

1. Effective no. of photoelectrons ≥ 10 at aerogel layer of $\leq 40\text{mm}$ and $n \sim 1.05$
 - HAPD: currently 7
 - MCP PMT: ~ 10
 - SiPM: ~ 30 (calculate effective equivalent)

2. Stability of operation
 - like breakdown/ramp-up.... rather short time for usual operation
 - HAPD: HV stability?, humidity an issue?, ramp up minutes
 - MCP PMT: no problems
 - SiPM: stable temperature?

3. Long term performance (ageing, radiation damage, ...)
 - after 10-year operation with 20 times BG (compared to the present one), sufficient overall efficiency has to be kept, effective no. of photoelectrons ≥ 8
 - HAPD: photocathode, rad. damage? (Total charge looks OK/Belle in-situ test OK so far/More test needed for neutrons)
 - MCP PMT: photocathode, (rad. d.?)
 - SiPM: rad. damage?

4. Performance in magnetic field: all conditions have to be satisfied in magnetic field.

- HAPD: OK, maybe slight increase in # photons
- MCP-PMT: OK, maybe slight increase in # photons
(improve performance of charge-sharing etc/timing resolution ?)
- SiPM: OK

5. Handling: how easily one can treat detectors (construction, running, manpower qualifications, manpower intensity)

- HAPD: high HV, environment issues (humidity)
- MCP-PMT: check minimal distance between tubes
- SiPM: very light (less material and support), no HV, need light guides + glue (radiation hardness?)

7. Signal-to-noise

- HAPD: correlated with leakage current (radiation damage?), check APD papers
- MCP-PMT: OK
- SiPM: initial performance (temperature dependence, cooling?), correlated with leakage current (radiation damage)

8. Readout electronics: possible technology, readiness/how quickly we will produce/how much in common with others...

- HAPD: ASIC R+D, from fixed design 1y production (More channels/chip – next step)
- MCP-PMT: test with WFS
- SiPM: test with WFS

9. Production and availability by 2.5 years

- HAPD: 2.5y after order (New facility dedicated to HAPD production from 2009 Jan)
- MCP-PMT: 2y after order (check for 10micron pores)
(Moving facility from US to Netherland. Start up 2009 Jan. Careful look required)
- SiPM: to be checked (specs, other producers?)

10. Cost (photon detector + front-end + power supplies)

- HAPD: < 7000EUR (now), maybe ½? x 600
- MCP-PMT: < 4000EUR (now) x 1000
- SiPM: no idea, now 70EUR/piece!, T2K ~20\$/piece x 500000

11. Additional features (timing)

- HAPD: check timing capabilities (need modified read out)
- MCP-PMT: timing (40ps per single photon), to be checked in mag. field (Vavra?)
- SiPM: ~100-150ps per single photon

12. Other/New things

HAPD: (New production facility from 2009 Jan. Expect to improve QE like super/ultra QE)

MCP-PMT:

SiPM: