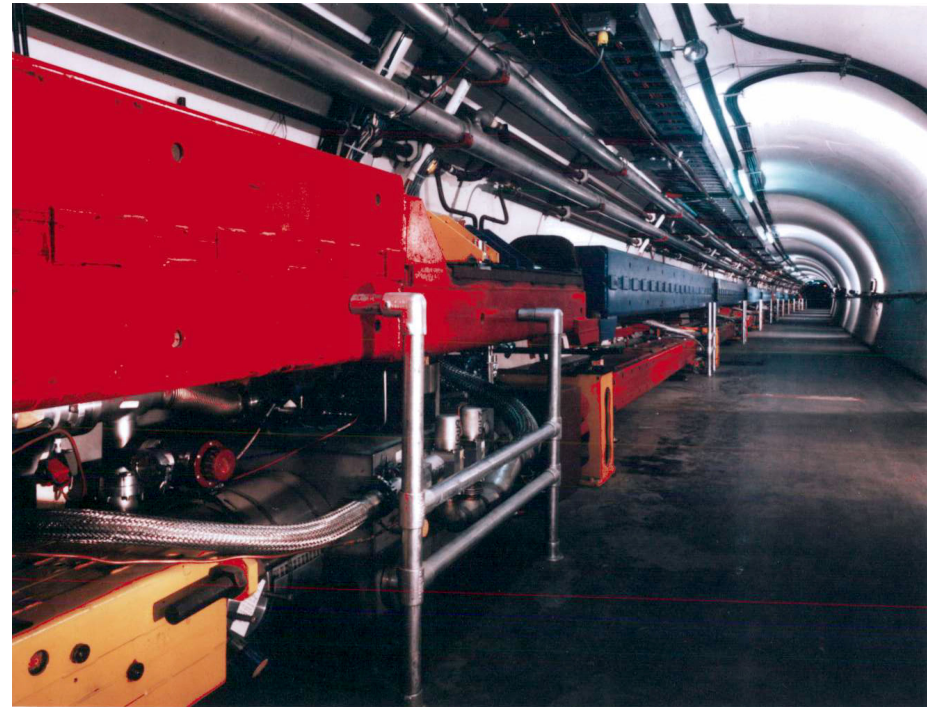


# FNAL's report on full-scale horizontal cable fire tests 1988

Michael Plagge

# Installation characteristics

- LINAC tunnel 152 m
- Booster ring 457 m
- Main ring 6437 m



W. M. Riches, Report on Full Scale Horizontal Cable Tray Fire Tests, FNAL, September 1988

# Fire Protection

- *Because of the non-combustible construction and mainly non-combustible contents in the underground enclosures, together with their enormous lengths, fire suppression systems are not provided in underground enclosures.*
- *Because of radiation levels experienced, [...] ionization or photoelectric smoke detectors are not practical or functional.*
- *The 24 hour/day on-site FNAL Fire Department provides a 4 minute response time to all accelerator and beamline locations [...].*

# Cable tray fire test program

- In cognizance that, [...] ignition could occur due to an overheated magnet melting its coil insulation or due to an electrical short in the electrical cable trays, FNAL initiated a full-scale fire test program [...] to determine the hazard presented by horizontal cable trays.
- [...] to measure flammability of cables and the rate and length of fire propagation in the horizontal trays
- [...] to determine the need, value and cost effectiveness of an automatic sprinkler system
- [...] establishing that existing manual fire fighting plans and techniques were appropriate

# Cable tray fire test program

- 14 tests
- Thermocouple instrumentation
- Video tape
- Photos
- Fire fighter observation
- Qualitative smoke analysis
- Test facility constructed for testing
  - 20 m long
  - Same geometry a main ring tunnel
  - Ends closed with plywood wall and door (both)
  - Ventilators put into plywood seal to provide laminar tunnel ventilation
- Some tests carried out in winter: propane and electric heaters used to maintain tunnel air temperature

*Who did say ignition source?!*

# Cable test site



# Results (No.1) Main Ring

- 12 inch cable tray
- 9 inch cable tray
- Side by side
- 193 control and signal cables
- Propane burner for 10 minutes
- Flames self-extinguished
- Flame propagation:
  - Upstream about 0.6 m
  - Downstream about 0.6 m



