PHYS 3446 – Lecture #17

Tuesday ,April 16, 2015

*Dr. **Brandt***

- Answered questions on hep vocabulary
- Time-of-Flight
- Bonus for finishing project in April

Projects

1 UA1 Higgs (non) discovery/Carlo Rubbia Nick Stadler, John Havens, Paul T.

2 Top Discovery CDF/Dzero John Crouch, Matthew Gartman

3 J/Ψ (Charm quark) Michael Davenport, Charles Knight, Richard Humphries

4 Top Quark at LHC: Kathleen Brackney, David Soward, Kevin Strehl

5 Charged Higgs1 search/discovery: Ashley Herbst, Anthony Rich

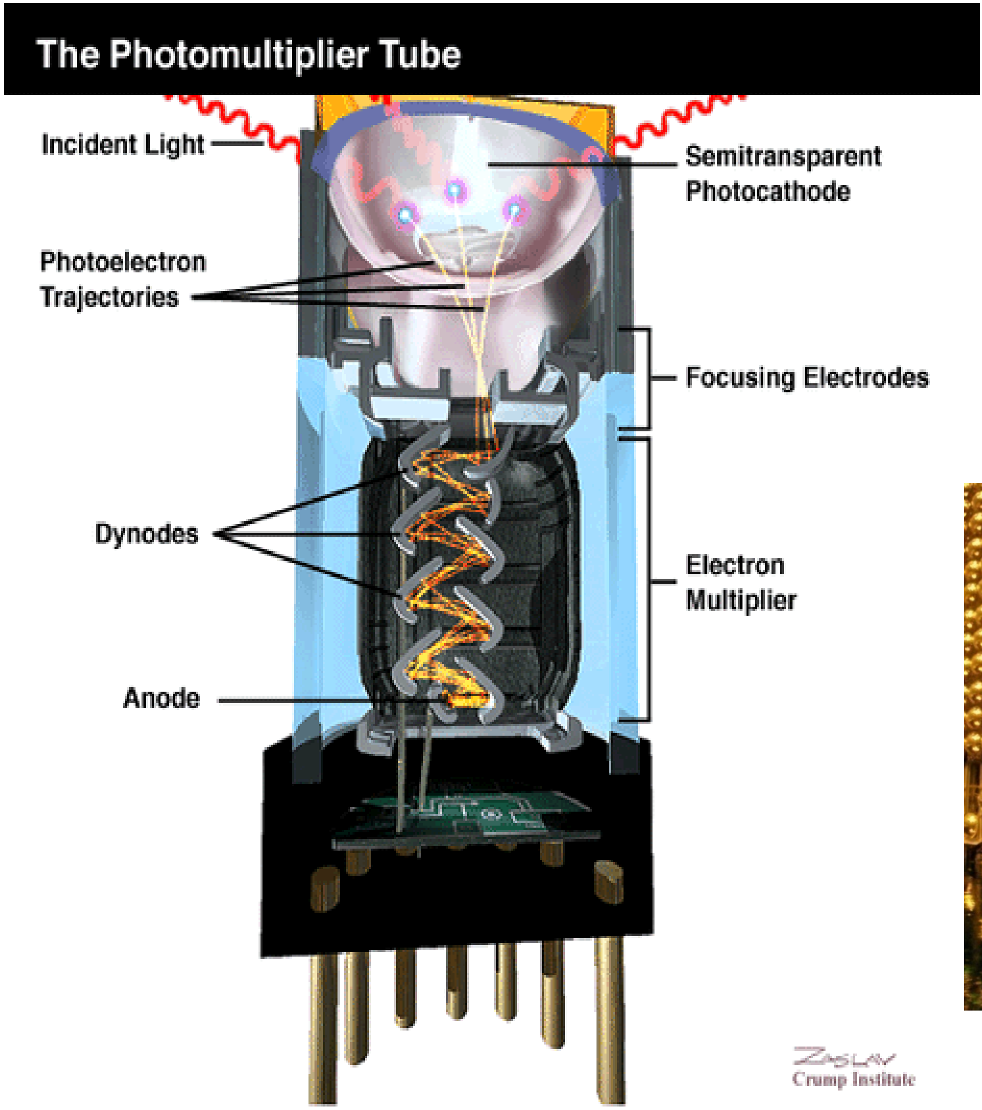
6 Charged Higgs2: Kelly Claunch, Robert Mathews, Charles Jay

