SHMS Heavy Gas Čerenkov
October 2008 Update

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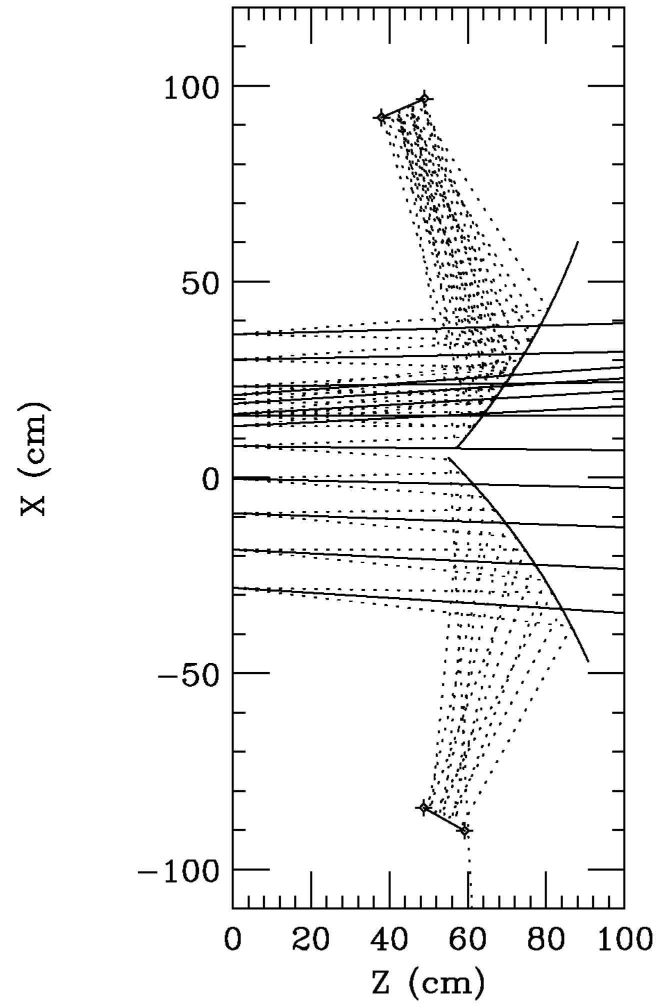
Feedback from August Hall C Workshop

- Design presented for 100 cm vessel length had local inefficiency near x=0.
- Permitted to now consider 100, 130, 160 cm vessel lengths.
  - 130 cm vessel implies that TRD and HGČ cannot be used simultaneously.
  - 160 cm length would leave room for only one Aerogel Č instead of two in addition to removal of TRD.



Mirror One:
1st corner: 88, 60; 2nd corner: 55, 5; radius: 175; focal point: 43.4, 94.3; phi: 247
Mirror Two:
1st corner: 92, −50; 2nd corner: 55, 5; radius: 175; focal point: 53.9,−87.3; phi: 299
Dispersive: $\Delta\theta$: 35.0; δ: −10.0 22.0; z=0 is at 18.80 m.
in: 39, caught: 38, eff: 97.44%, spot sizes: 95.84%, 97.76%

