SNS BLM System Overview
Detectors, Measurements, Simulations

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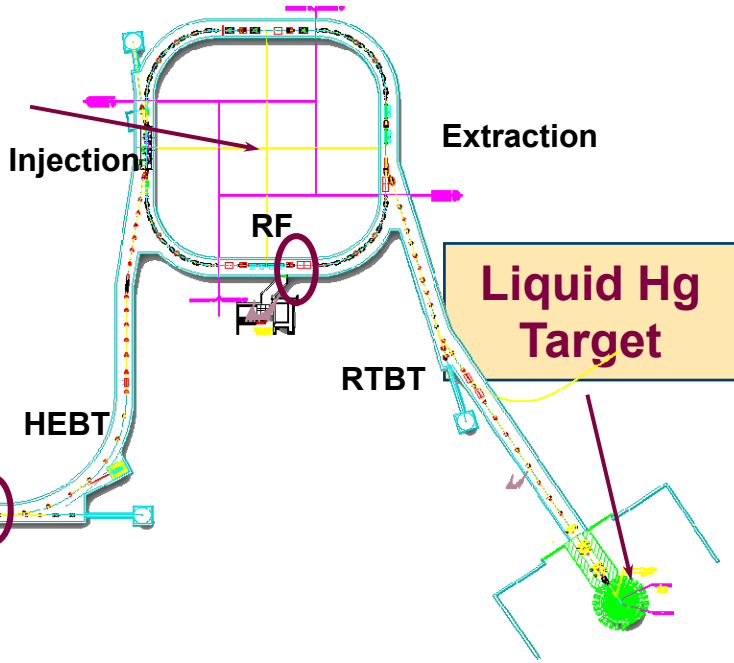
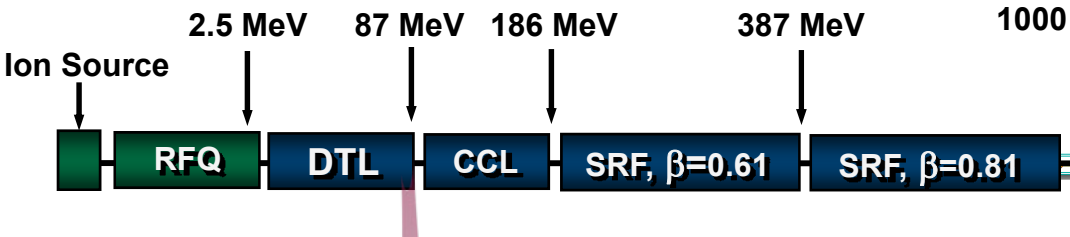
SNS Accelerator Complex

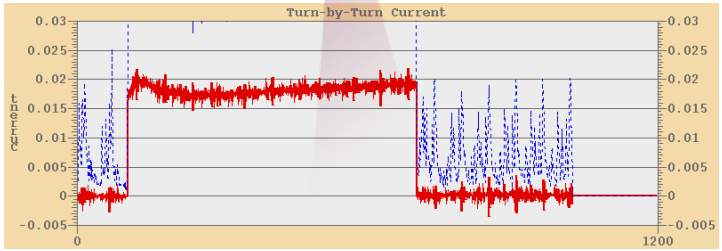
Front-End:
Produce a 1-msec long, chopped, H- beam

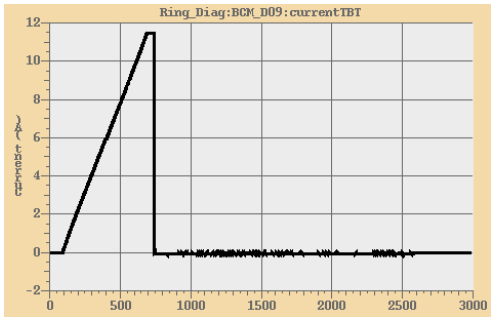
Accumulator Ring:
Compress 1 msec long pulse to 700 nsec

