LIDAR use for IACT (CTA/HESS)

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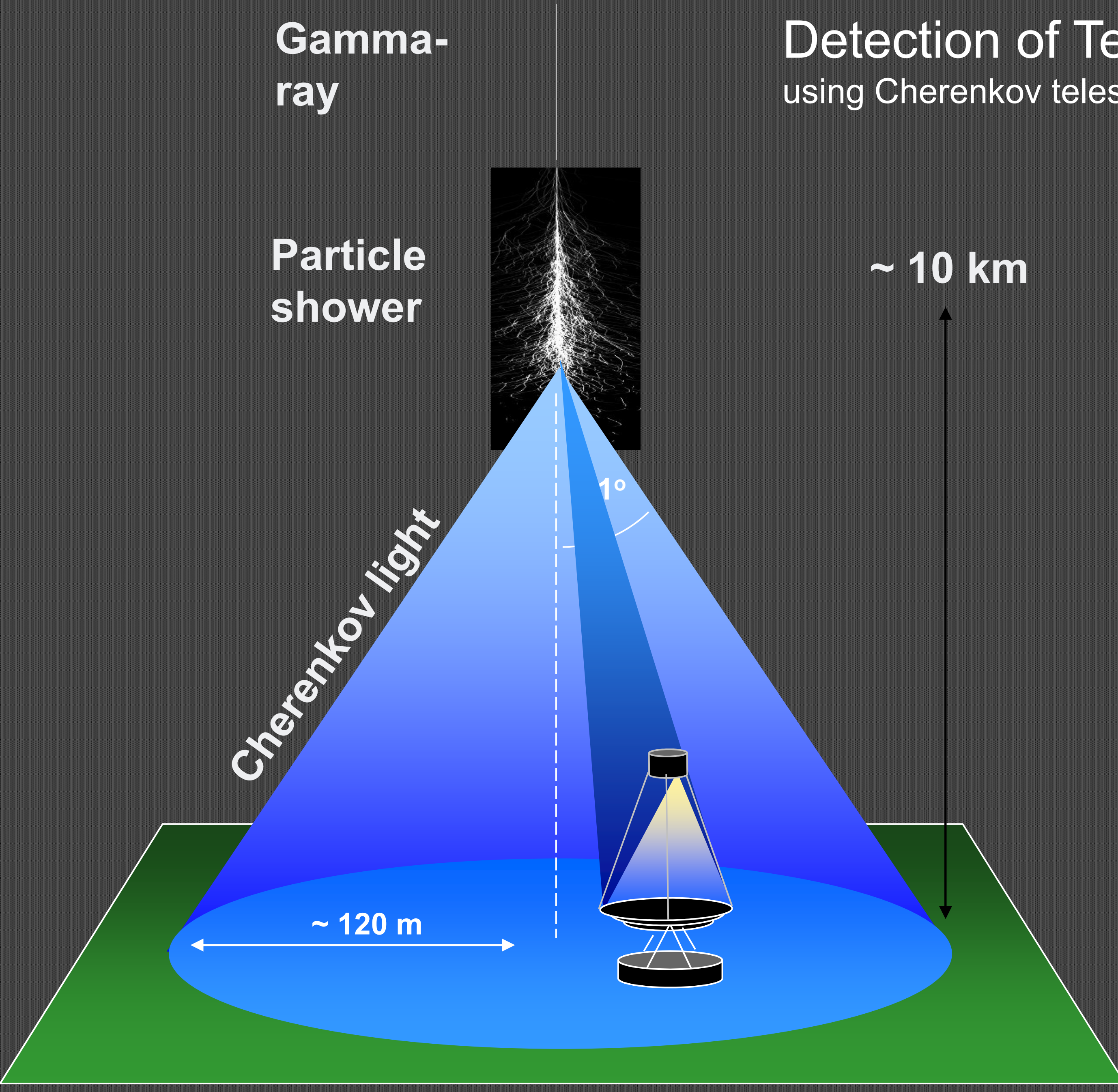
- ImagingAtmosphericCherenkovTechique?!
- Use of Lidars for IACT
- LPTA HESS Lidar
- Towards a more adapted solution

