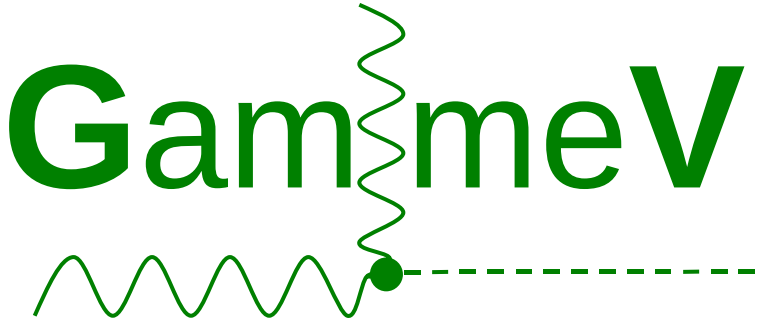
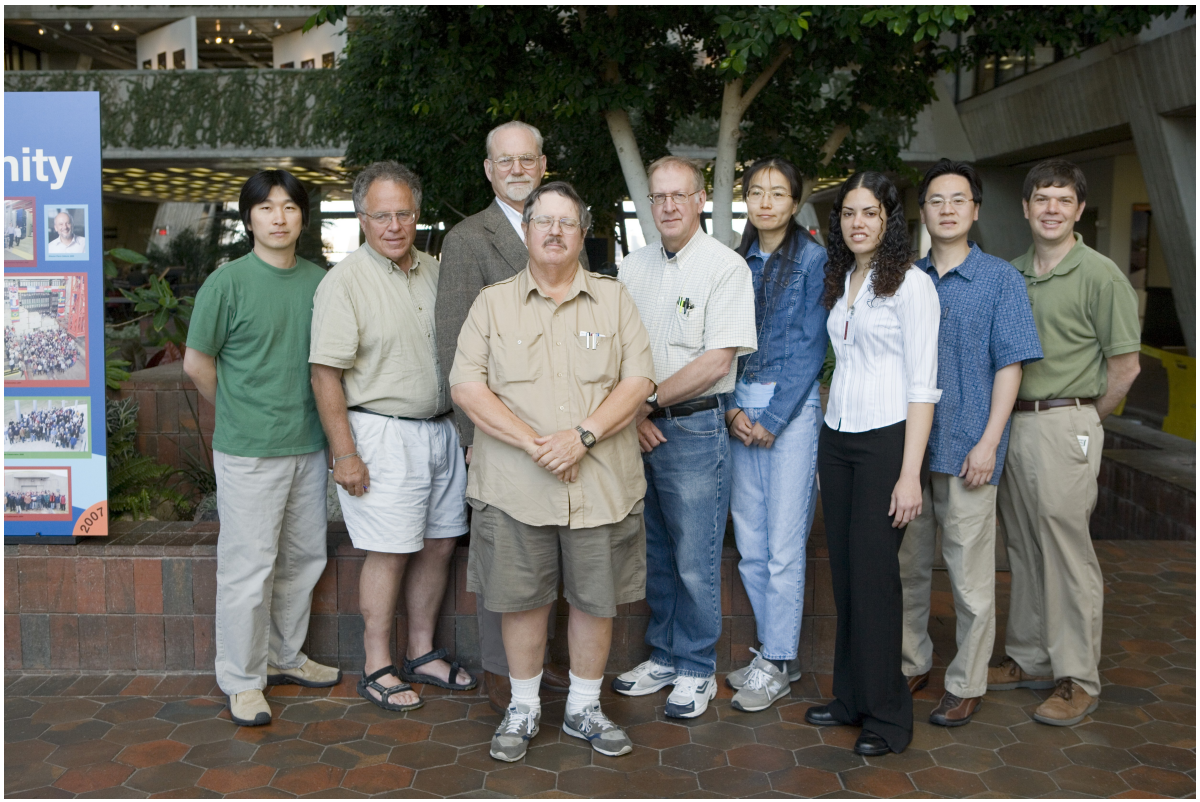


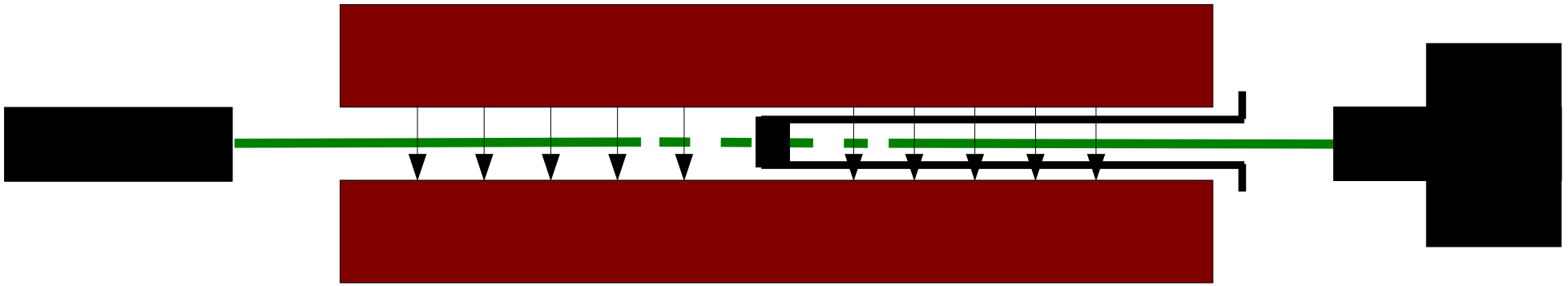
Jason H. Steffen
Brinson Postdoctoral Fellow
Fermilab Center for Particle Astrophysics
3rd Joint ILIAS-CERN-DESY Axion-WIMPs workshop
June 21, 2007

