Precision Timing Via Čerenkov Radiation, II

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http://puhep1.princeton.edu/mumu/timingtrans3.ps

Simulation of Čerenkov Timing with MCP-PMT's

http://puhep1.princeton.edu/mumu/timing.pdf

Hamamatsu R3809U microchannel-plate photomultipliers (MCP-PMT) claimed to have transit-time jitter of only $\sigma_t = 11$ ps for single

photoelectrons.

3 recent papers studying sonoluminescence claim to have verified that $\sigma_t = 13$-14 ps.

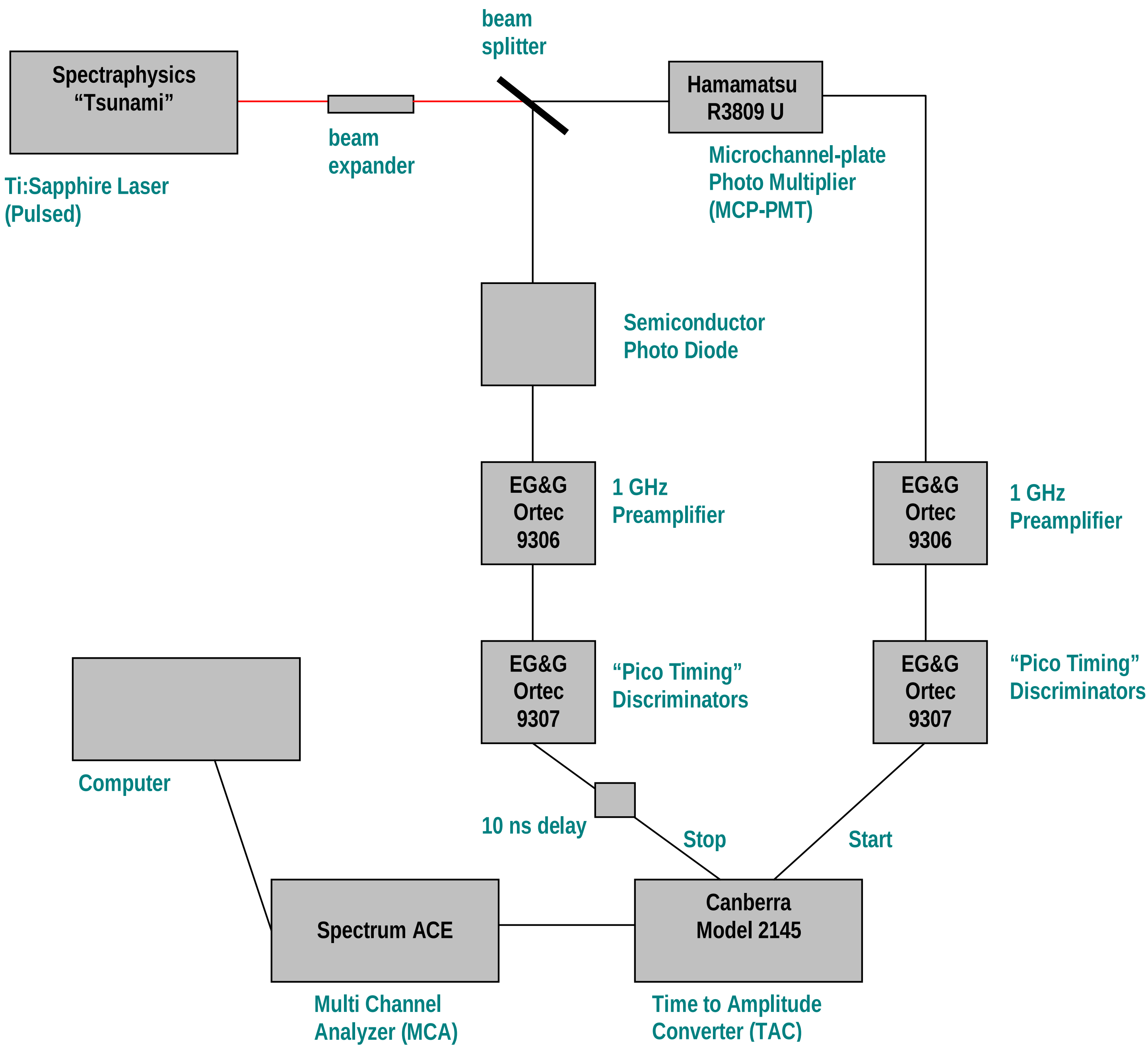
[Not clear that studies were really made for single photoelectrons.]

