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A U.S. Department of Energy laboratory managed by The University of Chicago

1st Workshop on Photo-cathodes: 300-500nm

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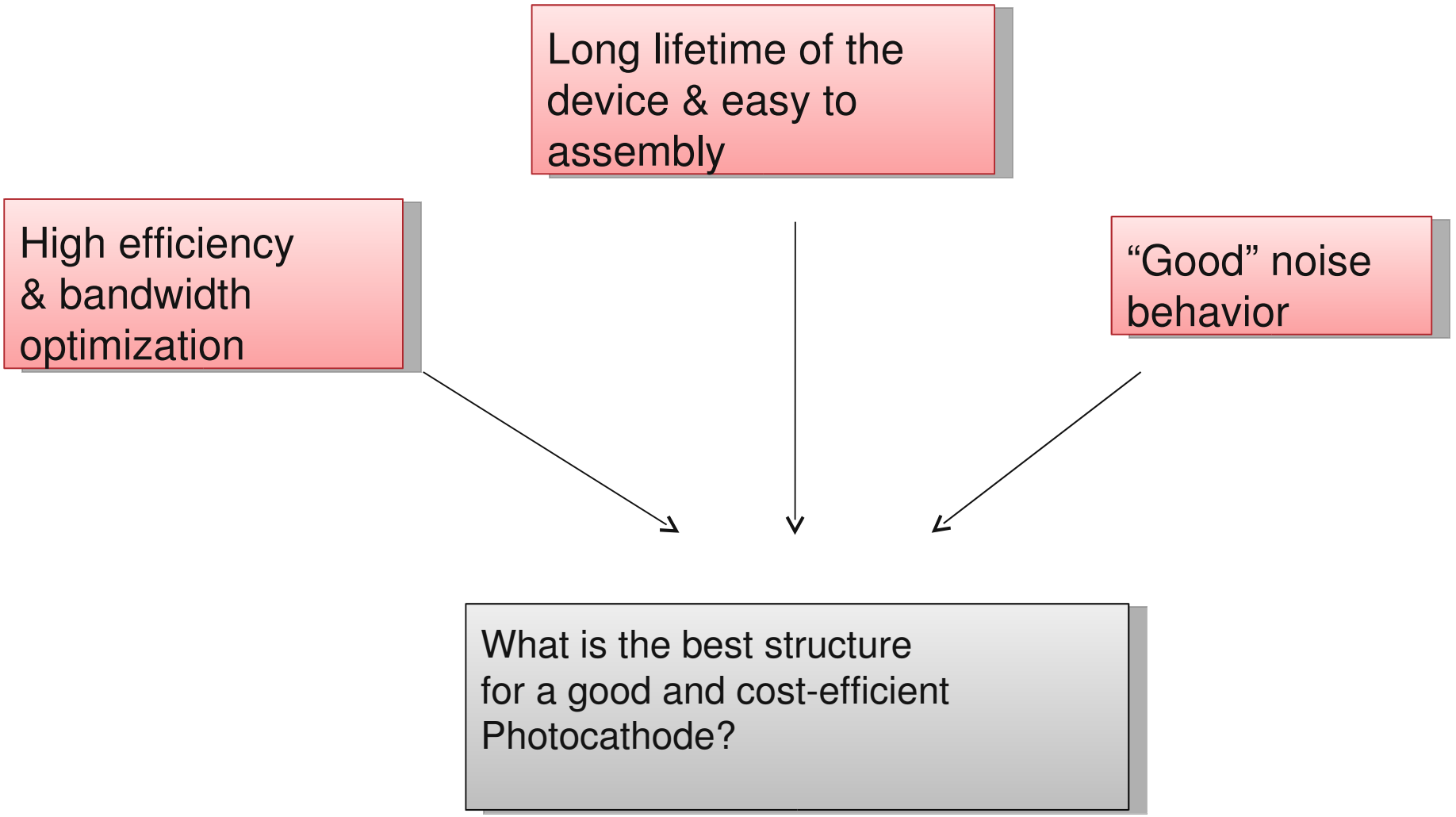
Motivation for the workshop: How to build a Single-Photon-Detector better than a PMT?

- ***Existing project for large area detector*** with single photon capability, time resolution of up to 1ps and 300µm spatial resolution.
- The new detector should be ***cost efficient and "easy" to build*** (in comparison to PMT based systems)
- What can ***we learn from the various communities*** to make a "perfect" photo-cathode.

The Three Criteria:



What is Our Goals?

1. Discuss and agree on the basic underlying physics processes (Finding a common Language)
2. Bring up and explore new directions, materials, techniques, and geometries
3. Elucidate the trade –offs between conventional choices: transparent/reflective, bialkali/III-V, etc.
4. Clarify the requirements for large-area photo-cathodes (Vacuum, fabrication, lifetime, mechanical & chemical)
5. Identify the most promising conventional materials for high-QE, low-noise cathodes in the 300-500nm range
6. Identify additional resources, facilities, and (possibly) collaborative efforts
7. Contribute to narrowing the possibilities for this year's work on photo-cathodes to a few most promising paths

Thank you for coming and enjoy the workshop

High Efficiency and Bandwidth Optimization:

- What are the best ways to reduce reflection losses, what are the problems
  - Pattering of substrate / nano-structures
  - Reflection versus transmission geometries
  - Refractive index matching
  - ??????
- Thickness optimization of the active layer
  - State-of-the-art simulation of electron and photon
  - Optimization of doping profile and how to make it
  - External versus internal electric fields
- The negative electron affinity (NEA) layer
  - The chemistry and crystal structure of the layer
  - Long term stability
  - Ion etching and how to protect the cathode
- Are there new (nano-)technologies which can help

Lifetime of the Device and How to Assembly

- Chemical and mechanical damage of the cathode
  - The process and is there a way of quantitative understanding
  - Effects of various gasses

- Protective layers
  - Membranes: influence on time structure, efficiency, and noise.
  - Cathodes with alternative geometries (like reflection geometry)

- Assembly issues
  - What are the vacuum requirements in the final detector (partial pressures?)
  - Which fabrication steps can be done in foundries and what has to be done in a precise vacuum/gas atmosphere
  - Final assembly in vacuum or ultra-pure gas atmosphere
  - How does the production line look like

What Determines the Noise Behavior

- Dopants and defects
  - Is there a basic understanding on the effects of different dopants (electron scattering, thermal excitation, E-field-strength effects)
  - Correlation between free carriers and macroscopic quantities like refractive index, DC/RC dielectric constant.

- Field emission
  - Limitations of the external field for nano structured surfaces
  - Effects of dopants on local field distributions
  -

- Spectral response
  - How precise can the bandwidth be matched to the source

- Thermal effects in detectors
  - Influence of high count rate
  - ……