Detection of TeV gamma rays

using Cherenkov telescopes



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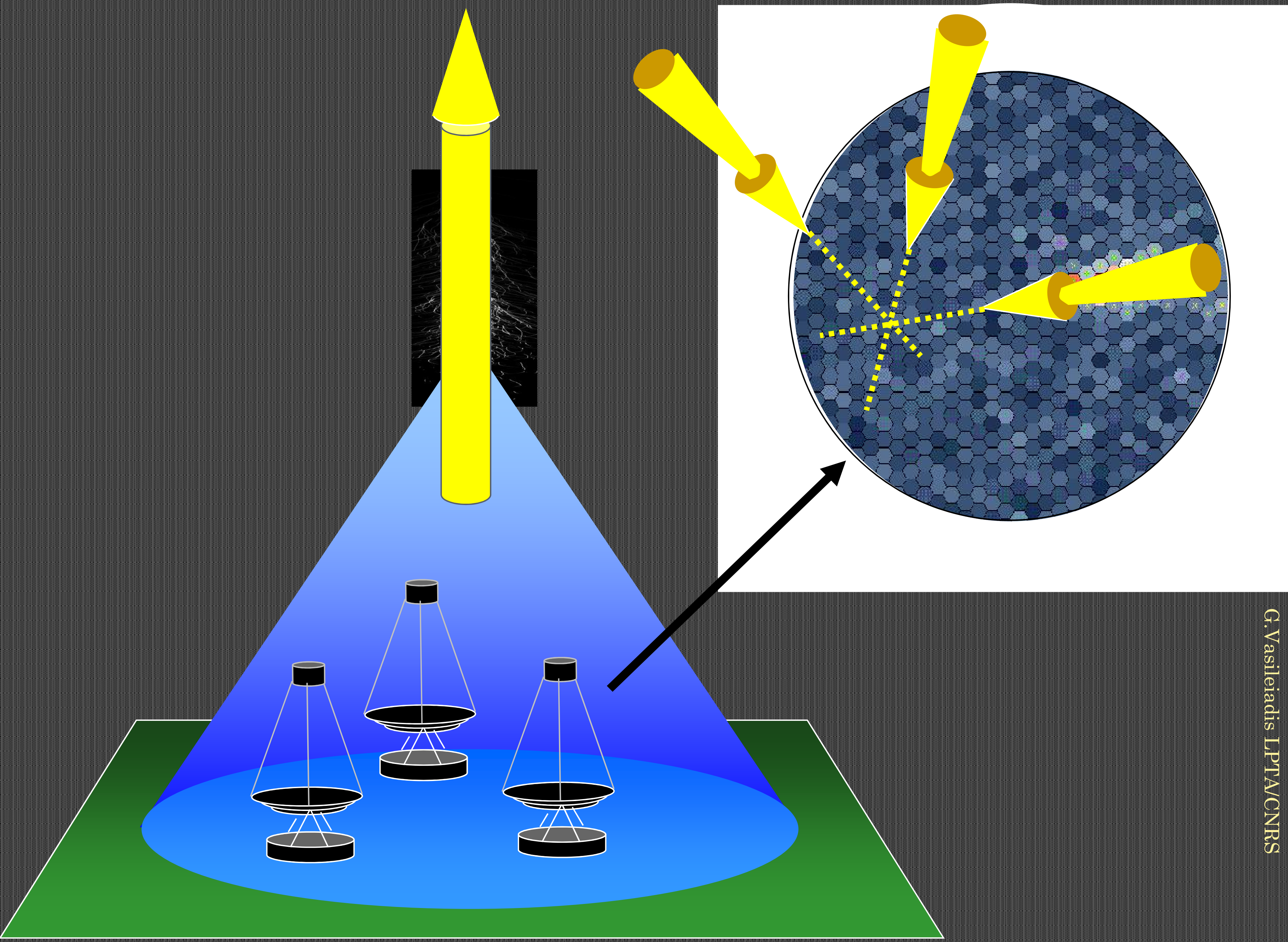

