Software Aspects of PET Acceptance Testing and the Draft IAEA TecDoc

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Software Aspects of PET Acceptance Testing

- The NEMA 2001 (and 2007) standards define:
  - Terminology and symbols
  - Phantoms and sources
  - Acquisition methods and conditions
  - Data analysis methods
  - Reported parameters

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The Value of the NEMA Standards

- Provide clear, unambiguous instructions on testing procedures
- Allow performance figures for different PET systems to be compared with standardized testing procedures. Results are critical for PET manufacturers as comparisons of performance figures influence customers' purchasing decisions
- Customers can use the same procedures to test whether systems conform with manufacturers' specifications before acceptance.

Results depend on

- Adherence to prescribed procedures for phantom setup, data acquisition, and reconstruction
- Use of correct activity (in some cases to be specified by vendor)
- Conformity of phantoms to prescribed design
- Conformity of methods implemented in the vendor's analysis software*

Measurements at the factory

- Vendors use in-house software to analyze the data and quantify performance
- Would all vendors' programs' provide the same results if applied to the same data?

Acceptance tests at customer site

- In many cases performed using vendor's instructions and software
- Some vendors don't provide software or instructions
  - Their customers are 'on their own' and must write software for acquisition and analysis, or pay the vendor a hefty fee to do acceptance testing for them
  - If vendor does it, it is not an independent test.
  - If customer writes software for one-off use, it may contain errors.

No vendors make their NEMA 2001 source codes available

- Impossible to verify the conformance of the software to the NEMA standard - we don't know exactly what it is doing.
- Non-conformities in acquisition or analysis methods could give results that over- or under-estimate actual NEMA performance.
- Customers cannot compare performance figures quoted by different vendors with complete confidence.

A Proposal

- An international collaborative project to develop and maintain open source software for NEMA-compliant PET acceptance testing.
- The free availability of source codes will enable the software to be:
  - Verified as correct.
  - Updated and improved over time by the user community (including vendors).
  - Used by all (vendors and customers alike).

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The project web site would host

- Software (including source codes) for different PET systems
- Sample data and results
- Manufacturer recommended activities for tests on different systems
- Email discussion lists
- FAQs and how-to documents

Advantages

- Anyone can see what the software does by examining the source code.
- All users can use the same software, eliminating differences between vendor implementations.
- Provides a solution for customers of vendors that do not support end-user acceptance testing.
- Updates and enhancements can be submitted for inclusion by any interested party.
- Will provide a valuable forum for the experienced and inexperienced alike.