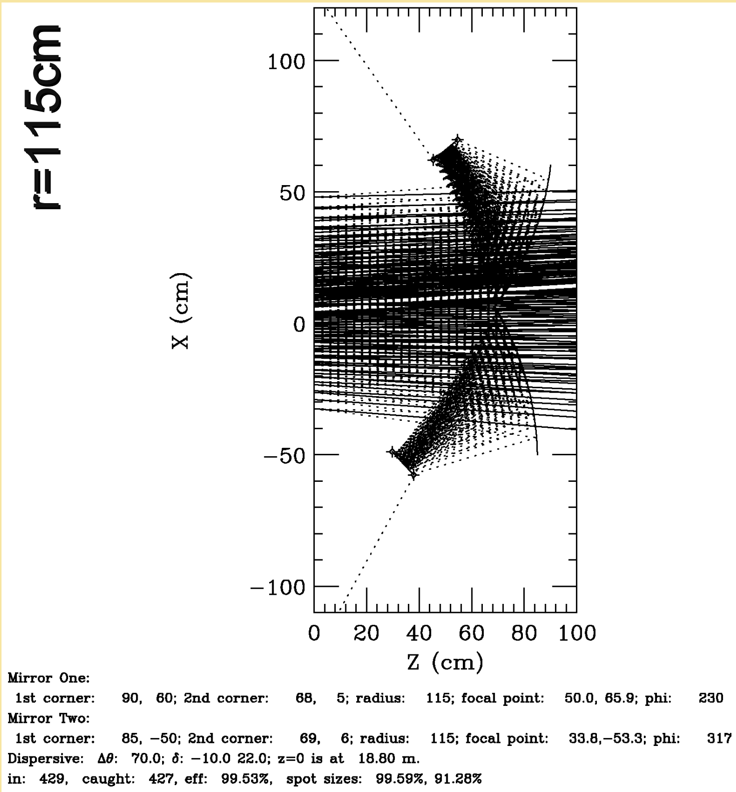
Optical Ray Trace study

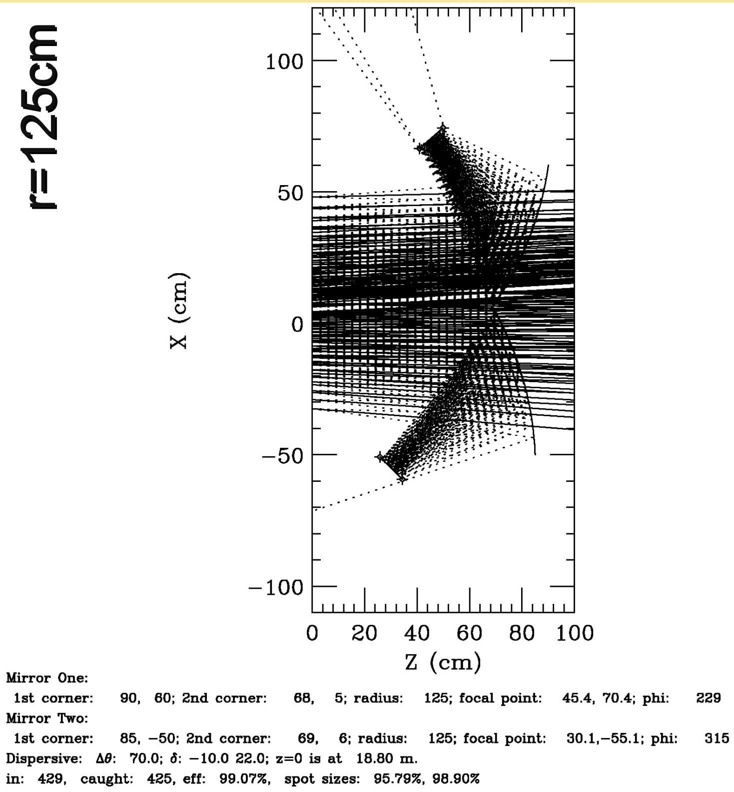
- **Study uses raytr program from UVa.**
  - Program originally developed for design of HMS Čerenkov.
  - Grid of tracks generated using SHMS matrix element and light rays traced using the Čerenkov cone angle (θ=2.84^o for 7.0 GeV/c pions).
  - Main limitation is that ray tracing is confined to the dispersive plane only (i.e. 2D).
- **Ray tracing routine automated to iterate over many mirror radii, mirror and PMT placements, to identify the best configurations for each pressure vessel length.**
  - Preliminary results will be shown, based on over 10^7 configurations run to date.
  - 429 light rays traced for each configuration, and ray collection efficiency and PMT spot sizes recorded for each.
    - Earlier studies used only 42 input light rays and many fewer configurations.
- Performance parameters are sensitive to small changes in PMT placement so further study is needed before conclusions can be considered final.

Length=100 cm Studies

- Study discovers best performance is obtained with ~120 cm mirror radius.
  - Radiator path varies ~55-80 cm over focal plane

    (corresponds to variation of 8.0-11.7 p.e. @3.2 GeV/c, ~0.3% local inefficiency).
- Small mirror radii were not considered in earlier studies because of desire to place PMTs outside the 155 cm inner radius pressure vessel.

