**Errors can always be reduced to the minimum possible consistent with the accumulated experience by effective error management systems and tracking progress in error reduction down the learning curve.**

**[Duffey RB, Saull JW. Know the risk: Learning from errors and accidents: Safety and risk in today's technology. US: Butterworth-Heinemann Publications, 2003]**

Spring 2014, CIS II Project #8, Johns Hopkins University

# Seminar Presentation
# Task Group 142 Report:
# Quality Assurance of Medical Accelerators

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**Mentors:**
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**Dr. Kai Ding**

**Johns Hopkins University**
**April 10, 2014**

BIO MARYLAND
Biotechnology Development Program

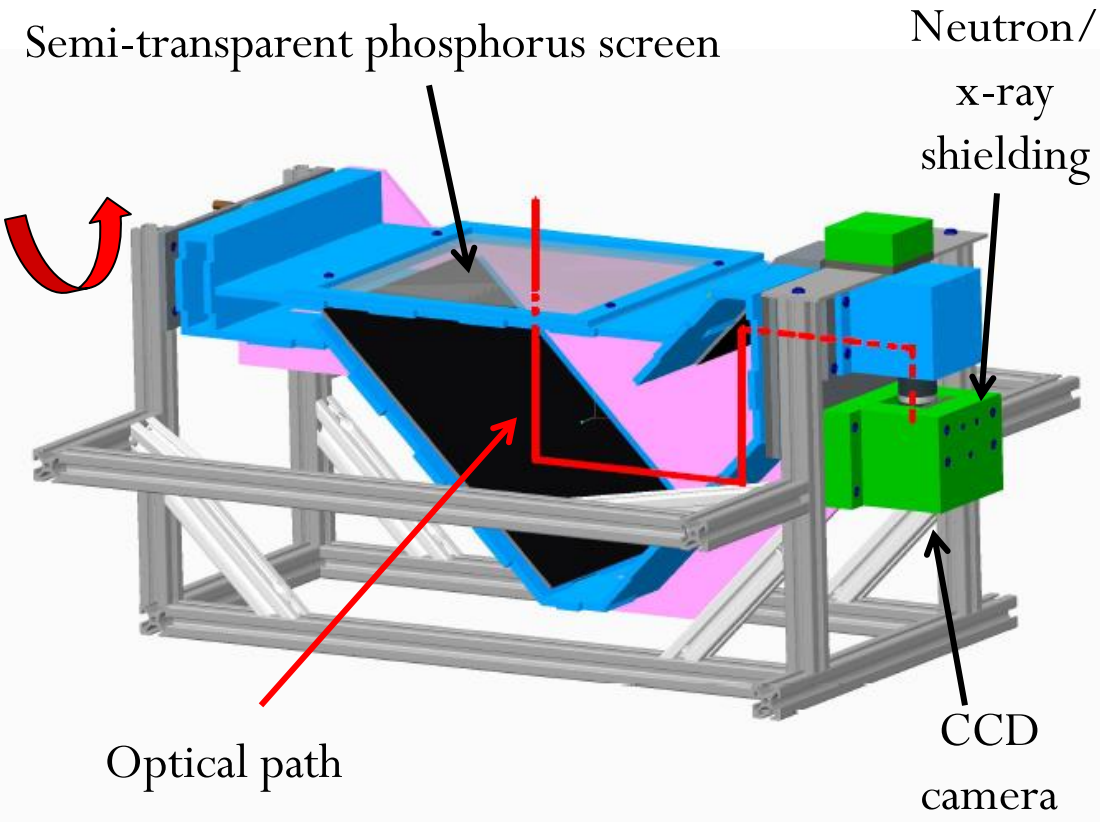
RAVEN QA

JOHNS HOPKINS MEDICINE
SCHOOL OF MEDICINE

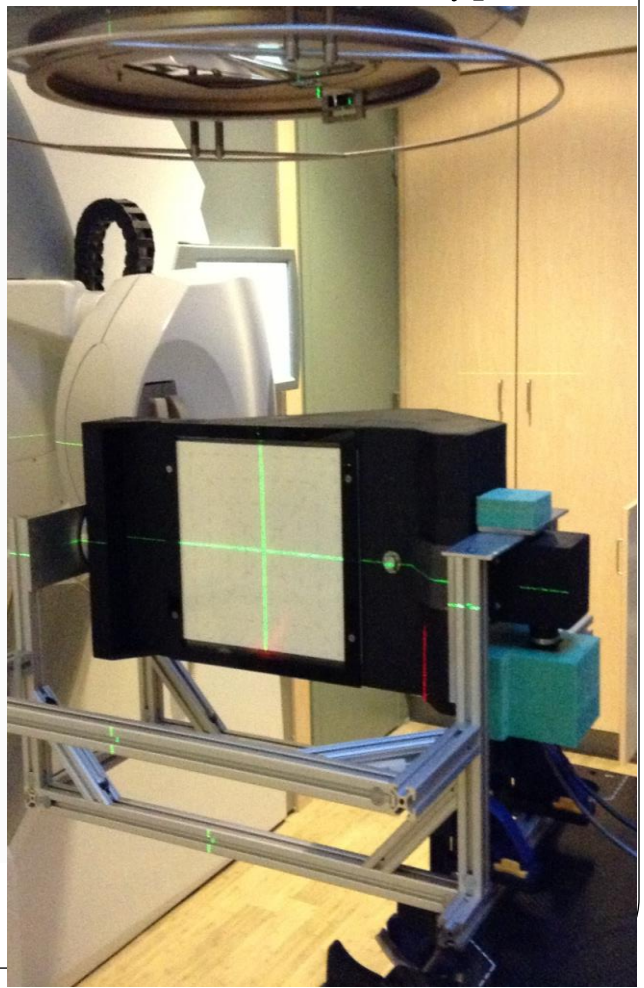
LABORATORY FOR Computational Sensing + Robotics
THE JOHNS HOPKINS UNIVERSITY

# 1. Project Overview

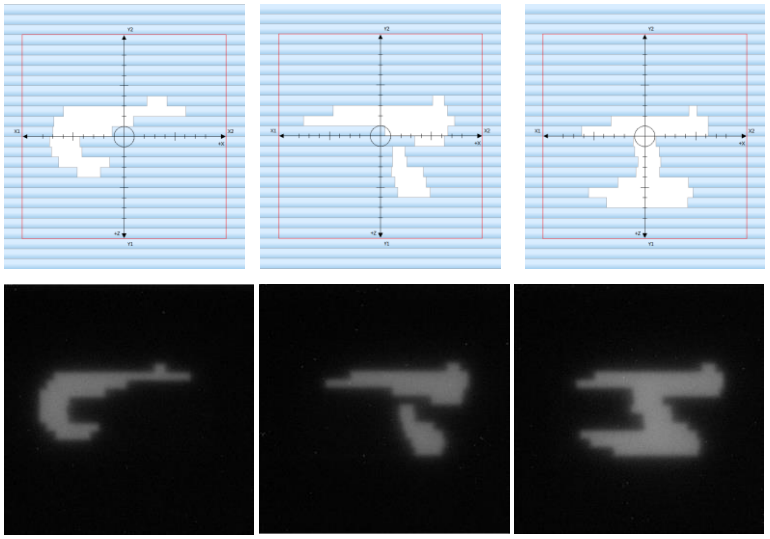
**Design and release a commercial software for Raven QA which includes: Image Acquisition; Image Processing Motor Control; User Workflow Guidance.**