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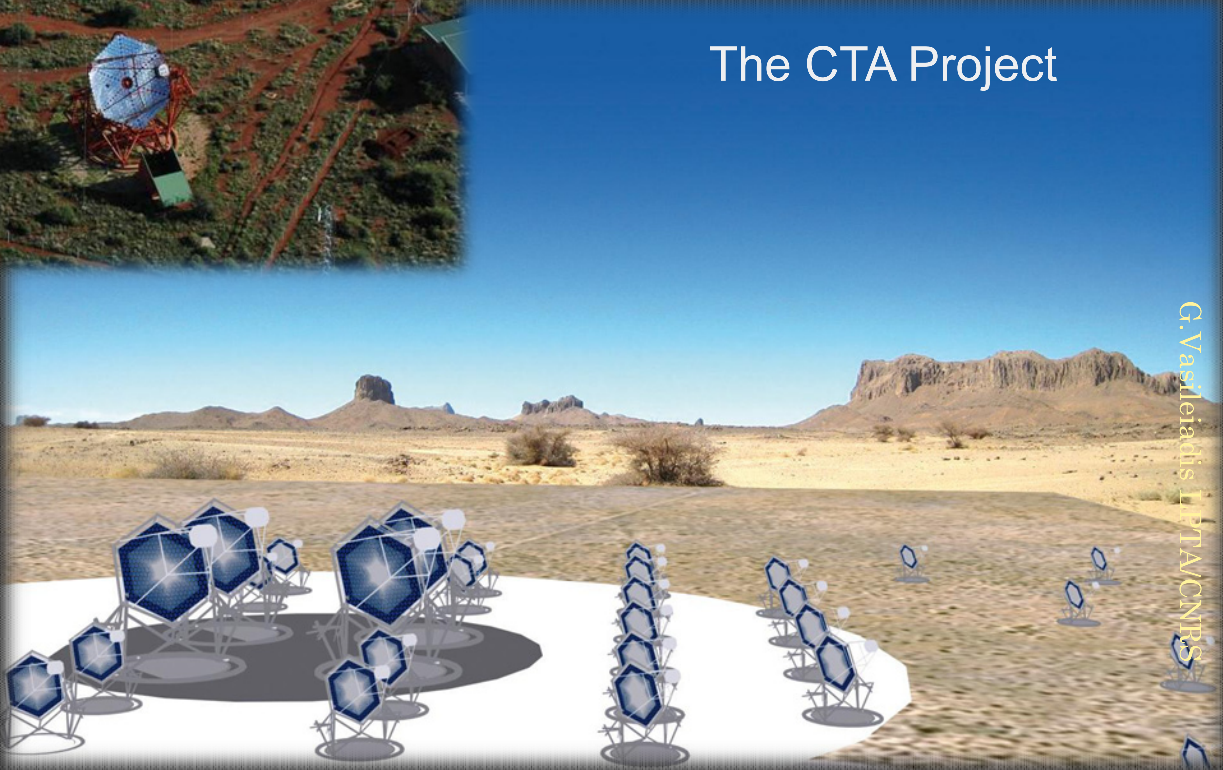

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WHY LIDARS AND FOR WHAT USE !

- **Cherenkov showers develops in the atmosphere**
- **Photon absorption critical**
  - Aerosols
  - Clouds
  - Dust
  - …
- **Atmospheric profile need (function of absorption coeff α) to be known.**
  - Input to MC studies
  - Effective Area calculations
  - Energy Spectrum & Detected Source Photon Yield
    - *see also S.Nolan's & C.Rulten talks*

So from a LIDAR point of view we need this α

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First Approach

Elastic Type LIDAR

(Leosphere,LPTA –Lidar at the HESS site)

