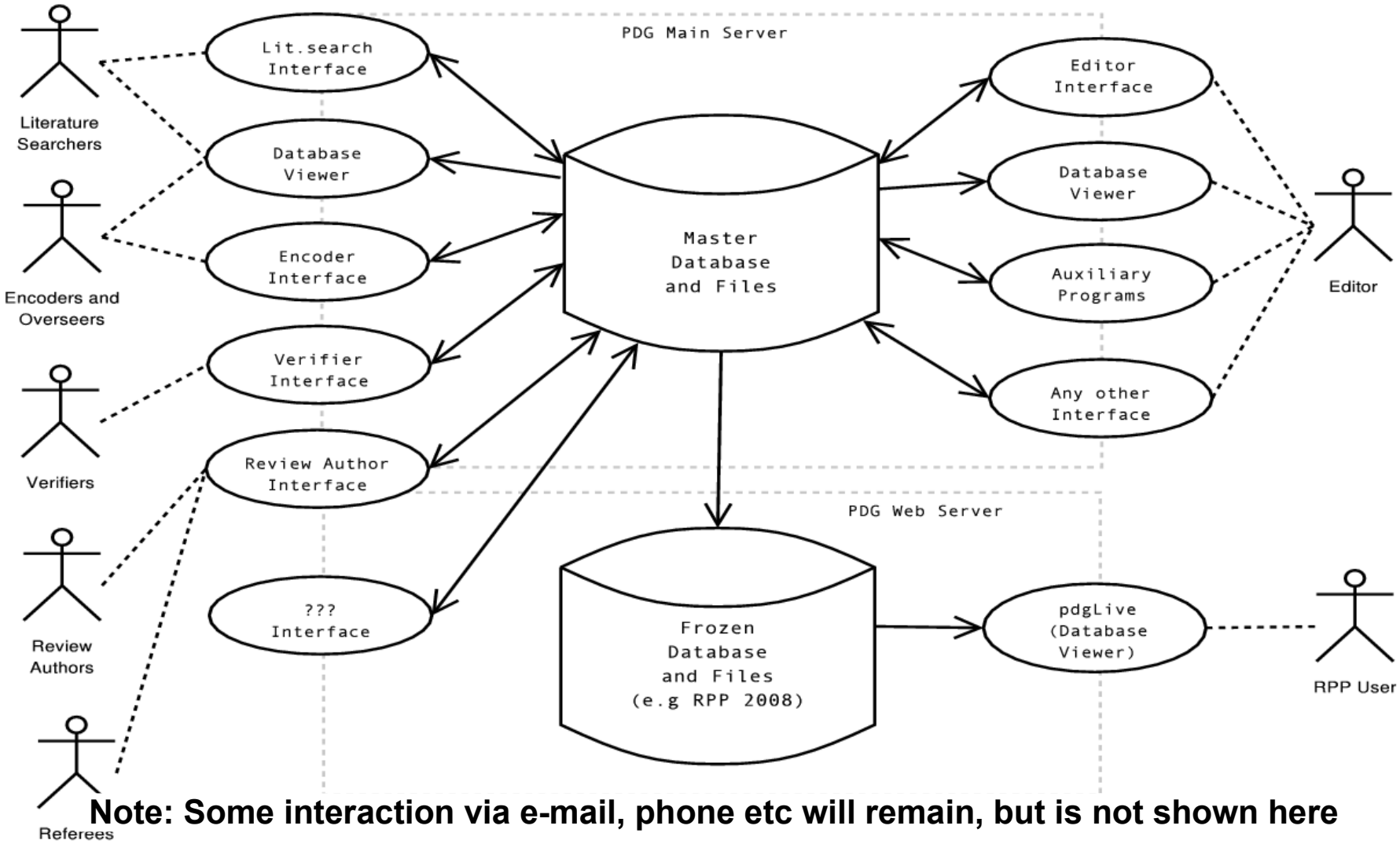
Shortcomings (II)

- **No support for verification of Listing entries**
  - Proofs are sent by e-mail to verifiers hoping for a reply in case of a problem ("no news is good news")
- **Lack of information on progress of Listings and Reviews**
  - Difficult to manage hundreds of people towards a timely completion of RPP if current status is not known
- **Current user interfaces are not maintainable long-term**
  - Arcane tools, programming languages (Kawa, BRL)
  - Not documented
  - **But are very valuable prototypes of what we need**
- **Auxiliary programs written in Fortran (and C)**
  - Maintenance completely dependent on single retiree

Computing Needs

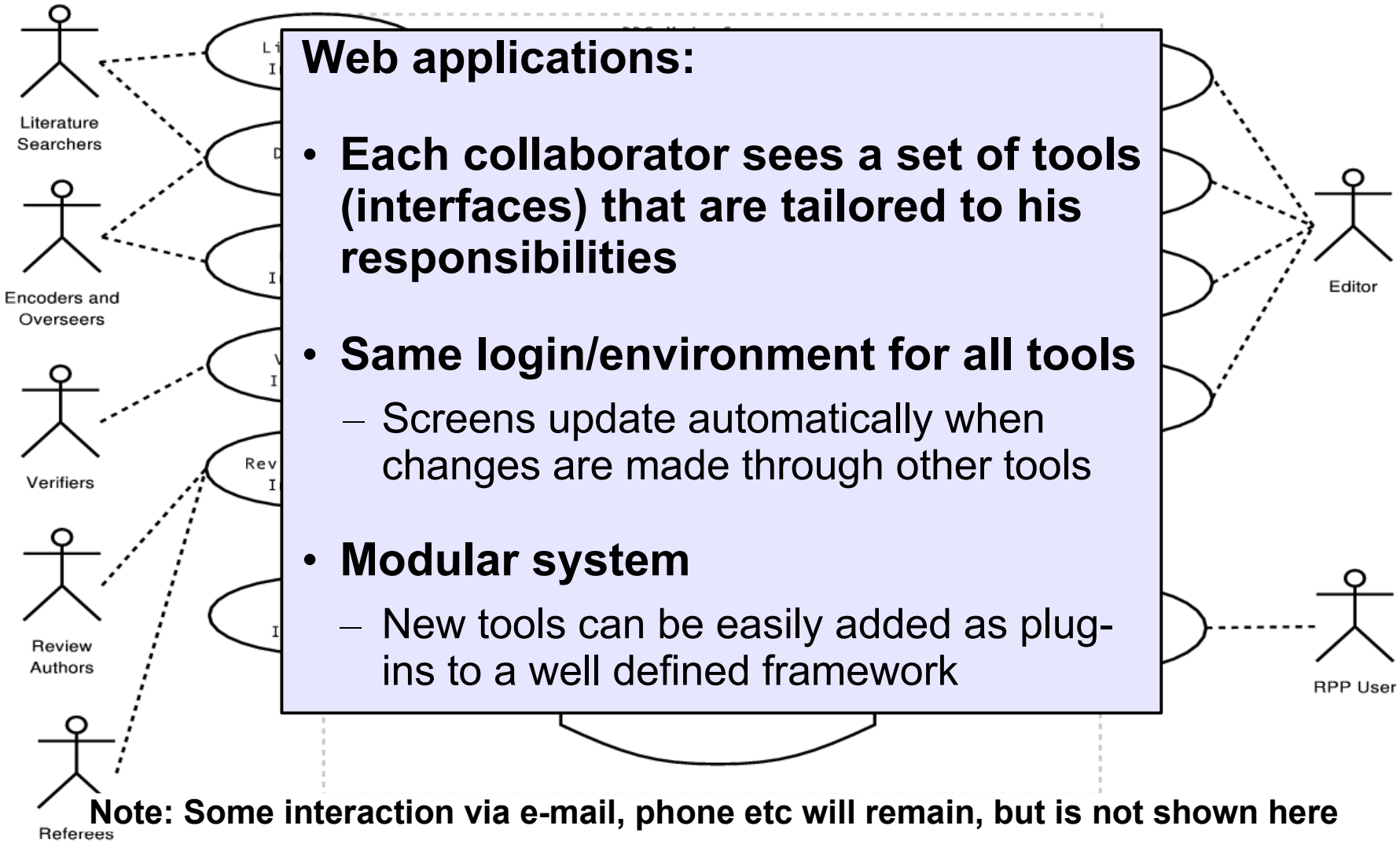
- **A modern, modular, scalable, easy-to-use, maintainable and well-documented computing infrastructure**
- **Production quality system – PDG data must be correct**
  - Extensive error-checking and cross-checking built into system
- **Need to support all areas of our work, including in particular:**
  - Decentralized, web-based data entry and verification for Listings
  - Interaction with over 100 review authors
  - Monitoring of progress in RPP production
  - Programs for evaluation of data (fits, averages, plots, ...)
  - Expert tools for editor, including creation of book manuscript and static web pages (PDF files)
  - Interactive browsing of PDG database similar to pdgLive

Planned System



Note: Some interaction via e-mail, phone etc will remain, but is not shown here

Planned System



Web applications:

- **Each collaborator sees a set of tools (interfaces) that are tailored to his responsibilities**
- **Same login/environment for all tools**
  - Screens update automatically when changes are made through other tools
- **Modular system**
  - New tools can be easily added as plug-ins to a well defined framework

Note: Some interaction via e-mail, phone etc will remain, but is not shown here

Required Web Applications (I)

- **Encoder interface and Literature Search interface**
  - Future primary data entry interfaces
  - Task driven, easy-to-use tools for non-experts
  - Single-user prototype available but needs to be redesigned as production-quality tool for concurrent usage
- **Database viewer (pdgLive)**
  - Web-based application for browsing of database contents
  - Dynamically generates web-pages in format similar to RPP book
  - Used both for pdgLive (on published RPP edition),
  - And as tool to inspect new entries during encoding process
  - Provides direct links from RPP entries to SPIRES to actual papers
  - Current version of pdgLive is not maintainable, must be replaced