GammeV Team

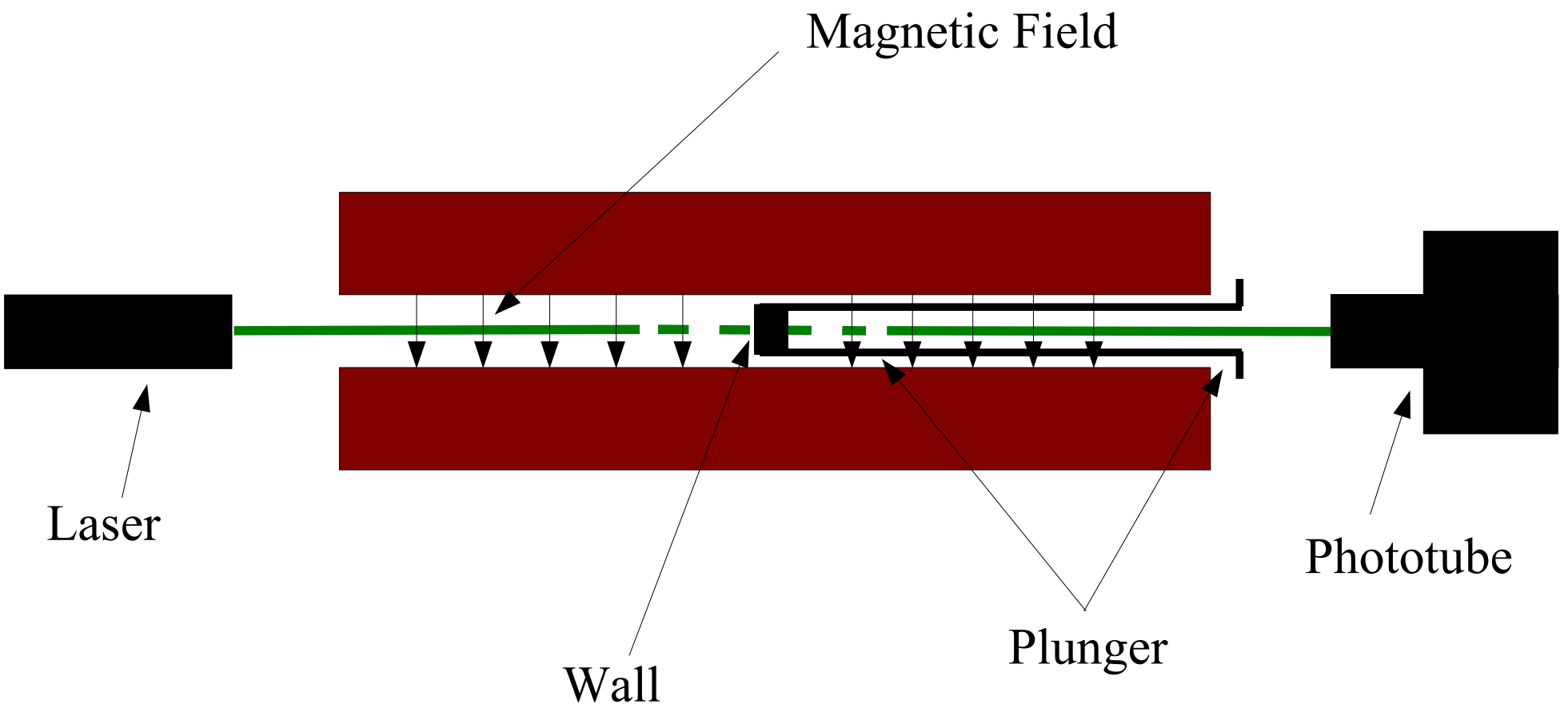
Aaron Chou (project scientist)
William Wester (project manager)
Al Baumbaugh
Dick Gustafson
Yilda Irizarri-Valle
Peter Mazur
Jason Steffen
Chris Stoughton
Ray Tomlin
Xi Yang
Jonghee Yoo



Experimental Design

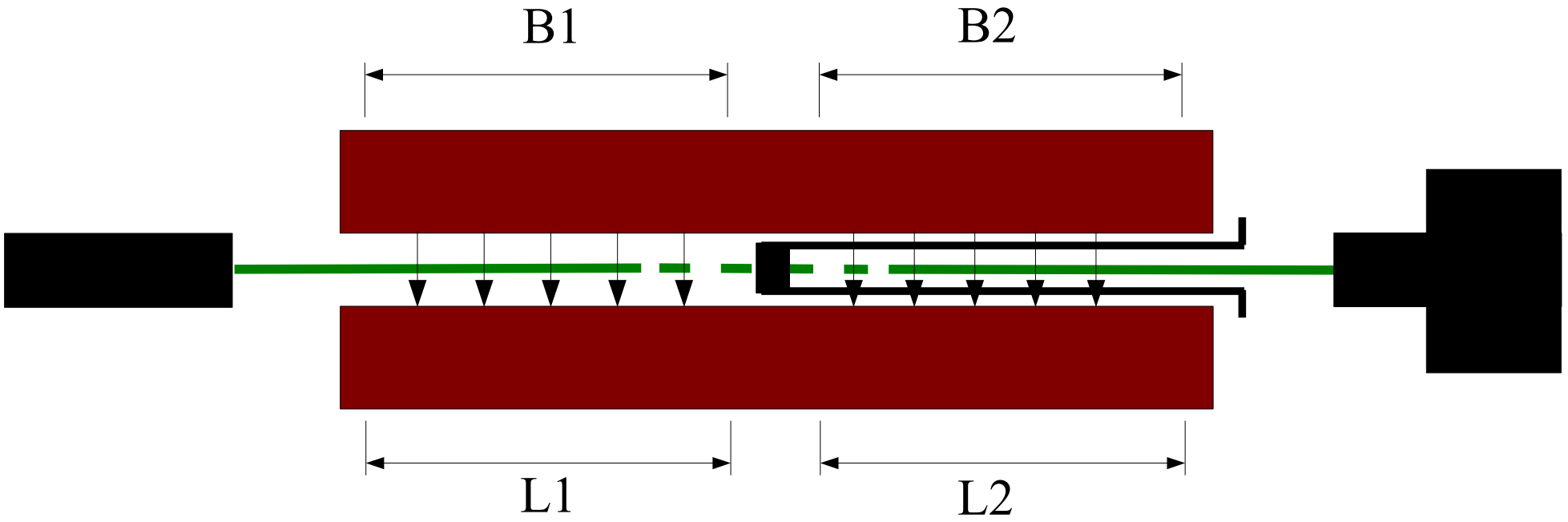


Experimental Design



Experimental Design

$$P_{regen} = \frac{16 B_1^2 B_2^2 \omega^4}{M^4 m_\phi^8} \sin^2\left(\frac{m_\phi^2 L_1}{4\omega}\right) \cdot \sin^2\left(\frac{m_\phi^2 L_2}{4\omega}\right)$$



