A Reliability Retrospective

Accelerator Reliability Workshop 2015

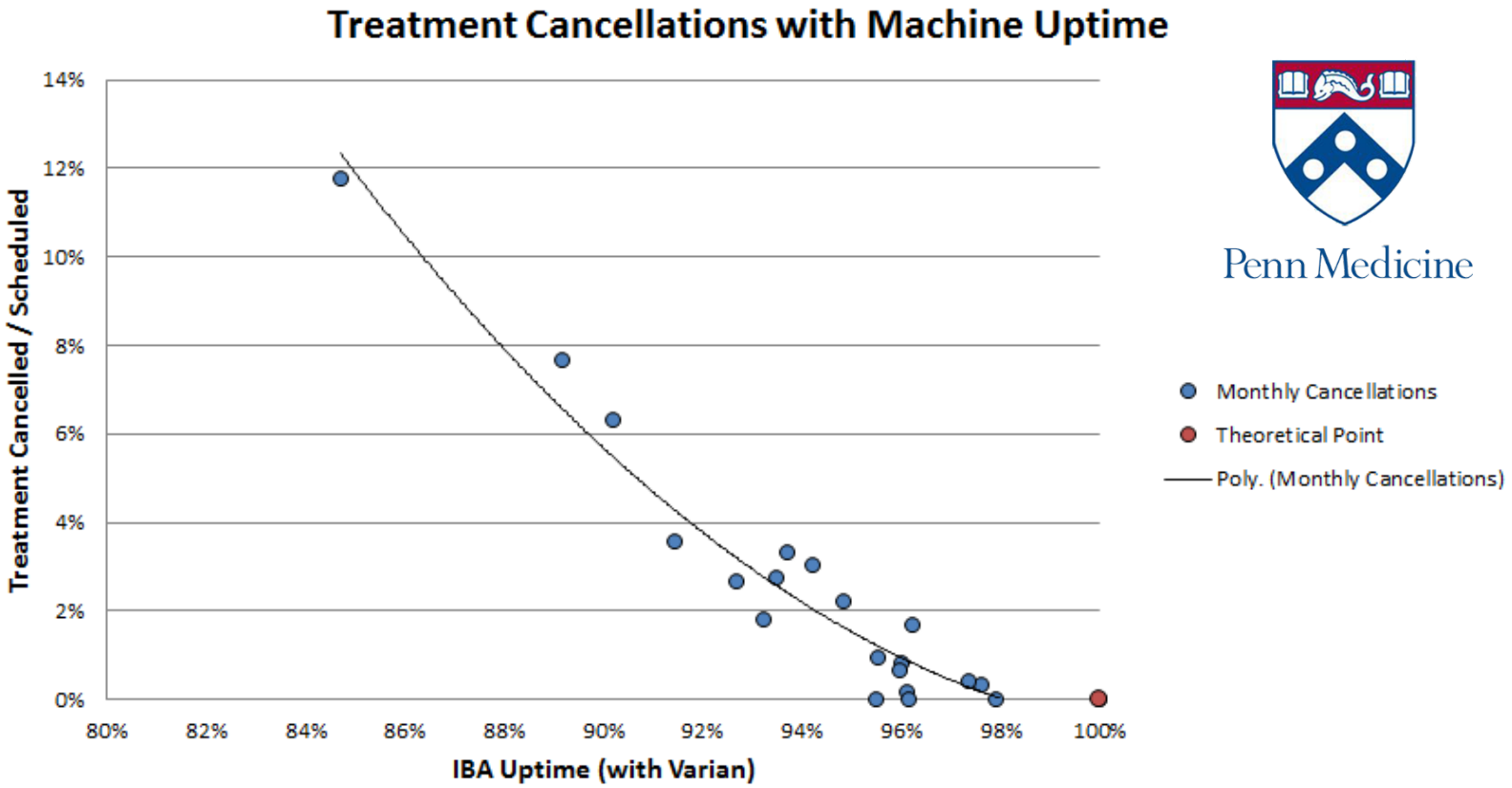
Stephen Thorson

Why does reliability matter?

The Human Element

Why does reliability matter?

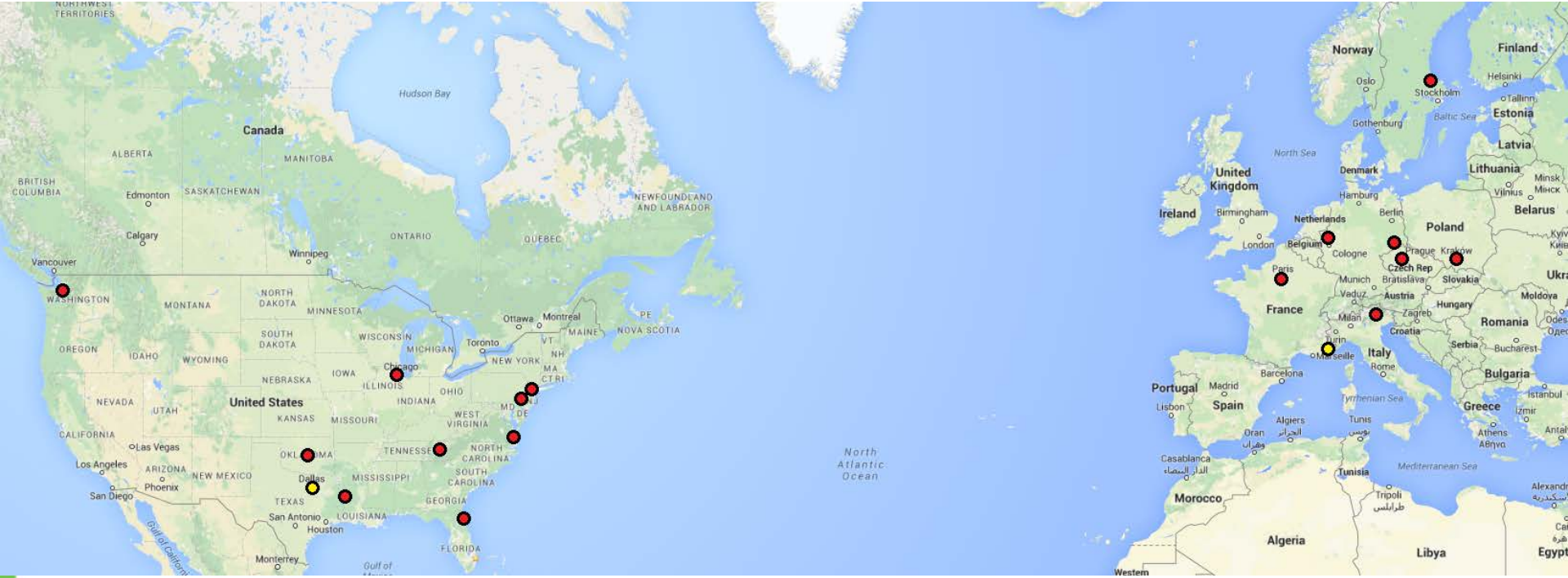
The Data Element



Penn Medicine

IBA's Service Business Today

There are more Proton Therapy centers every year.

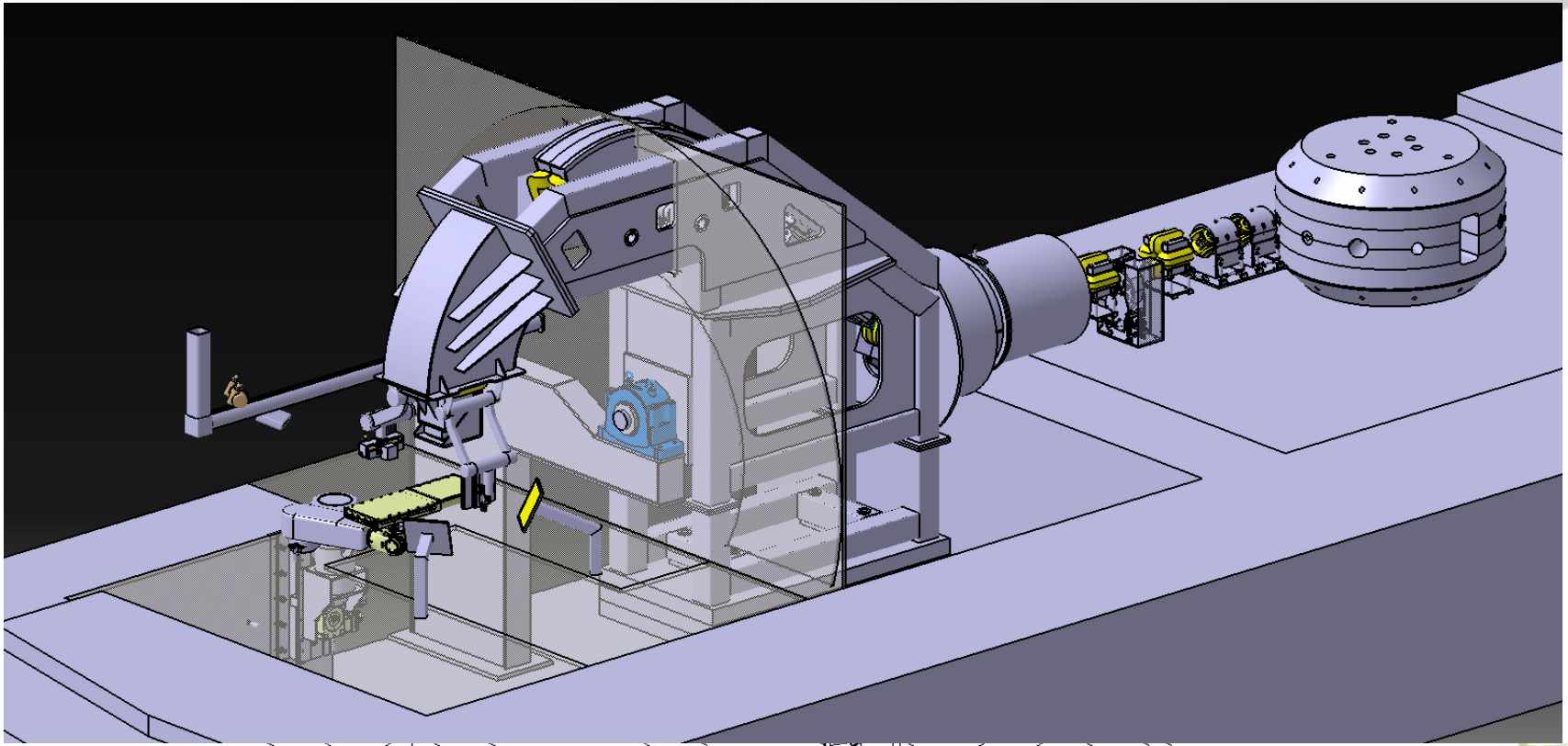


Comparison with Research Facilities

- Proton Therapy Challenges
  - Equipment is spread around the world, but expertise is concentrated.
  - Access to the equipment is limited by clinic operation. Fix it now!
  - Not possible to have every spare part locally.
  - Differences in the equipment configuration.
  - Working with suppliers to fix reliability issues.
- IBA's Advantages
  - Large installed base and long data history to draw from.
  - Large R&D and Accelerator Engineering Dept. (300 / 1100 employees)
  - 30 years of experience in commercial accelerators
  - Worldwide spare part network