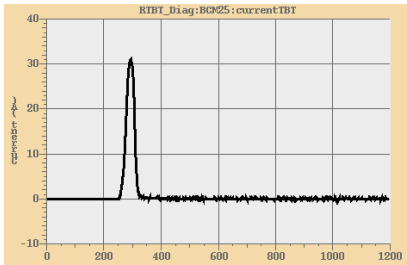


1 GeV LINAC









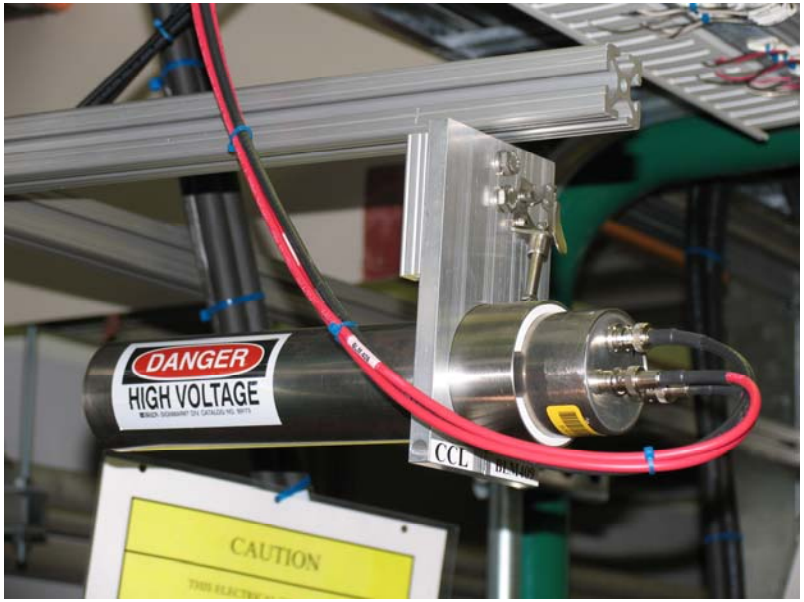
BLMs at SNS

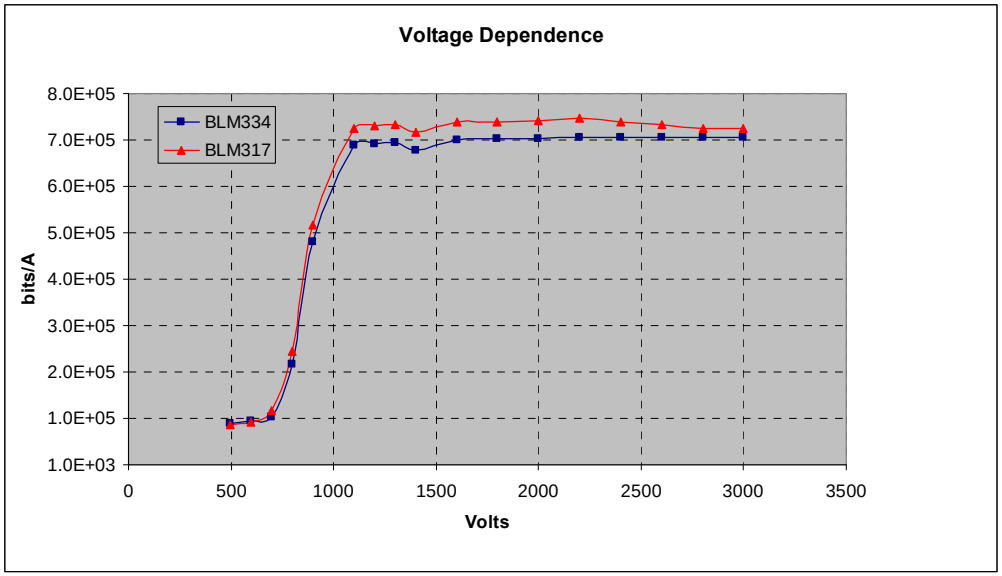
- **Major MPS device**
  - **Fast MPS – abort the current beam pulse within 10 μS (hardware – analog integrator), not applicable to RTBT**
  - **Slow MPS – keep average loss reasonable**
- **Diagnostic device - machine tuning**
- **Activation "planning"**
- **Activation decaying**
- **Activation buildup ?**
- **Halo measurement with the help of WS**

Detectors used

- **Ion chambers ~300+**
- **Neutron detectors ~30+**
- **Low level neutron detector 8**
- **PMTs ~10+**

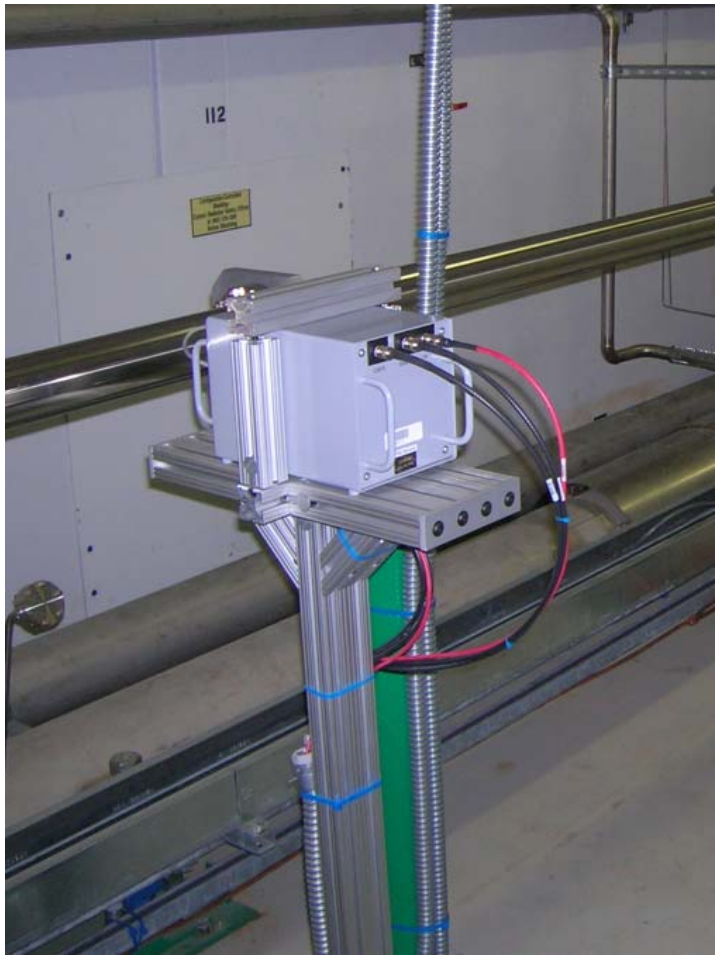
Ion Chambers

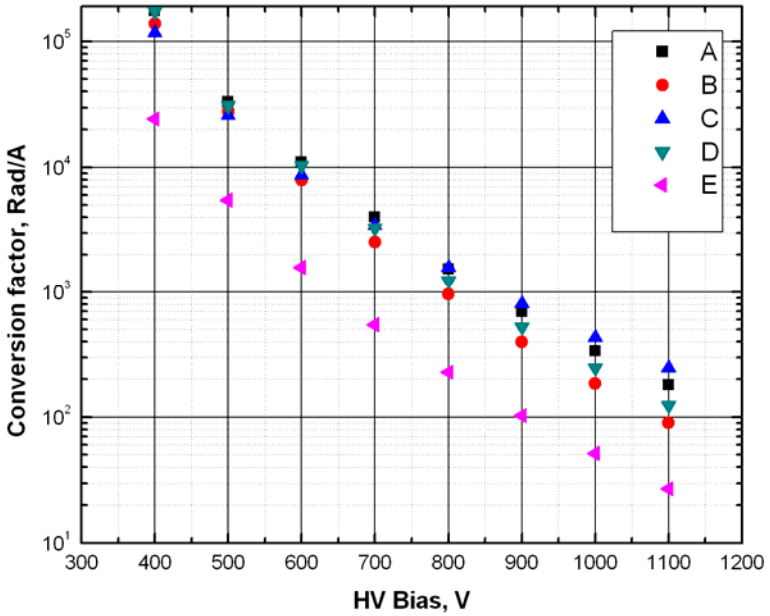




- **Argon filled, 113 cc volume, 2 kV bias.**
- **Response 70 nC/Rad**
- **Slow ~1 μS (charge collection)**

