The BMV project: photoregeneration experiment.

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\+ ≈ 10 technical staff, esp. G. Bailly & J. Mauchain

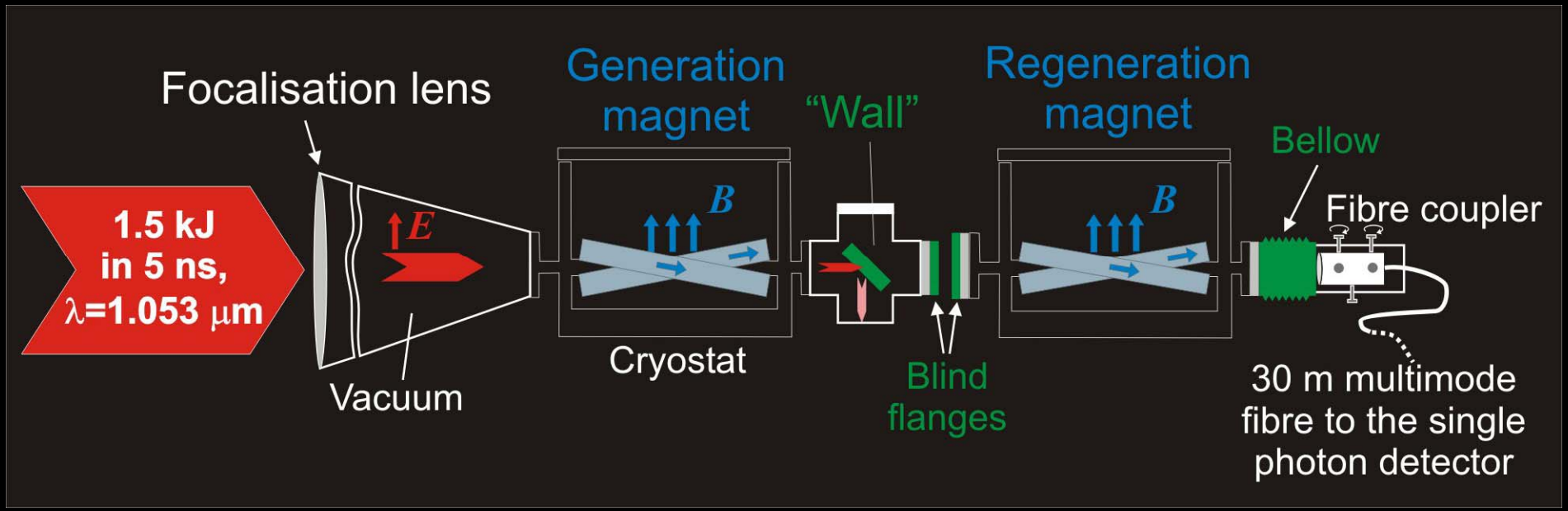
Collaboration with

LMA-VIRGO, IN2P3, Lyon, France

LULI, École Polytechnique, Palaiseau, France.

Principle of the experiment

- Model independent.
- Purely earth-based search.
- Robust interpretation.



Performance

Conversion probability:

$$p(z) = \left| \int_0^z dz' \frac{B(z')}{2M} \times \exp\left(-i \frac{m_a^2 z'}{2\omega} \right) \right|^2$$

- m_a axion mass
- M inverse coupling constant
- ω photon energy

Detection rate:

$$R = p(L)^2 \frac{P}{\omega} \eta_{\text{det}}$$

- P laser power
- L magnet length
- η_{det} detection efficiency

Expected results:

- After 5 pulses: test PVLAS results (2σ confidence level).
- With 100 pulses: improve BFRT limits for all masses.

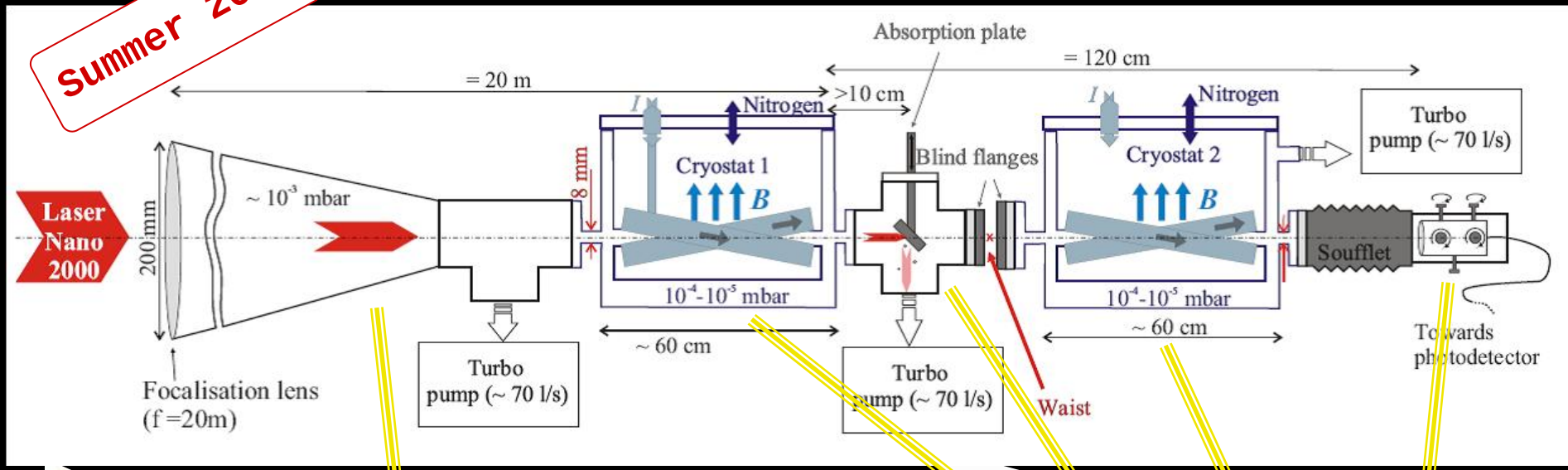
Nano 2000 laser chain (LULI)