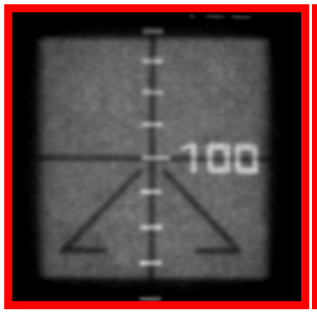



Second Prototype

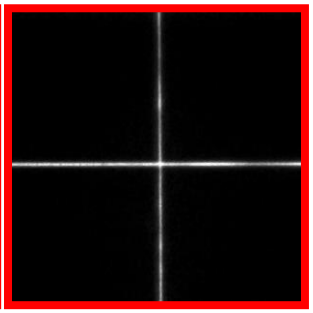


# 1. Project Overview: What do we do in QA?

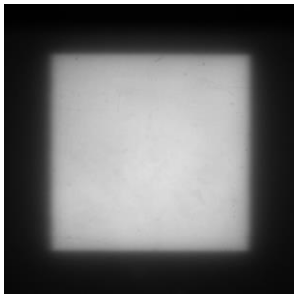




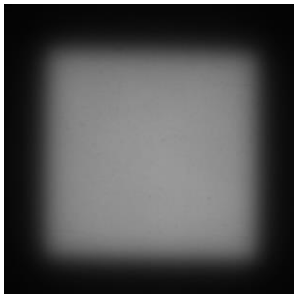

*Light field with ODI*



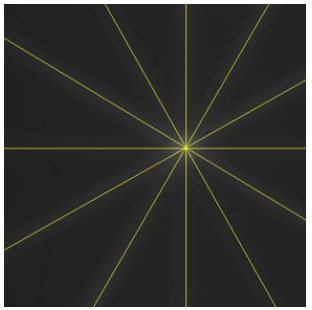
*Room Lateral Laser*



*6 MV x-ray at dmax*



*12 MeV electron at dmax*



# 2. Paper Information

- **Task Group 142 Report:**
  **Quality Assurance of Medical Accelerators**

- **Eric E. Klein, Joseph Hanley, et al. AAPM 2009**

- **First responsibility: Do no harm**
- **Second responsibility: Make things better**

- **Quality Assurance is proving that machines, processes and people perform as expected.**

# 3. TG-40, 1994 vs. TG-142, 2009

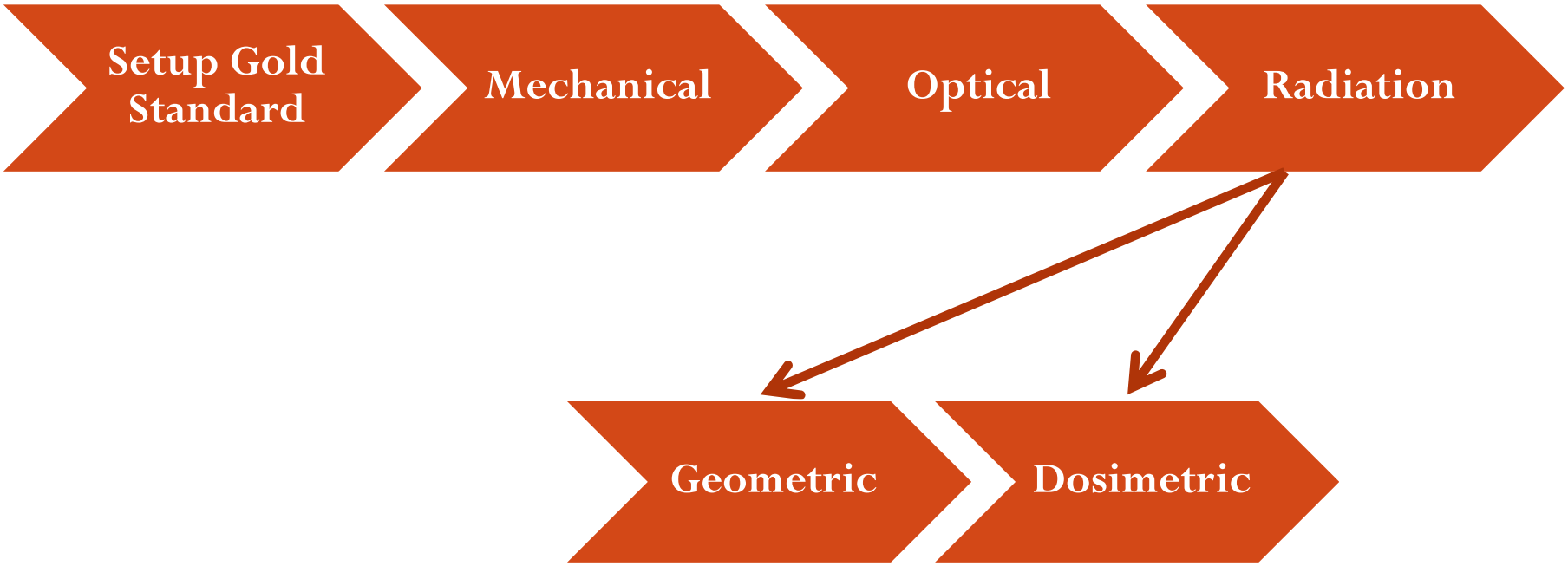
- Guidelines for administrators
- Cobalt-60 teletherapy units
- Brachytherapy
- Conventional simulators
- CT scanners
- Measurement equipment for dosimetry
- Treatment planning computer systems
- External beam treatment planning process
- External beam QA for individual patients
- QA of clinical aspects
- QA of medical electron accelerators

