

GammeV Status Report

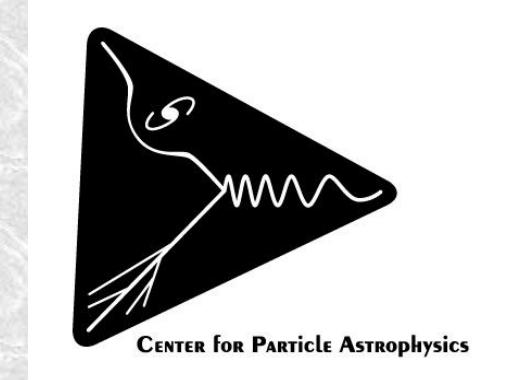
Jason H. Steffen
Brinson Postdoctoral Fellow
Fermilab Center for Particle Astrophysics

All Experimenters' Meeting
October 1, 2007



Aaron Chou
William Wester
Al Baumbaugh
Dick Gustafson
Yilda Irizarri-Valle

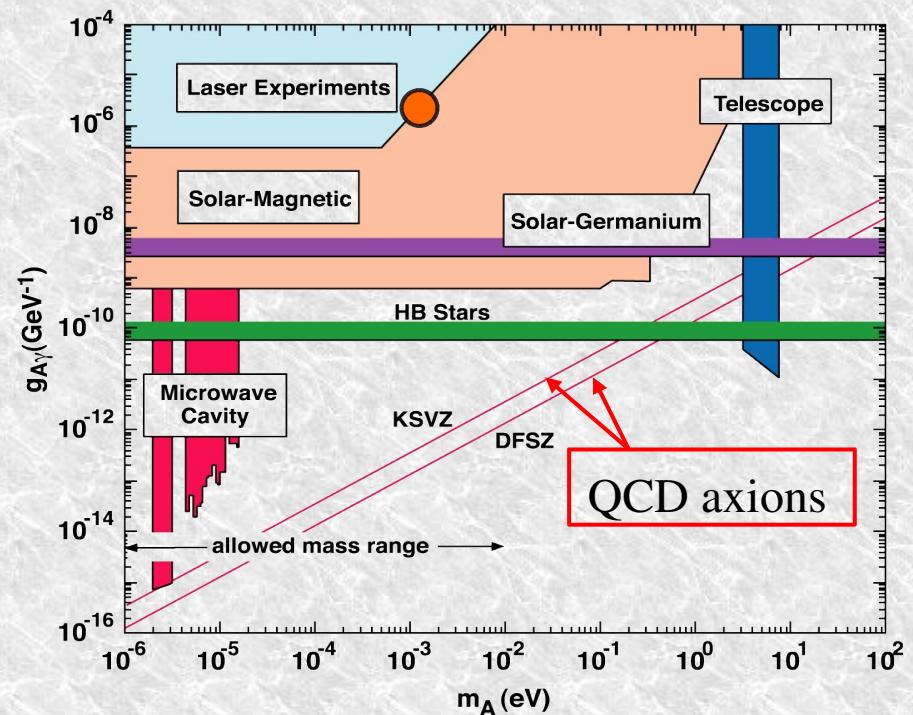
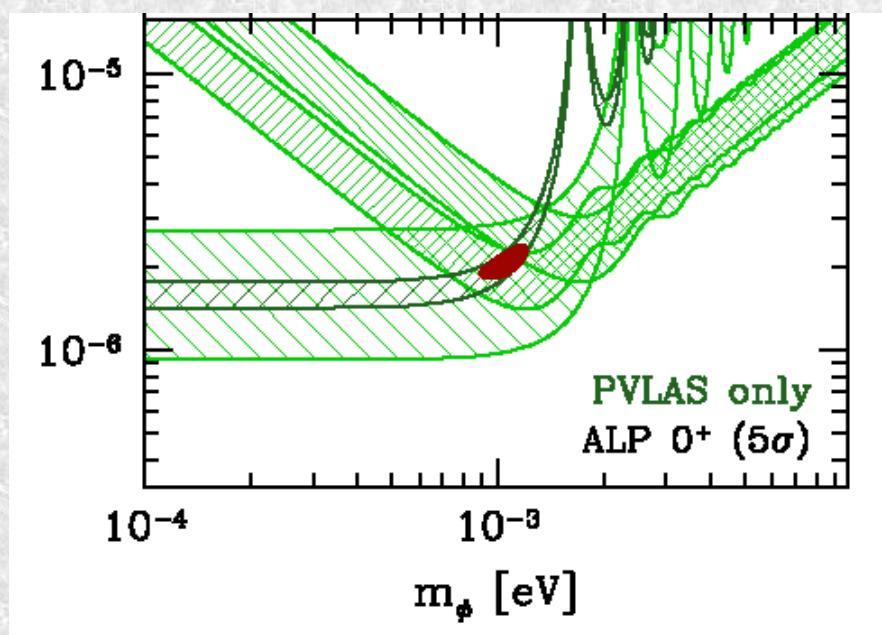
Peter Mazur
Jason Steffen
Ray Tomlin
Xi Yang
Jonghee Yoo