Neutron Detector



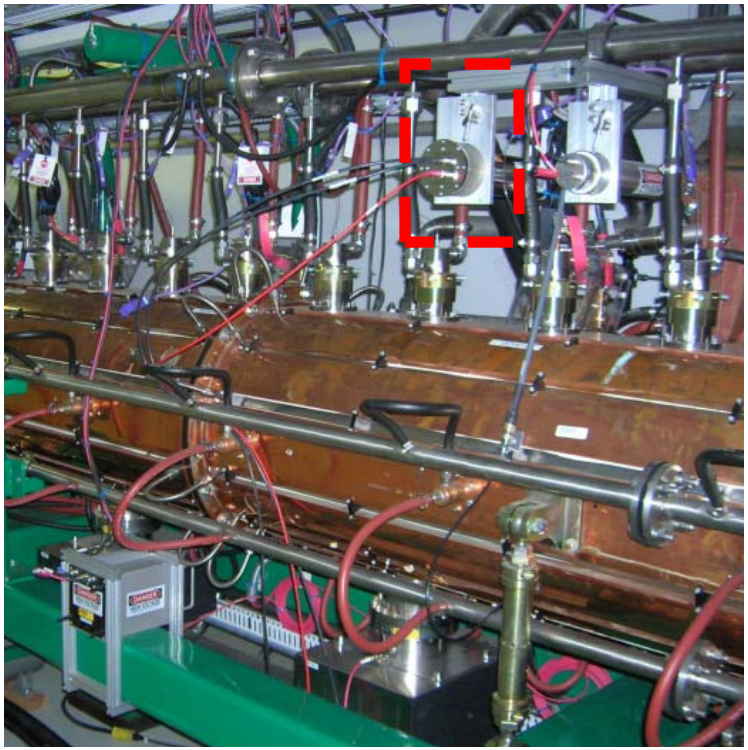


- 35 mm poly moderator
- Li (n,alpha)
- Scintillator
- PMT
- 10^4 – 10^8n/cm^2/s
- 0.03eV - 3MeV

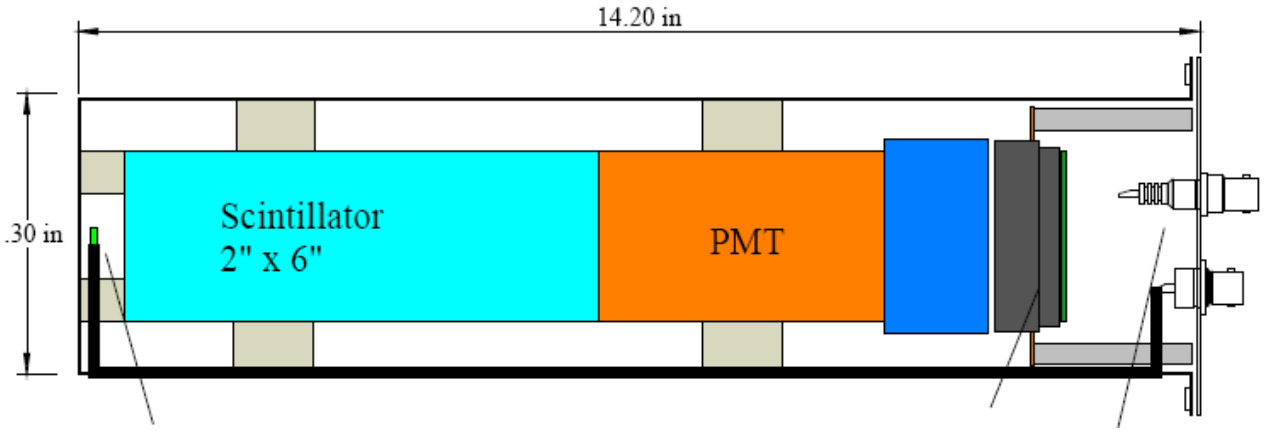
Low Level Neutron Detector

- **85 mm poly moderator**
- **B (n,alpha)**
- **Counter**
- **10^2 – 10^4n/cm^2/s**
- **0.03eV-10 MeV**