Required Web Applications (II)

- **Verifier interface**
  - Manage verification process and provide web page for verifiers to report their acceptance or corrections
- **Review author interface**
  - Keep track of status and responsibilities for each review
  - Manage different versions during authoring and refereeing
- **Editor interface**
  - Expert-only web-based GUI to edit raw content of PDG database
  - Only used by editor
  - Diminishing role as most data entry tasks will be done decentralized through Encoder Interface
- **Status Reporting**
  - Reports on progress of Listings & Reviews

Required Web Applications (III)

- **User Profile Management and Configuration**
  - Users (including collaborators) can create a profile, order products, and update their address and preferences
  - Configuration tool allows coordinators and editors to assign responsibilities
- **Mailing System**
  - Send messages to different groups of users, e.g. to announce availability of new RPP edition, to remind collaborators about deadlines, etc.
- **Interface for updating Institution Database**
- **Additional smaller applications can be added easily when needed once the framework is available**

Required Programs & Scripts

- **Data analysis environment**
  - Environment with both access to PDG data and to numerical algorithms, data analysis and graphics tools (for example ROOT, CERN libraries, ...)
  - Preferably has option to work interactively
- **Auxiliary programs and scripts**
  - Fitting, averaging, graphics, production of TeX files for Listings
  - Used directly by editor and indirectly through encoder interface
  - Ultimately based on above data analysis environment
- **System Monitoring**
  - Scripts and web pages that alert us as early as possible to problems (e.g. web server down, low disk space, etc.)

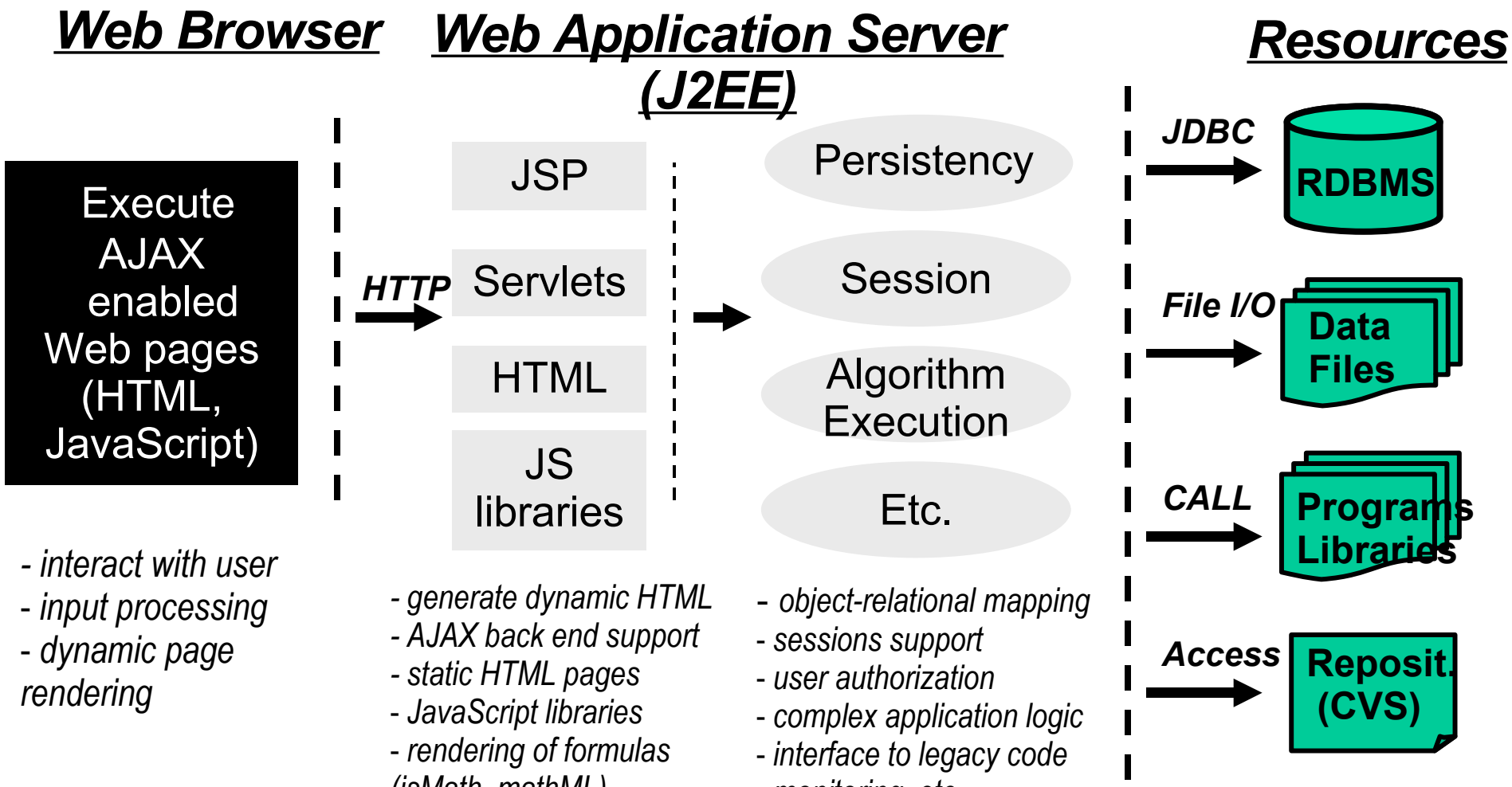
Industry-Standard Software Development

- **Software development process should**
  - Adhere to widely-adopted practices
  - Be well-documented (including the code itself)
  - Minimally personalized (to facilitate long term code maintenance)
  - Maximally efficient (use existing tools, components, libraries)
- **Software architecture must be**
  - **Adequate** to fulfill functional requirements
  - **Flexible** to accommodate further extensions/modifications
  - **Scalable** to cope with ever-increasing load
  - **Lean** system (easy to maintain)

Key Technology Principles

- **Chosen technologies must be**
  - **Suitable** for specific PDG problems
    - "one size does not fit all"
  - **Stable and mature** - production system
  - **Sustainable** in the long run (~10 years from now)
    - based on standards
  - **Popular**
    - another guarantee for stability
  - For which there is **sufficient expertise** (at LBNL)
  - **Relatively easy** to learn and deal with
  - **Free** (open source, GPL, etc.)

Three-Tier Web Architecture



Web Applications Domain

- **J2EE-based Web Application Framework**
  - Commonly used industry standard (ex: eBay - 1B transactions/day)
  - Dynamic HTML generation
  - An infrastructure for building scalable, distributed Web apps
  - A number of useful services/mechanisms (ORM, sessions, etc.)
  - Leverage from broad community
  - Employs component-based development approach
  - Multiple implementations exist (free examples: GlassFish, JBoss)
- **AJAX-enabled Web pages on the client side**
  - User-friendly and highly interactive GUI behavior
  - De-facto standard for Web pages
  - Asynchronous interaction with the Web server
  - “Smart” user input (auto-suggestion/auto-completion “as you type”)

Choice of Programming Languages

- **Select minimal set of programming languages that meet requirements and are widely accepted**
  - **Java** and JSP for the Web Application Framework backend
  - **JavaScript** for client-side HTML (AJAX)
  - **Python** API for programmatic access to database
- **Benefits of leverage from broad community of developers**
  - Maintainability

Why not use just one language?

– *Each has its own benefits (Java, JS, Python)*

Handling Legacy Applications

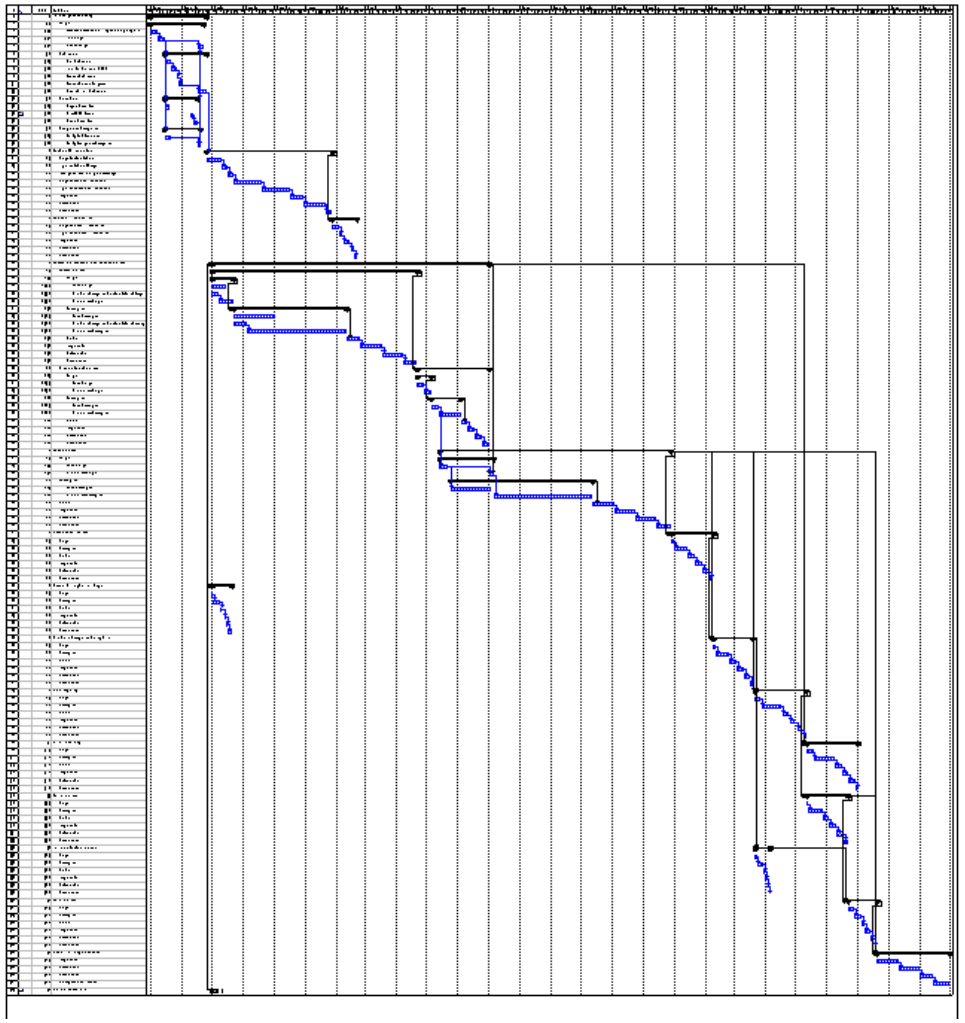
- **Legacy FORTRAN applications**
  - Restructured as libraries (to be usable as **resources**)
  - Migrated onto the unified high-level database access API