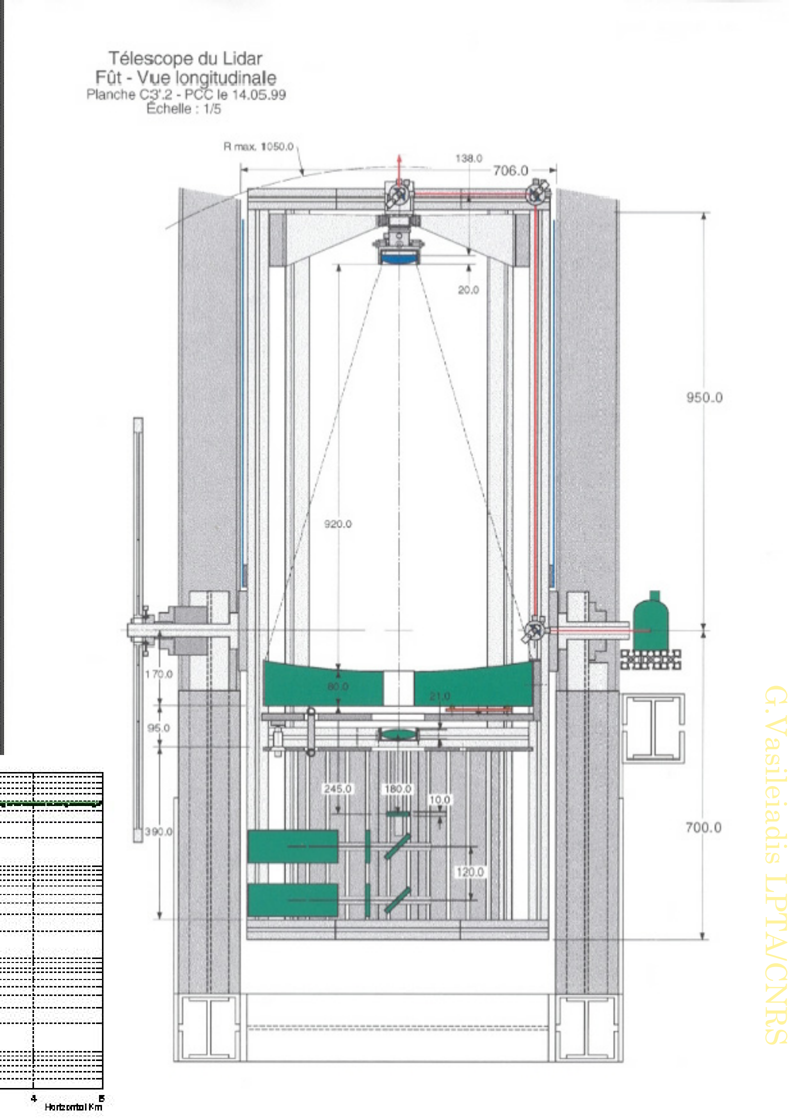
- **Pros**
  - Double WL (532&355nm)
    - Covers better detected Cherenkov photon spectrum
  - Easier to construct
  - Comfortable Photon Yield
  - Easier to Operate.
- **and Cons**
  - Parameters (α,β) more difficult to extract
  - Big systematic error (~15-20%)
  - No information available after Clouds & Aerosols

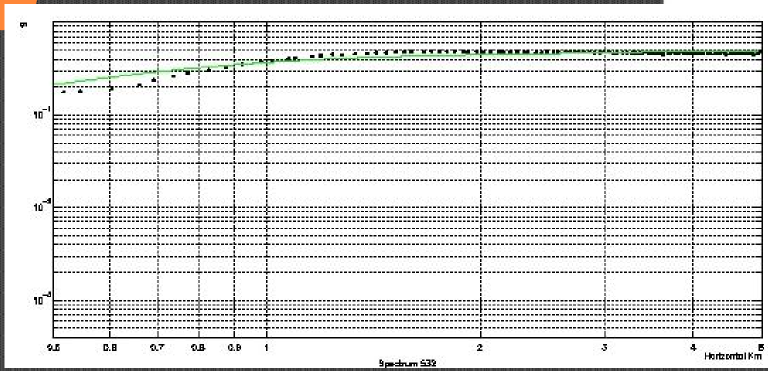
$$P(R) = \frac{E_0 \eta_L}{R^2} O(R) \beta(R) \exp\left[-2\int_0^R \alpha(r)\,\mathrm{d}r\right]$$

LPTA LIDAR AT HESS-I

In a nutshell :

- **Double WL (355,532 nm)**
- **Overlap at 800m-1km**
- **CG Type Telescope**
  - 60cm Ó, f=102cm
- **Quantel Brilliant 20 Nd:YAG**
  - 10Hz
  - 180mJ (65mJ)
  - 2.5m resolution
  - Octopus CAGE 8265
- **PMTs Readout (XP2012B)**
- **Linux/LabView SW**