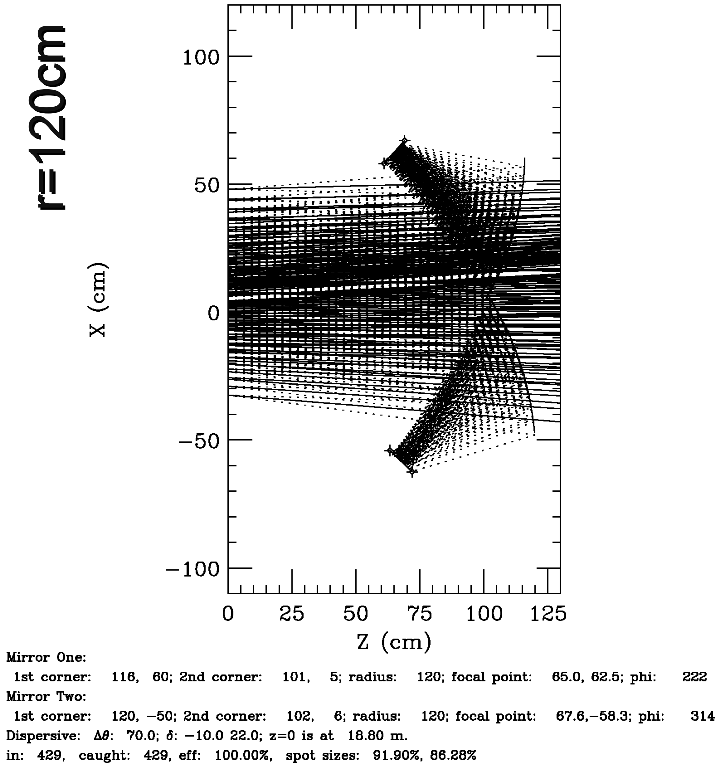


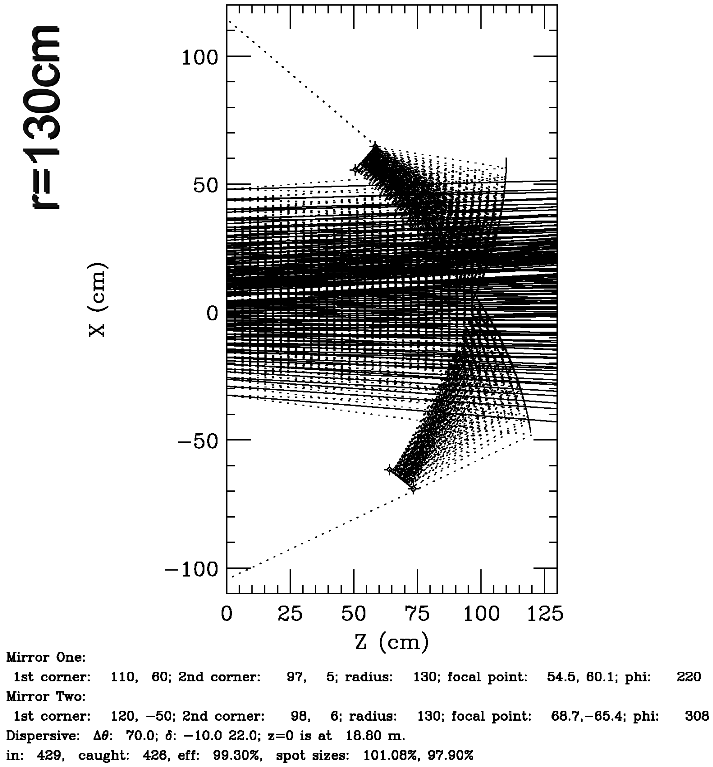


Length=130 cm Studies

- Optimal mirror radius ~125 cm, similar to Length=100 cm configuration.
  - Radiator path varies ~85-110 cm over focal plane