Caveats

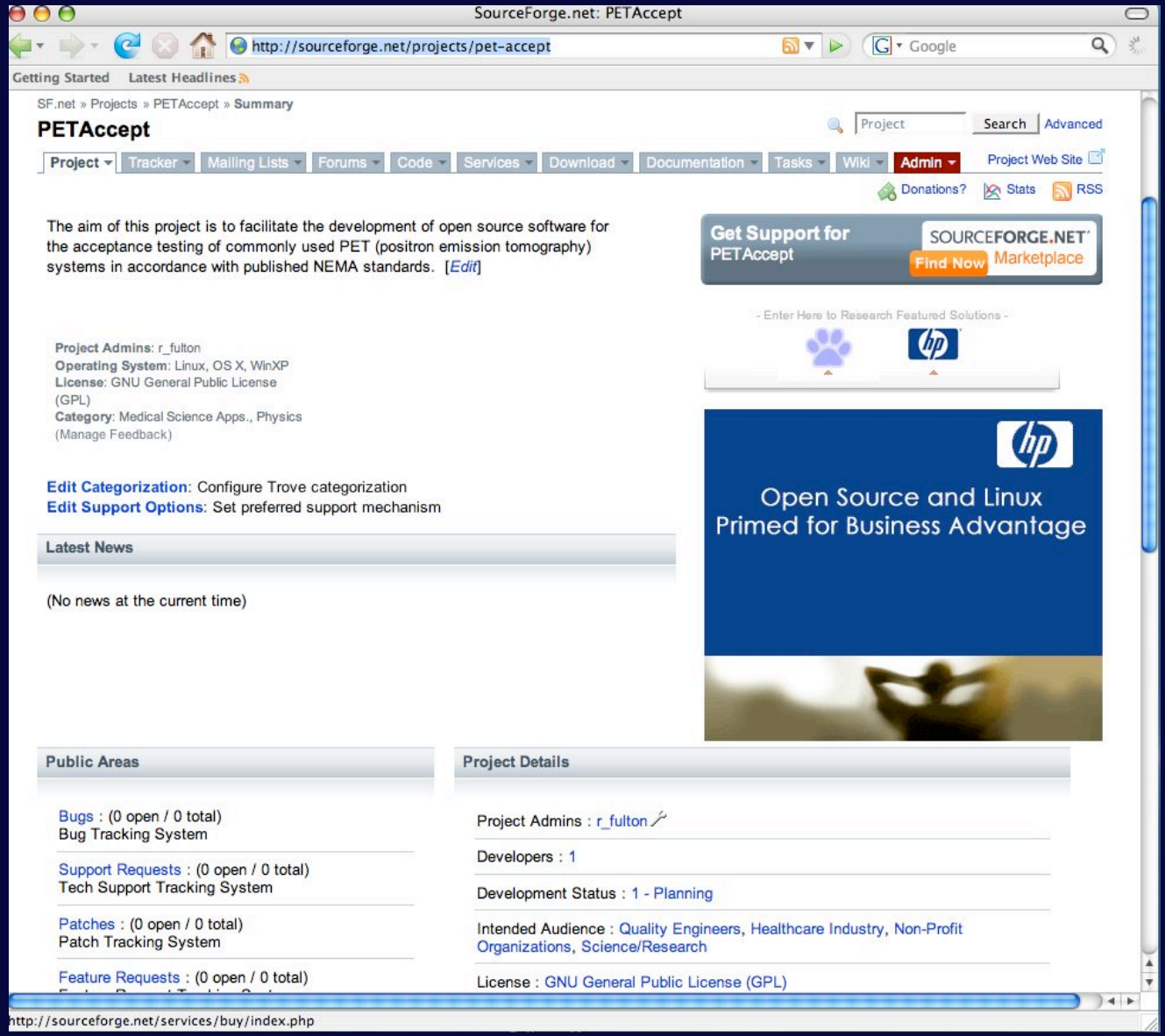
- A moderator will be required to manage submissions and maintain the site.
- Version control will critical. Software revisions will need to be carefully managed.
- Desirable to have a paid moderator with advanced software skills, especially in the early stages, to ensure success. Funding?

Has anything been done so far?

- SourceForge project PET Accept.
- See http://sourceforge.net/projects/pet-accept

Project Admin:	Roger Fulton
Operating Systems:	Linux, OS X, WinXP
License:	GNU General Public License (GPL)
Category:	Medical Science Apps., Physics

"The aim of this project is to facilitate the development of open source software for the acceptance testing of commonly used PET (positron emission tomography) systems in accordance with published NEMA standards".



http://sourceforge.net/projects/pet-accept

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Nitty gritty

- Different PET systems have different data formats and computer platforms. Is it feasible to develop software that will work on all PET systems?
  - With a sensible software engineering approach, it is feasible to develop software that just needs to be recompiled to run on different computer platforms.
  - The project website could maintain precompiled binaries for the most common platforms.
  - Analysis programs could be split into two modules:
    - A system-dependent front-end that is different for each PET system type and handles the process of reading the data into a standard sinogram or image structure, and
    - A system-independent part that is the same for all systems and handles the analysis of data supplied to it in the standard format.

What language/s should the code be in?

- Interactive Data Language (IDL) ?
- Other languages (C, C++, Matlab) ?

Why IDL?

- Multiplatform
- Short development time
  - Code for GUIs, plots, image display is portable, and easier than in C, C++, Visual C etc.
- Programs can be distributed in a single ready-to-use project file that runs on the IDL Virtual Machine.
- No IDL licence required for end-user.

Intended scope

- Software for all NEMA tests on all PET and PET/CT systems in widespread use.