PMT

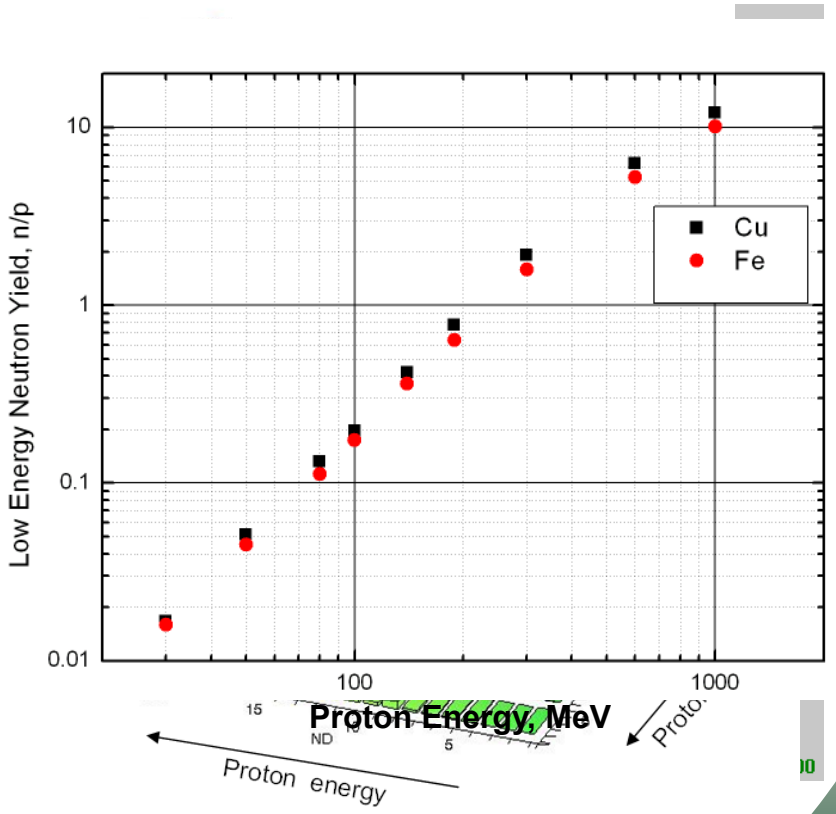


- Scintillator
- PMT
- Response 50 pC/MeV
- Fast ~10 nS



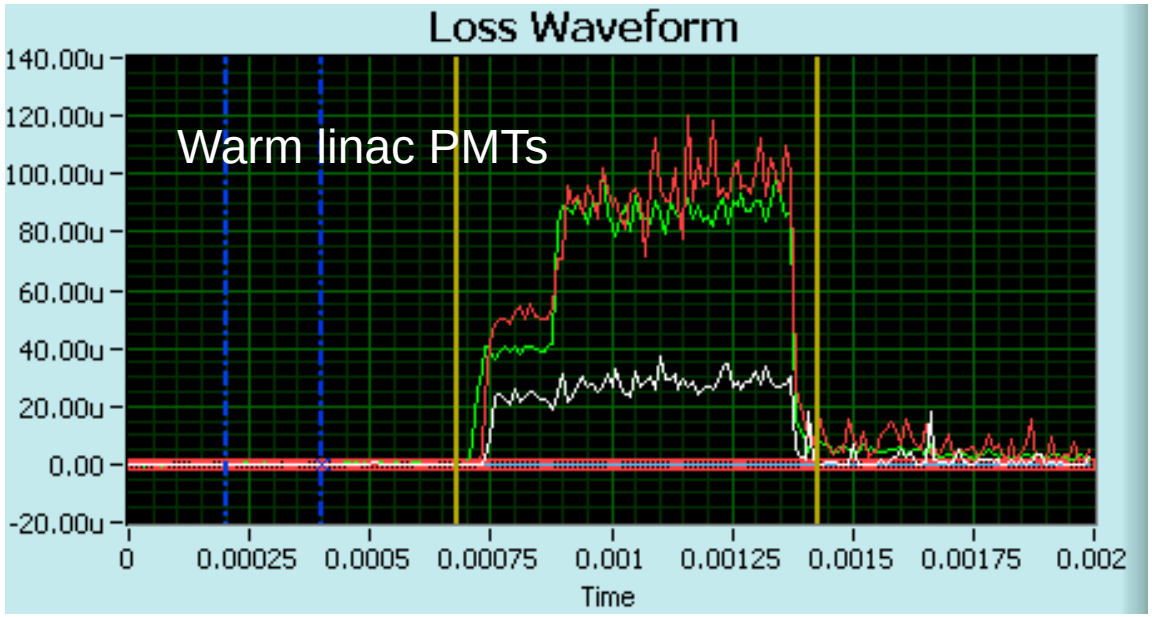
Neutron Detector vs. Ion Chamber

- **Commons**
  - **Analog output**
  - **Same electronics, low level software, MPS interface**
- **Differences**
  - **Waveform shape (neutron moderation in NDs)**
  - **Distance range: IC – local, ND remote**
  - **HV controlled dynamic range for NDs**
  - **Neutron signal originates from beam loss only, in contrast there are several x-ray sources**



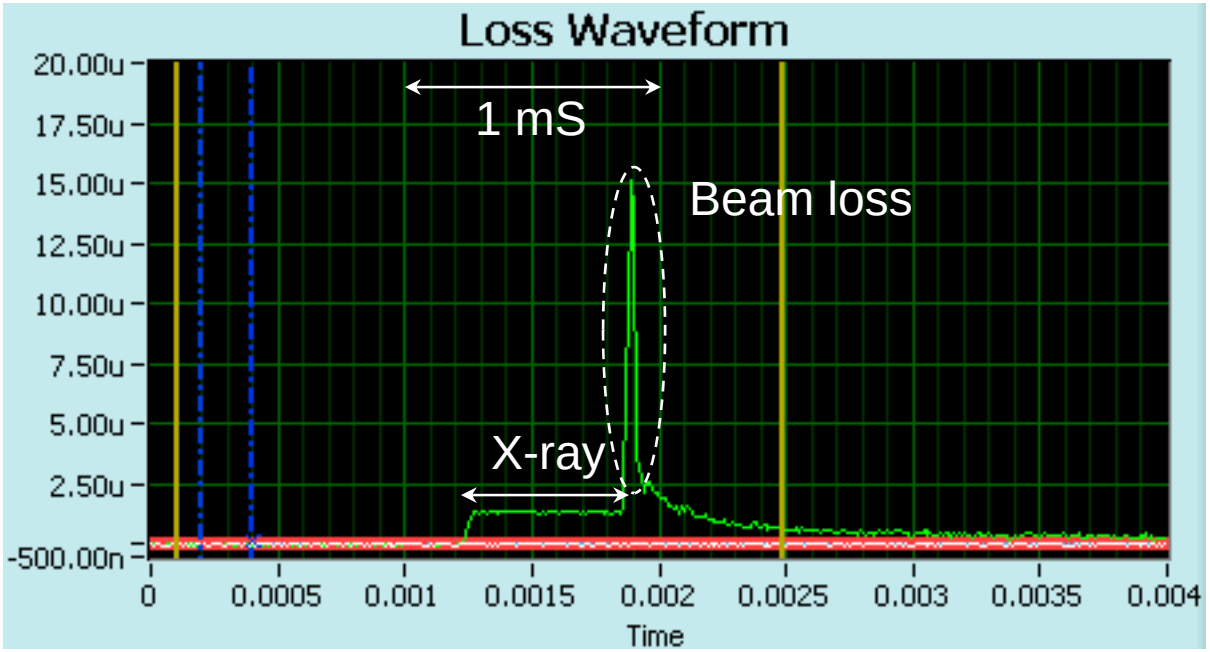
Challenges: Low energy part of linac

- **low energy beam (<20MeV)**
  - **IC not sensitive enough**
  - **ND sensitive, but hard to calibrate (no sufficient experimental data for reliable simulation)**
  - **Still the biggest issue**
  - **PMTs are supposed to help**