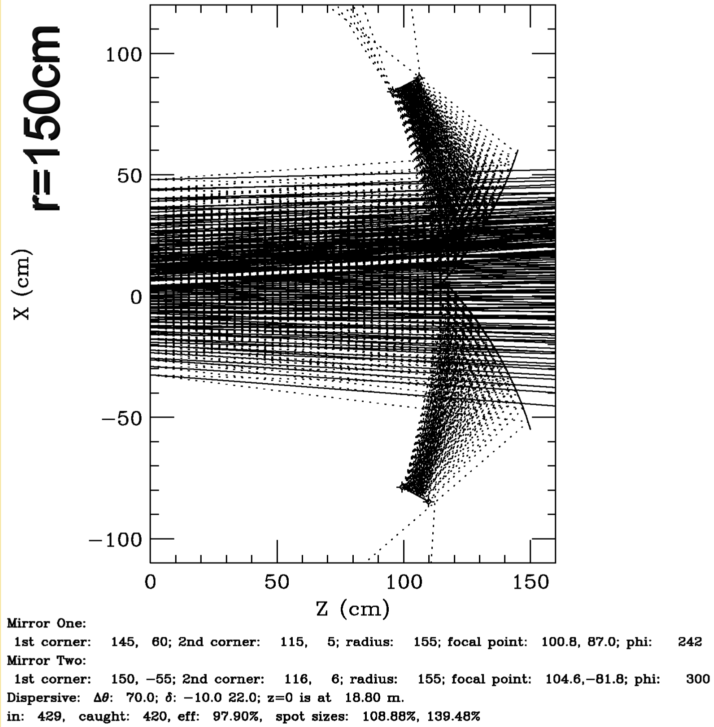
    (corresponds to variation of 12.4-16.0 p.e. @3.2 GeV/c, <0.05% local inefficiency).
- Best ray collection efficiencies and PMT spot sizes are slightly-better than Length=100 cm.

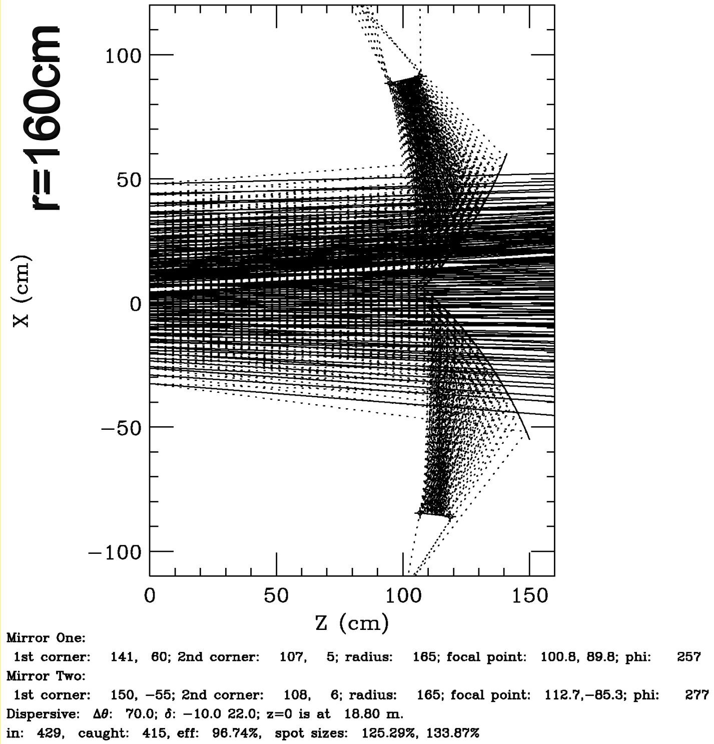




Length=160 cm Studies

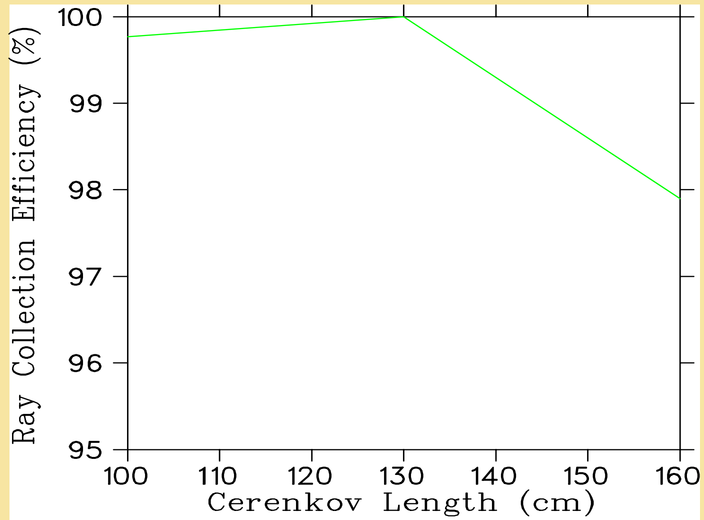
- Optimal mirror radius ~155 cm.
  - Radiator path varies ~90-130 cm over focal plane (negligible local inefficiency).
- Yet to find a configuration with ray collection efficiencies and PMT spot sizes as good as best for Length=100,130 cm.
  - Might be because optical rays have greater divergence in a longer detector and so are difficult to focus efficiently onto 5” PMTs.