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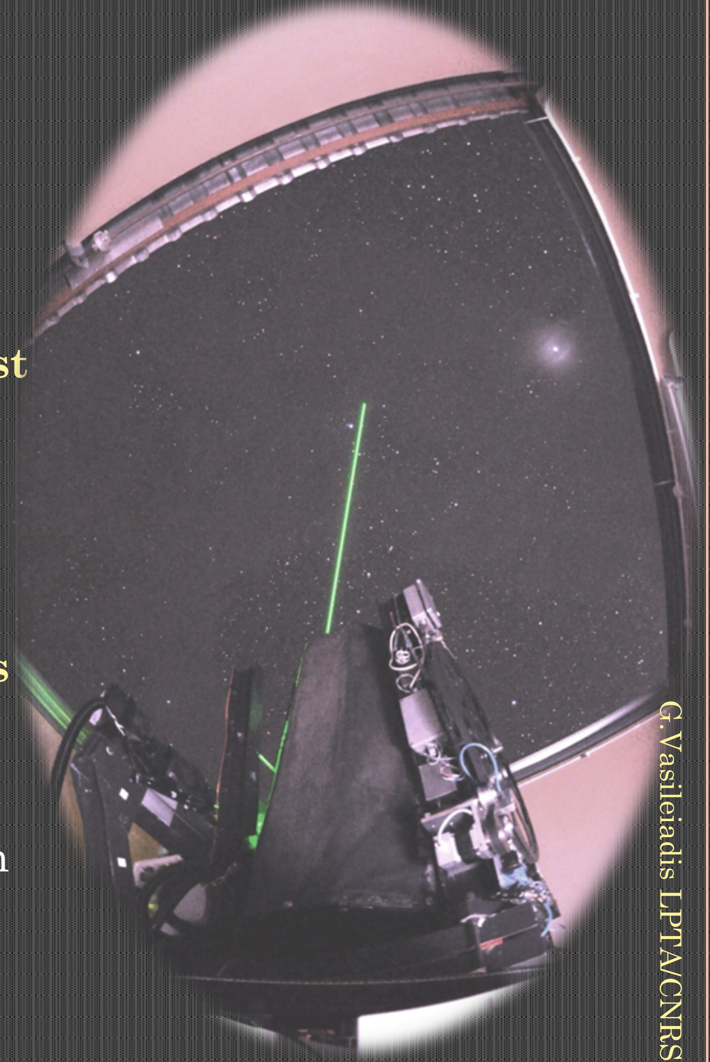
LPTA LIDAR AT HESS-II

In a nutshell :

- Double WL
- CG Type Telescope
- Useful Range 1-20 km
- Completely Automated
- Remote Operated from FR
- Operational (..or so..) for the last 2y on site.
- Simultaneous LIDAR&Physics data available.
- Data available via Web (Hess)
- First analysis shows limitations
- Mechanical and other issues
    - Namibian weather conditions
    - Not really conceived for harsh enviroment
    - Still one of the few currently working Cherenkov Lidars.



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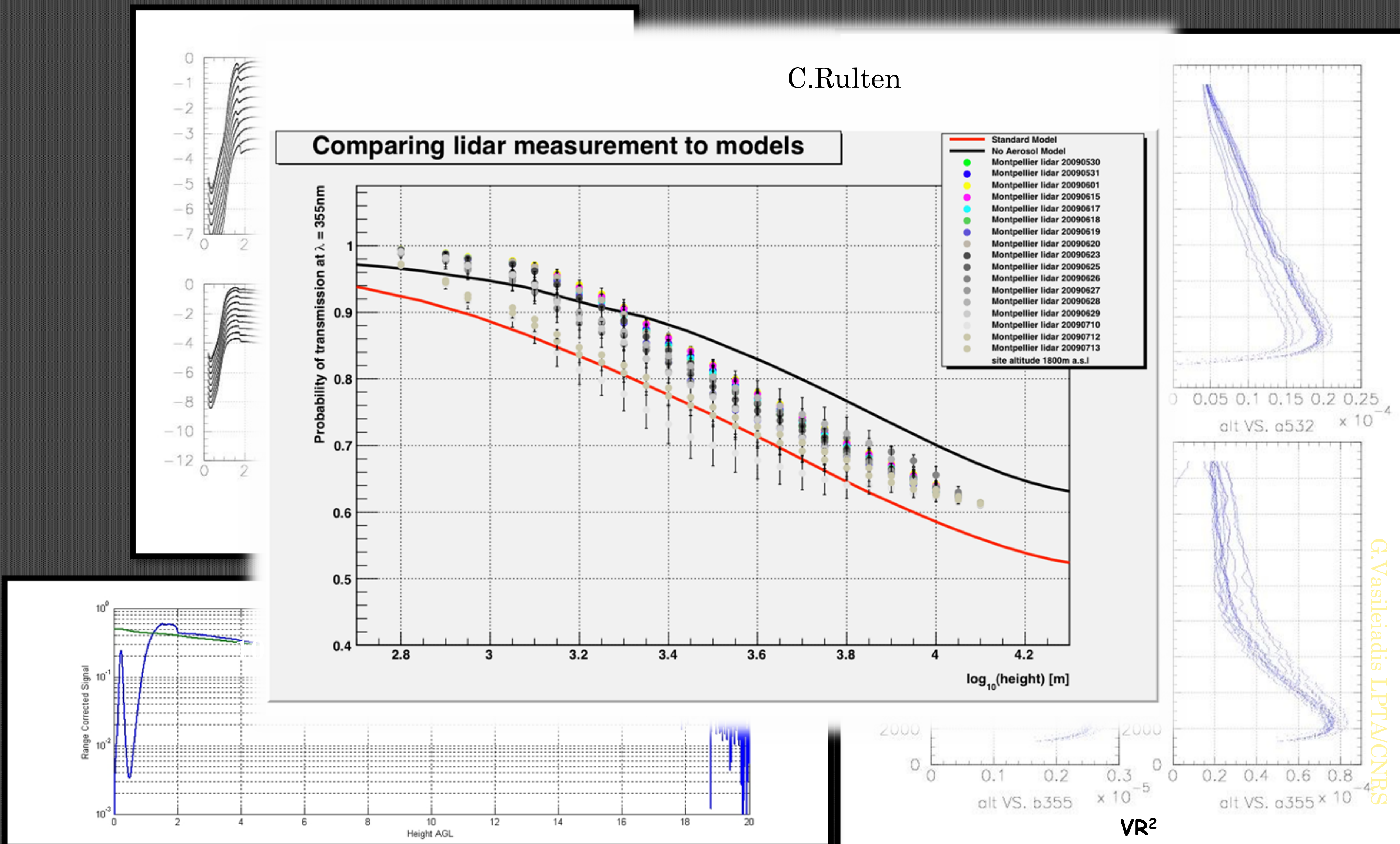
ACTUAL DATA ANALYSIS SAMPLE