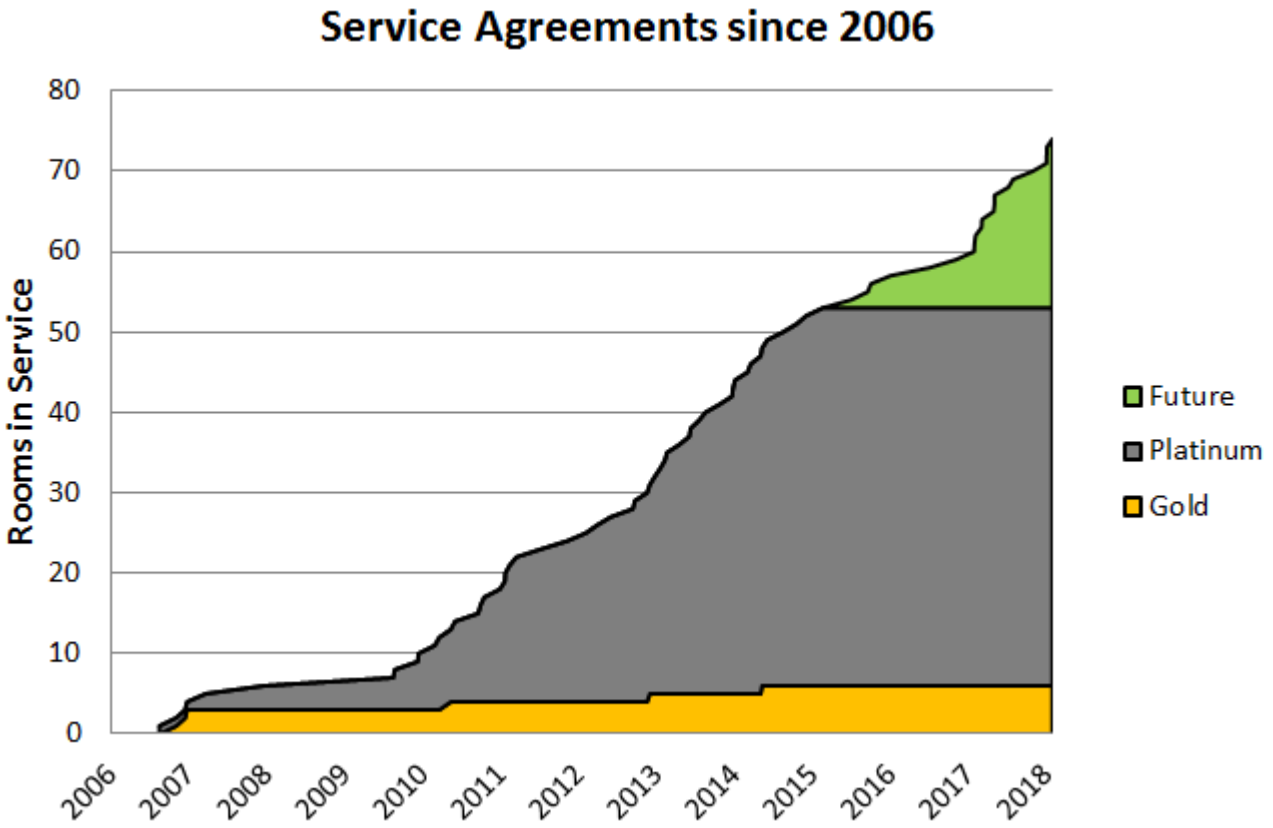
IBA's Proton Therapy Solutions

ProteusPLUS and ProteusONE



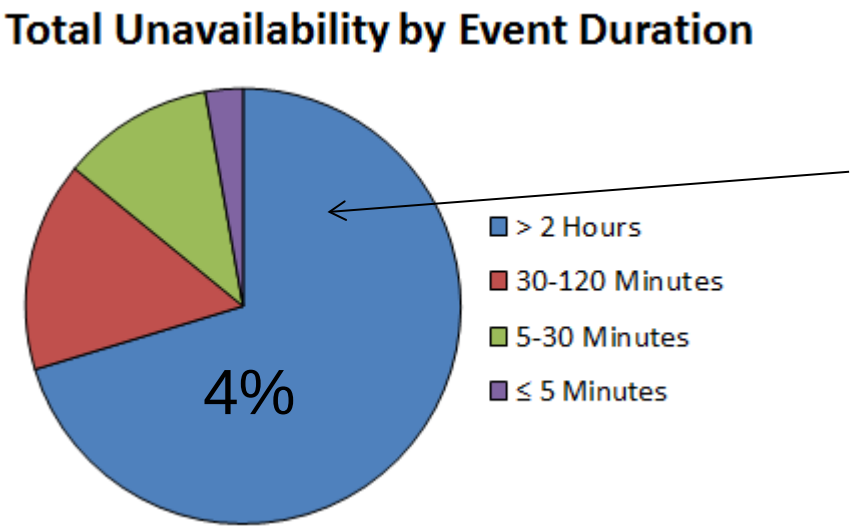
Reliability Retrospective

Rooms in Service Increase – Availability Increases



Extended loss of availability in 2014

Problem and Opportunity



Problem

Complex failures cause 70% of the availability loss.