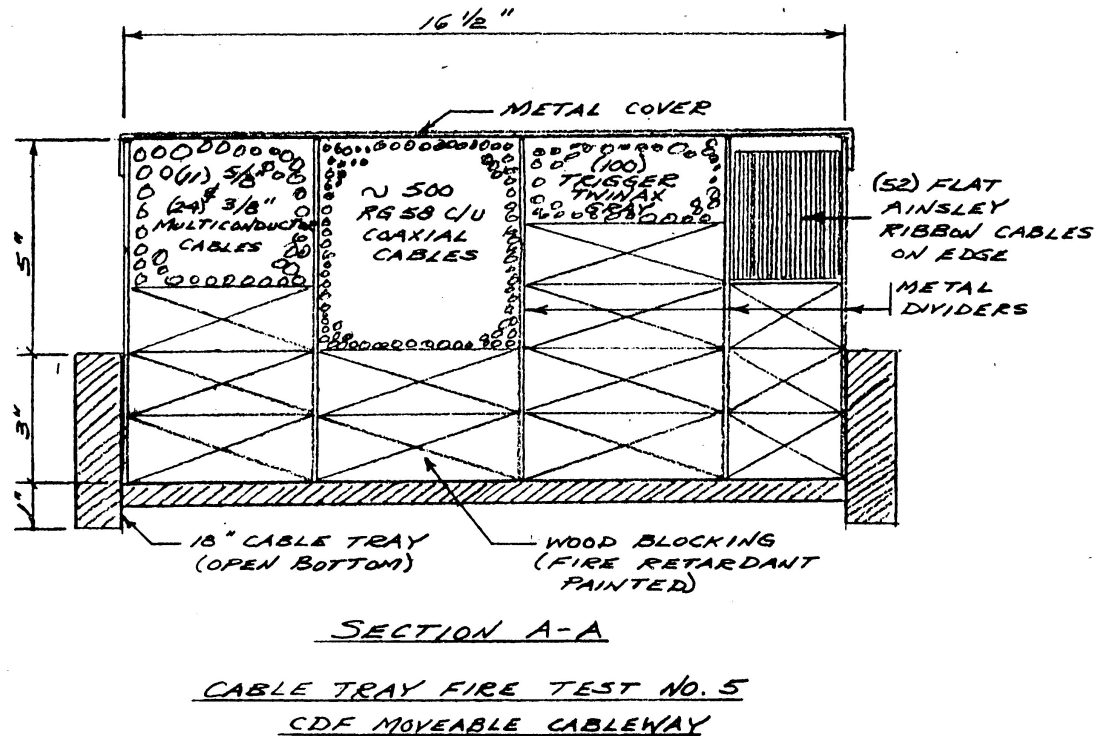


# Results (No.3) NMO enclosure

- 18 inch tray (power cables)
- 12 inch tray (control and signal cables)
- Stacked
- Propane burner for 7 min
- Flame propagation:
  - None in lower tray
  - *20 Hardline coaxial cables in top tray exploded and propagated horizontally 2.1 m up- and downstream [...] until the end of the cables*

# Results (No.5) CDF moveable cableway

- 4 different cables
- Open bottom
- Closed top (metal)
- Propane burner
  - 20 kW; 31 min
  - 40 kW; 15 min
- Propagation
  - 0.6 m upstream
  - 0.6 m downstream
  - During 84 min!



WMR  
4/22/88

# Results (No.5) NMO enclosure

*When we came back from lunch about 1300 hours, we noticed some flaming at the extreme downstream end of the covered tray.*

*When I uncovered the tray I noticed a great amount of destruction and pyrolyzation of the insulation of all the wires in the tray. We then removed the rest of the covers downstream. When the covers were removed, there was a large amount of grey smoke being produced from what appeared to be deep seated heat [...].*

**1.5 m further fire propagation unnoticed!**

# Selected report conclusions

- *High intensity fires with fast flame propagation by cable in FNAL underground enclosures is highly improbable, if not impossible. Adequate sealing of penetrations to above ground support facilities is a necessity.*
- *Automatic sprinkler system would be [...]:*
  - *Of little benefit*
  - *Not cost effective*
  - *Ineffective minimizing smoke damage*
- *Early warning fire detection followed by manual fire fighting is the most effective defense against underground enclosure fires.*
- *Property loss would not be a major factor. Accelerator or experimental beam time would be lost in any case, with an estimated one person-week recovery time.*
- *FNAL Fire Department*
  - *Portable fire extinguishers most effective for cable trays*
  - *Ventilation rates have little impact on horizontal flame propagation rate*
  - *Visibility is not a problem in ventilated tunnels*