Approved by Program Committee September 2006

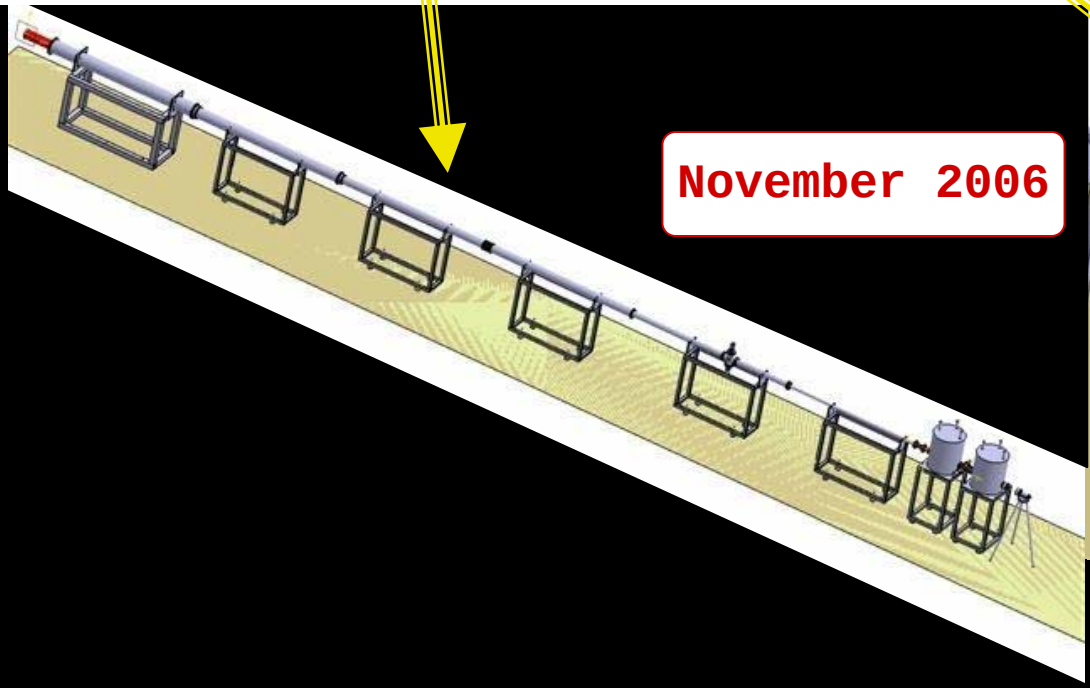
- 1 to 1.5 kJ / pulse
- λ = 1053 nm $\Rightarrow$ Nγ = 5 to 8×10^{21} / pulse
- Pulse duration 5 ns
- ~ 6 pulses per day

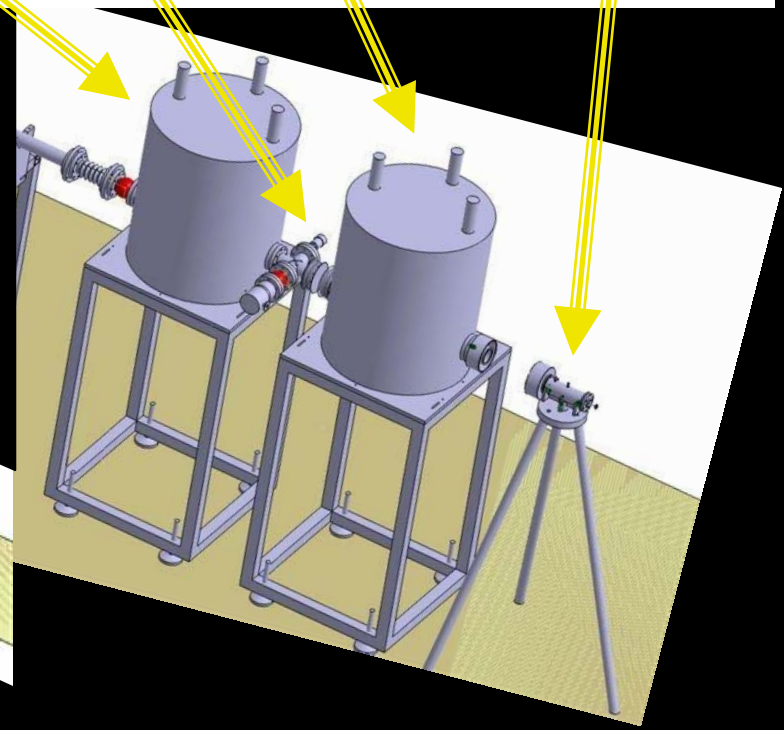
General set-up (LCAR)