B1 = B2 = 5.0 T
L1 + L2 = 6.0 m

Oscillation Length: 3 m
$P_{regen} = 4 \times 10^{-21}$

Experimental Design

3.2 W laser

5ns pulse
20 Hz

100 Hz noise

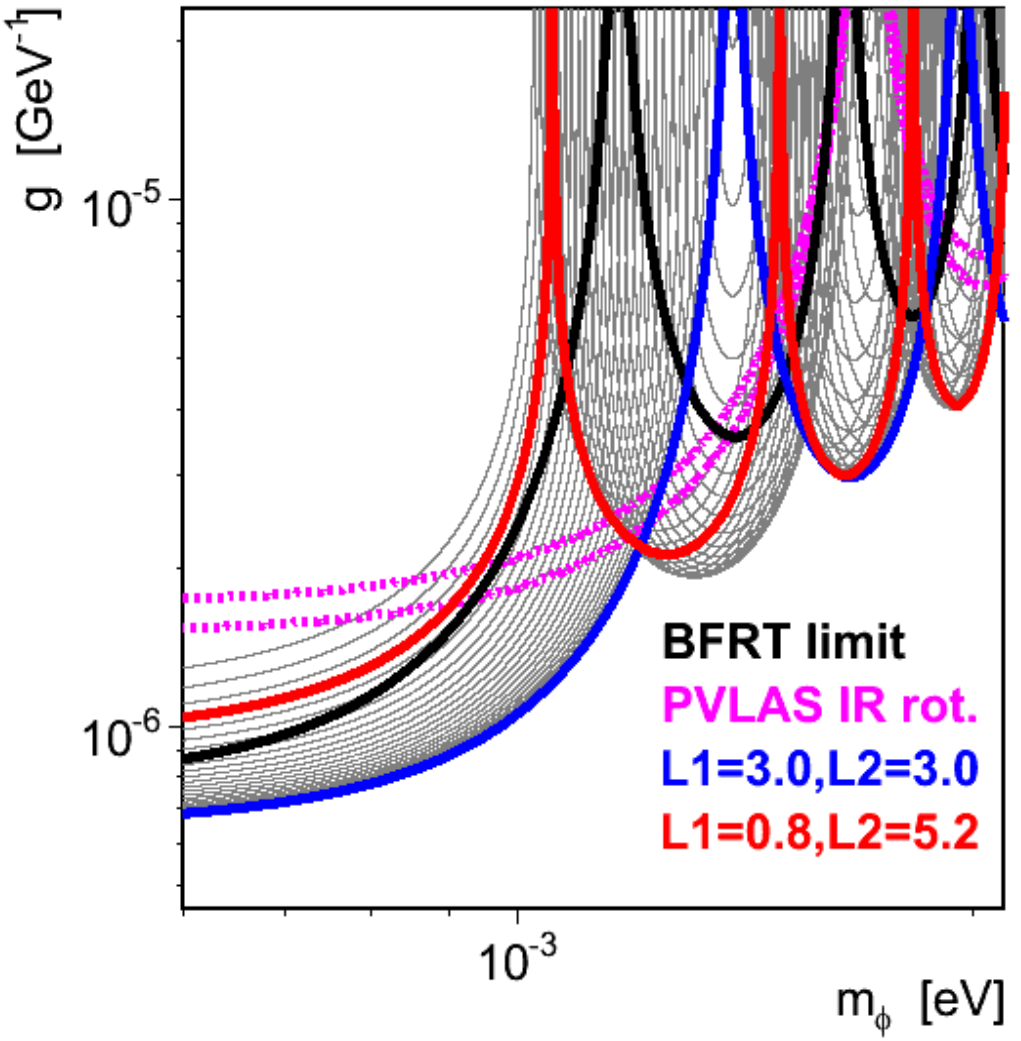
signal rate = 4×10^{-3} photons/sec

coincident noise rate = 1×10^{-5} photons/sec

signal-to-noise ratio = 400

Design Goals

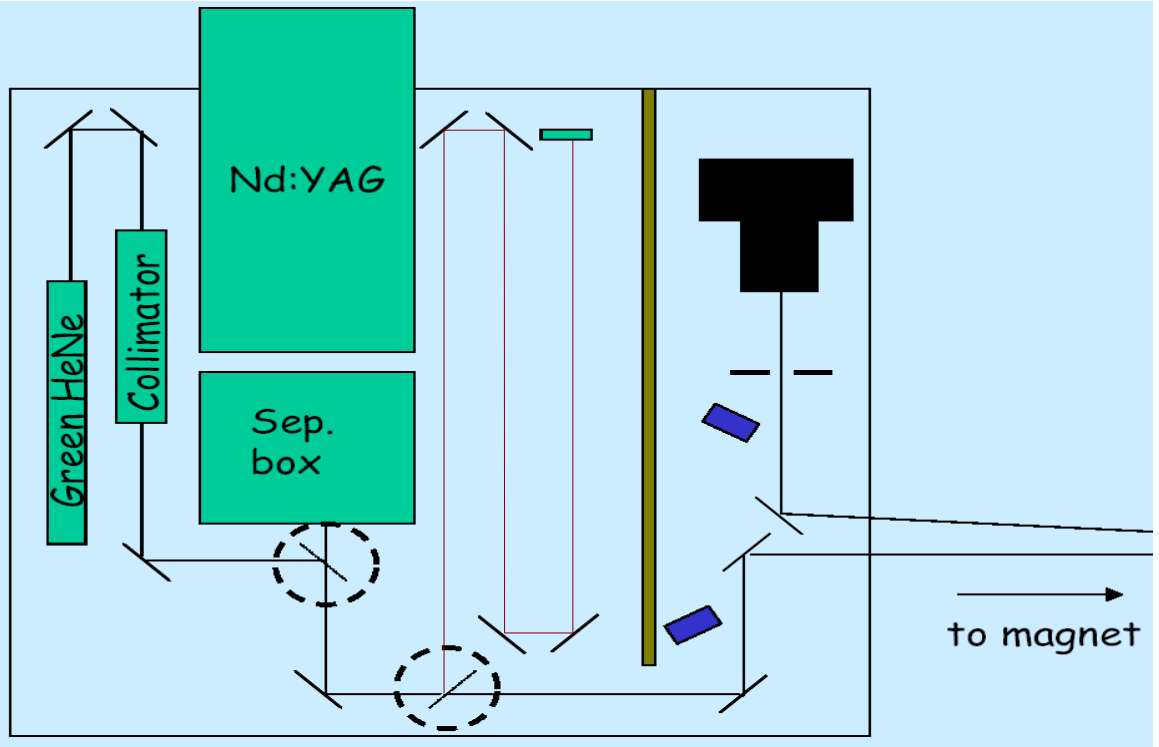
- Black = BFRT 3 sigma upper bound
- Pink = PVLAS 5 sigma signal region
- Grey = GammeV 3 sigma exclusion with 5 hours running at each plunger position
  - Blue = center of magnet
  - Red = 0.8m from end
- By changing the baseline, we cover the entire PVLAS signal region