Key Computing Personnel

- **Cecilia Aragon (50%)**
  - Computer scientist/architect/programmer, 20+ years experience in computing including physics applications and user interface design; PhD in CS from UC Berkeley. Most recent project: Sunfall for the Nearby Supernova Factory.
- **Igor Gaponenko (25-50%)**
  - Computer software engineer/architect, ~20 years experience in scientific databases and automation of HEP experiments; MS physics/CS. Most recent project: BaBar.
- **Computing professionals (125%)**
  - Two experienced developers with suitable skills
- **Work will be performed in close collaboration with PDG physicists (J. Beringer, O. Dahl, P. Zyla)**

Computing Project Plan (As Presented to DOE)

- **We have prepared a WBS (Work Breakdown Structure) and Gantt chart**
  - Upgrade requires 2 FTEs for 2 years (4 FTE-years)
  - Detailed project plan
- **Includes task breakdown and resource allocation**



High Level WBS (4 FTEs total effort)

WBS	Task Name	Start	End
1.	Initial Design and Planning	8/1/2008	9/25/2008
2.	Database Abstraction Layer	9/26/2008	2/3/2009
3.	Data Analysis Environment	2/4/2009	2/27/2009
4.	Encoder Interface/Lit. Search Int.	10/1/2008	7/8/2009
5.	Database Viewer	5/21/2009	1/8/2010
6.	Review Author Interface	1/11/2010	2/19/2010
7.	Refactor Existing Auxiliary Programs	10/1/2008	10/20/2008
8.	User Profile Management/Mailing	2/22/2010	4/1/2010
9.	Status Reporting	4/2/2010	5/19/2010
10.	System Monitoring	5/20/2010	7/6/2010
11.	Verifier Interface	5/20/2010	6/29/2010
12.	Institution Database Interface	4/2/2010	4/16/2010
13.	Editor Interface	6/30/2010	7/21/2010
14.	Final System Integration	7/22/2010	9/30/2010

- *Note that design phases for some components are shorter because of IHEP prototype*

Challenges (I)

- **Distributed data entry**
  - Concurrency issues (locking) to be addressed in the design
  - Need to define exactly when changes become visible to other collaborators
  - Editor must still sign off each individual entry / change
- **Use of TeXsis and TeX needs to be rethought**
  - Use of TeX unavoidable for printed book(let),
  - but not ideal for web output
  - How to efficiently display equations in a web browser?
    - Investigating jsMath, MathML, conversion to gif images, ...
- **Browser and platform independence for data viewer**
  - Use existing libraries where possible

Challenges (II)

- **Database structure and contents**
  - Current database structure for scientific information non-optimal since some modern database features were not available or efficient when current system was designed
    - Need middleware to address this
  - Improve separation between content and output format
    - Use of TeX snippets in data entries
    - Non-unique specification of particles (e.g.”K_s^0” prints same as “K^0_s”)
  - Concurrency requires additional locking information
  - Workflow information needs to be added / redesigned
  - Mechanism for history and errata needs to be revisited
- **All changes (to the database) must be made incrementally without jeopardizing the ongoing production of the Review**

Risks and Mitigations (I)

1. PDG is different from commodity interfaces

- Database structure for scientific information
- Non-ASCII formats for particles
- Use of custom formatting macros and TeXsis

- **Mitigation: careful design, staff experience in building physics systems**

Risks and Mitigations (II)

2. Technology risks

- J2EE, Python platform stability

- **Mitigation: industry standard, weight of community (ex. RHEL)**

3. Internal risks

- Underestimate amount of work, loss of staff

- **Mitigation: incremental plan (do highest priority items first), use industry standard technologies, large pool of expertise at LBNL**

Contingency Plans

- **Design of framework so new tasks can easily be added**
- **If necessary, can de-scope individual tasks and still accomplish main goals**
- **According to preliminary feedback from the DOE review, the computing upgrade should be funded at 150% of our request**

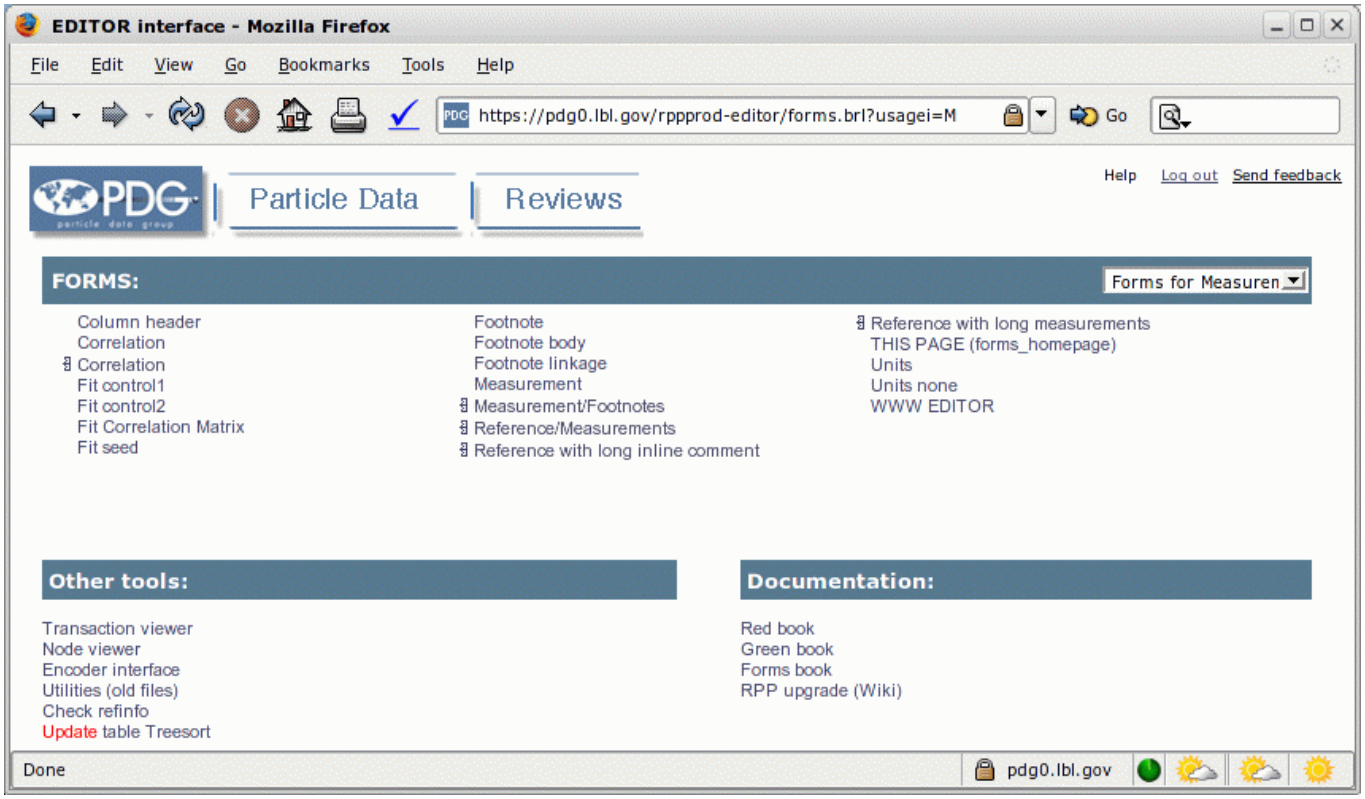
Conclusions

- **Completing the upgrade of the aging PDG computing system has become critical**
- **We have a clear understanding of the requirements for the future PDG computing system**
- **We have identified a team of experienced LBNL computer scientists for the design and implementation of the upgrade**
- **We have developed a project plan and a high-level design**
  - 4 FTE-years
  - Discussed risks, mitigation, contingency plans
- **Hope for funding from DOE plus NSF for 6 FTE-years**
  - Supplements already received for FY07/08 allows proceeding as planned until end of February 2009
  - **But money is not yet in hand, need to keep pushing**