March 2006:

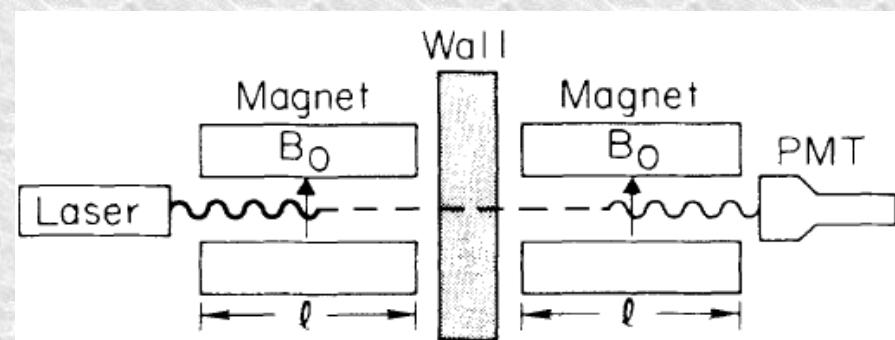
PRL Publishes PVLAS Results

- Designed to study the vacuum by optical means:
 - birefringence (generated ellipticity)
 - dichroism (rotated polarization)
- Reported a signal that is consistent with an Axion-like particle of mass 1.2meV and coupling $2 \times 10^{-6} \text{ (GeV)}^{-1}$