If so, our simulation claims we could obtain timing of $\sigma_t = 10$ ps for 200-MeV/c muons incident at 45° on 1×1 cm^2 quartz bars up to 30 cm long.

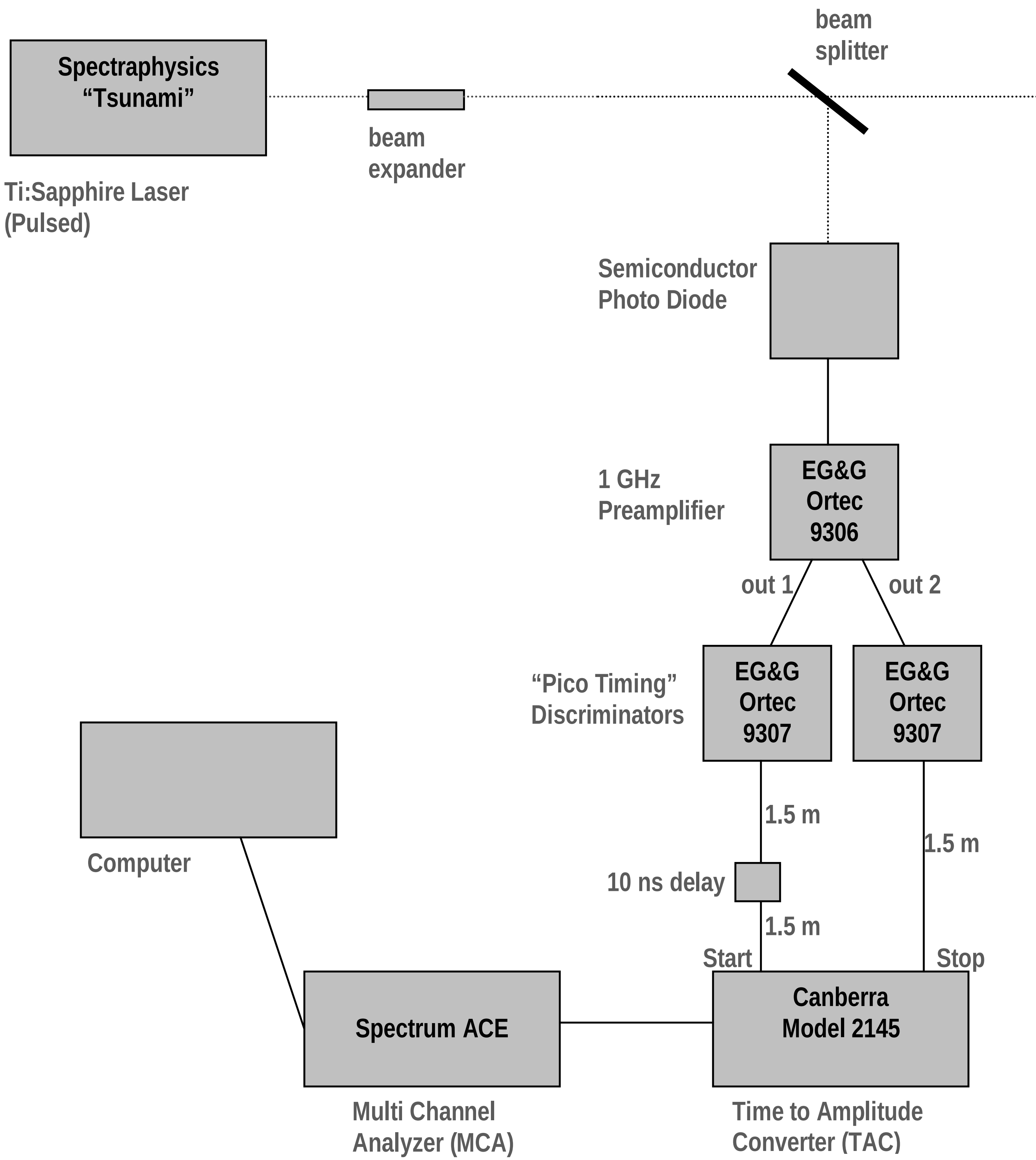
Simulation in good agreement with Kichimi *et al.*, NIM **A371**, 91 (1996), who studied fine-mesh PMT's coupled to 2×4 cm^2 quartz bars.