Summer 2006

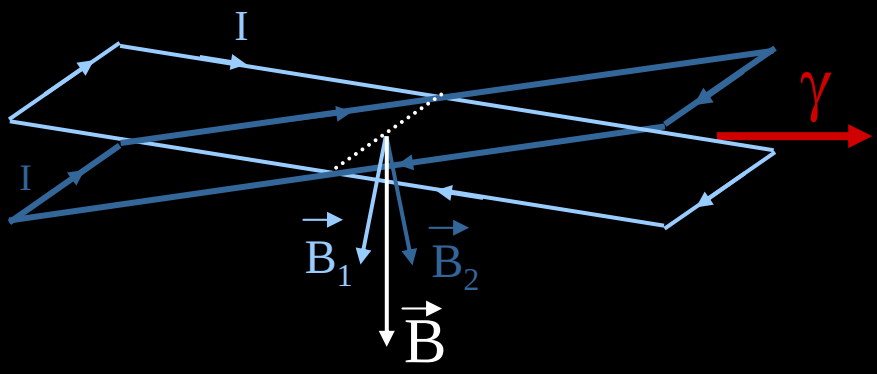


November 2006





Coils development (LNCMP)



X coil geometry

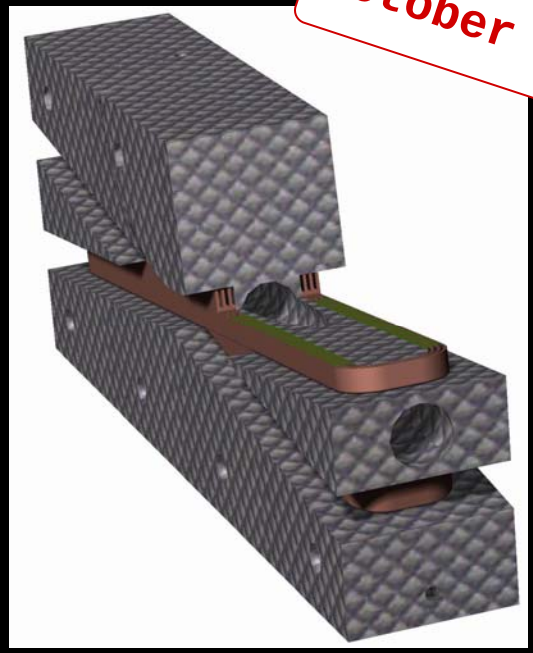
- Length = 45 cm
- Aperture 12 mm

$\Rightarrow$ 10 T over 45 cm

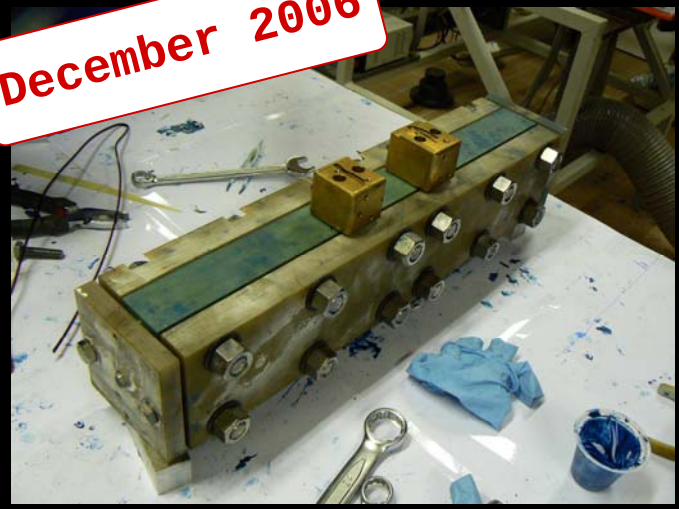
$\Rightarrow$ B.L = 4,5 T.m during 5 ms

Coils originally developed for the BMV experiment by S. Batut & O. Portugall.

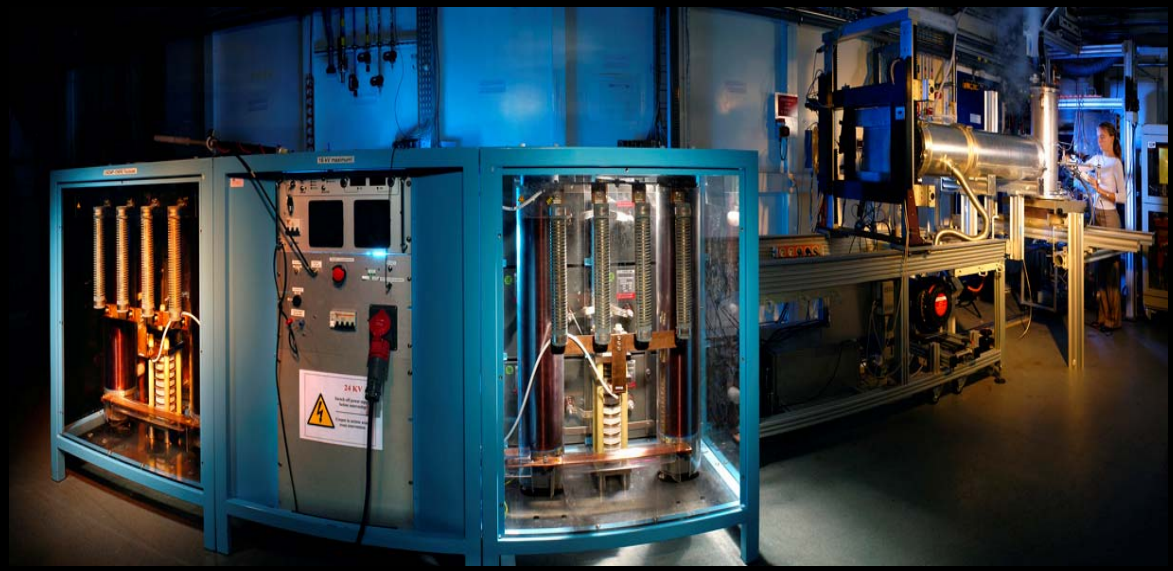
October 2006



December 2006



Coils tests (LNCMP)



Transportable generator:

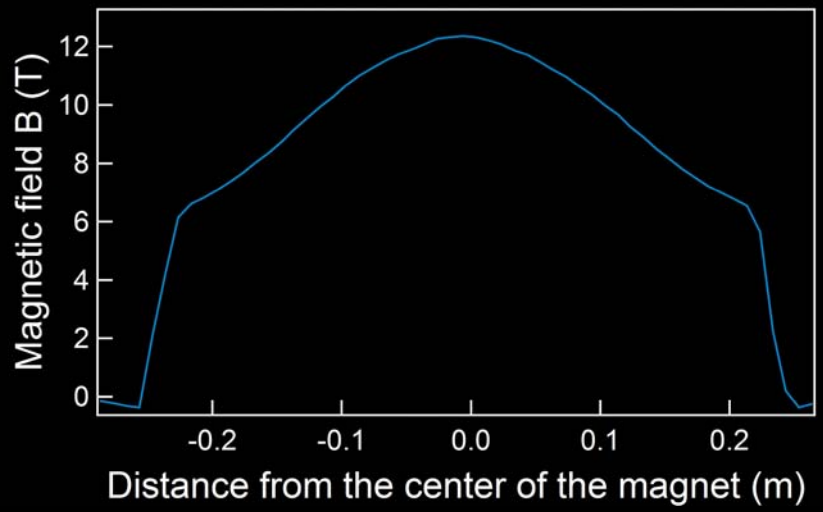
V_{max} = 16 kV

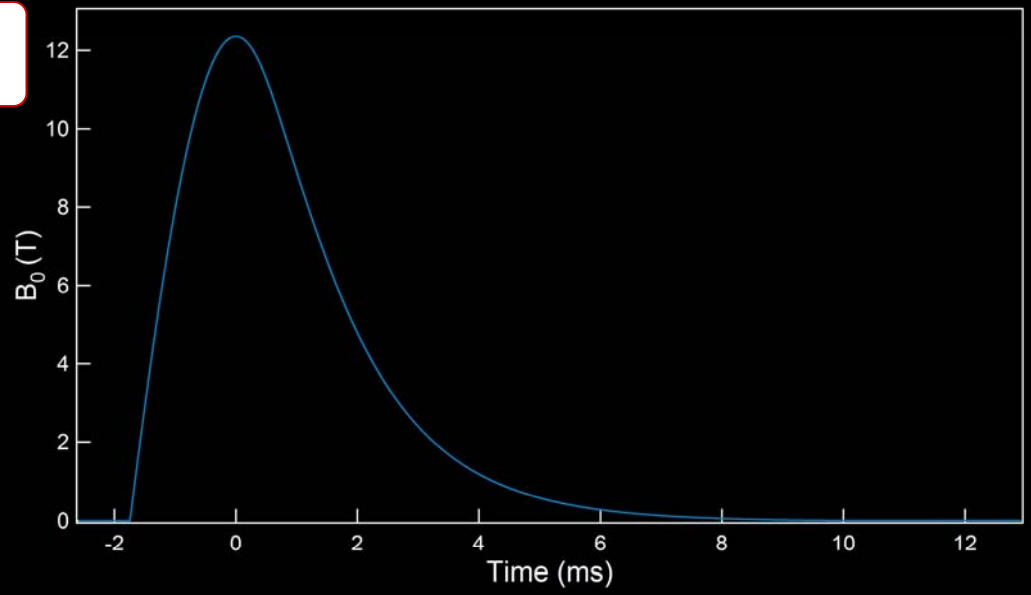
3 x 1 m^3

~ 3 tons

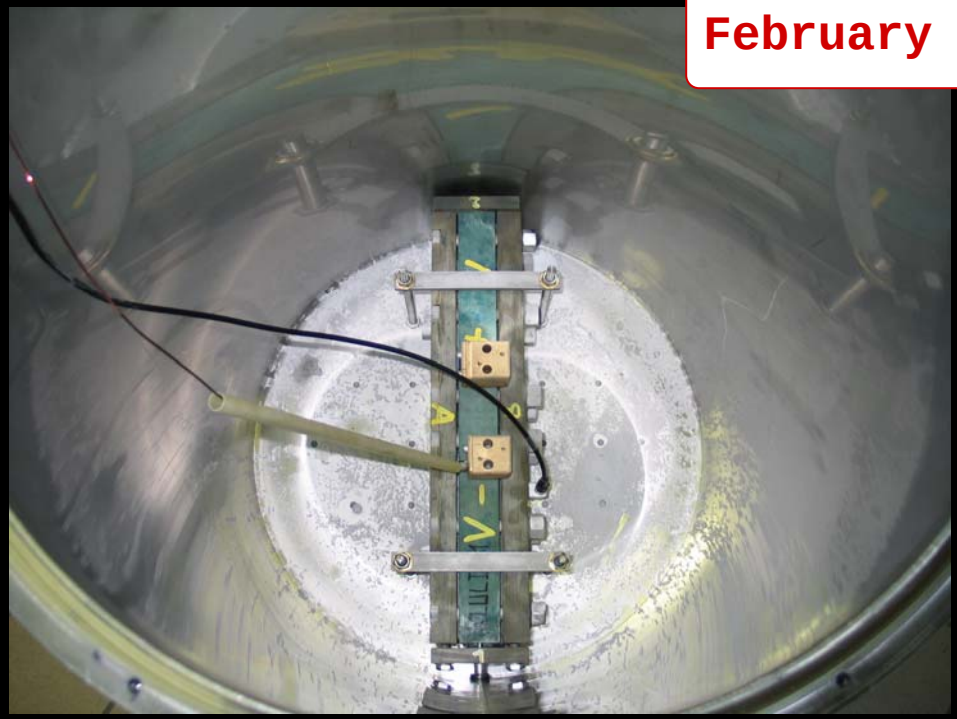
Generator originally developed for experiments at ESRF by P. Frings.

January 2007





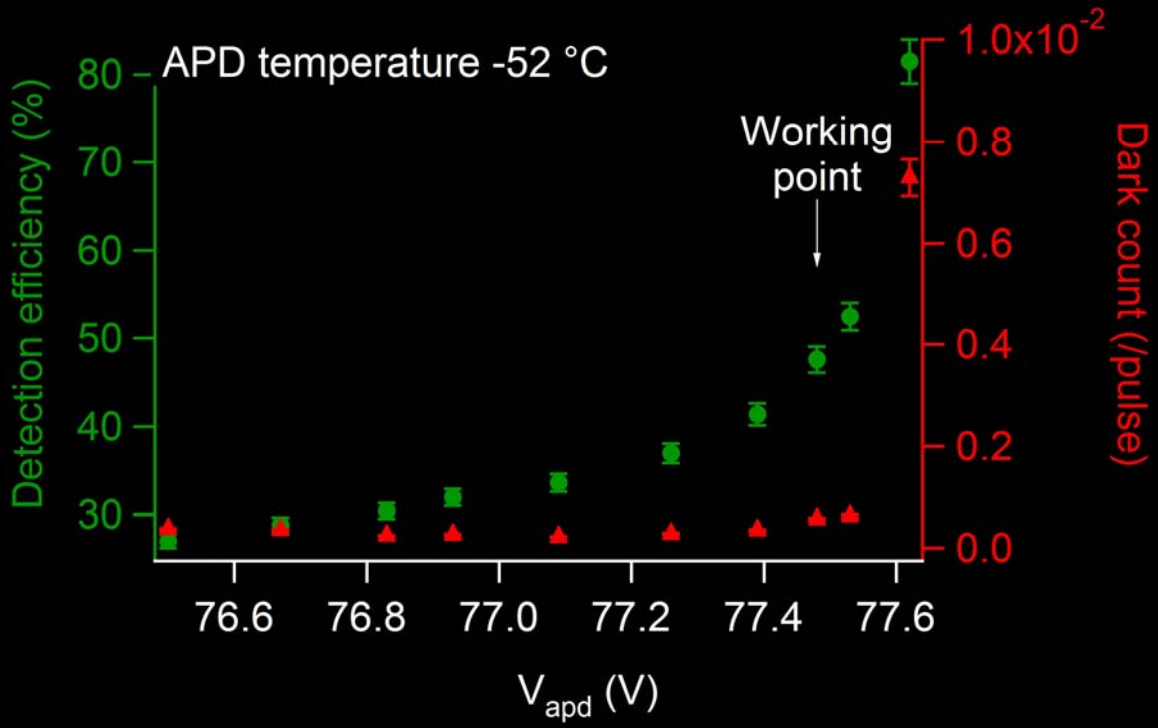
Coils cryostats (LNCMP)



