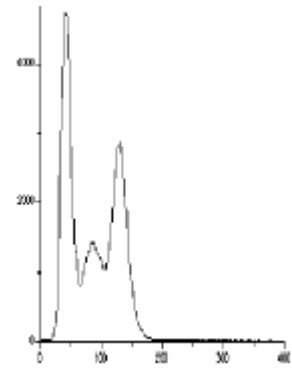




MIDWEST  
CHAPTER

# THE SPECTRUM

NEWSLETTER OF THE HEALTH PHYSICS  
SOCIETY'S  
MIDWEST CHAPTER  
March 26, 2010  
midwesthps.org



## Spring Meeting Tuesday, March 30, 2010

Sponsored by Ameriphysics, LLC

### Chapter Officers

President: Cindy Boggs  
President-Elect: Sheri Minnick  
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Treasurer: Sunita Kamboj  
Past President: John Schrage

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Kelly Grahn  
Adam Becker  
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Legislative: Darrel Wiedeman  
Nominations: John Schrage  
Program: Sheri Minnick  
Publications: John Schrage  
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Advanced Measurement  
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Chase Environmental Group, Inc.  
DEQ Technical Sales  
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Mirion Technologies - Dosimetry  
Services  
Philotechnics, Ltd.

## The Process of Repairing a Highly Activated NuMI Horn

Gary Lauten

### Fermi National Accelerator Laboratory

Fermilab's NuMI is a beam line used for neutrino production from an intense 120-GeV proton beam. Protons from the Main Injector beam line interact with a target to produce neutrinos, which are used for the MINOS experiment to determine if neutrinos have mass. Two high-voltage magnetic focusing devices ("horns") help focus the secondary pions from target interactions and are exposed to very high radiation. As a result, they become thermally hot and require cooling to minimize adverse thermal effects.

Cooling lines have broken on two occasions, resulting in cooling failure. Replacement horns were not ready, so it was necessary to repair the leaks. ALARA principles were closely observed in planning water line repairs. Mock-ups were constructed and workers spent many days practicing assigned steps, as the total allotted repair time in the high dose rate field was about two minutes for each horn. The estimated dose reduction for each repair was 2 person-rem.

Gary Lauten is currently the Deputy Radiation Safety Officer for the Accelerator Division at DOE's Fermilab. He has been at Fermilab for 18 years. Among his responsibilities are ALARA planning and Radiation Work Permits for radiological work involving high dose rates and contamination from high energy beam activation of materials in the Accelerator Division complex.

**Upcoming Events**  
**Third Annual**  
**Midwest Health Physics Technical Symposium**  
**Saturday, April 24, 2010**  
**Argonne National Laboratory, Argonne, IL**

***Radioactive Contamination Events  
Response and Prevention***

Sponsored by Midwest Chapter of the Health Physics Society

This full-day symposium will feature a wide range of technical presentations and vendor displays.

**PRE-REGISTRATION IS REQUIRED** (by April 9 for non-citizens, April 16 for U.S. citizens)

If you are not an Argonne employee, your name must be on the access list and you must have a photo ID to enter the site.

Pre-paid registration is encouraged and offered at a reduced cost. The symposium is open to Chapter members and non-members. The Chapter has applied for ABHP CE credits.

View full announcement at [midwesthps.org](http://midwesthps.org) for registration and payment information.

***Presentation Topics***

***New Concepts in Radiological Emergency Planning***

***Recent Intakes of Transuranics in the DOE Complex***

***The Importance of Health Physics and Medical Coordination during Radiation Emergencies***

***2008 NIST-Boulder Plutonium Source Contamination Incident***

***Biosafety at Ricketts Biocontainment Laboratory***

***The Tritium Guy***

***Lessons Learned from Leaking Am-241 Smoke Detectors***

***Operational Experience with Next Generation Gamma Sensitive RCA Exit Monitors at D.C. Cook Nuclear Plant***

***Respiratory Protection Issues***

***Operational Guidelines for Consequence Management of Radiological Dispersal Device Incident***

# Message from the Past President

**John L. Schrage**

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With apologies to theoretical physicists, I truly believe that the passage of time accelerates as one gets older. And so it goes with the three year journey from President-Elect, through the position of President, to my current role as Past President. As the snow melts, this phase is coming to an end as well, which brings me to the subject of this message – solicitation of interest and willingness to continue the work of the Chapter.

As the Nominations Chair, one of my tasks is to recruit energetic and interested members for election to a position as a Chapter Officer or Board member. Now, I can give you the spiel about the intrinsic rewards of actively participating in a growing and improving professional society, of which there are many. Or I can wax poetic of the progress that the Chapter has made over the past four years, which has been considerable.

The primary reason that the Chapter has grown and improved over the past four years has been the willingness of Chapter members to step-up and make a difference, as was the case with my predecessor – Gerry Davidson – a true visionary and relentless task master.