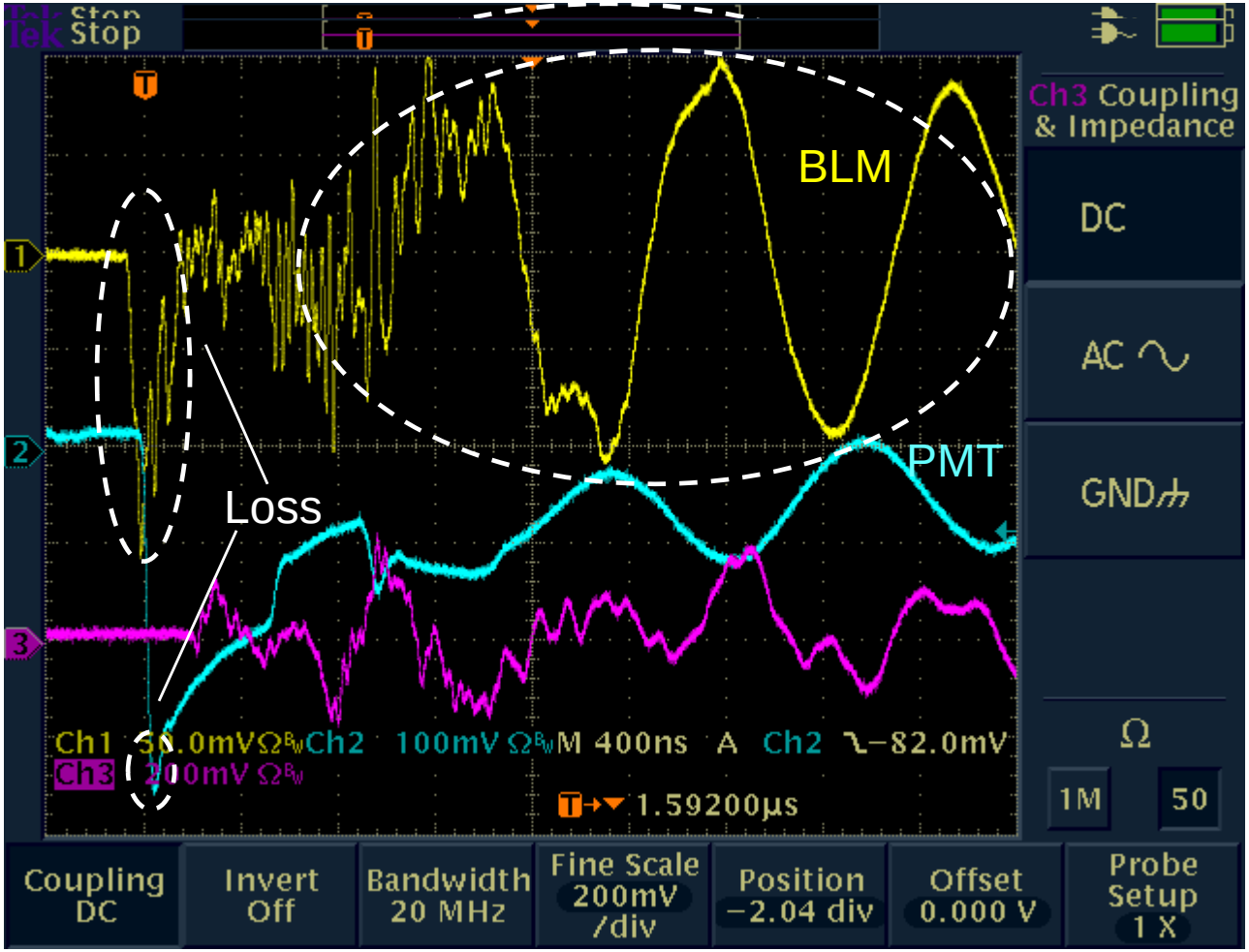
Challenges: WF subtraction

- **Cavity X-rays give significant input to loss signal**
- **The software subtracts the RF only waveform (the beam rep rate is 59.9 Hz to allow one reference signal per 10 seconds)**
- **Fast MPS is compromised**



Challenges: RTBT noise

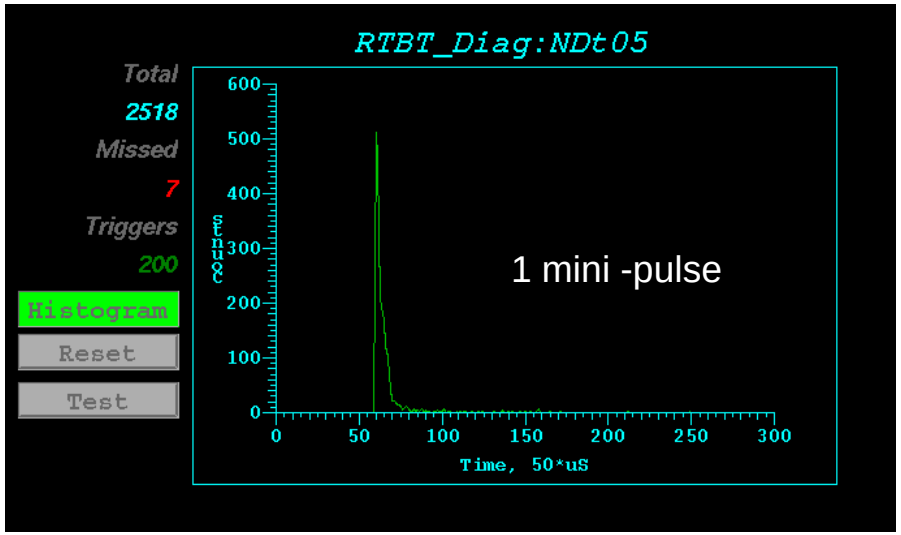
RTBT noise/EM interference with the beam or image current

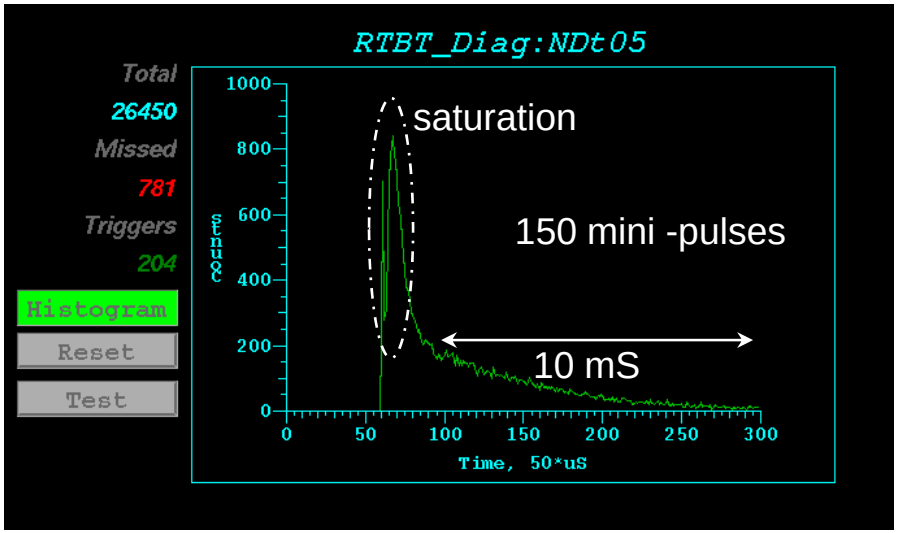


HV ON

- Problem is present with beam only
- Gets worse with beam charge increase

Challenges: RTBT noise (continued)