February 2007

Detector tests (LCAR)

Commercially available single photon detector from Princeton Lightwave Instruments, specially adapted for our experiment: APD optimized at 1064 nm, multimode & large NA fiber.

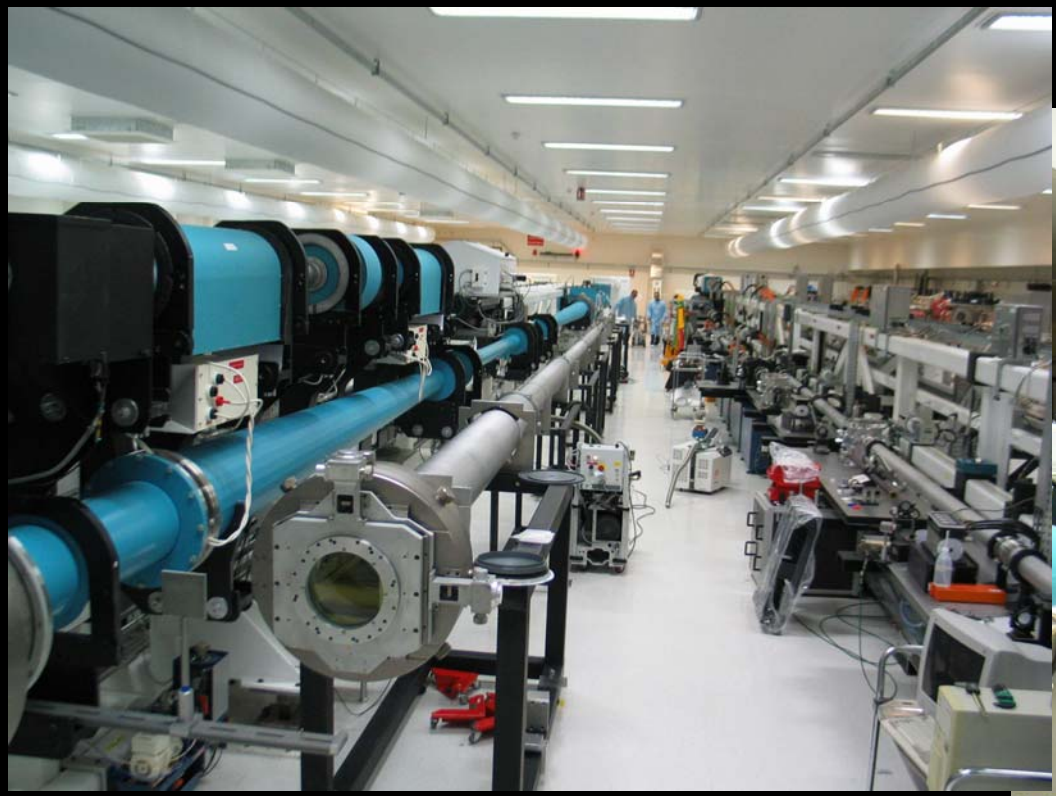


Tests performed with cw Nd:YAG monomode laser.

Detection gate: 5 ns

February 2007

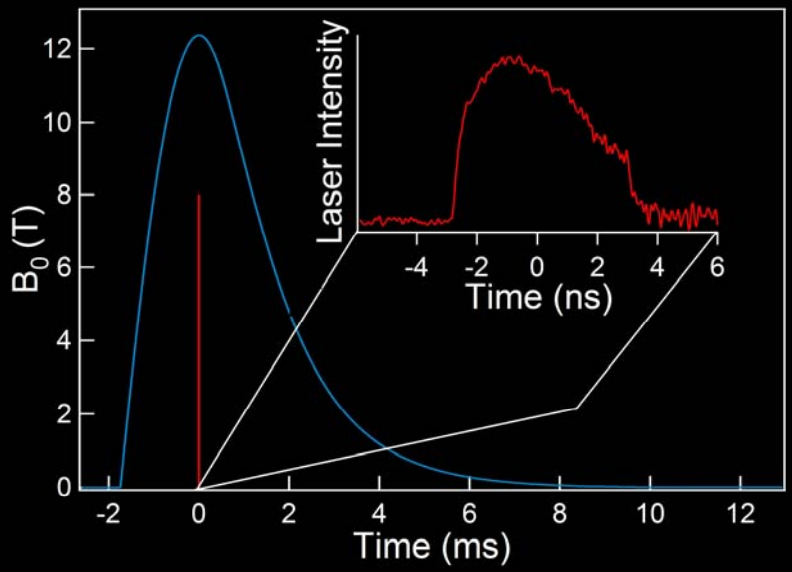
Implementation at LULI (1)