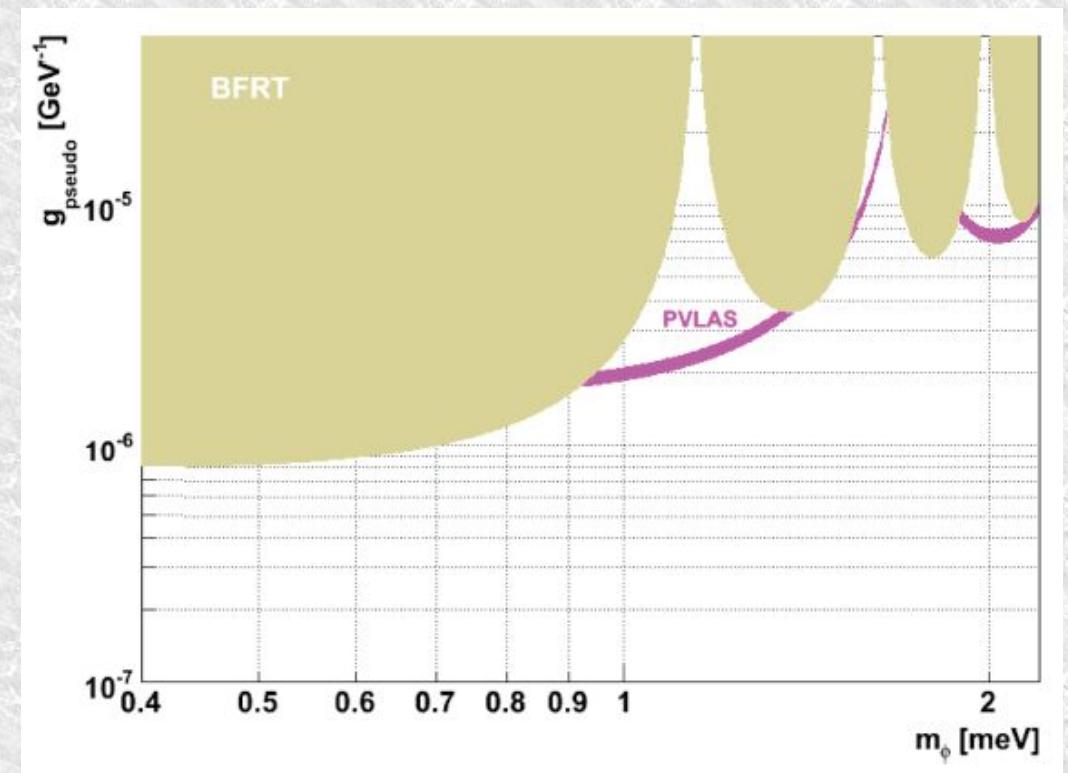


November 2006:

Initial Discussions for GammeV



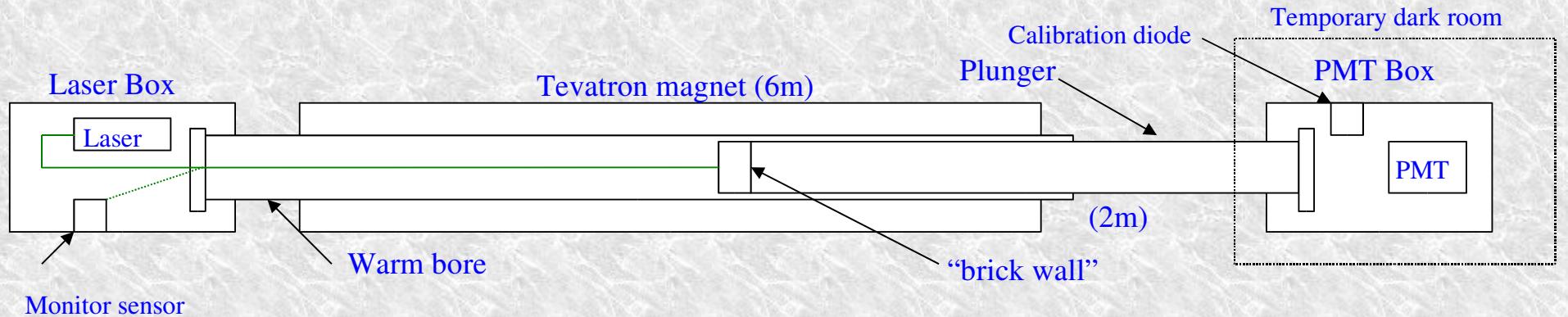
K. Van Bibber, et. al., PRL 59, 759 (1987)