Systems

- Optical System
  - Laser
  - Alignment system
  - Detector
- Mechanical System
  - Magnet
  - Vacuum
  - Plunger
- Electronic System
  - Control
  - Data acquisition

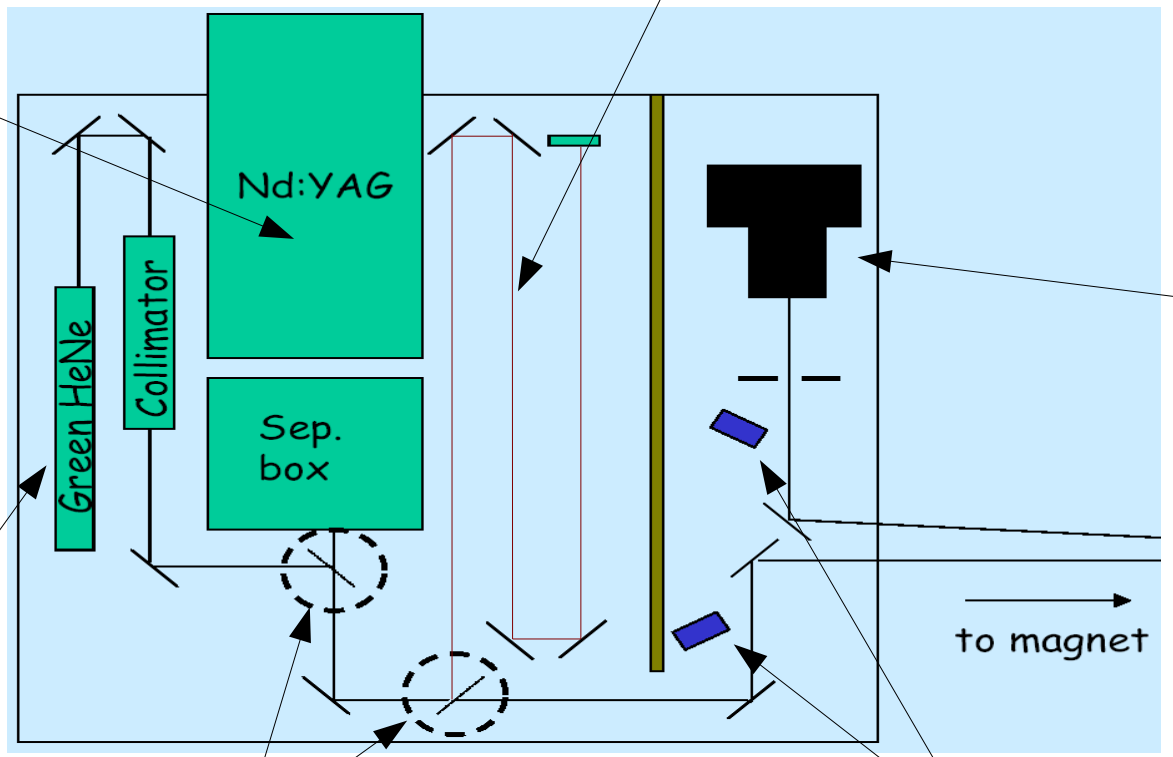
Optical System



Optical System

5ns pulse
160 mJ/pulse
20Hz
532nm

Pre-alignment path (3m)