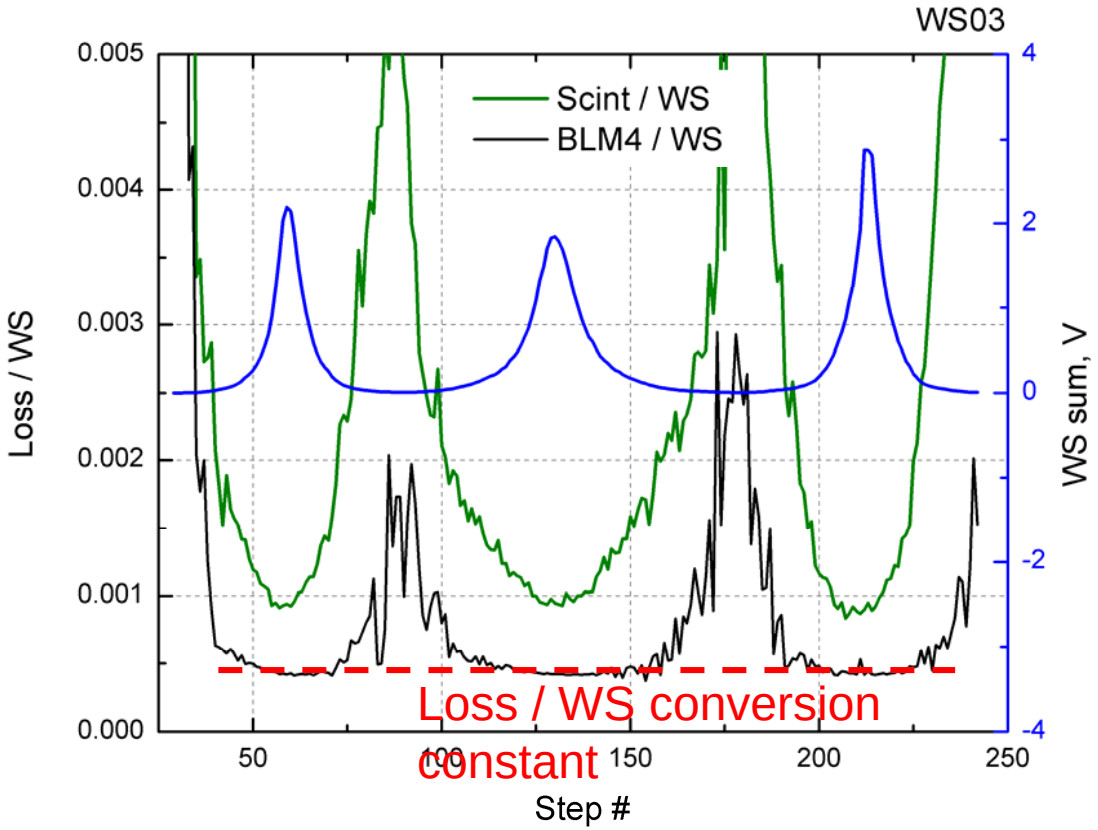




Low Level NDs

- Counter output (solves noise issue)
- Registration of time distribution effectively increases dynamic range
- Capable of registering losses from 1 mini-pulse
- Need time to collect statistics 10 s ~ 600 pulses