Backup Slides

Editor Interface

- **An expert-only web-based GUI to edit the raw content of the PDG database**
- **Knows about connections between tables and constraints on input values**




https://pdg0.lbl.gov - REFERENCE MEASUREMENT form - Mozilla Firefox
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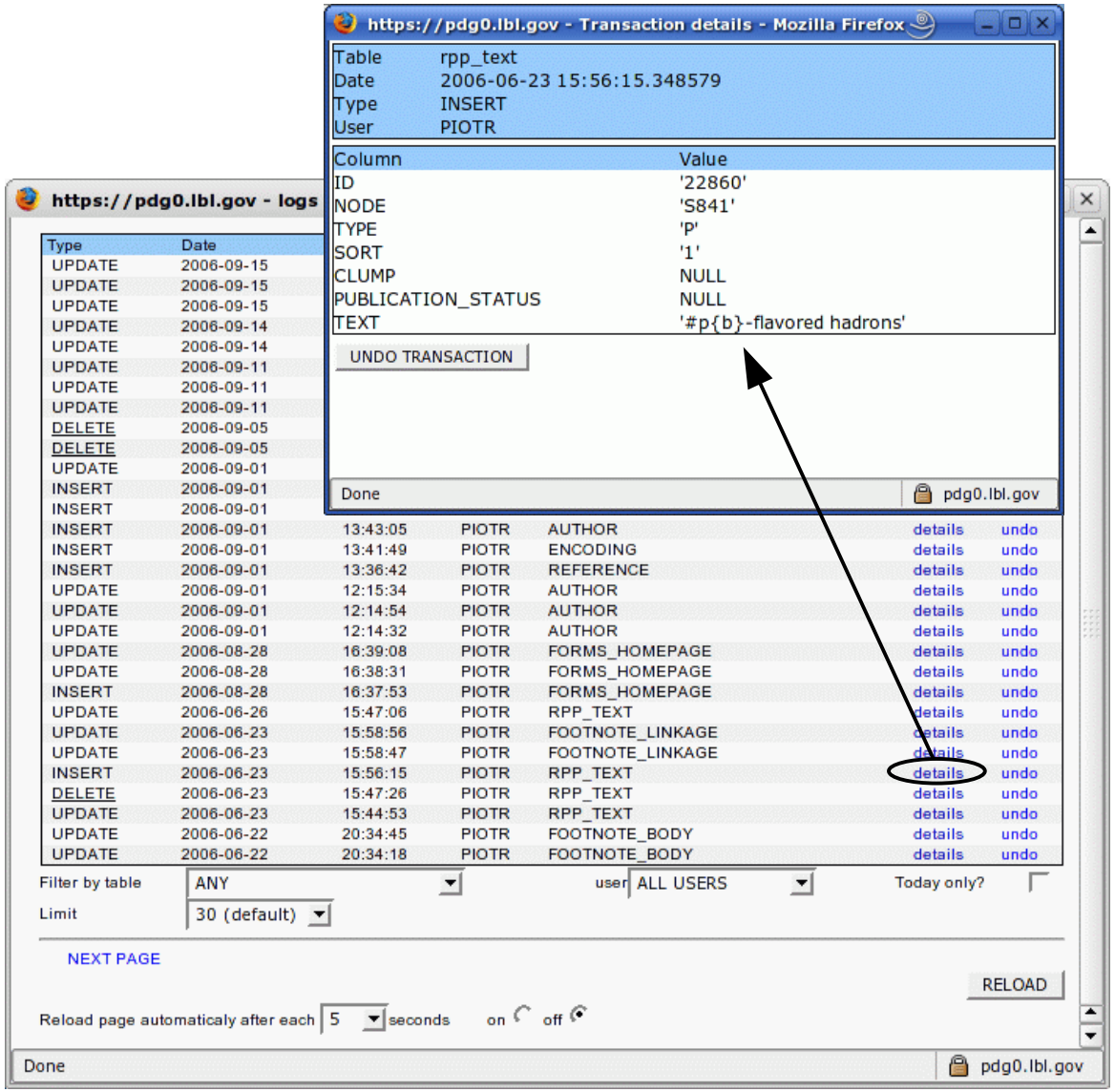
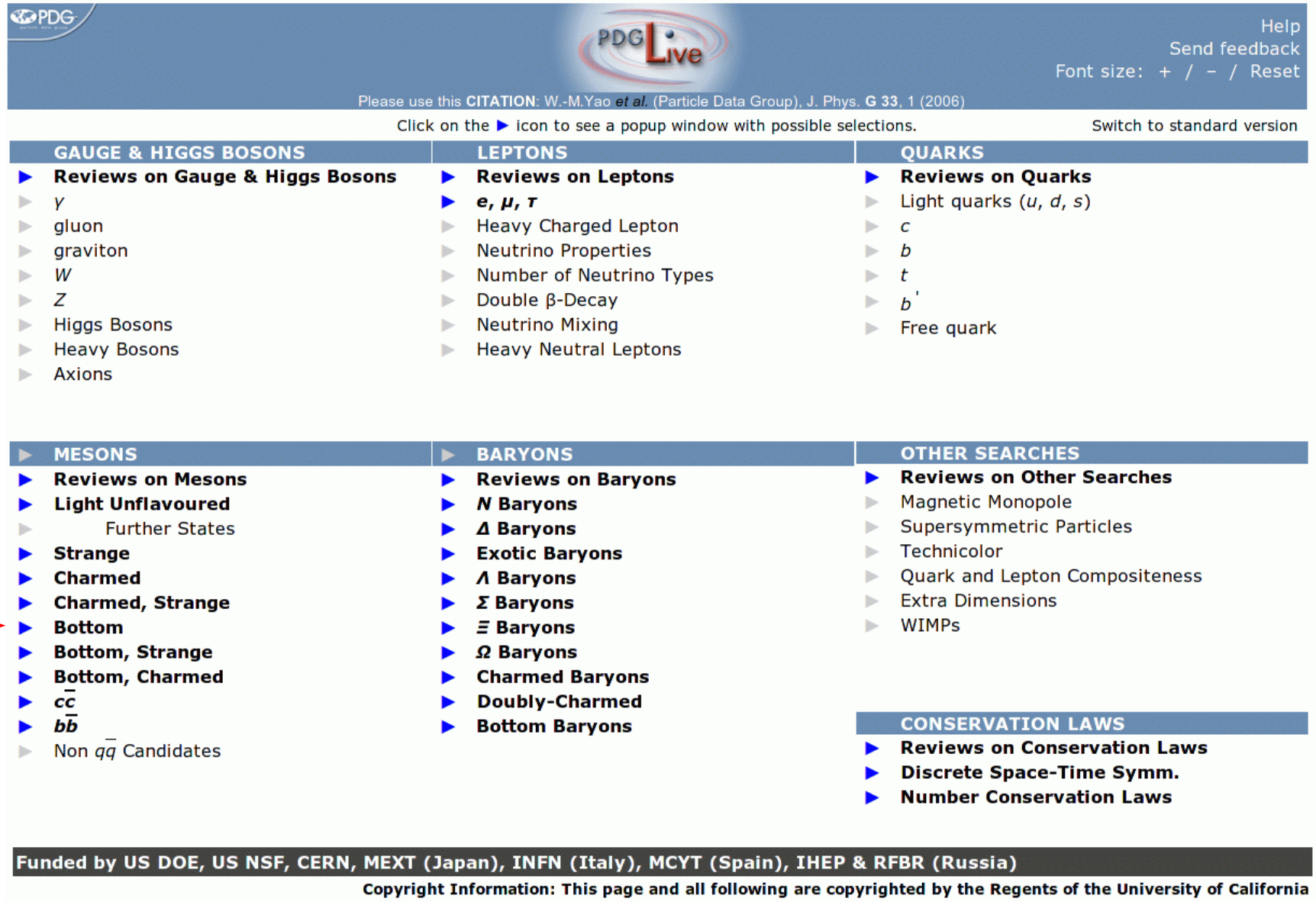
Editor Interface Tools

- **Database transaction logger with “undo”**
- **Improved access to tree table**
- **Easily customizable to support new database tables**
- **Sufficient for short-term**
- **Maintenance issues**



pdgLive (http://pdglive.lbl.gov)