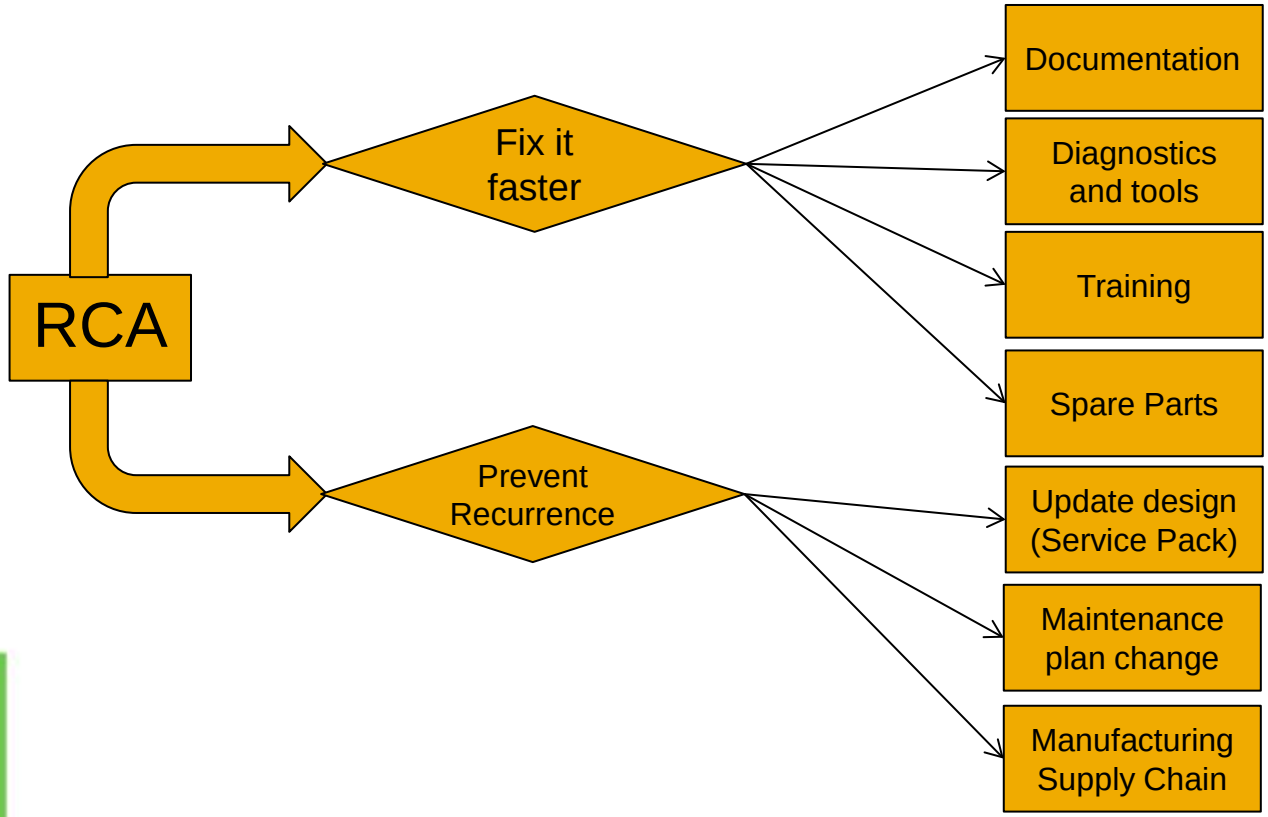
Opportunity

Without these failures, we can get another 3% uptime improvement.

4% of the failures cause 70% of the downtime.