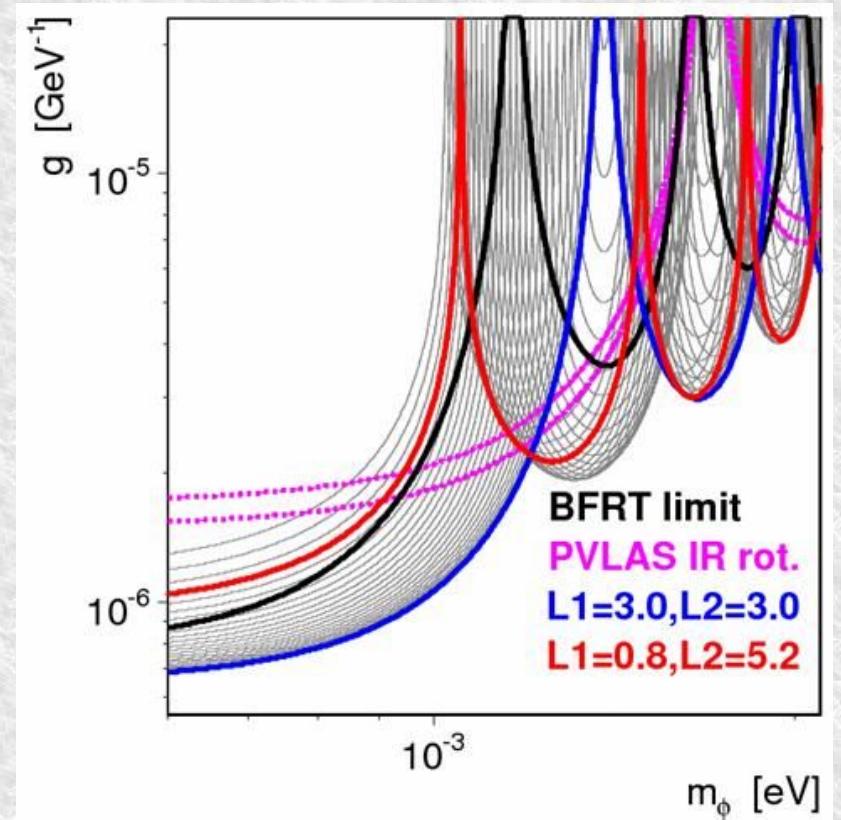
$$\begin{aligned} P_{\text{regen}}^{\text{GammeV}} &= (3.9 \times 10^{-21}) \times \frac{(B_1/5 \text{ T})^2 (B_2/5 \text{ T})^2 (\omega/2.33 \text{ eV})^4}{(M/4 \times 10^5 \text{ GeV})^4 (m_\phi/1.2 \times 10^{-3} \text{ eV})^8} \\ &\quad \times \sin^2 \left(\frac{\pi}{2} \frac{(m_\phi/1.2 \times 10^{-3} \text{ eV})^2 (L_1/2.0 \text{ m})}{(\omega/2.33 \text{ eV})} \right) \sin^2 \left(\frac{\pi}{2} \frac{(m_\phi/1.2 \times 10^{-3} \text{ eV})^2 (L_2/2.0 \text{ m})}{(\omega/2.33 \text{ eV})} \right) \end{aligned}$$

April 2007:

GammeV Design Approved: Budget \$30,000



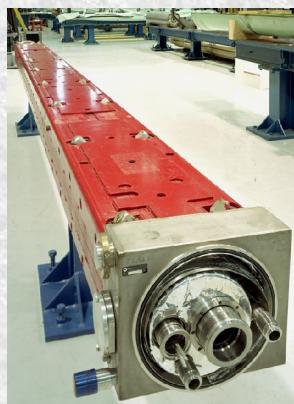
- Built from mostly spare parts or existing equipment
- Variable baseline in order to cover PVLAS region and to scan different values of m
- Should be able to achieve a 3-sigma exclusion with roughly 10 hours of data
- Can test for scalars and pseudoscalars



June 2007:

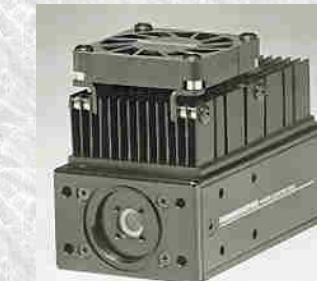
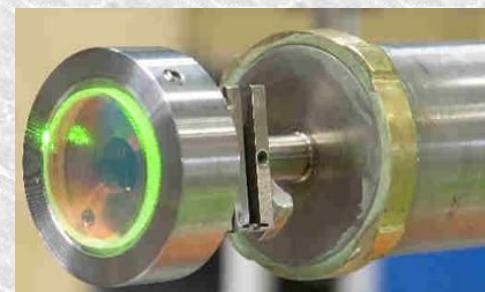
Acquire and Assemble Parts

Existing laser from
accelerator division



Spare Tevatron
dipole (with
LHC warm bore)

The Wall



High-QE,
low noise,
fast PMT
(purchased)