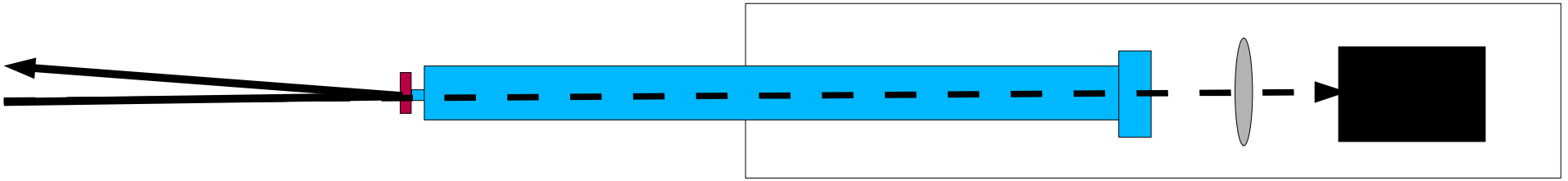
Power Meter

Low-power Alignment Laser

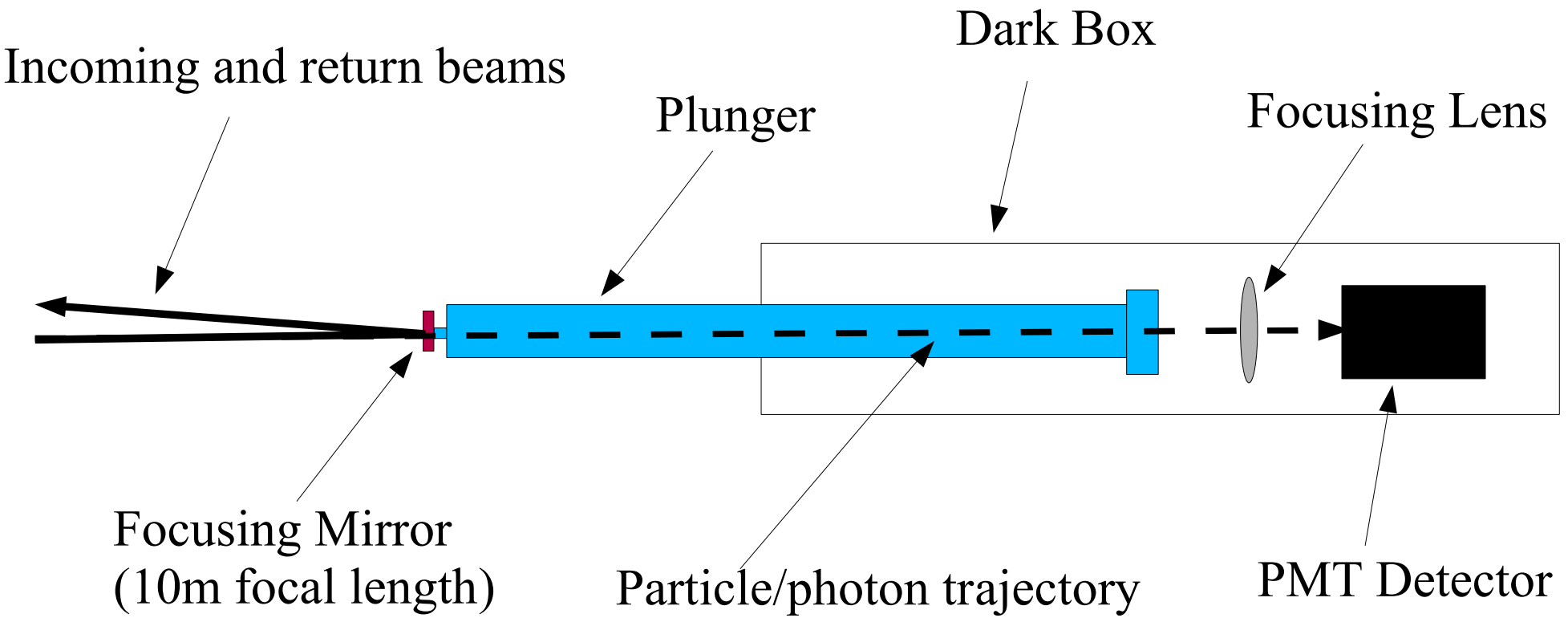
Movable Mounts

Photodiodes for monitoring scattered light

Optical System