But, do the MCP-PMT's really perform as claimed?

Test MCP-PMT Transit Time with a Femtosecond Laser

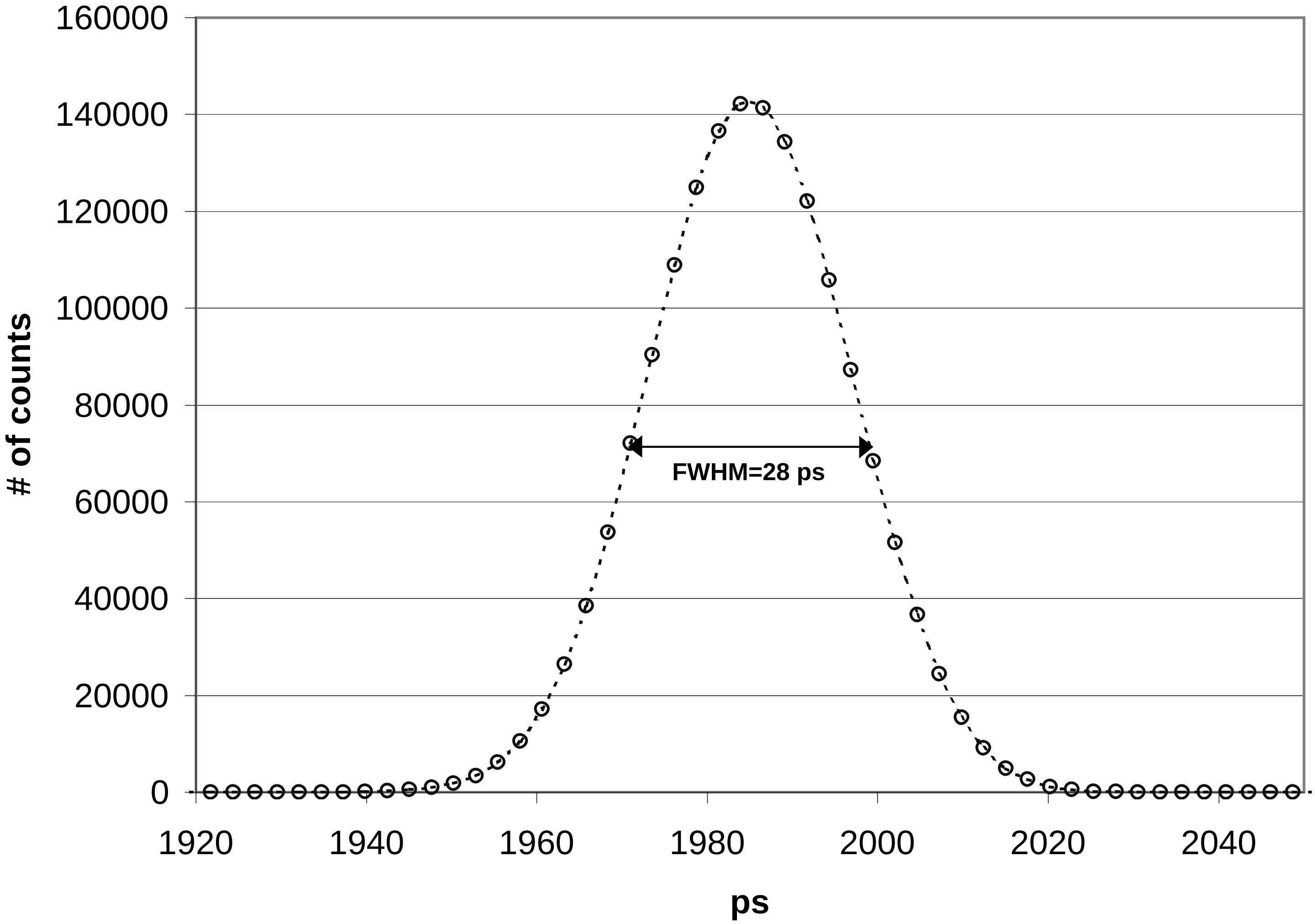


Calibrate with a 4-GHz Photodiode



$\sigma_t \leq 8.5$ ps with Reference Photodiode

Timing between adjacent laser pulses (14 ns apart).

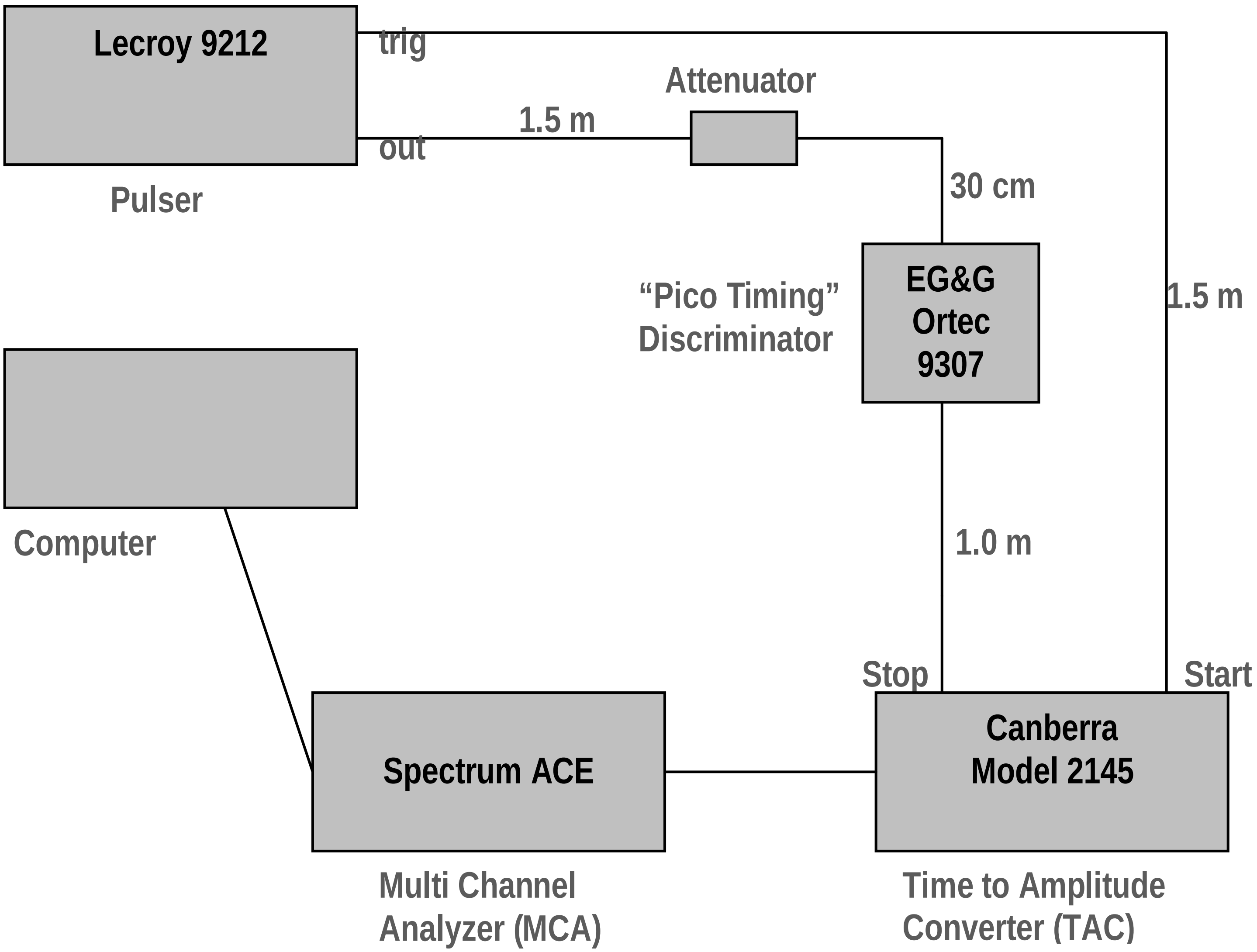


$$\sigma_t = \frac{28.5}{2.35\sqrt{2}} = 8.5 \text{ ps.}$$

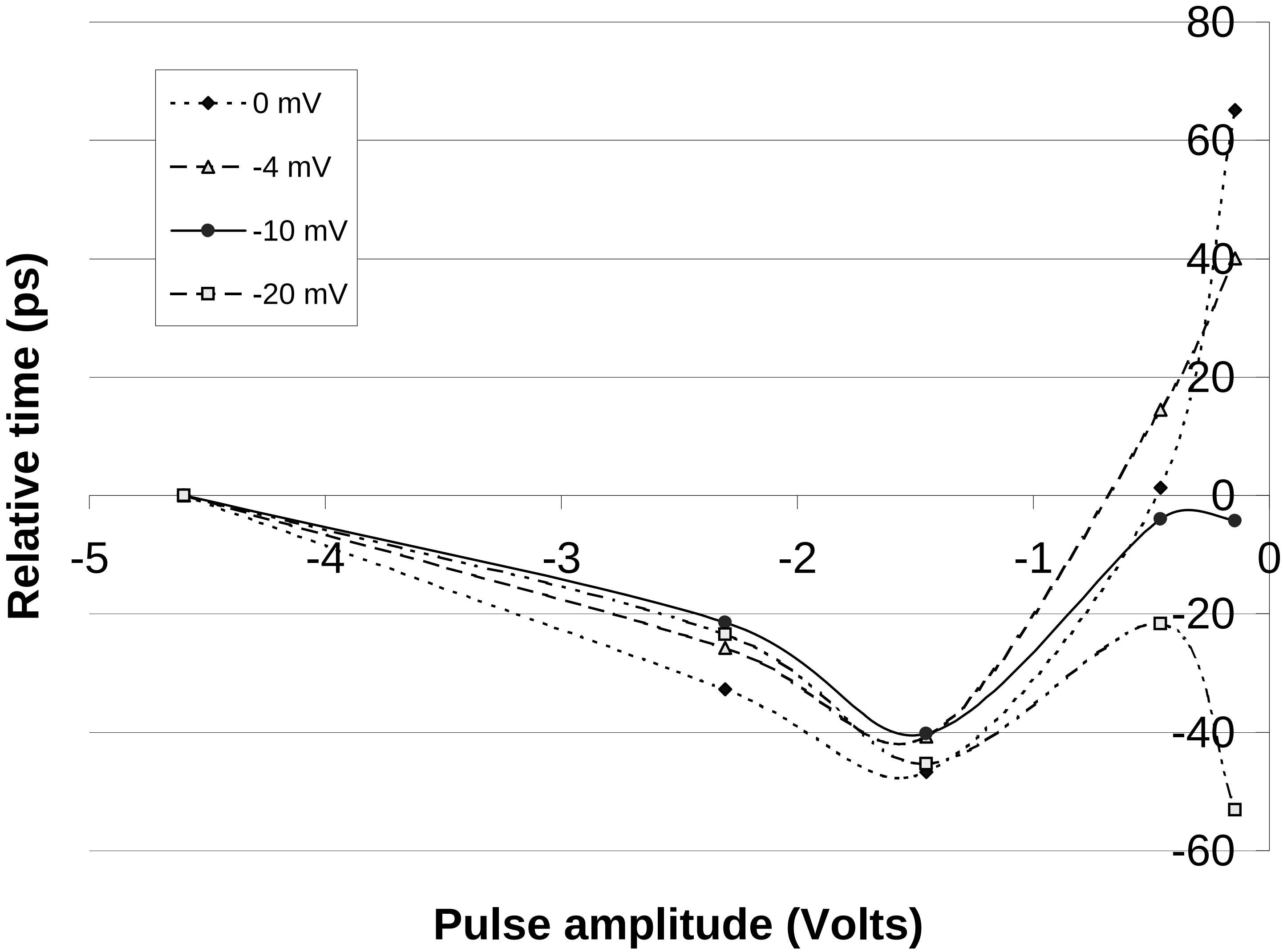
[Timing on same laser pulse $\Rightarrow \sigma_{t,\text{electronics}} \approx 4$ ps.]

Study Discriminator Time Walk

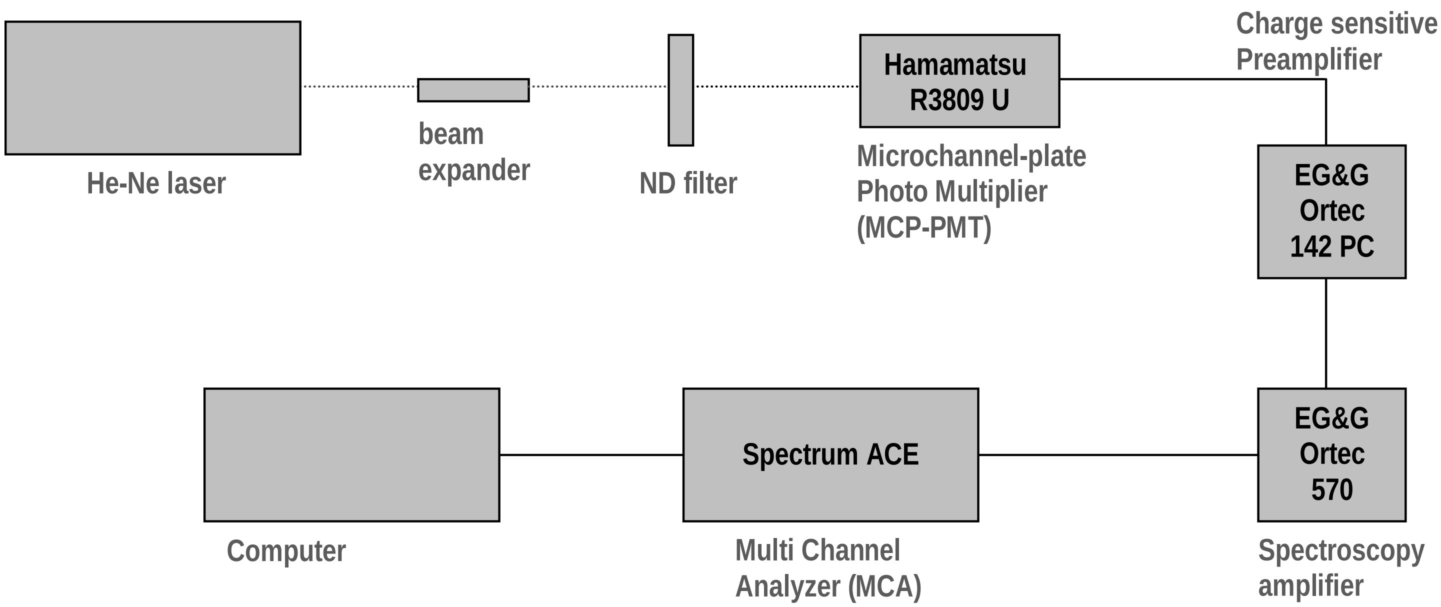
EG&G 9307 1-GHz discriminator.



Measured Time Walk for Various "Slewing Compensation"