QuarkNet boards
for control and
data acquisition



June and July 2007:

Start Collecting Data

June: First hours of data

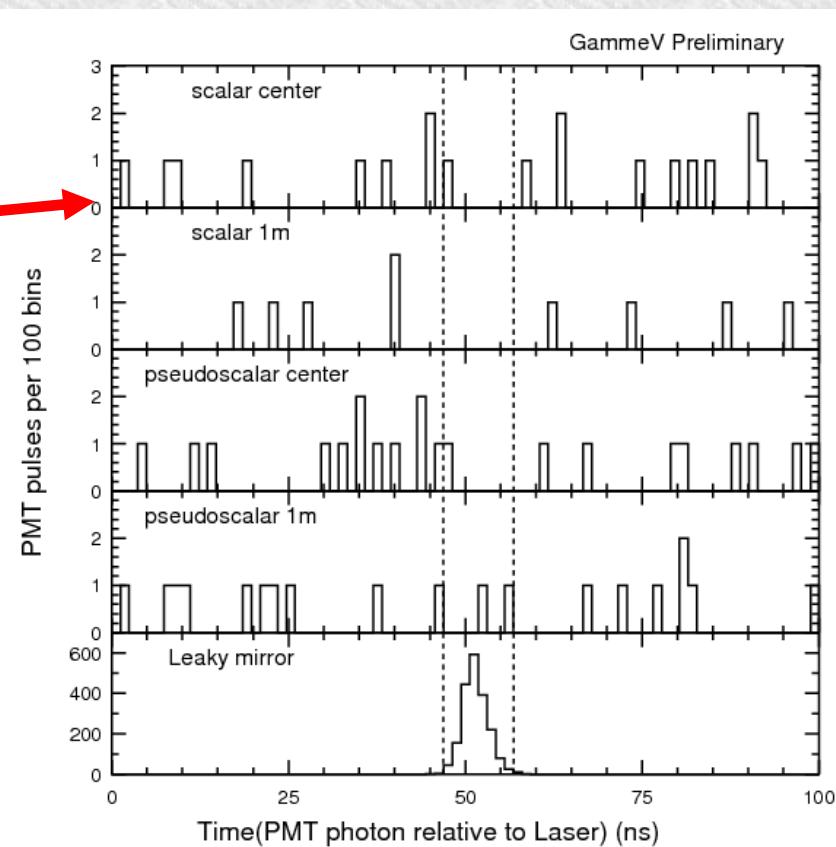
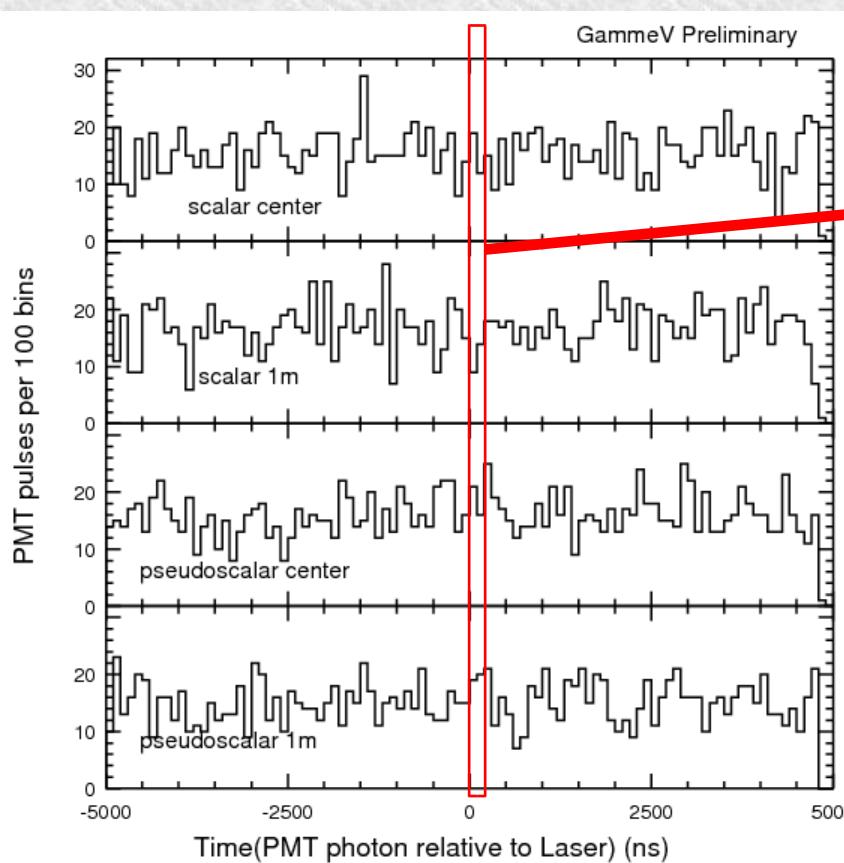
July: Magnet and laser problems