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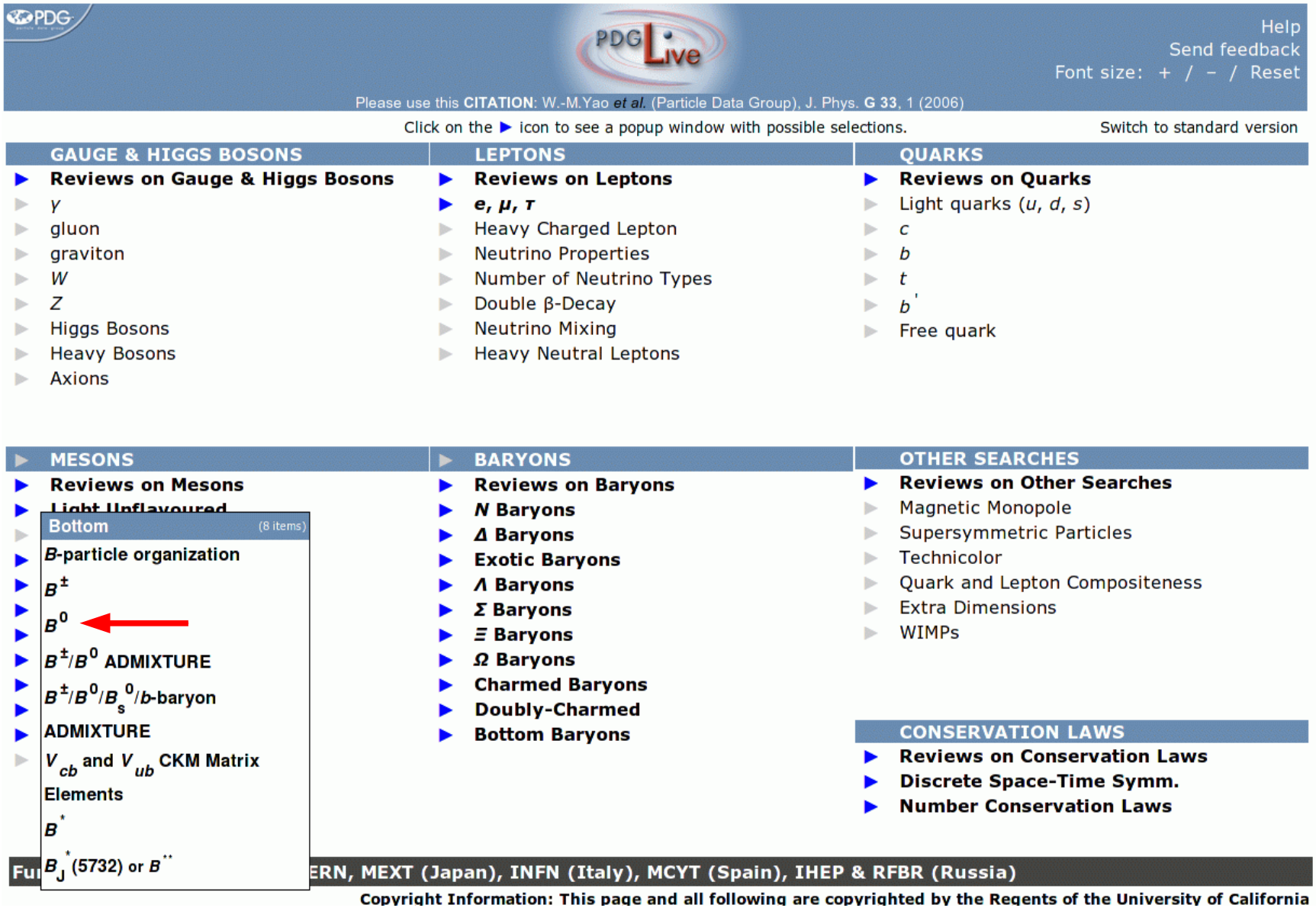
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Reviews on Other Searches
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Supersymmetric Particles
Technicolor
Quark and Lepton Compositeness
Extra Dimensions
WIMPs
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Reviews on Conservation Laws
Discrete Space-Time Symm.
Number Conservation Laws
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	▶ Inclusive modes			
	▶ D, D^*, or D_s modes			
	▼ Charmonium modes			
Γ_{134}	$\eta_c K^0$	$(9.9 \pm 1.9) \times 10^{-4}$		1753
Γ_{135}	$\eta_c K^*(892)^0$	$(1.6 \pm 0.7) \times 10^{-3}$		1648
Γ_{136}	$J/\psi(1S) K^0$	$(8.72 \pm 0.33) \times 10^{-4}$		1683
Γ_{137}	$J/\psi(1S) K^+ \pi^-$	$(1.2 \pm 0.6) \times 10^{-3}$		1652
Γ_{138}	$J/\psi(1S) K^*(892)^0$	$(1.33 \pm 0.06) \times 10^{-3}$		1571
Γ_{139}	$J/\psi(1S) \eta K^0_S$	$(8 \pm 4) \times 10^{-5}$		1508
Γ_{140}	$J/\psi(1S) \varphi K^0$	$(9.4 \pm 2.6) \times 10^{-5}$		1224
Γ_{141}	$J/\psi(1S) K(1270)^0$	$(1.3 \pm 0.5) \times 10^{-3}$		1390
Γ_{142}	$J/\psi(1S) \pi^0$	$(2.2 \pm 0.4) \times 10^{-5}$		1728
Γ_{143}	$J/\psi(1S) \eta$	$<2.7 \times 10^{-5}$	CL=90%	1672
Γ_{144}	$J/\psi(1S) \pi^+ \pi^-$	$(4.6 \pm 0.9) \times 10^{-5}$		1716
Γ_{145}	$J/\psi(1S) \rho^0$	$(1.6 \pm 0.7) \times 10^{-5}$		1611
Γ_{146}	$J/\psi(1S) \omega$	$<2.7 \times 10^{-4}$	CL=90%	1609
Γ_{147}	$J/\psi(1S) \varphi$	$<9.2 \times 10^{-6}$	CL=90%	1519
Γ_{148}	$J/\psi(1S) \eta'(958)$	$<6.3 \times 10^{-5}$	CL=90%	1546
Γ_{149}	$J/\psi(1S) K^0 \pi^+ \pi^-$	$(1.0 \pm 0.4) \times 10^{-3}$		1611
Γ_{150}	$J/\psi(1S) K^0 \rho^0$	$(5.4 \pm 3.0) \times 10^{-4}$		1390
Γ_{151}	$J/\psi(1S) K^*(892)^+ \pi^-$	$(8 \pm 4) \times 10^{-4}$		1514
Γ_{152}	$J/\psi(1S) K^*(892)^0 \pi^+ \pi^-$	$(6.6 \pm 2.2) \times 10^{-4}$		1447

See Data Listings

$\Gamma(J/\psi(1S)\,K^0)$ / Γ_{total}				References	History since 1990	Γ_{136}/Γ
VALUE (10^{-4})	CL%	EVTS	DOCUMENT ID	TECN	COMMENT	
8.72 ± 0.33	**OUR AVERAGE**					
8.69 ± 0.22 ± 0.30			[1] AUBERT	05J	BABR	$e^+e^- \to Y(4S)$
7.9 ± 0.4 ± 0.9			[1] AB			$e^+e^- \to Y(4S)$
9.5 ± 0.8 ± 0.6			[1] AV			$e^+e^- \to Y(4S)$
11.5 ± 2.3 ± 1.7			[2] AB			$p\bar{p}$ at 1.8 TeV
7.0 ± 4.2 ± 0.1			[3] BORTOLETTO	92	CLEO	$e^+e^- \to Y(4S)$
9.3 ± 7.3 ± 0.1		2	[4] ALBRECHT	90J	ARG	$e^+e^- \to Y(4S)$
* * * We do not use the following data for averages, fits, limits, *etc.* * * *						
8.3 ± 0.4 ± 0.5			[1] AUBERT	02	BABR	Repl. by AUBERT 2005J
$8.5\ ^{+1.4}_{-1.2} \pm 0.6$			[1] JESSOP	97	CLE2	Repl. by AVERY 2000
7.5 ± 2.4 ± 0.8		10	[3] ALAM	94	CLE2	Sup. by JESSOP 1997
<50	90		ALAM	86	CLEO	$e^+e^- \to Y(4S)$

AUBERT 2005J : Physical Review Letters **94** (2005) 141801 Measurement of Branching Fractions and Charge Asymmetries for Exclusive B Decays to Charmonium

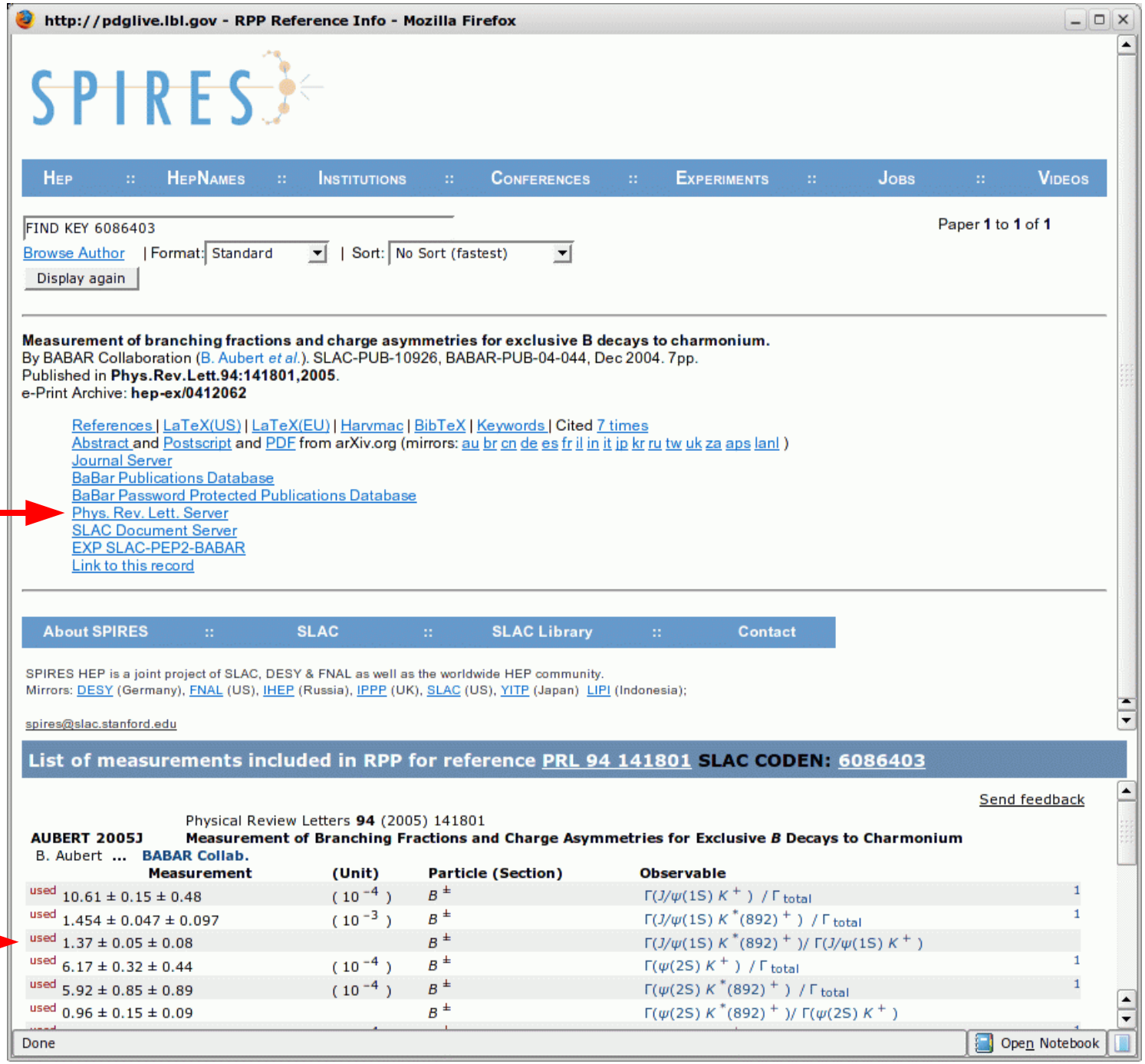
[1] Assumes equal production of B^+ and B^0 at the $Y(4S)$.