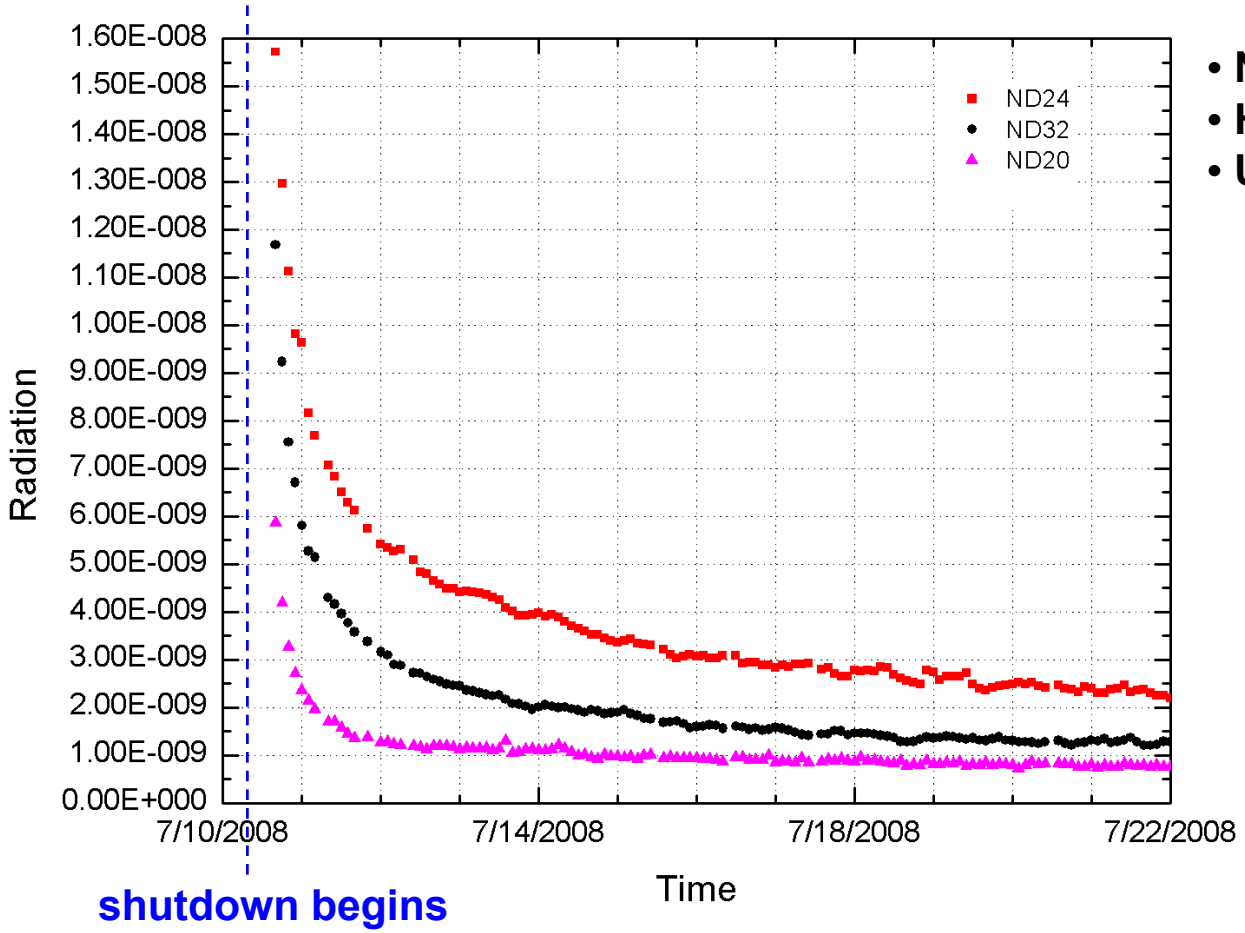
WS and halo studies



Attempt to improve WS performance in halo part

- Special scintillating fiber
- Ordinary IC
- Scan of loss signal vs WS position gives good measurement around the beam center, but halo shape isn't really detectable
- Optimized fiber is being designed

Activation decaying



- **NDs in SCL**
- **HV ramped up**
- **Using gamma sensitivity**

Electronics and Low Level Software

- **Standard IC & ND amplifier**
  - **High channel density**
  - **Obsolete parts (big problem!)**
  - **3 gains jumper settable**
- **VME ADC**
  - **24 bits for dynamic range (~10 bits digitizing noise)**
  - **High channel density**
  - **100 kS sampling rate**
- **VxWorks based EPICS running WF subtraction at 60 Hz**
- **PMT custom made amplifier/HV boards + cRIO + LabVIEW RT**
- **Low Level ND LabVIEW on Windows**

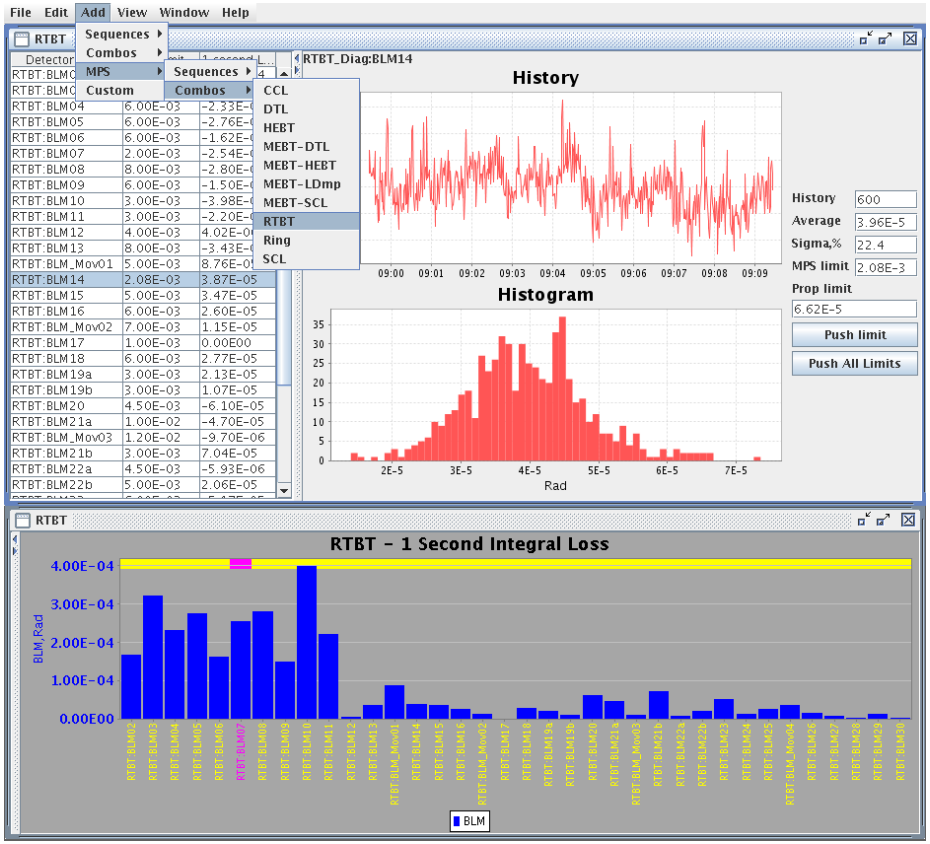
Currently running production system

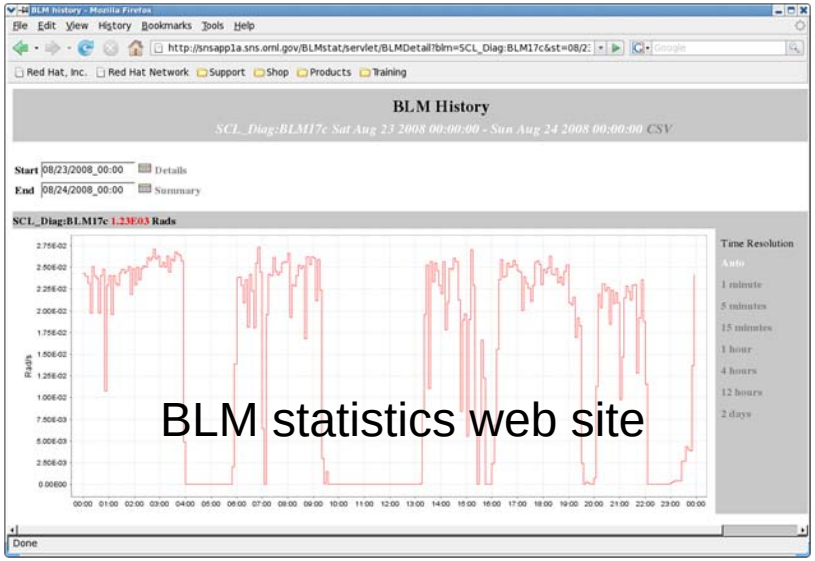
Electronics and Low Level Software Future

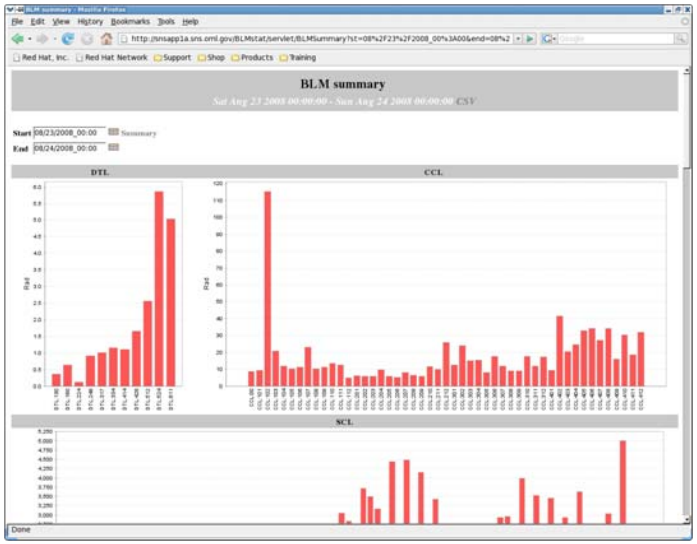
- **FPGA based WF subtraction**
  - **Test with cRIO based PMTs currently installed**
  - **Increase of sampling rate is desirable**
- **Choosing FPGA platform**
  - **VxWorks vs. PXI vs. cRIO ?**
- **Smart devices for higher beam availability**
  - **Every detector has its own hot pluggable data acquisition board**
  - **Complete replacement of 1 channel should not affect other channels (no beam downtime)**
  - **Full remote configuration: all setup data come from one source (Oracle)**

High Level Software

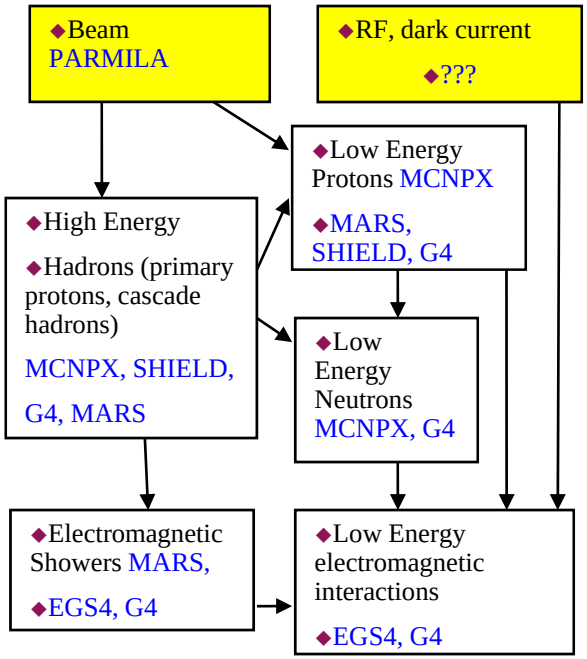
Lossviewer2 (XAL application)



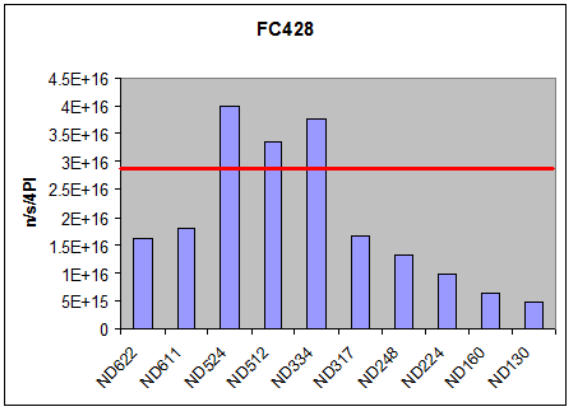


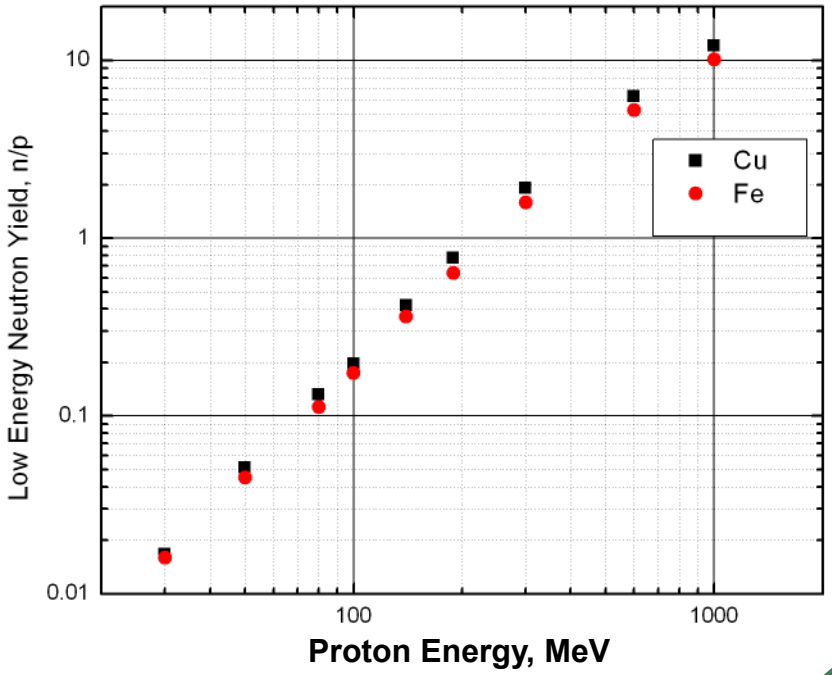


Simulations (MC transport codes)



Ultimate goal
Recreate the loss location and absolute value using BLM measurements





Thank you!