(6 weeks of analysis development and calibration data.)

September 2007:

Finish Collecting Data

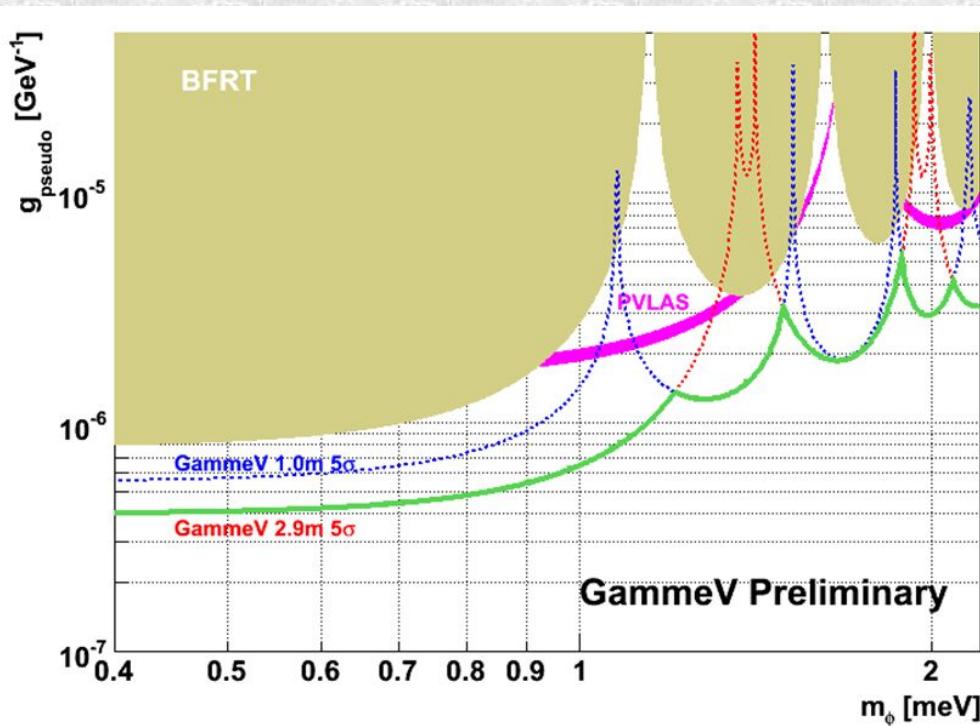
Spin	Position	# Laser pulse	# photon / pulse	Expected Background	Signal Candidates
Scalar	Center	1.34 M	0.41e18	1.56 ± 0.04	1
Scalar	1 m	1.47M	0.38e18	1.67 ± 0.04	0
Pseudo	Center	1.43M	0.41e18	1.59 ± 0.04	1
Pseudo	1m	1.47M	0.42e18	1.50 ± 0.04	2