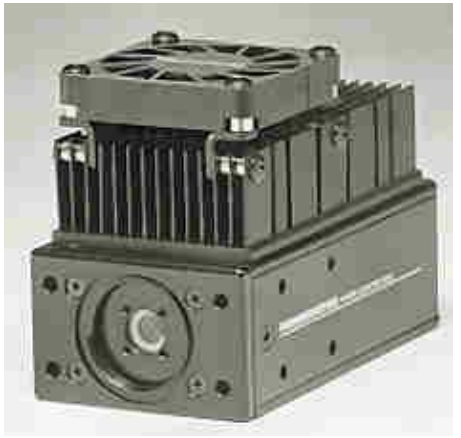


Optical System



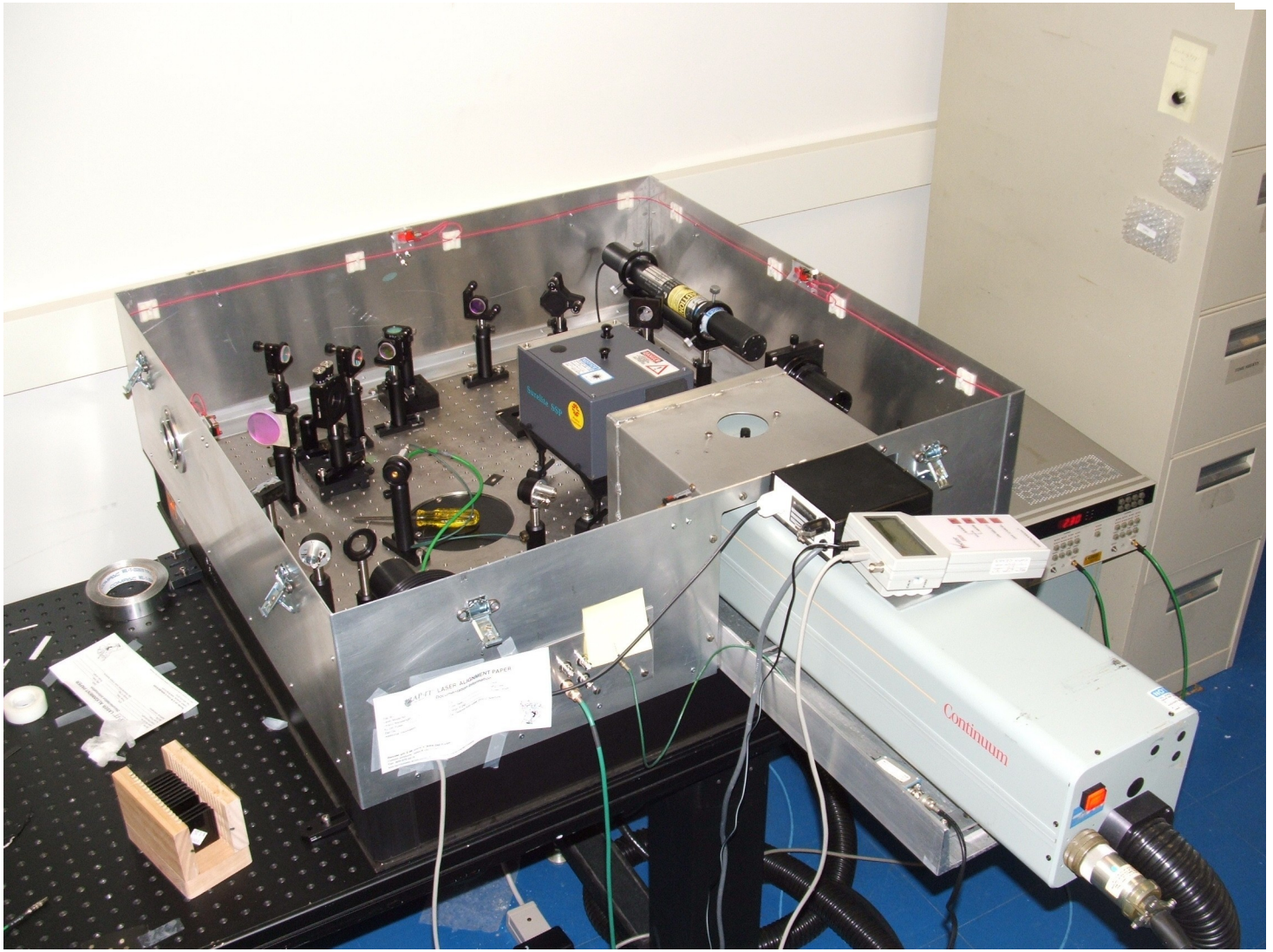
Optical System

Dark Box



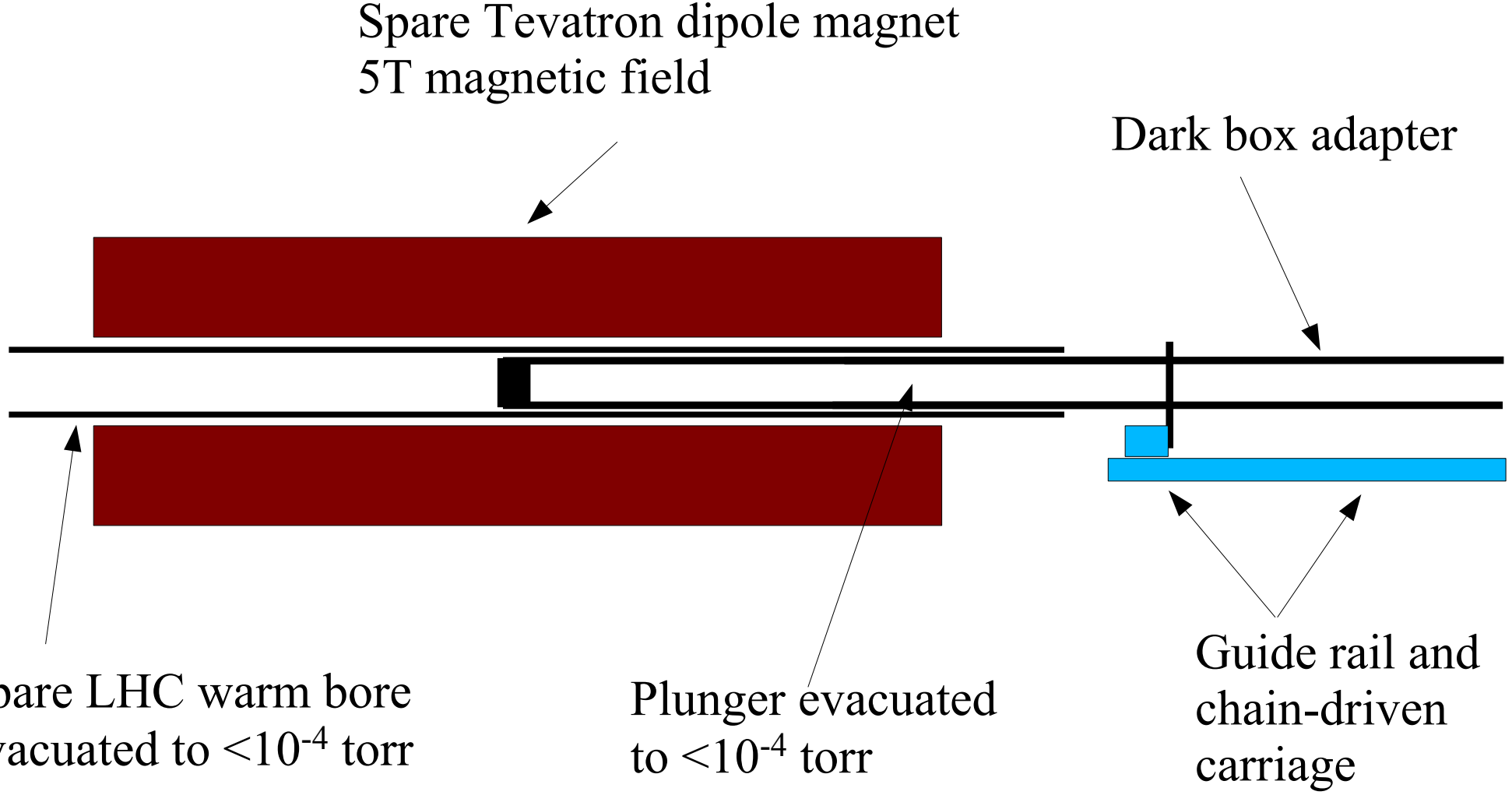
Hamamatsu
H7422P-40 PMT
100 Hz dark current
40% QE