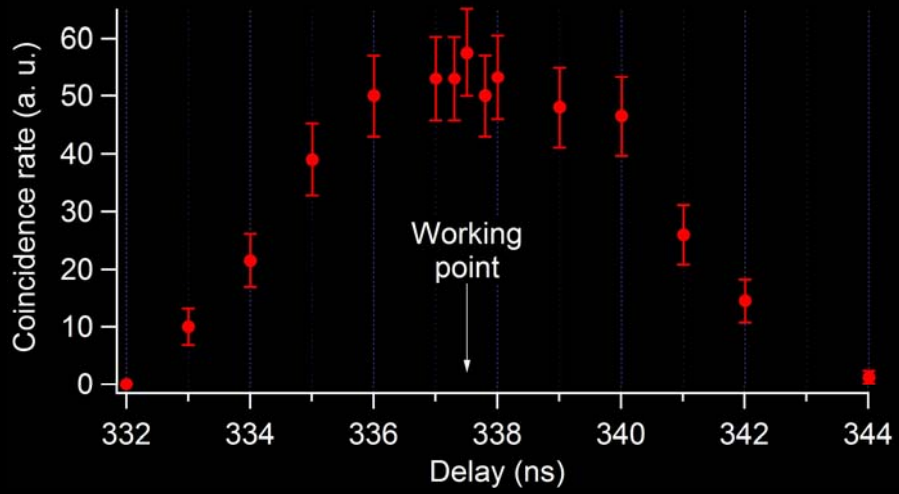
March 2007

Implementation at LULI (2)

Synchronization B & laser



Synchronization detector & laser



April 2007

Fibre injection: transmission 80-90 %

Implementation at LULI (3)

May 2007

- Test of optical shielding: no count.
- Test of electromagnetic noise: no count if detector in shielding bay.
- Alignment procedure: with the unchopped pilot laser beam.
- How can we be sure that the high energy pulse follows exactly the same optical path ?

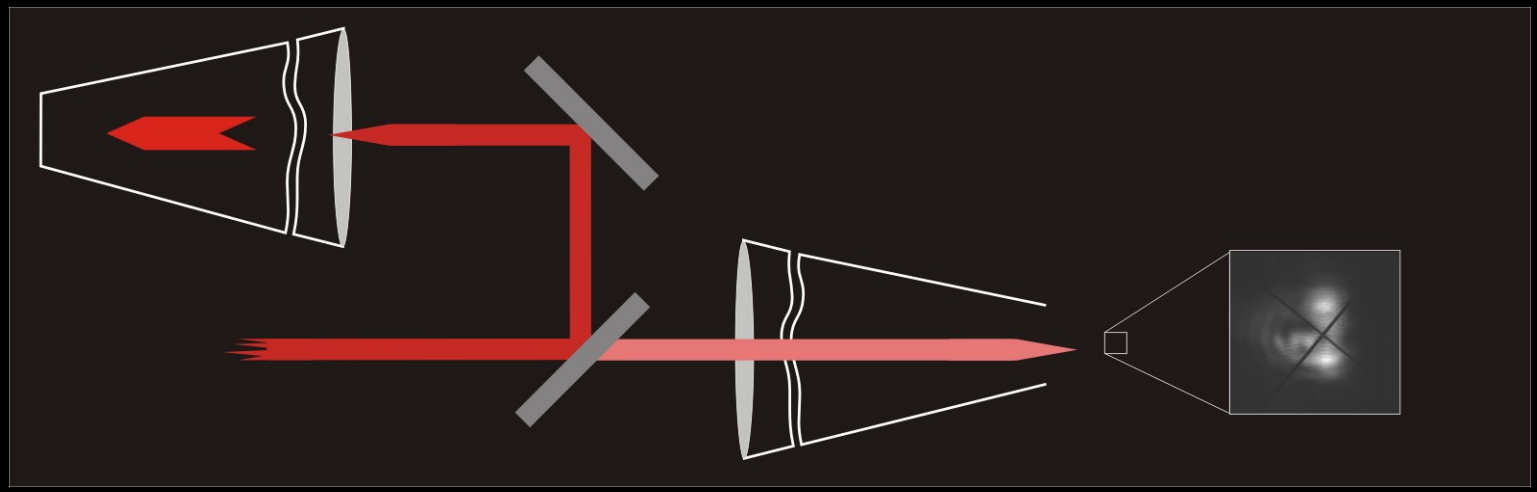


Image recorded for each pulse.
Injection losses ~ 20 % without correction,
< 3 % when corrected.