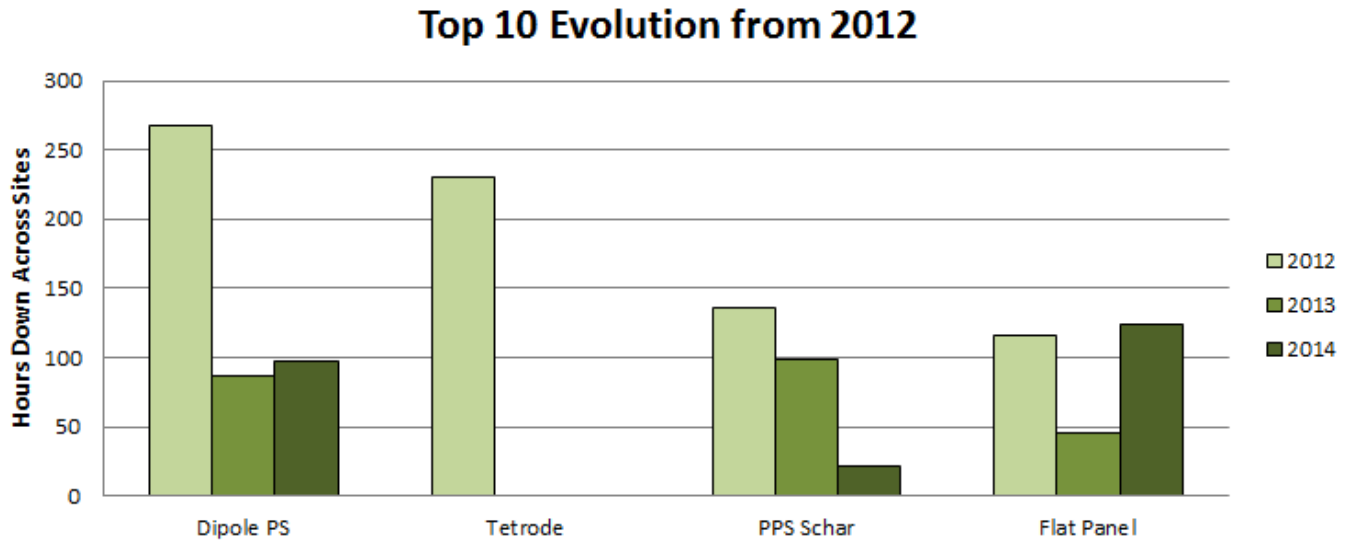
Our Continuous Improvement Program

2+ hour failure triggers RCA process.



Sources of data

- “Uptime tool” tracks logs failure incidents.
- Computerized maintenance management system (CMMS) tracks repairs and consumption of spare parts.
- Software logs and the logged monitoring data.



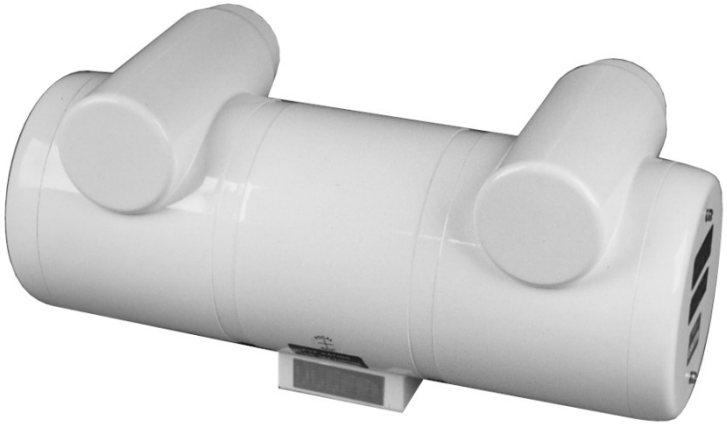
Specific Examples

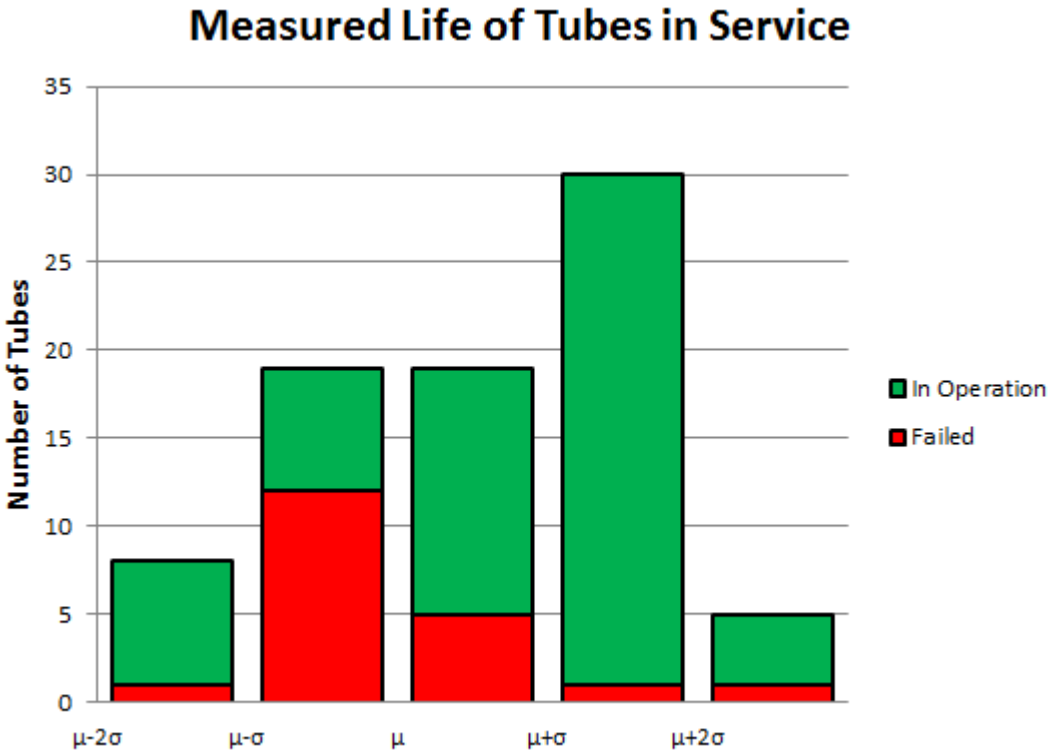
Working through a “degraded mode.”

- Getting through the day is critical to the clinic operation.
  - Avoid costly cancellations of treatment
- Cable breaks in an inconvenient place
- “Safety” interlock that only protects equipment
- System limited in certain respects:
  - Gantry rotation
  - Beam energy
  - Beam current

Specific Examples

Improving the maintenance plan





Specific Examples

Improving the maintenance plan

- After approximately 4 years of operation, holes appear in the ionization chamber.
- Last year, we launched a 2-year replacement schedule.

Specific Examples

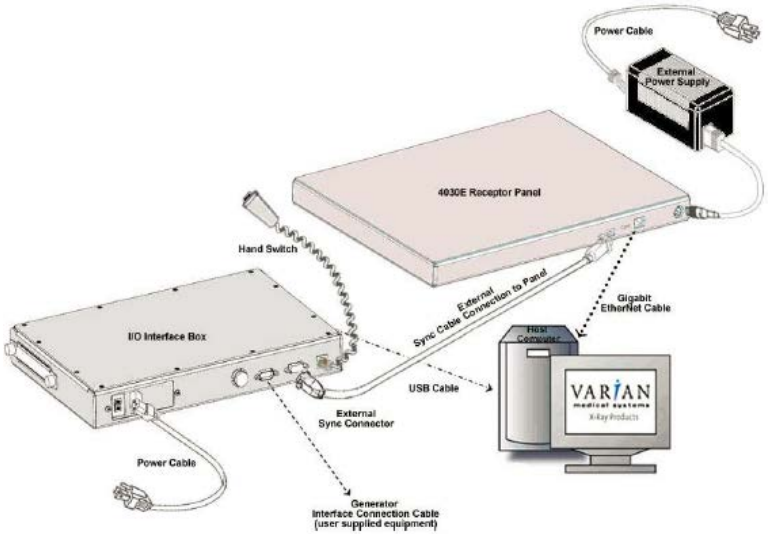
Improving the design

- Many failures of the RF ion source contact
  - 2 failures in 2011, 1 in 2012, 2 in 2013
- New design was implemented on installed base last year.
  - Change of spring-type RF contact to finger-type
  - Lowering the position of the contact (where the temperature is lower).
  - Improve the diameter of the upper ring part to avoid thermal conduction

Specific Examples

Improving the Supplier Part Reliability

- X-ray Digital Flat Panel destroyed by its power supply.
- Symptom: Flat panel not showing sufficiently good images. Power supply found burned. New power supply does not restore.
- Problem: Supplier denies the problem.
- Brainstorming possible root cause:
  - Radiation damage
  - Overheating
  - Power surges



Specific Examples

Configuration differences between multiple centers

- Hazemayer dipole power supply failure.
  - “Optical fiber” fault followed by IGBT arc flash on next ramp.
- MTBF is 2.5 years (12 failure per year)
- Supplier offers no solutions
- Failure only happens on 4 of 12 centers.
- What are the configuration differences?
- IGBT current rating drastically different.

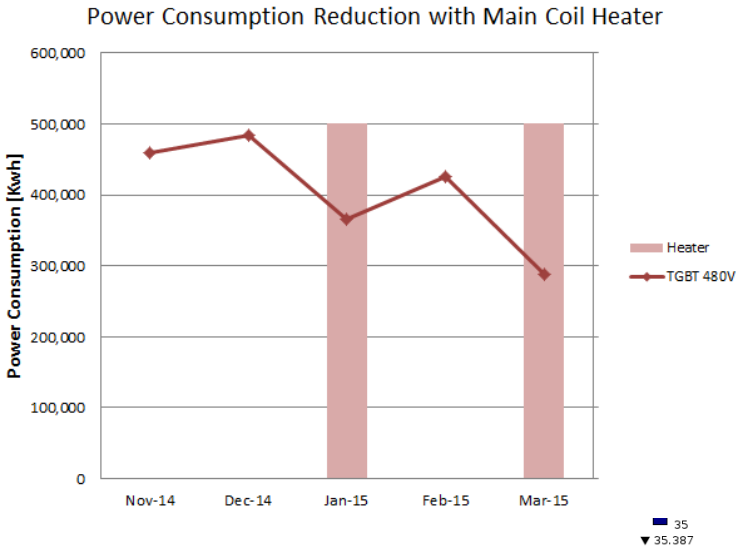
Where are we going in the future?