7 Higgs Discovery (ATLAS/CMS): Raul Dominguez, Peter Hamel, Kennedy

8 B quark Discovery: Garrett Leavitt, Bernard Nuar, Rajendra Paudel

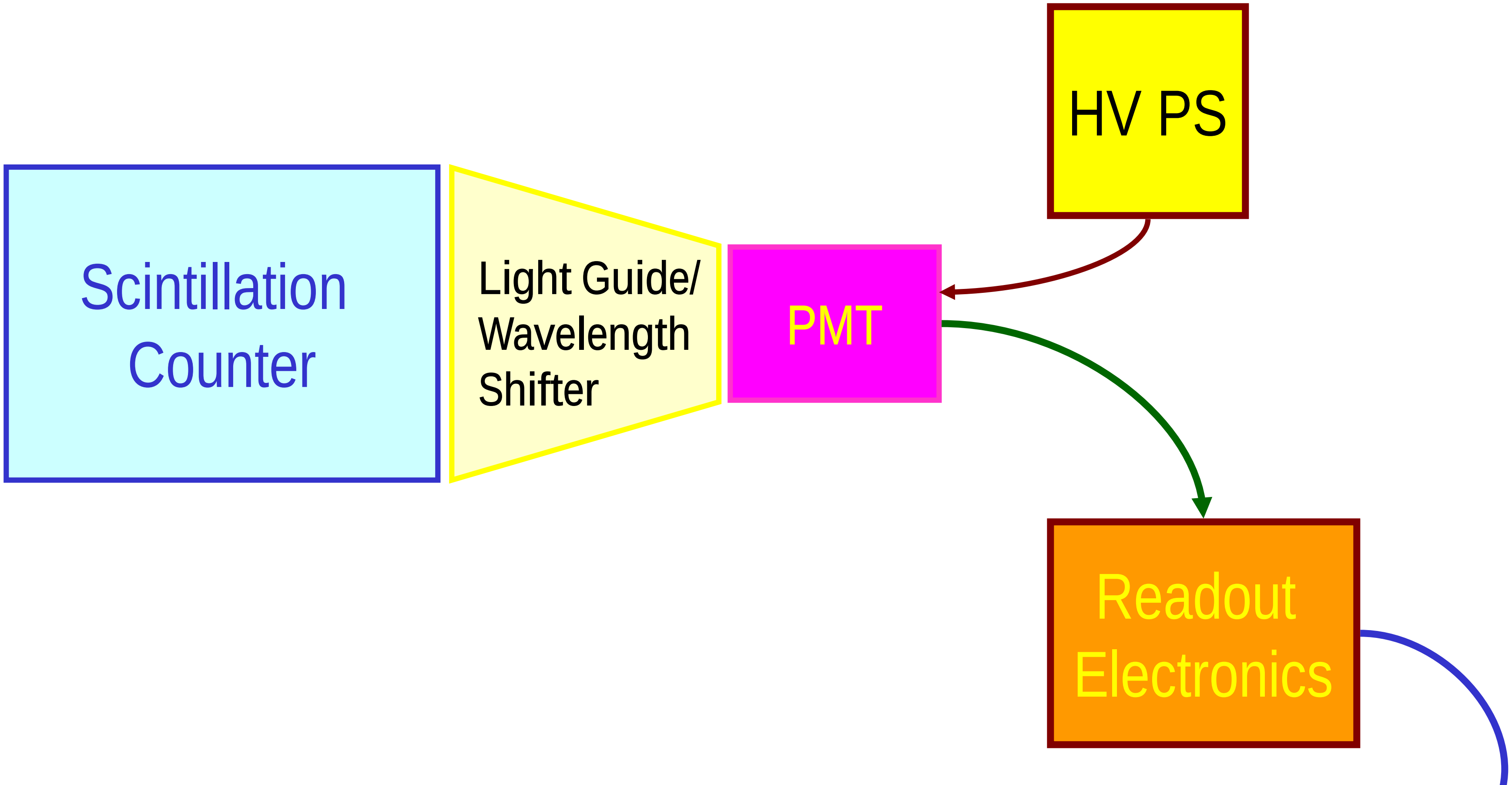
1) Intro/Theory-what are you looking for and what is it's signature and background: how do you know if you find it
2) Detector-how is detector optimized for the task at hand, trigger/data collection
3) Analysis-operate on the data to accomplish the goals/Conclusion
4) Grading will include intermediate milestones; outline due next Tuesday 21st

Some PMT's

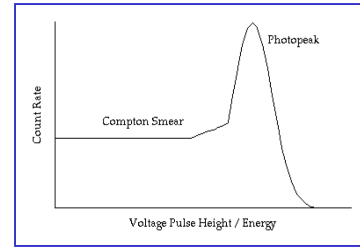


Super-Kamiokande detector

Scintillation Detector Structure



Oscilloscope



Time of Flight

- Scintillator + PMT can provide time resolution of 0.1 ns.
  - What position resolution does this correspond to?
    - 3cm
- Array of scintillation counters can be used to measure the time of flight (TOF) of particles and obtain their velocities
  - What can this be used for?
    - To distinguish particles with the similar momentum but with different mass
  - How?
    - Measure
      - the momentum (p) of a particle in the magnetic field
      - its time of flight (t) for reaching some scintillation counter at a distance L from the point of origin of the particle—this gives the velocity
      - from the momentum and velocity of the particle can determine its mass

Time of Flight (TOF)

- TOF is the distance traveled divided by the speed of the particle, t=L/v.
- Thus Δt in flight time of the two particle with m_1 and m_2 is

$$\Delta t = t_2 - t_1 = L\left(\frac{1}{v_2} - \frac{1}{v_1}\right) = \frac{L}{c}\left(\frac{1}{\beta_2} - \frac{1}{\beta_1}\right)$$

- For known momentum, p,
  - Since $$\frac{1}{\beta} = \frac{1}{\beta} \times \frac{\gamma mc^2}{\gamma mc^2} = \frac{\gamma mc^2}{\gamma m\beta c \cdot c} = \frac{E}{pc}$$

$$\Delta t = \frac{L}{c}\left(\frac{E_2}{pc} - \frac{E_1}{pc}\right) = \frac{L}{pc^2}\left[\sqrt{m_2^2c^4 + p^2c^2} - \sqrt{m_1^2c^4 + p^2c^2}\right]$$

- In non-relativistic limit, $$\Delta t = \frac{L}{p}\left(m_2 - m_1\right) = \frac{L}{p}\Delta m$$
- Mass resolution of ~1% is achievable for low energies