[2] ABE 1996H assumes that $B(B^+ \to J/\psi\,K^+) = (1.02 \pm 0.14) \times 10^{-3}$.

[3] BORTOLETTO 1992 reports $6 \pm 3 \pm 2$ for $B(J/\psi(1S) \to e^+e^-) = 0.069 \pm 0.009$. We rescale to our best value $B(J/\psi(1S) \to e^+e^-) = (5.94 \pm 0.06) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $Y(4S)$.

[4] ALBRECHT 1990J reports $8 \pm 6 \pm 2$ for $B(J/\psi(1S) \to e^+e^-) = 0.069 \pm 0.009$. We rescale to our best value $B(J/\psi(1S) \to e^+e^-) = (5.94 \pm 0.06) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $Y(4S)$.

Link to SPIRES



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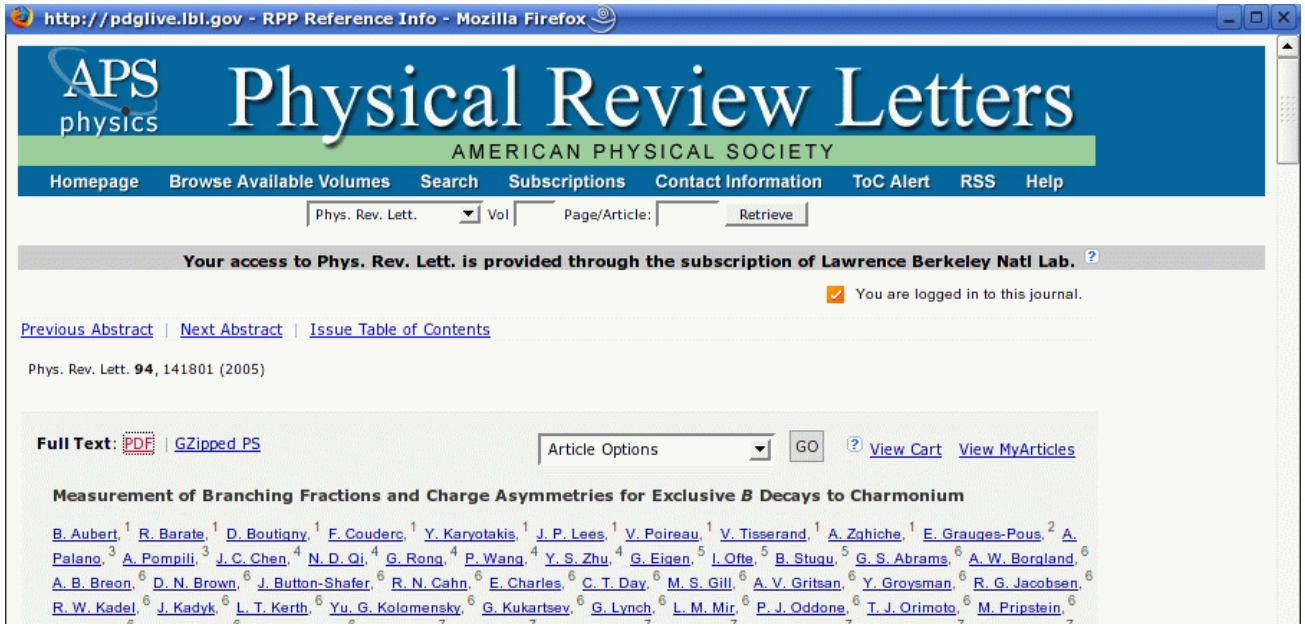
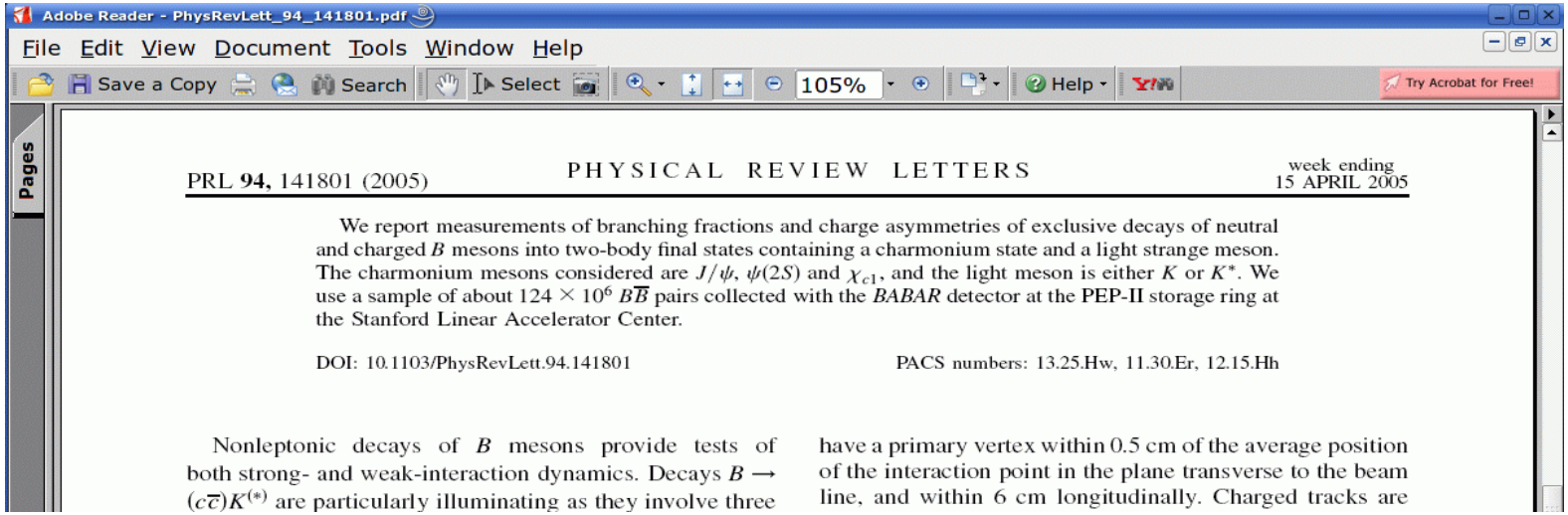
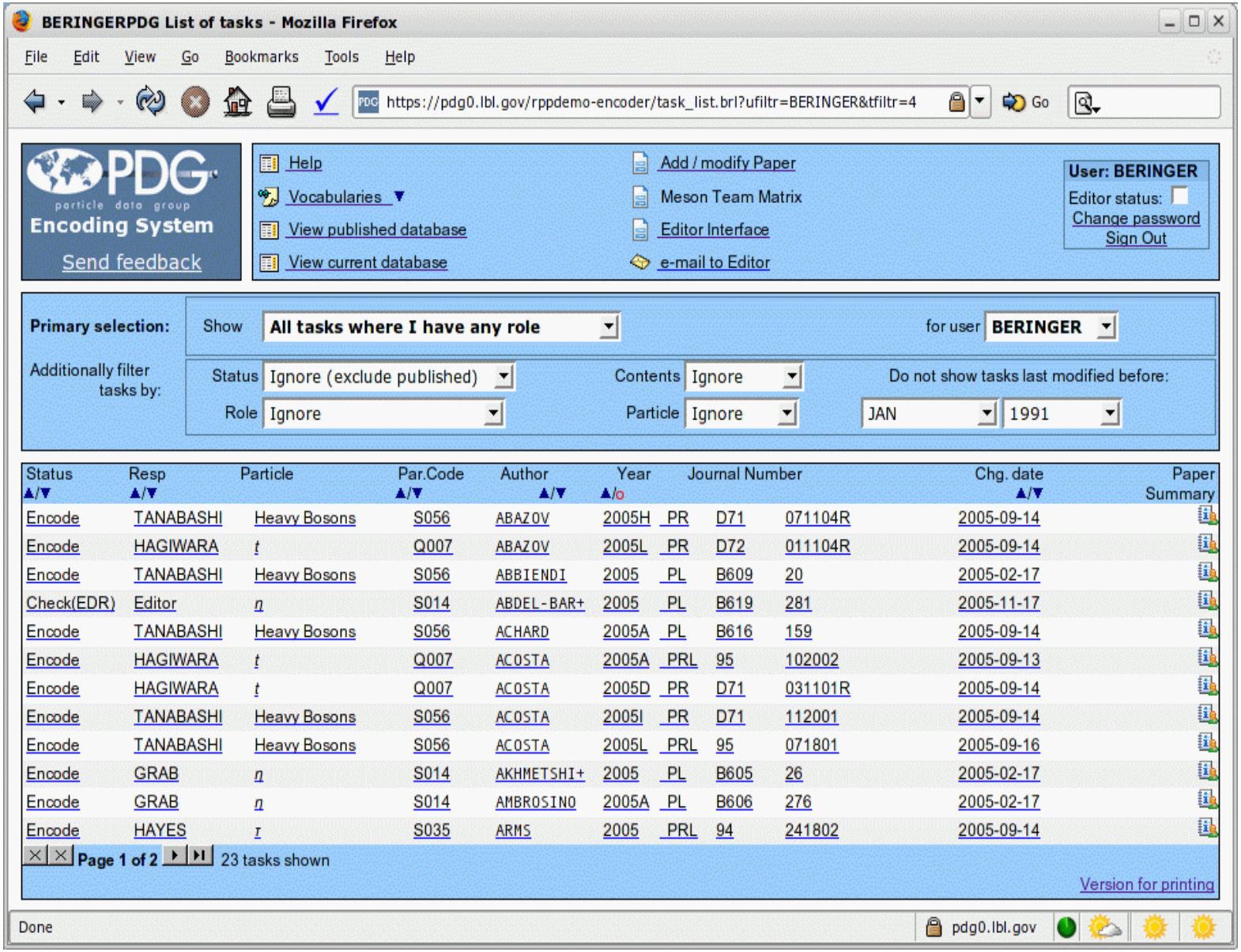
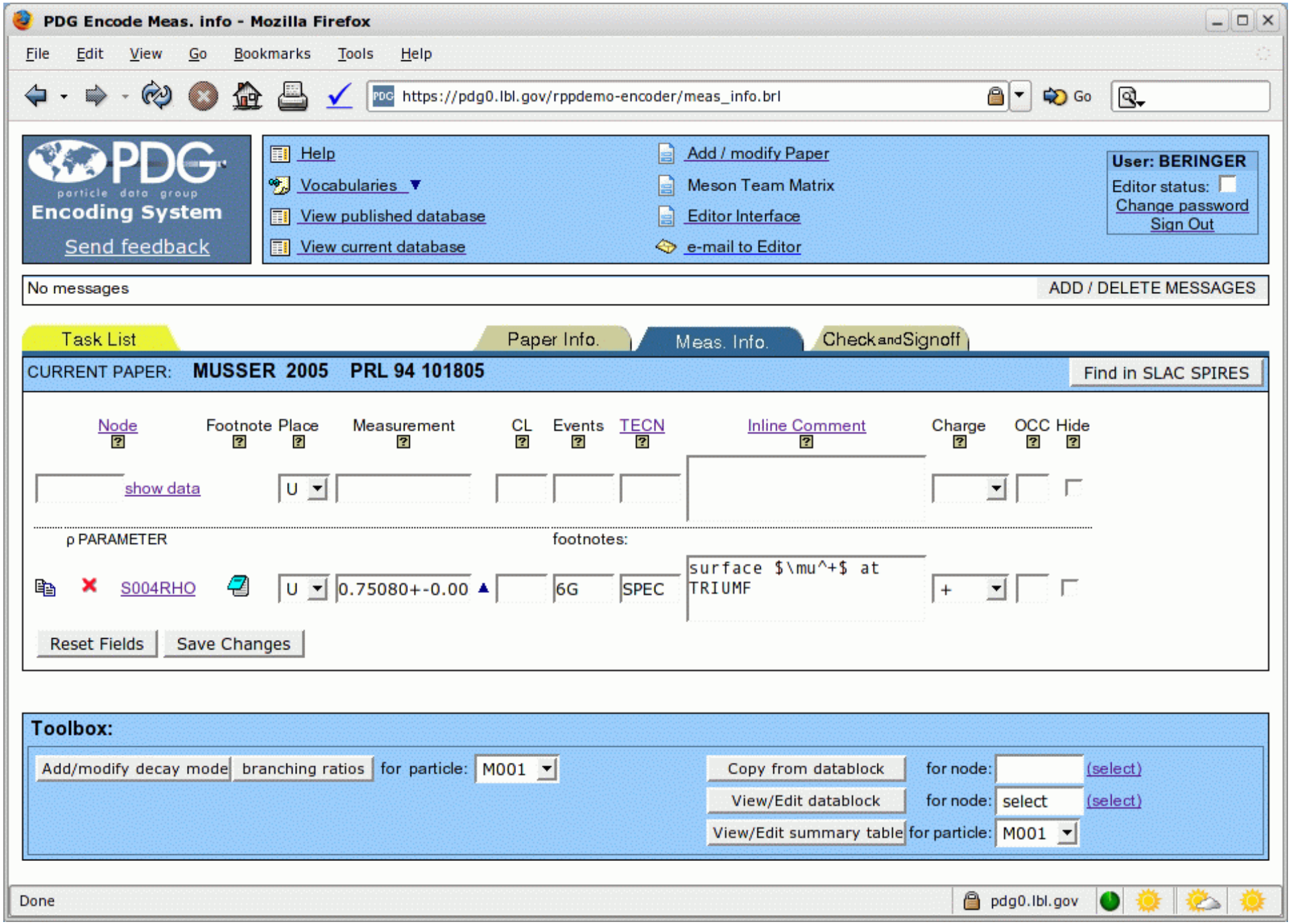