Optical System

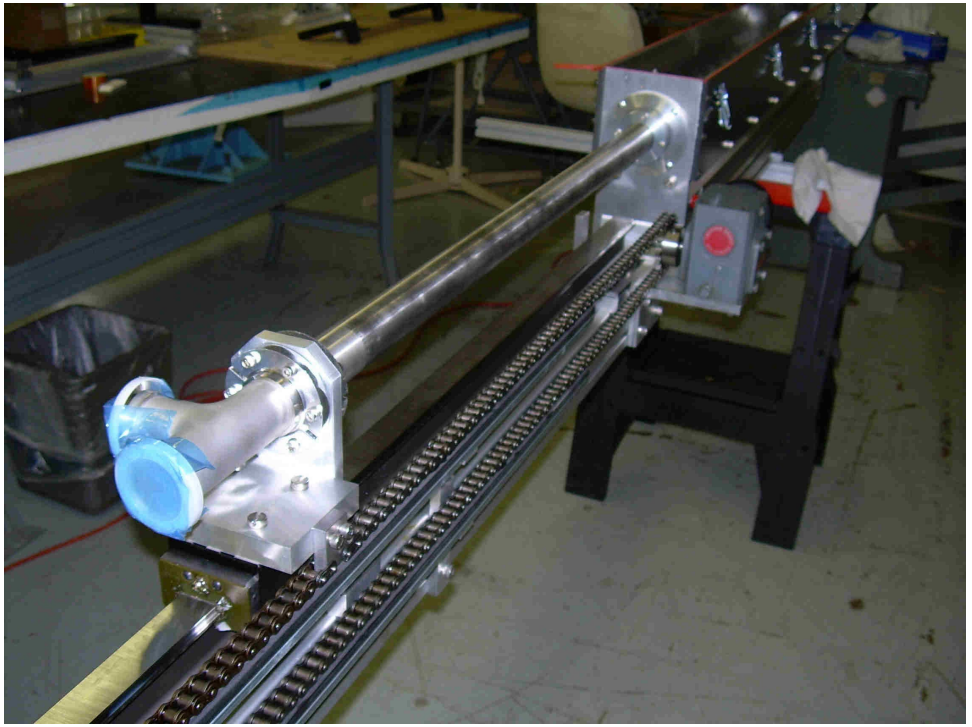


Mechanical System

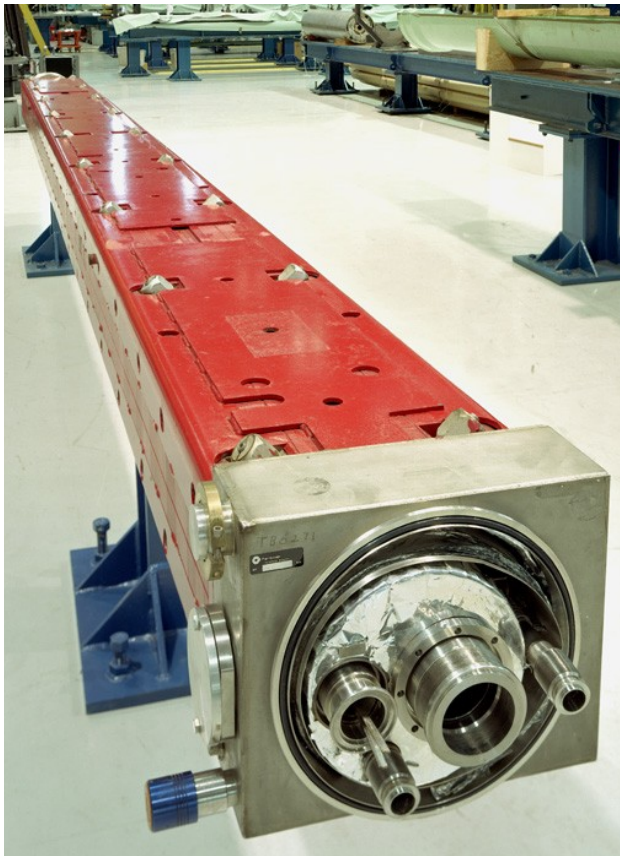
Mechanical System



Mechanical System

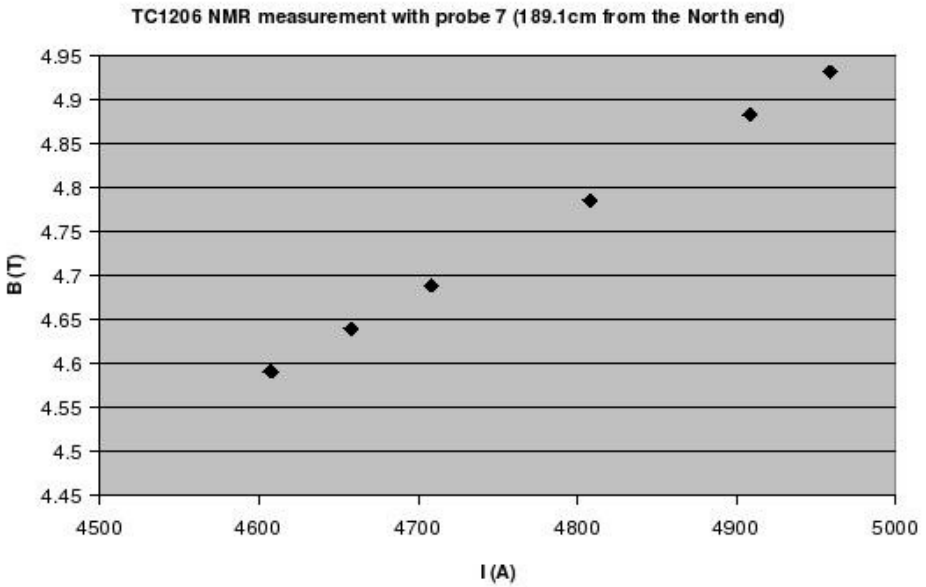


Guide rail, carriage, and adapter

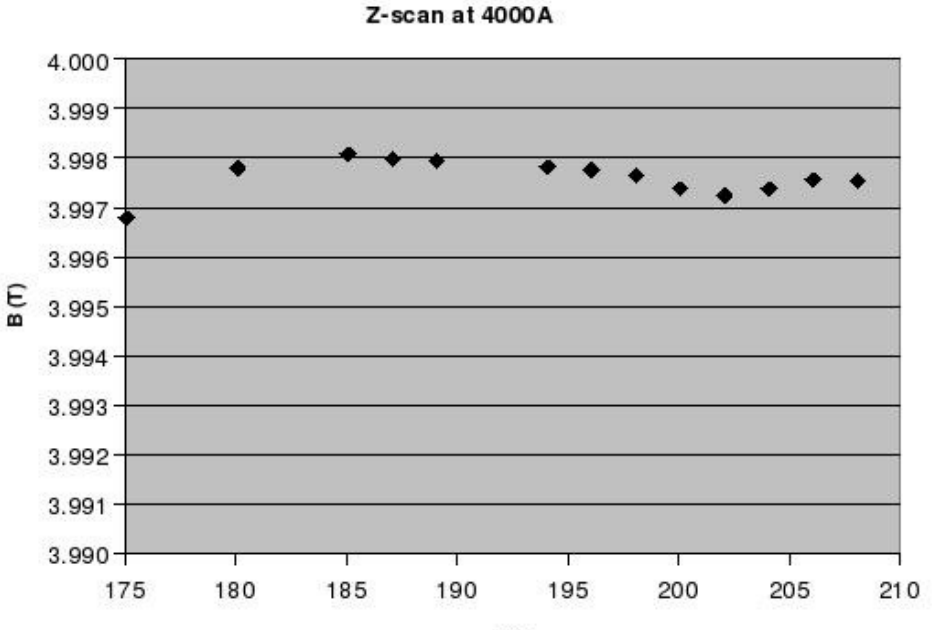


Tevatron dipole magnet

Mechanical System



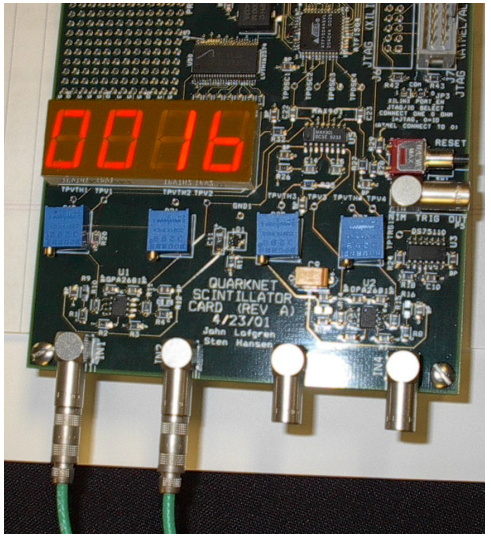
Magnetic Field vs. Current



Magnetic Field vs. Position

Electronic System

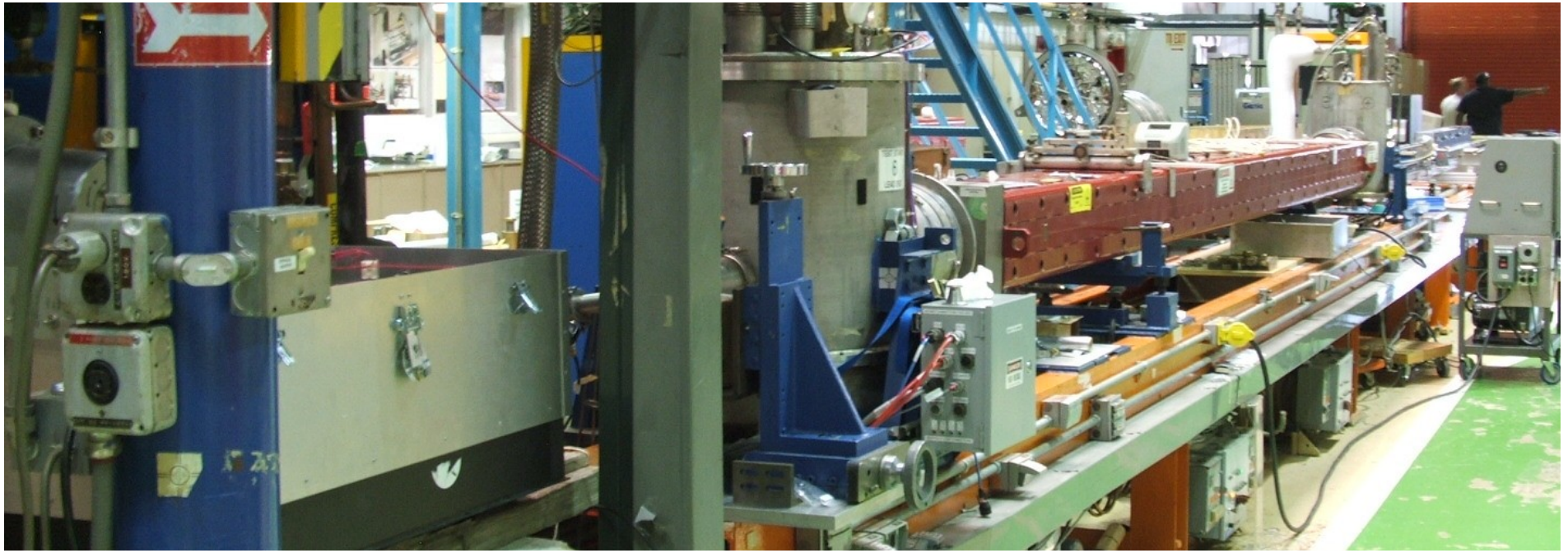
"QuarkNet" boards control the laser and data acquisition systems.



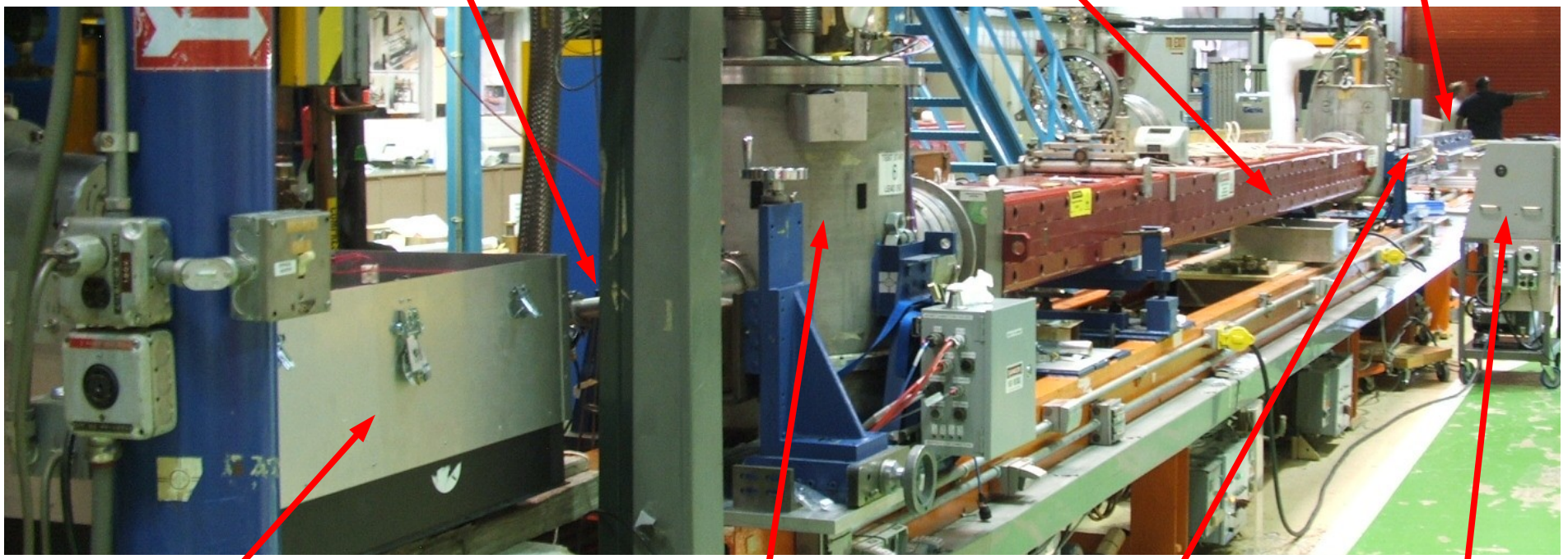
- Sample time to 1.25 ns
- Configurable with FPGA
- Graphical user interface
- Well understood

  "QuarkNet" is a public outreach cosmic ray detector array for high school students

GammeV Apparatus



GammeV Apparatus



Schedule

- November – first discussion
- April – review and approval
- May/June acquire or machine parts
- Currently
  - Assemble apparatus
  - Test electronics
  - Calibrate PMT
- July – start taking data

Conclusions

- Variable path length allows us to probe different particle masses
- Pulsed laser system gives high signal-to-noise ratio (400)
- Relatively simple design reduces phase space of "things that go wrong"
- Small budget, small team, small scope, table top experiment

http://gammev.fnal.gov