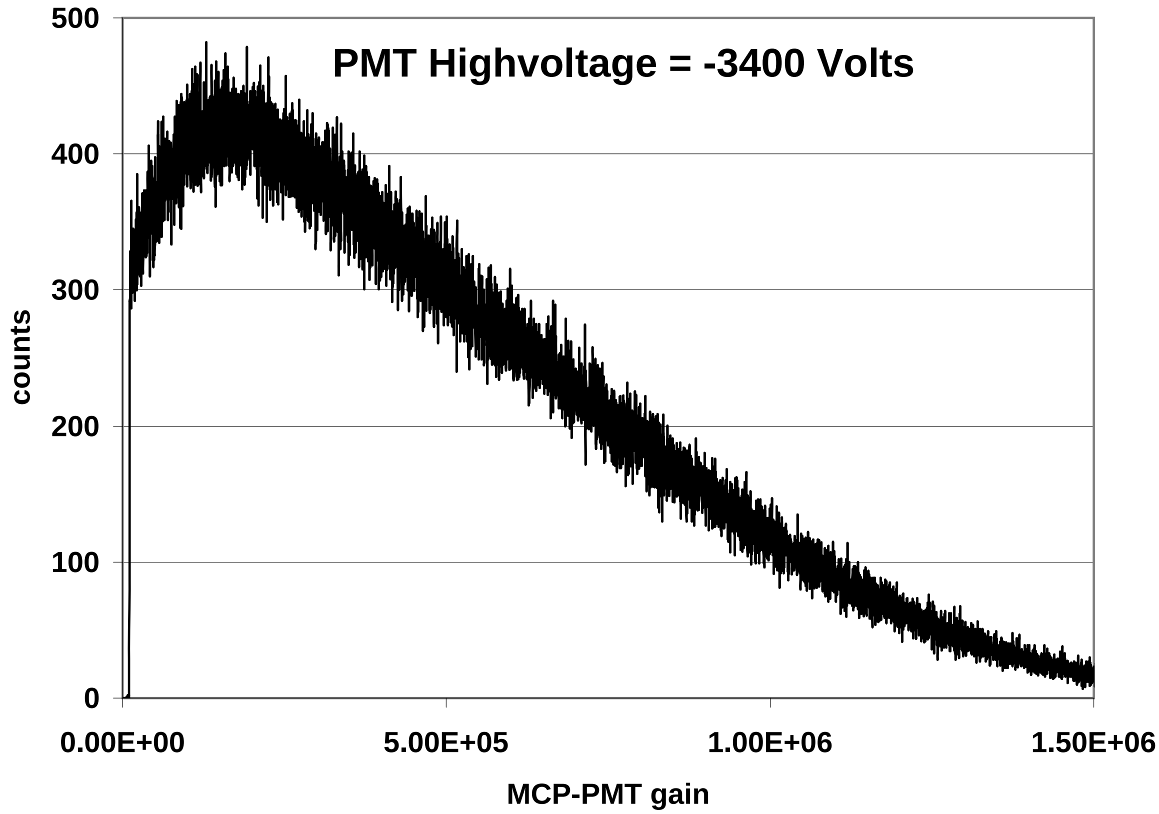


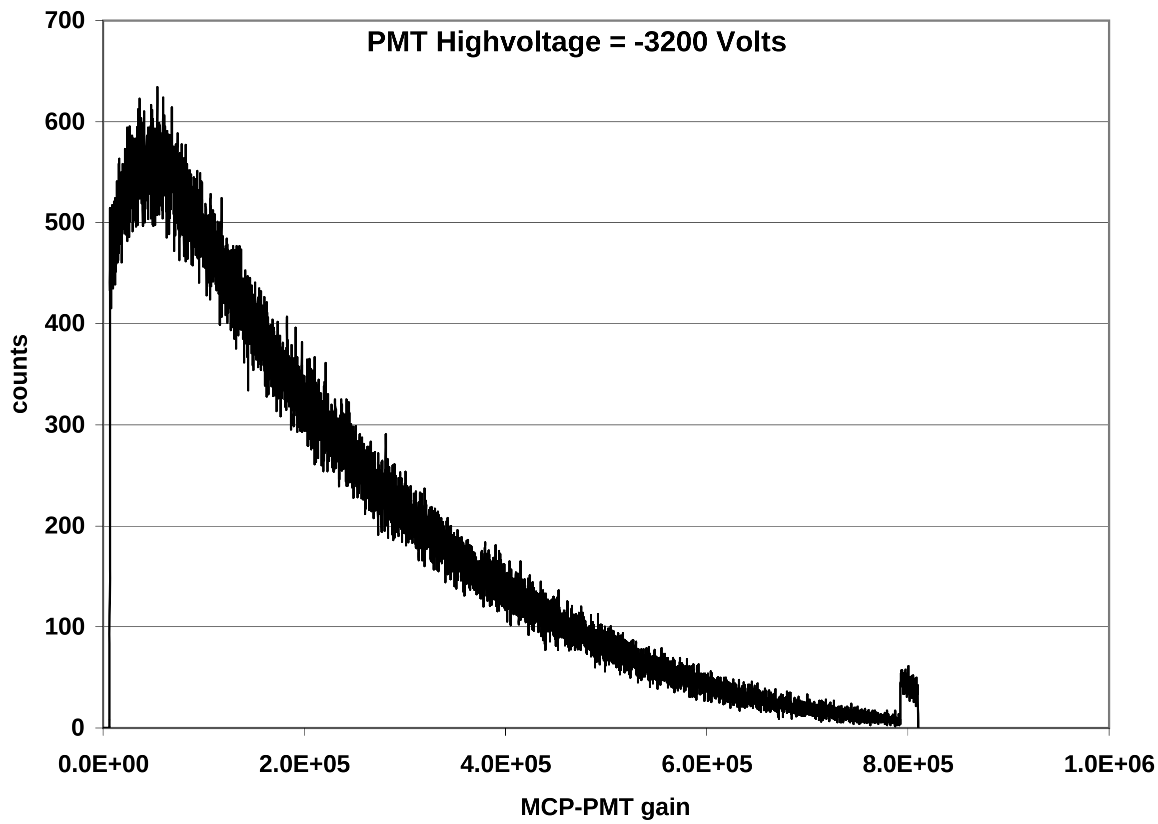
Study MCP-PMT Pulse-Height Spectrum



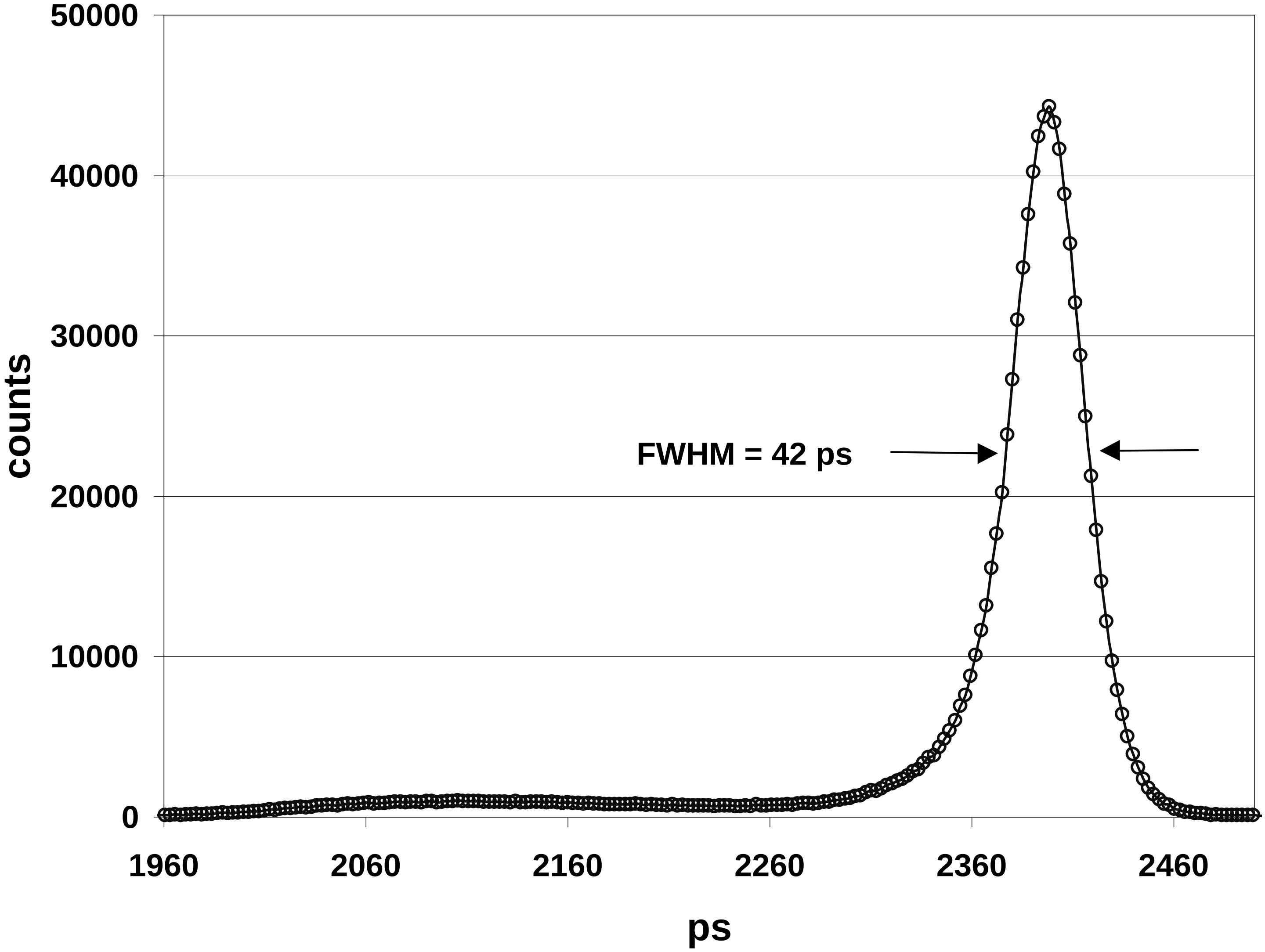
To insure we are studying only single photons, attentuate the laser beam until the MCP-PMT counts only 1 in 1000 laser pulses.

MCP-PMT Pulse-Height Spectra





MCP-PMT Single Photon Timing: $\sigma_t \leq 16$ ps



$\sigma_t = \sqrt{(42/2.35)^2 - (8.5)^2)} = 16$ ps, after removing 8.5 ps due to jitter of the reference diode.

Conclusion

MCP-PMT single photon timing certainly very good.

But haven't fully confirmed Hamamatsu's claim yet.

Timing would improve significantly if made a time *vs.* amplitude correction event by event (as was done by Kichimi *et al.*).

We plan to do this – but must spend real money for a new DAQ system.

Then: Beam test with 30-cm quartz bar;

Investigate Galileo MCP-PMT timing "kit".