Now it is your turn.

The Chapter needs you to get involved – to run for a position as a Chapter Officer or a Board Member, or volunteer on a Committee.

Specific to Chapter elections, which will take place in May, I am asking each and every member to seriously consider this opportunity to help the Chapter and its members. Please feel free to contact me with your questions or concerns regarding service as a Chapter Officer or Board Member. Better yet, please contact me to express your desire to run for the position of President-Elect, Treasurer, Secretary, or Board Member.

Best Regards,

John L. Schrage

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# **Industry Experience**

## **Radiation Cancer Therapy Machine Mishaps in 1985-86 due to Safety Critical Software Control Errors**

### **Brief History**

The Therac-25 is a double pass accelerator produced by Atomic Energy of Canada Limited (AECL) and released to the market in 1983. At that time, the radiation therapy machine was at the forefront of technology, as it is completely controlled by computer. This means that not only was the initial patient setup run by computer software, but so were the safety checks and the operation of the radiation beam. The design was approved by the U.S. Food and Drug Administration (FDA), based on the heritage designs of the machine's predecessors, the Therac-5 and the Therac-20.

Therac-25 has two radiation beam operating modes: a direct electron beam with an energy range of 5 to 25 MeV, and an x-ray beam consisting of Bremsstrahlung radiation of created using 25 MeV electrons. The electron beam mode utilizes scanning magnets to spread the beam into a useful therapy concentration. The x-ray mode utilizes a converter target, a flattening filter, a collimator and an ion chamber to measure the strength of the beam.

### **The Events**

Within a two-year span from 1985 to 1987, no fewer than 6 radiotherapy patients were massively over-dosed by the electron beam of the Therac-25. Three of the patients died from direct effects of the radiation dose. The cause of the over-exposure was a failure to engage the flattening filter while operating the machine in x-ray mode. As a result, the high-energy electron beam struck the patients directly, supplying nearly 100 times the prescribed dose. The burn effects of the radiation dose were visible within days and the deaths occurred not long after.

### **Causes**

The primary cause of the malfunction has been attributed to software interlock failures. The software was modified from the Therac-5 and Therac-20 programs. Upon later inspection, a number of problems within the software were considered to be unsafe. Two glaring aspects of the software are main contributors: the combination of a multi-tasking environment and access to shared data allows for program failure under certain conditions. In the case of the Therac-25, the certain condition is one in which operators perform a setup quicker than is accommodated by the design, and a "race" condition manifests. This software malfunction is the direct cause of the failure to implement the flattening filter prior to initiation of the high-energy electron beam.

The problem was exacerbated by a lack of response to the first over-exposures. AECL was notified of the first overexposure in July 1985. Engineers were unable to reproduce the failure that caused the overexposure and deemed it a hardware malfunction. After hardware modifications were made, AECL informed all customers that the machines were still fully operable. A number of subsequent malfunctions occurred, each of which were handled similarly by AECL. The hospital personnel involved with the Therac-25 units were each told that they were experiencing isolated incidents, with insufficient corrective action by the manufacturer.

By January 1987, after six total malfunctions were reported, the FDA and its Canadian counterpart ordered the shut-down of all Therac-25 units. A final correction plan was created by AECL that included numerous software fixes and independent mechanical safety interlocks. The FDA eventually approved the correction plan and units became operational once more.

### **References**

ComputingCases.org Case Materials for Therac 25,  
[http://computingcases.org/case\\_materials/therac/therac\\_case\\_intro.html](http://computingcases.org/case_materials/therac/therac_case_intro.html)

Nancy G. Leveson and Clark S. Turner, "An Investigation of the Therac-25 Accidents," IEEE Computer 26 .7 (July 1993): 18-41.

**Spring 2010 Meeting  
Tuesday, March 30, 2010**

Sponsored by Ameriphysics, LLC

The Process of Repairing a Highly Activated NuMI Horn

Gary Lauten

Fermi National Accelerator Laboratory

**Date:** Tuesday, March 30, 2010

**Time:** 6:00 P.M. Social Hour  
7:00 P.M. Dinner  
7:45 P.M. Featured Speaker

**Location:** Casey's Restaurant  
415 East North Avenue  
Lombard, IL  
630/932-4777  
<http://caseysrestaurant.com/>  
for directions

**Cost:** \$20 per person for Chapter  
members and spouses  
\$23 per person for non-members

**Menu Choices are:**

London Broil with noodles,

Fettuccine Alfredo with chicken, or

Baked Boston Scrod with rice

Eggplant Parmesan

Soup, salad, and dessert are included  
with all meals

**Reservations:** Phone or e-mail your reservation with your meal choice to Cindy Boggs at  
(630) 252-3701, or [cboggs@anl.gov](mailto:cboggs@anl.gov) by 4 p.m. on Monday March 29.