# From 2017 perspective

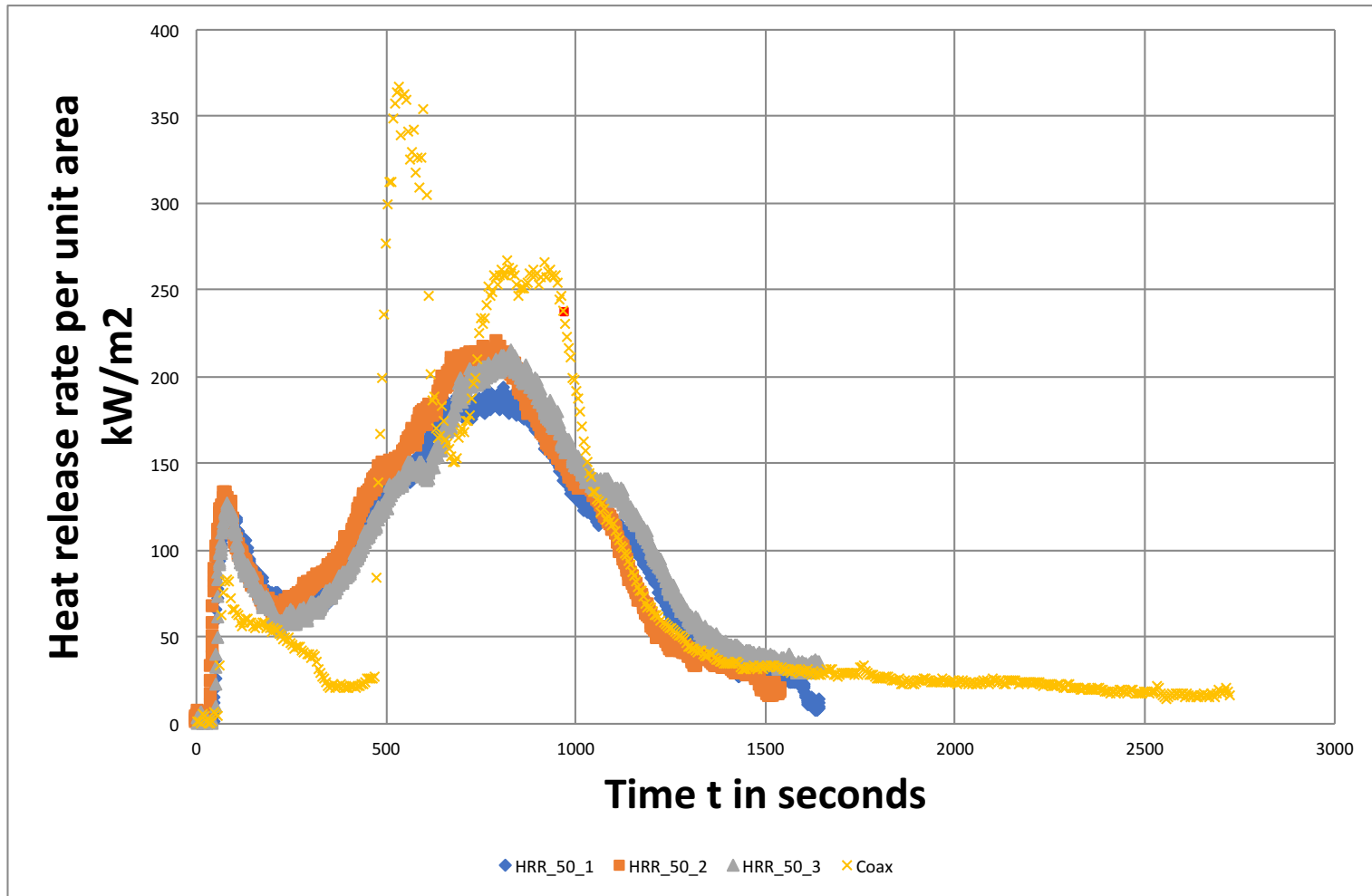
- Still no data (statistics) on fire events
- Compartments: even today not systematically applied.
- PVC cables outdated for accelerator installations
- Mobile remote fire fighting possibilities
- More electrical and electronic installations than before; higher density on trays
- Cost rise: one week downtime still acceptable?
- No more halon use!

# Coaxial cables?!



T. Hehnen and M. Plagge, Cone Calorimetry of CERN-specific cables at Lund University, June/July 2017

# Coaxial cables?!



# Questions?!



T. Hehnen and M. Plagge, Cone Calorimetry of CERN-specific cables at Lund University, June/July 2017