- Operation of the machine should cost less than it does today.
  - Fewer guys on site, automatic operation, targeted maintenance missions
  - Lower energy costs
- 1/3 of the problem resolution time is in troubleshooting. We need improved monitoring to allow:
  - Automatic alerts to trigger corrective maintenance
  - Remote troubleshooting and diagnostics.

Specific Examples

Reducing the sensitivity to temperature

- Consistent temperature critical
  - Need to keep main coil on 24/7.
    - 200,000 kWh per month!
  - Long periods without RF cool down yoke.
  - Several 5-10 minute tuning delays
- New heater system tested in Paris
  - Keeps the yoke warm without the magnet



adapt service ver. 0.1

Single Monitoring Interface

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Monitoring

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Analysis

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Troubleshooting

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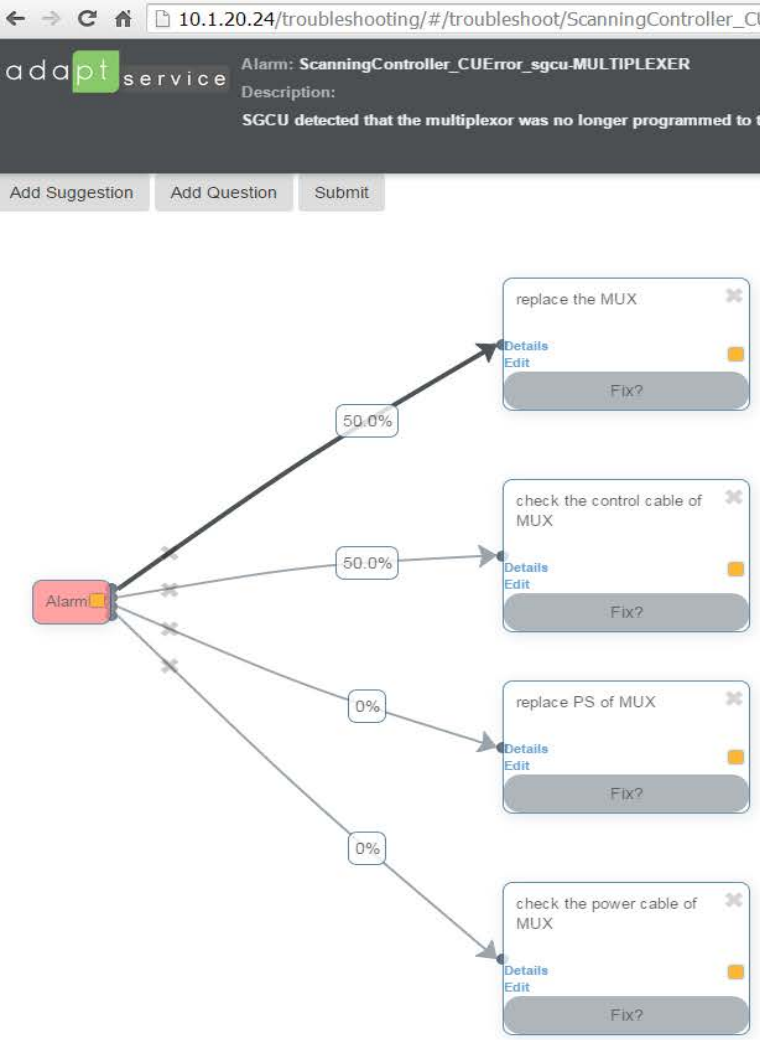
Monitored Centers

Selected Center

CENTRE DE PROTONTHÉRAPIE
DE L'INSTITUT CURIE

Paris (Orsay), France

Treating since 2009



Do you have experience with “learning” troubleshooting tools?

Thank you

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