- Gives performance-based recommendations, but incorporates process-oriented concepts and advancements in linacs since 1994
- Linac QA: acceptance testing, commissioning, CQI
- Ancillary treatment devices
  - Asymmetric jaws
  - Dynamic/virtual/universal wedge
  - MLC
  - TBI/TSET
  - Radiographic imaging
  - Respiratory gating

# 4. Monthly QA Table

| Procedure | Machine-type tolerance | | |
|---|---|---|---|
| | Non-IMRT | IMRT | SRS/SBRT |
| **Dosimetry** | | | |
| X-ray output constancy | | | |
| Electron output constancy | | 2% | |
| Backup monitor chamber constancy | | | |
| Typical dose rate output constancy | NA | 2% (@ IMRT dose rate) | 2 |
| Photon beam profile constancy | | 1% | |
| Electron beam profile constancy | | 1% | |
| Electron beam energy constancy | | 2%/2 mm | |
| **Mechanical** | | | |
| Light/radiation field coincidence | | 2mm or 1% on a side | |
| Light/radiation field coincidence (asymmetric) | | 2mm or 1% on a side | |
| Distance check device for lasers compared with front pointer | | 1 mm | |
| Gantry/collimator angle indicators(@ cardinal angles) | | 1.0° | |
| Accessory trays (i.e., port film graticle tray) | | 2 mm | |
| Jaw position indicators (symmetric) | | 2 mm | |
| Jaw position indicators (asymmetric) | | 1 mm | |
| Cross-hair centering (walkout) | | 1 mm | |
| Treatment couch position indicators | 2 mm/1° | 2 mm/1° | 1 mm/0.5° |
| Wedge placement accuracy | | 2 mm | |
| Compensator placement accuracy | | 1 mm | |
| Latching of wedges, blocking tray | | Functional | |
| Localizing lasers | ±2 mm | ±1 mm | <±1 mm |
| **Safety** | | | |
| Laser guard-interlock test | | Functional | |
| **Respiratory gating** | | | |
| Beam output constancy | | 2% | |
| Phase, amplitude beam control | | Functional | |
| In-room respiratory monitoring system | | Functional | |
| Gating interlock | | Functional | |