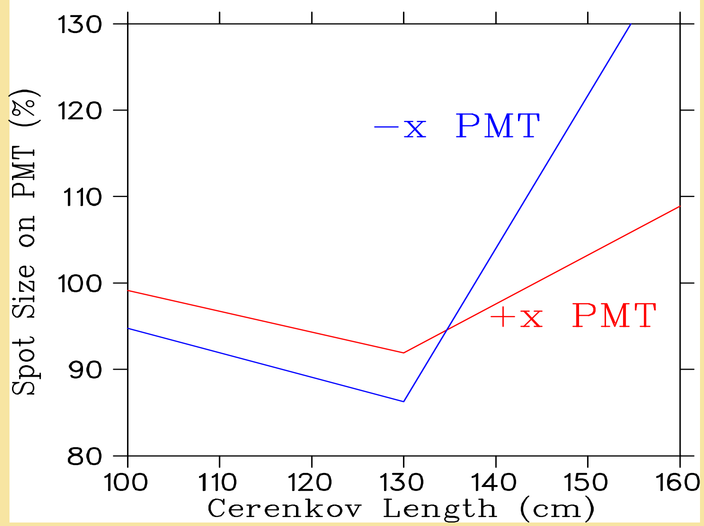


Preliminary Optical Ray Trace Conclusions

- Detector length >100 cm appears to allow better light collection characteristics.
- Greater length also reduces local inefficiency at x=0 to <0.1%.
- Further study needed to identify the optimal configuration, but it seems unlikely that the detector needs to be longer than 130 cm.



Larger # is better

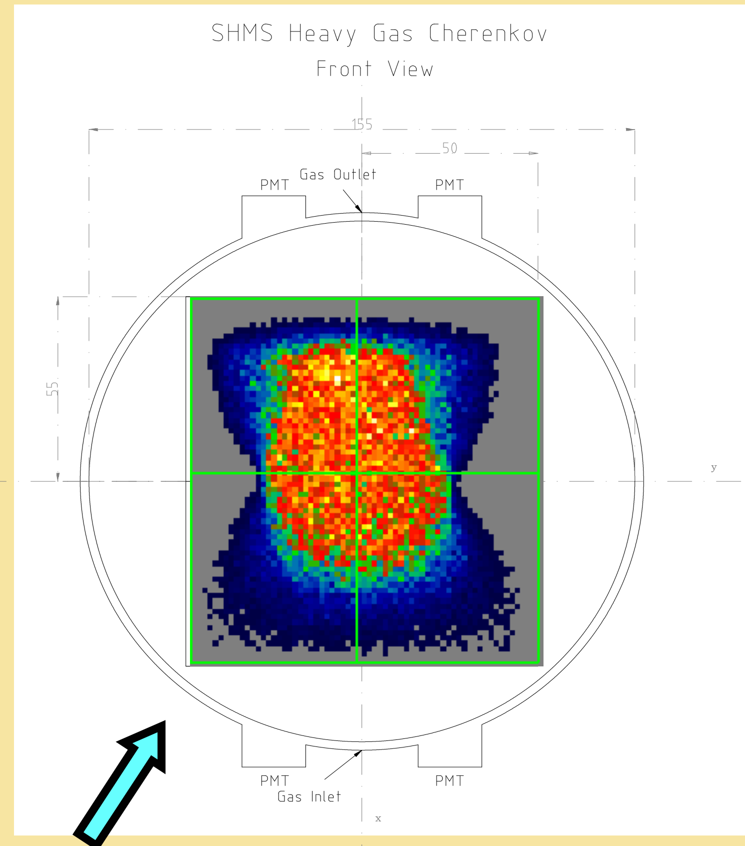


Smaller # is better

Mechanical implications

- These studies imply an adjustment to the vacuum vessel design.
  - Smaller mirror radius

    → PMTs must be closer to mirrors.
- Requires one of:
  1. PMTs outside a **non-cylindrical** (i.e. box-like) enclosure.
  2. PMTs inside cylindrical enclosure with **radius ~200 cm**.
  3. PMTs outside but "straddling" boundary of 155cm cylindrical enclosure.
- Optical ray trace studies have not taken mechanical considerations into account.



Cylindrical vessel minimum inner diameter =155 cm.