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Verification

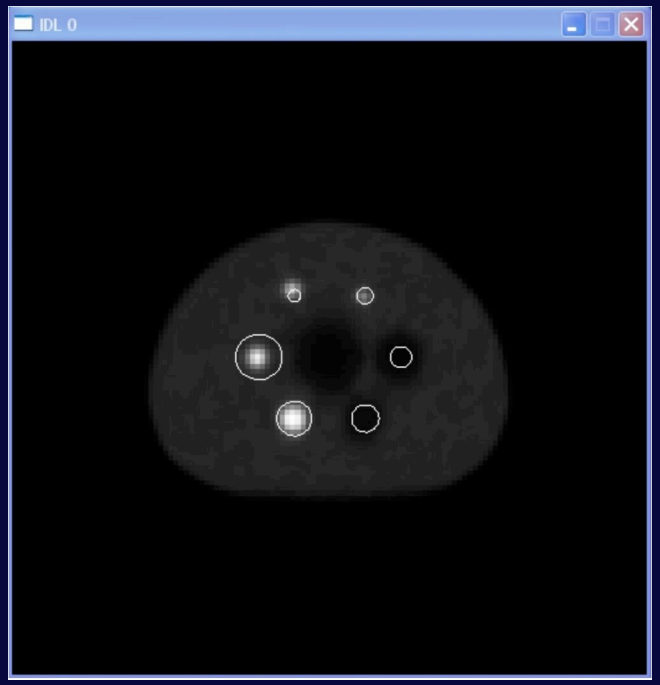
- The test data on the website will be a very useful resource.
- The website will publish results of PETAccept software applied to these test data.
- Vendors and other developers of acceptance testing software will be able to compare their results with the PETAccept results on the same data as a means of verifying their software.

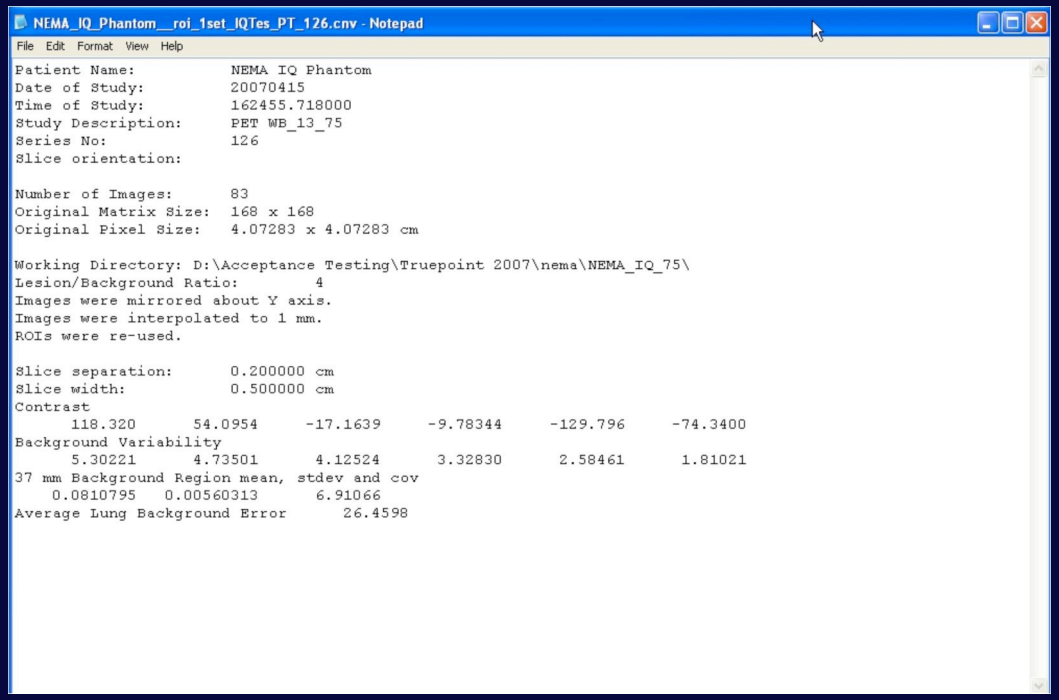
How can you help?

- Contribute sample acceptance test data acquired on your system. This will enable the project team to develop and test software for your system.
- Contribute software or documentation for acceptance testing on particular systems.
- If you are a vendor, you can contribute software, sample data, materials, disk space or funding to the project.
- Become a member of the project team.
- All contributions will be gratefully acknowledged.
- Contact Project administrator at r_fulton@users.sourceforge.net, or send an email to the project mailing list pet-accept-general@lists.sourceforge.net.

The first contribution

- NEMA 2001/7 Image Quality Analysis Program
  - Automated ROI definition
  - Runs on IDL Virtual machine
  - Tested on Siemens LSO Biograph and True-V
  - Will need some modifications for other PET systems
- Contributor: Stefan Eberl, RPAH.

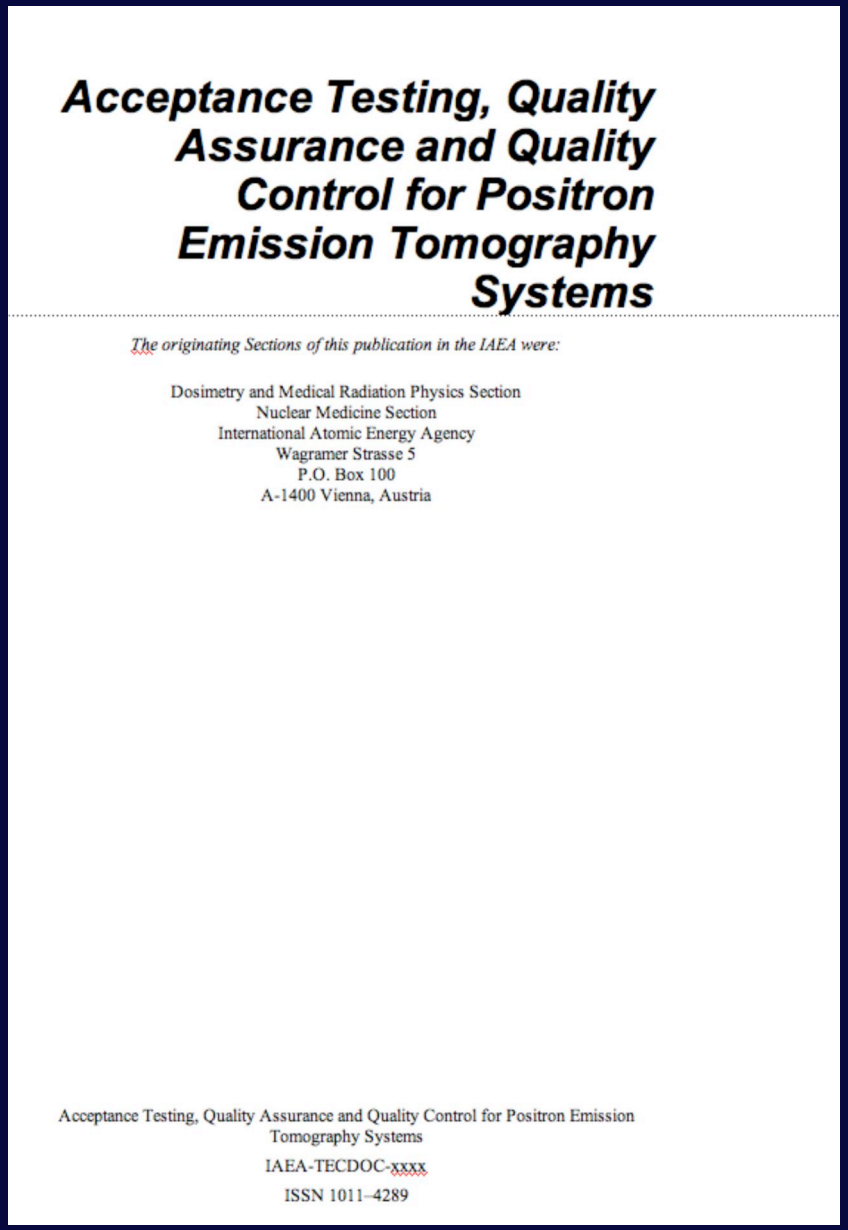




The future

- If the PETAccept project achieves it aims, it will
  - be used by vendors and end users.
  - be a valuable repository for resources and information about PET acceptance testing.
  - assist end users in developed and developing countries to easily perform acceptance tests in the correct manner with validated software and procedures.
  - Enable vendors to certify their test results against an accepted and verifiable standard.

2. The Draft IAEA Tec Doc



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  - CT.
- Specially targeted for use in developing countries.
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