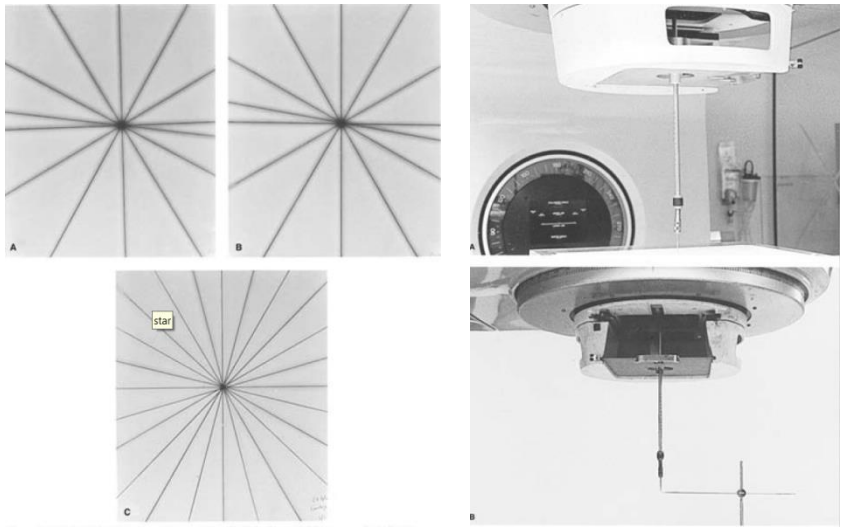
# 5. TG-142 QA Workflow



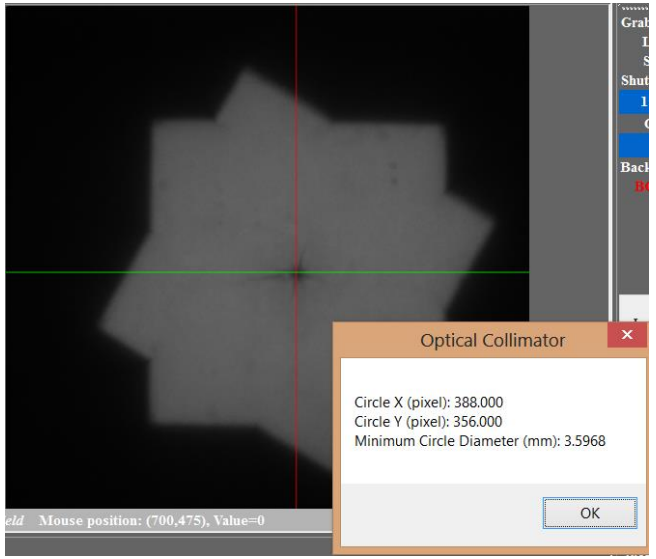
# 6. TG-142 Raven QA Solution

Setup Gold Standard → Mechanical → Optical → Radiation Geometric → Radiation Dosimetric

## Winston-Lutz Test (BB Machine)



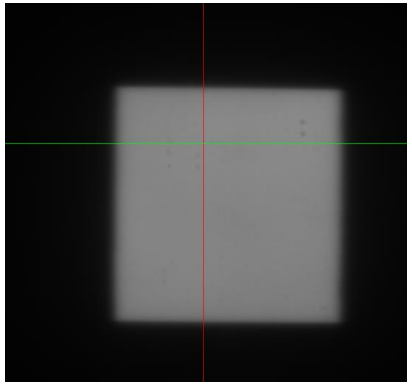

## Collimator Rotation Test

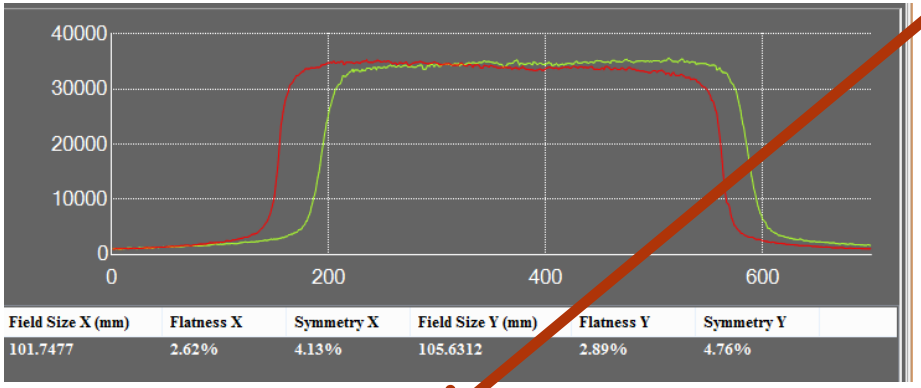


# 6. TG-142 Raven QA Solution

Setup Gold Standard → Mechanical → Optical → Radiation Geometric → Radiation Dosimetric

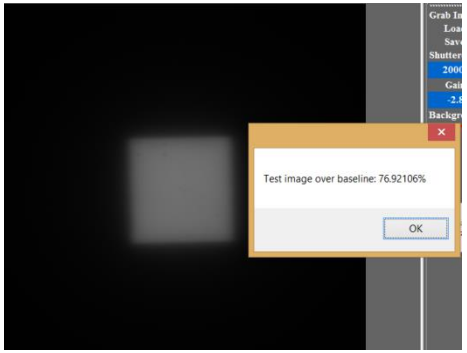
## Flatness and Symmetry Test



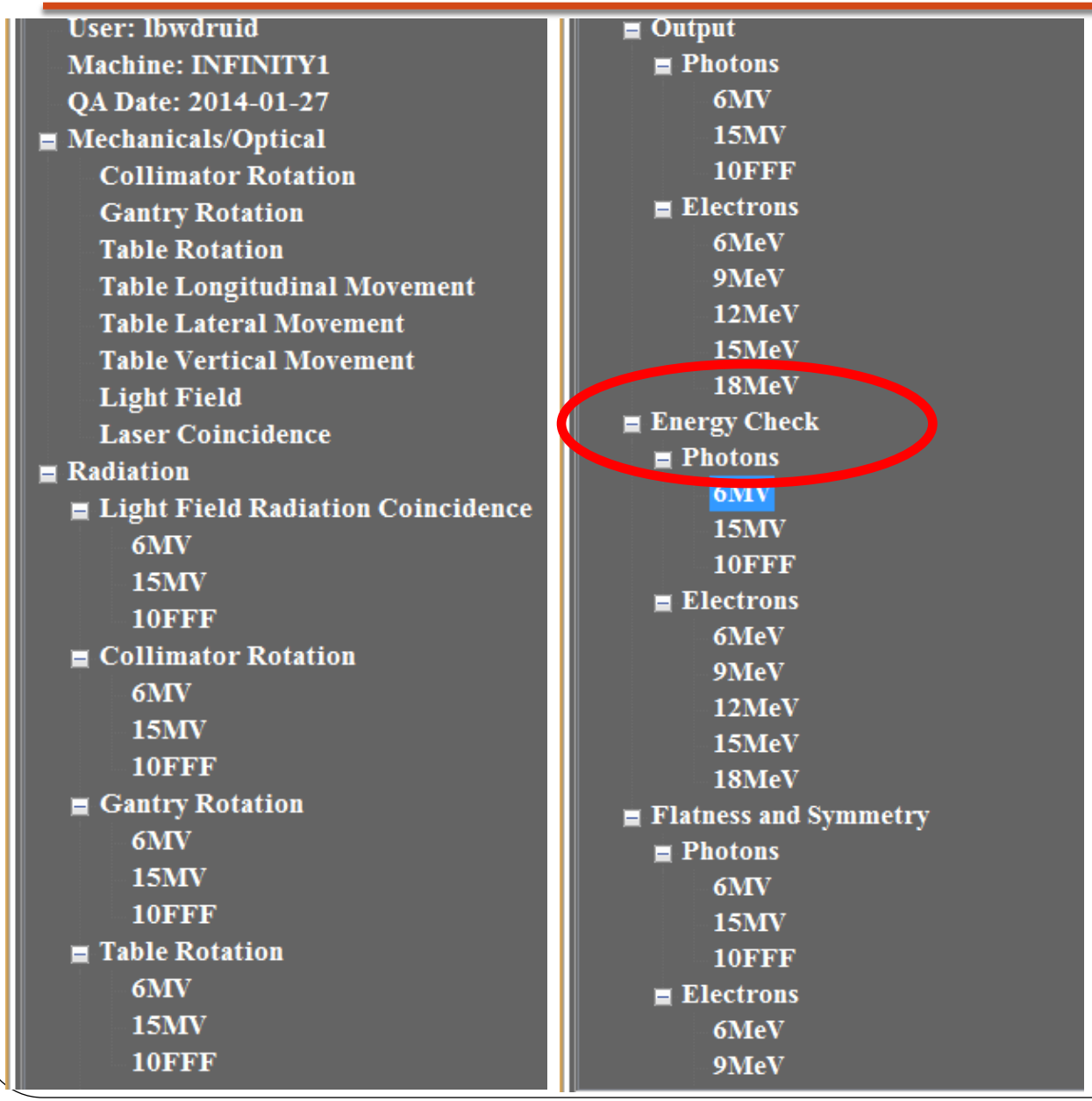



| Field Size X (mm) | Flatness X | Symmetry X | Field Size Y (mm) | Flatness Y | Symmetry Y |
|---|---|---|---|---|---|
| 101.7477 | 2.62% | 4.13% | 105.6312 | 2.89% | 4.76% |

## Energy Comparison Test



# 7. Raven QA Practical Workflow




**The Raven QA workflow covers TG-142 daily, monthly, and part of the annual table.**

**Physicists will go inside the radiation room once only.**

**Mechanicals and Optical tests can be done within 15 minutes.**

**Radiation tests can be done within 1 hour.**

# 8. TG-142 Summary

- **QA team led by the Quality Management Plan supports all QA activities, policies and procedures.**
- **The first step is to establish institution-specific baseline and absolute reference values.**
- **There is over lap of tests for daily, monthly and annual that can achieve independence with independent measurement devices.**
- **During the annual QA, absolute outputs should be calibrated as per TG-51 and all secondary QA dosimeters cross-checked.**

# Thanks for your attention!

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**April 10, 2014**