First measurements

- Total incident energy 8 kJ, effective number of incident photons 2.7 x 10^{22}.
- No regenerated photon detected.

What can we say ?

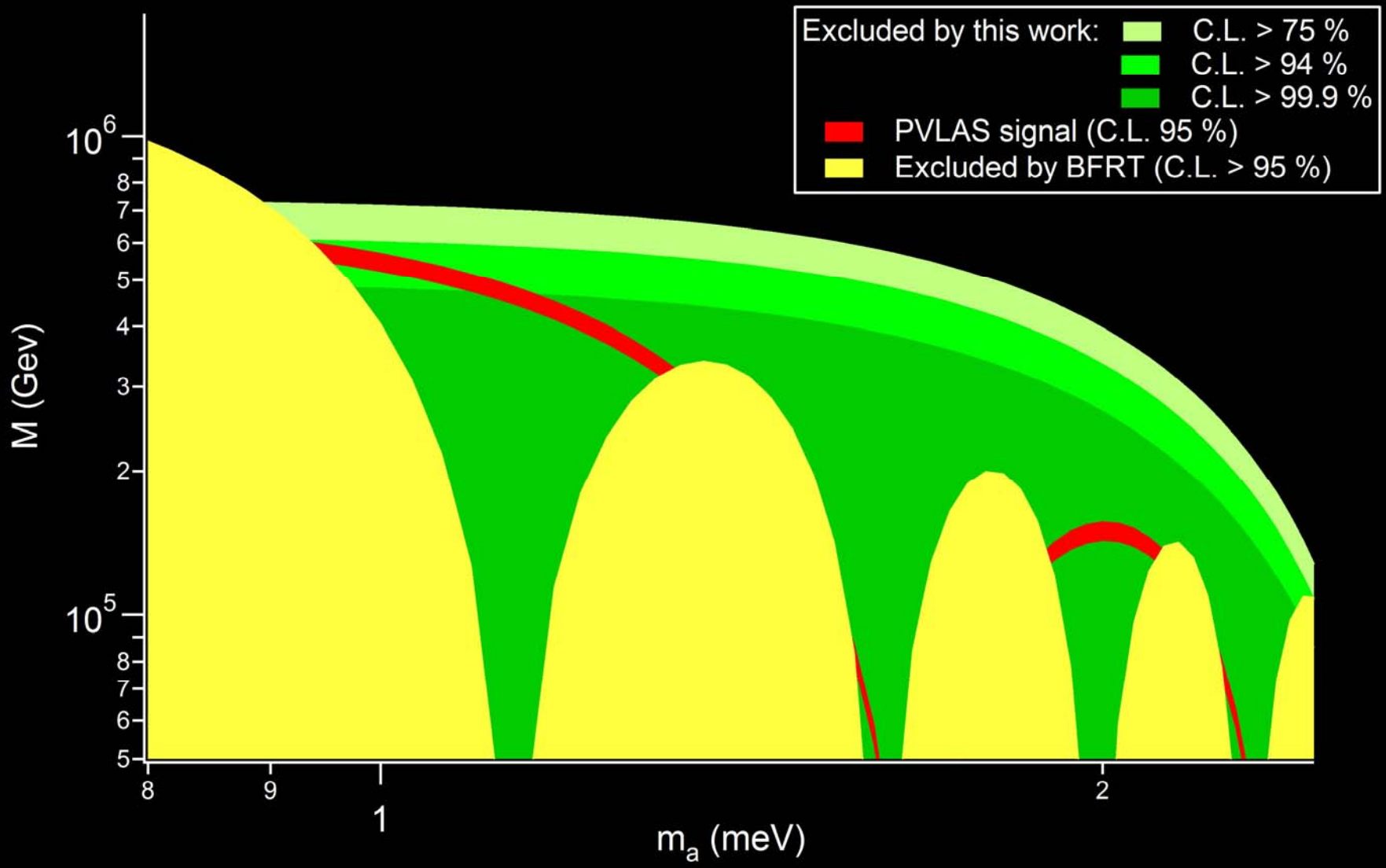
- For a detection efficiency η_{det}, probability that n regenerated photons were missed by the detector $P_n = (1-\eta_{\text{det}})^n$

Ex.: $P_4 = 0.06 \Rightarrow$ with a confidence level of 94 %, $p(L)^2 \times N_{inc} \leq 4$

- Numerical integration of $p(L) = \left| \int_0^L dz' \frac{B(z')}{2M} \times \exp\left(-i \frac{m_a^2 z'}{2\omega} \right) \right|^2$

$\Rightarrow$ Limits in the (m_a, M) plane.

Our present limits



Plans for the future

- Two more runs in 2007 + ? in 2008:

  improve limits on pseudoscalar particles

  + tests with B $\perp$ laser polarisation $\rightarrow$ scalar particles.

- Thinking of spatially modulated fields to test higher masses.

- Measure the Magnetic Birefringence of Vacuum with our cavity experiment.