Encoder Interface Prototype

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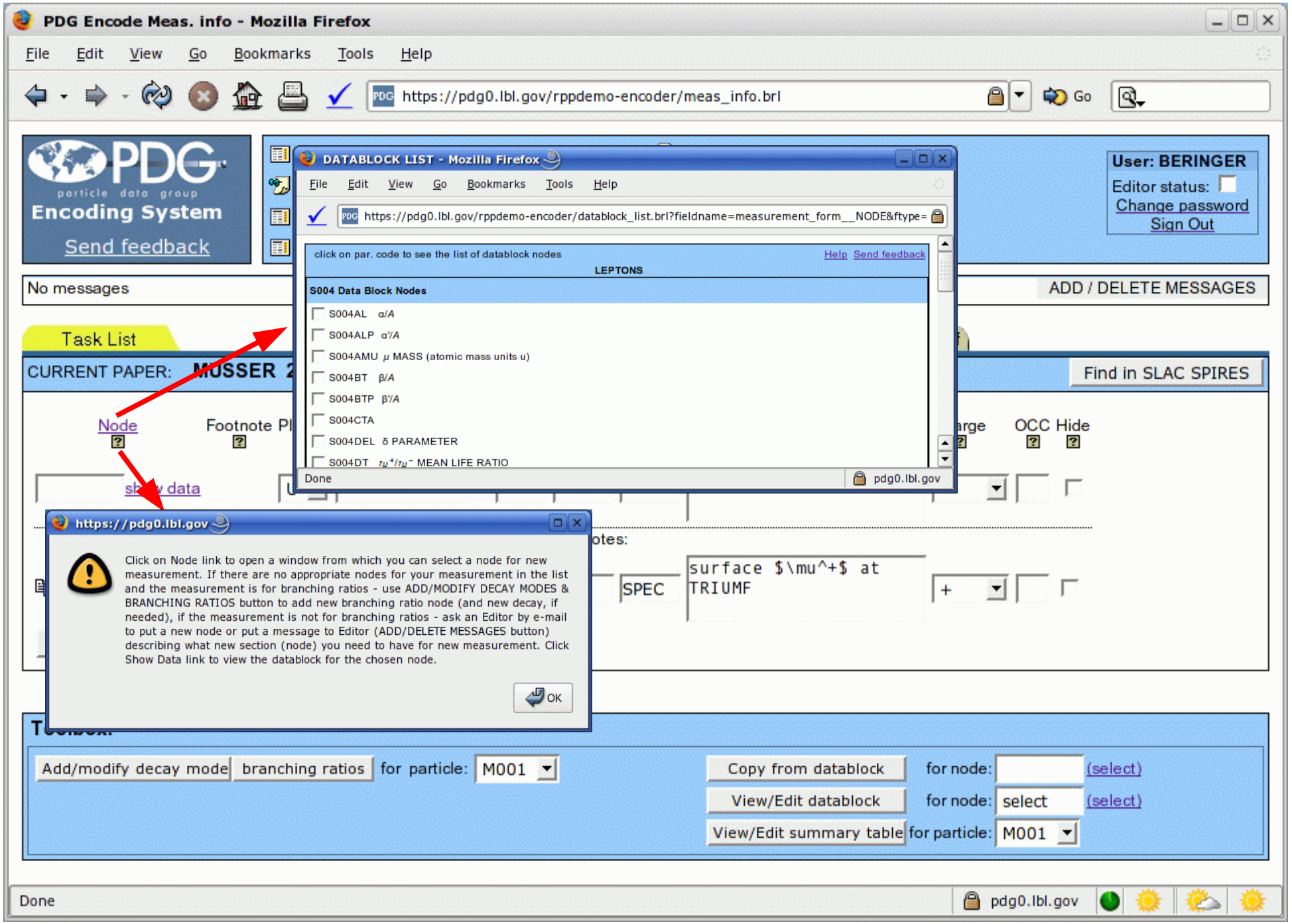
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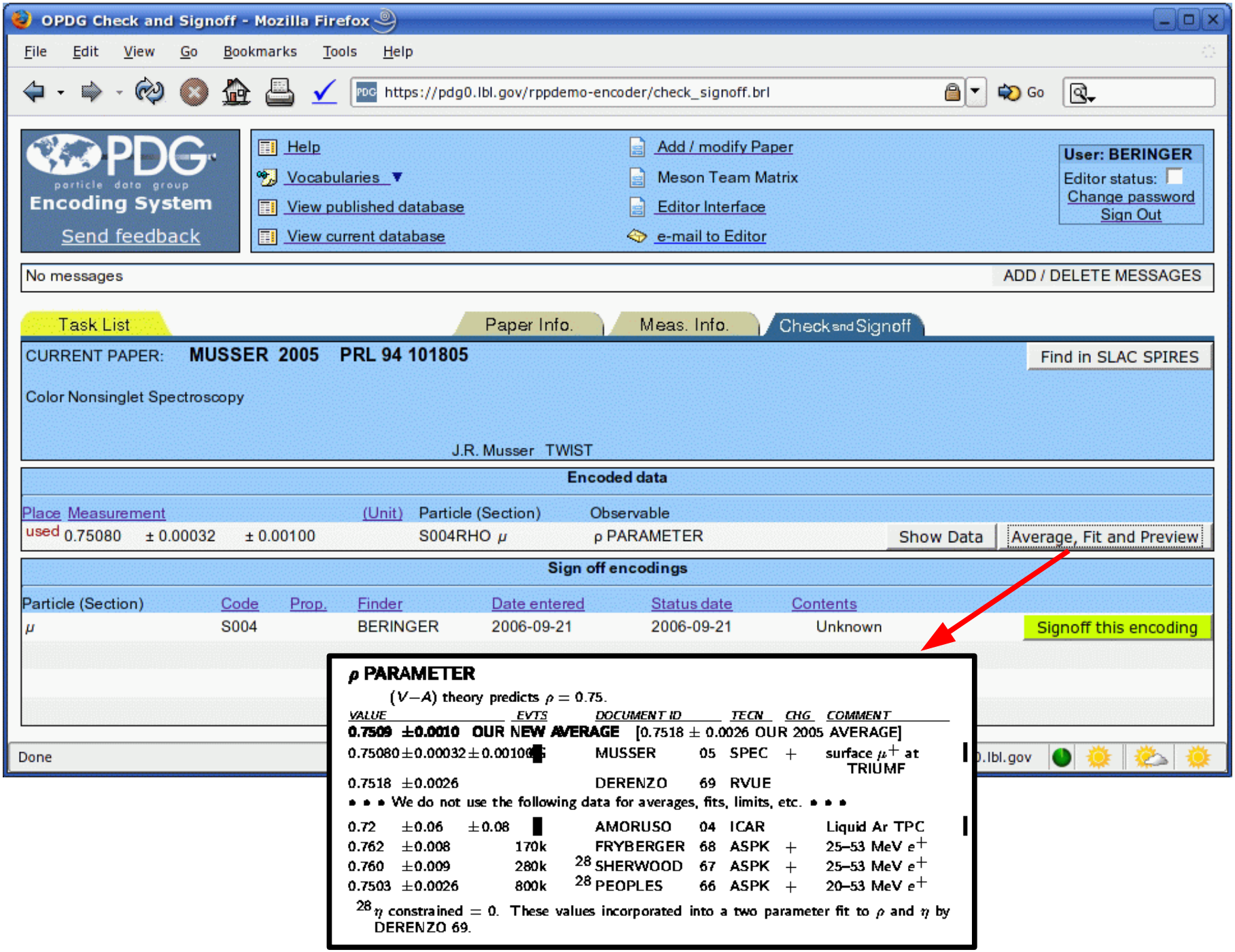
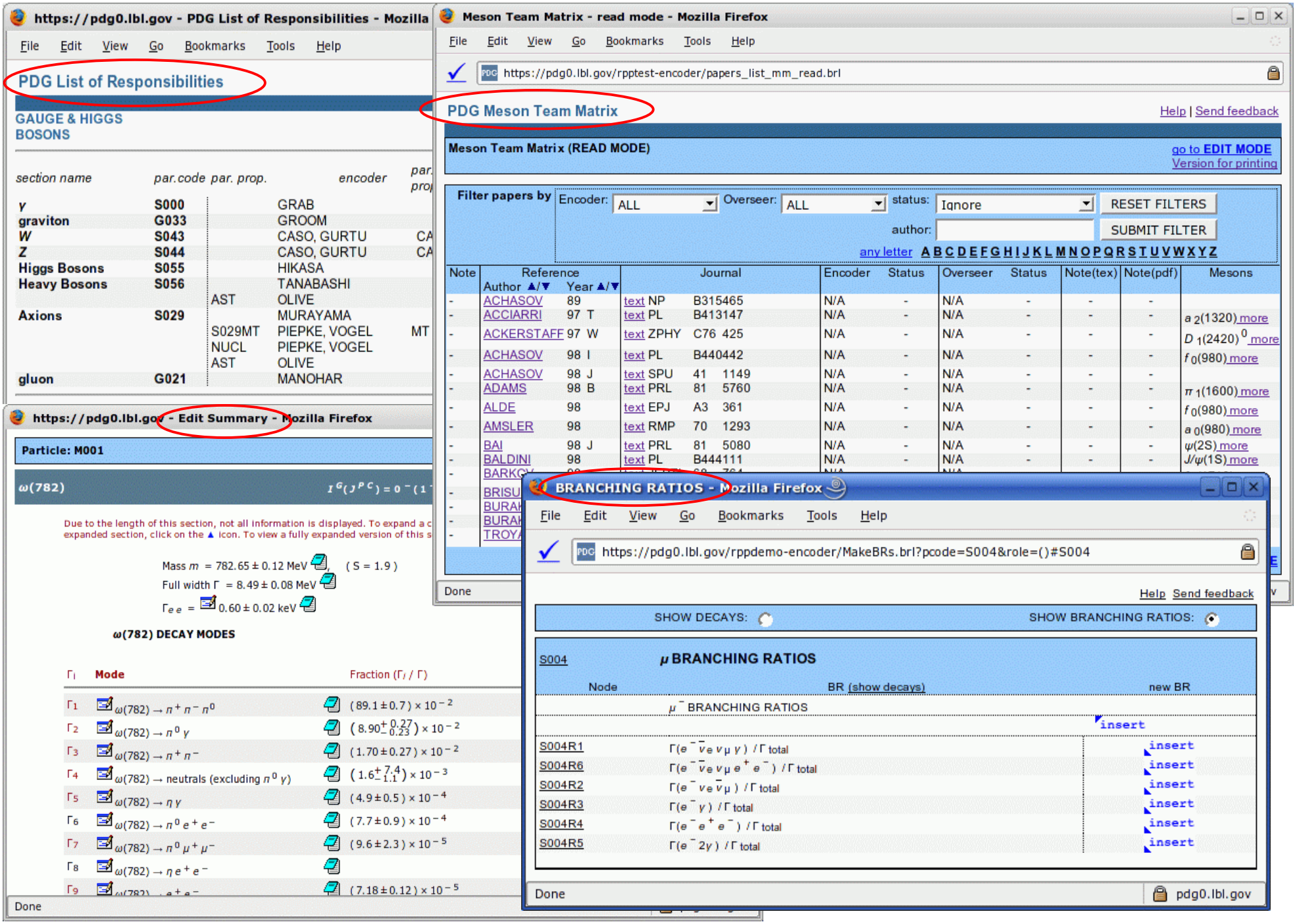


ρ PARAMETER

$(V-A)$ theory predicts $\rho = 0.75$.

VALUE	EVTS	DOCUMENT ID		TECN	CHG	COMMENT
0.7509 ±0.0010 OUR NEW AVERAGE [0.7518 ± 0.0026 OUR 2005 AVERAGE]						
0.75080±0.00032±0.00100		MUSSER	05	SPEC	+	surface μ^+ at TRIUMF
0.7518 ±0.0026		DERENZO	69	RVUE		
• • • We do not use the following data for averages, fits, limits, etc. • • •						
0.72 ±0.06 ±0.08		AMORUSO	04	ICAR		Liquid Ar TPC
0.762 ±0.008	170k	FRYBERGER	68	ASPK	+	25–53 MeV e^+
0.760 ±0.009	280k	[28] SHERWOOD	67	ASPK	+	25–53 MeV e^+
0.7503 ±0.0026	800k	[28] PEOPLES	66	ASPK	+	20–53 MeV e^+

[28] η constrained = 0. These values incorporated into a two parameter fit to ρ and η by DERENZO 69.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BALDINI 98 text PL B444111 N/A N/A J/ψ(1S) more