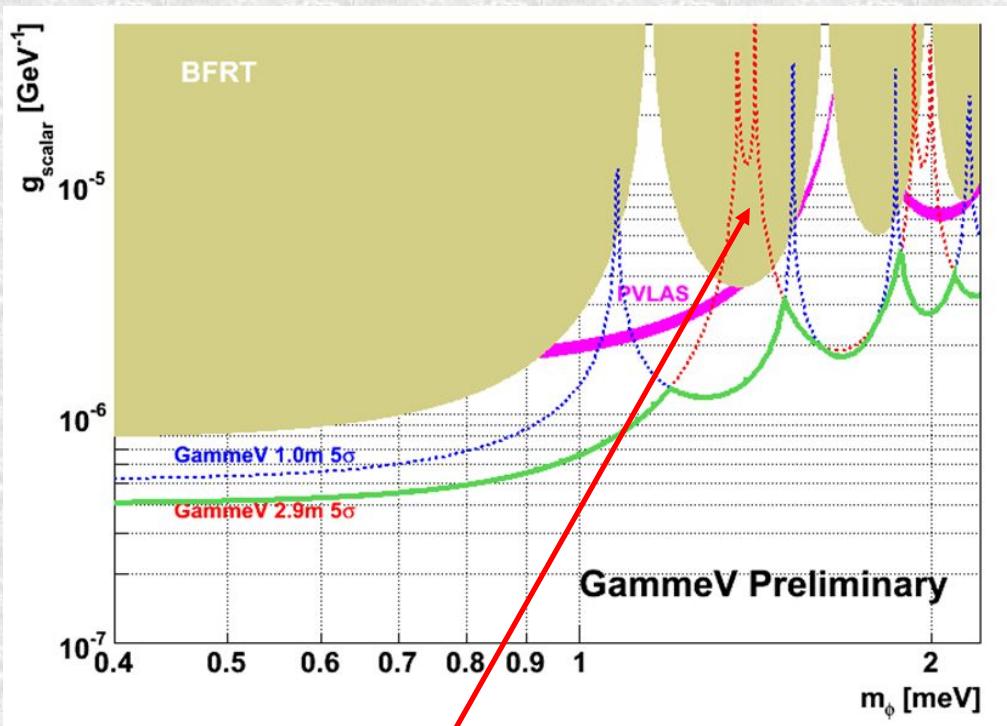
October 2007:

Present Status at All Experimenters' Meeting

Pseudoscalar



Scalar



Double spike because we were 10cm away from center.

With 20 hours of data in each of the 4 configurations, we exclude the PVLAS region of interest by more than 5-sigma.

October 2007:

Publish Results and Give Thanks

- A preprint is nearing completion and should be submitted for internal review and publication within a few weeks
- Additional configuration to search for “Chameleon” particles (~20 hours).
- GammeV was a cooperative work from nearly every division and section of Fermilab.
 - Technical staff from PPD
 - Technical staff from the Magnet Test Facility at IB1

October 2007:

The Competition

name	place	magnet (field length)	laser wavelength power	P_{PVLAS}	photon flux at detector
ALPS	DESY	5T 4.21 m	1064 nm 200W cw	$= 10^{-19}$	10/s
BMV	LULI	11T 0.25 m	1053 nm 500W 4 pulses/day	$= 10^{-21}$	10/pulse
LIPSS	Jefferson Laboratory	1.7T 1.0 m	900 nm 10 kW cw	$= 10^{-23.5}$	0.1/s
OSQAR (preliminary phase)	CERN	9.5T 1.0 m 9.5T 3.3 m	540 nm 1 kW cw	$= 10^{-20}$	10/s
PVLAS (regeneration)	INFN Legnaro	5T 1 m 2.2T 0.5 m	1064 nm 0.8W cw $N_{\text{pass}} = 5 \times 10^5$	$= 10^{-23}$	10/s

A world-wide effort to test the PVLAS result.

October 2007:

The Competition

- OSQAR: null result for PVLAS scalar/pseudoscalar, but no limits set and they may use a residual gas (not vacuum)
- LIPSS: begin to cover PVLAS region of interest for scalar particle interpretation.
- BMV: Use 14 pulses (hep-ex/0707.1296) and cover PVLAS region of interest for pseudoscalar case. Only group with a current preprint.
- ALPS: Should also be taking data and have something to say soon?

