Alexander Vostrikov
for LAPPD Collaboration

University of Chicago

psec.uchicago.edu

April 15, 2013

APS April Meeting 2013
Denver, CO, USA
Motivation

- **Colliders.**
  - Jets content & better vertexing. Require $\sim 1$ psec resolution.

- **Neutrinos.**
  - Tracks reconstruction from position and arrival time of photons.
  - Require $\sim 100$ psec resolution.

- **Rare Kaon Decays:** Require $\sim 1$ psec resolution.

- **Medical Imaging:** Require $\sim 50$ psec resolution.
Large Area Picosecond Photo Detectors (LAPPD)

Goals
- Picosecond timing.
- Large area.
- Inexpensive.
- Integrated electronics.

Components
- Photo-cathode.
- Micro-channel plates.
- Anode.
- Hermetic package.
- Electronics.
Final Product: Super Module

- Size: 24” × 32” - 6 sq. ft.
- Thin planar glass body detector.
- 12 tiles share single delay line anode.
- Fully integrated electronics.
  - 90 channels from both sides.
Glass Package: 8” × 8”

- Vertical slice
  - \( \sim 10^{-6} \) torr vacuum.
  - Aluminum photocathode.
  - Stack of two MCPs.
  - Anode.
  - Readout with high bandwidth scope or integrated electronics.

- MCP stack details
  - Cheap, widely available float glass.
  - Chevron geometry (8° bias angle).
  - No pins, single HV cable.
  - Modular design.
Testing Setups: 33 mm, 8”, Demountable

33mm Testing

- Operational experience
- Testing fundamental properties of MCPs
- Study wide variety of sample prototypes

8” Testing

- Demonstrate working 8” MCPs
- Test near complete detector systems with realistic anode
- Optimize and measure key resolutions

Complete detector systems

- Demonstrate complete sealed-tube detector
- Study characteristics of 80cm anode
- Test integrated front-end electronics in fully operational conditions
Commercial MCP

Incom glass substrate MCP
The average gain is over $2 \cdot 10^7$.

Readout based on PSEC4 has more noise than readout with the scope, but allows to read multiple channels at once.
Slope $\sim 10 \text{ psec/mm}$ corresponds to $\sim \frac{2}{3}c$ signal propagation speed along the anode stripline.
Differential time resolution of 5.49 psec corresponds to spatial resolution of $\sim 500 \, \mu\text{m}$.
Noise limits time resolution.

- Noise is dominated by laser Pockel cell (deterministic noise).
- Ultimate differential time resolution is $\sim 1$ psec.
Summary

Conclusion

- A complete detector system close to final detector design built.
- The average MCP stack gain of over $2 \cdot 10^7$ demonstrated.
- Time-of-flight resolution of better than 30 psec demonstrated.
- Differential time resolution of better than 6 psec demonstrated.
- Spatial resolution of better than 1 mm achieved.

Plans

- Many applications can benefit from precise timing and large area coverage.
- 1 year goal: produce first sealed tube.
- 3 years goal: deliver first tile systems to early adopters.
Acknowledgment

- Bernhard Adams
- Marcel Demarteau
- Gary Drake
- Andrey Elagin
- Jeffrey Elam
- Henry Frisch
- Harold Gibson
- Joe Gregar
- Mary Heintz
- Anil Mane
- Jason McPhate
- Robert Metz
- Howard Nicholson
- Richard Northrop
- Razib Obaid
- Eric Oberla
- Oswald Siegmund
- Robert Wagner
- Dean Walters
- Haidan Wen
- Matthew Wetstein
- Jeffrey Williams
- Mark Zaskowski