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ω(782) I G(J P C) = 0 − (1
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expanded section, click on the ▲ icon. To view a fully expanded version of this s
Mass m = 782.65 ± 0.12 MeV (S = 1.9)
Full width Γ = 8.49 ± 0.08 MeV
Γee = 0.60 ± 0.02 keV
ω(782) DECAY MODES
Γi Mode Fraction (Γi / Γ)
Γ1 ω(782) → π+ π− π0 (89.1 ± 0.7) × 10−2
Γ2 ω(782) → π0 γ (8.90 +0.27 −0.23) × 10−2
Γ3 ω(782) → π+ π− (1.70 ± 0.27) × 10−2
Γ4 ω(782) → neutrals (excluding π0 γ) (1.6 +7.4 −1.1) × 10−3
Γ5 ω(782) → η γ (4.9 ± 0.5) × 10−4
Γ6 ω(782) → π0 e+ e− (7.7 ± 0.9) × 10−4
Γ7 ω(782) → π0 μ+ μ− (9.6 ± 2.3) × 10−5
Γ8 ω(782) → η e+ e−
Γ9 (7.18 ± 0.12) × 10−5
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S004R6 Γ(e− ν̄e νμ e+ e−) / Γ total insert
S004R2 Γ(e− νe ν̄μ) / Γ total insert
S004R3 Γ(e− γ) / Γ total insert
S004R4 Γ(e− e+ e−) / Γ total insert
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