Raw Data



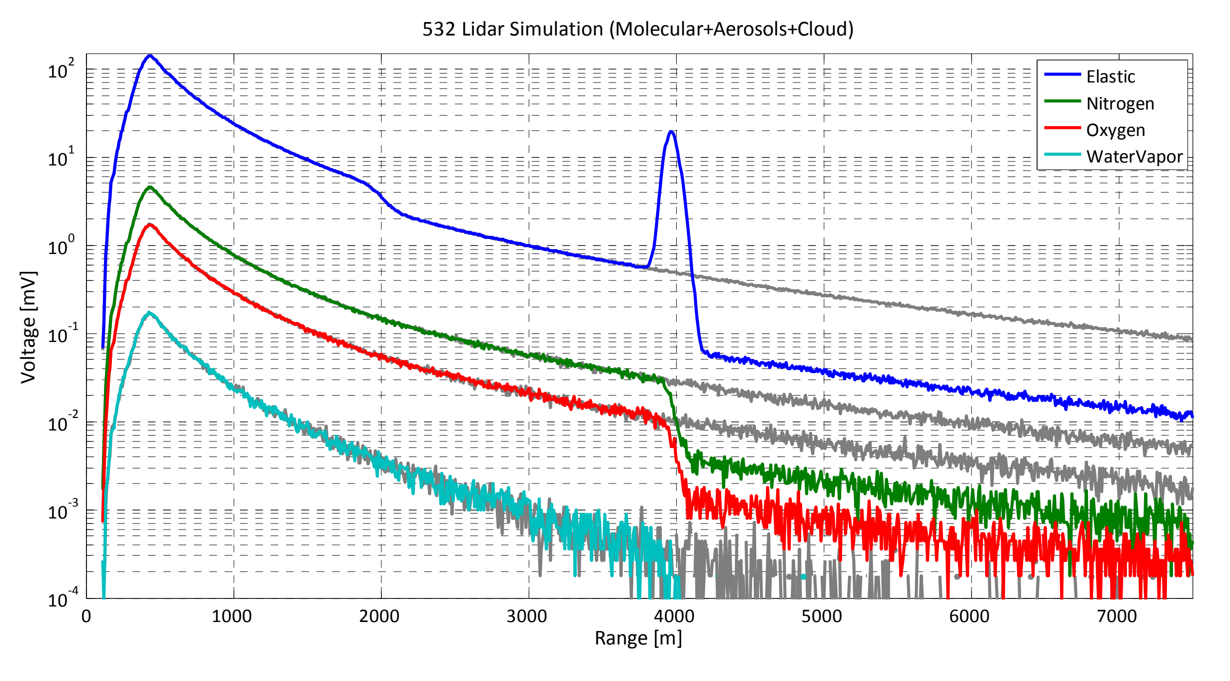
Simulated data (provided by P.Ristori in green overlapping

So what's next ?

As a results of divers discussions but mainly as an outcome of the 1st workshop in Prague we have orient ourselves on developing a RAMAN Lidar.

Benefits :

- Direct establishment of α.



Another IACT peculiarity : ***We need to obtain a reasonable Raman spectrum within 120sec.***

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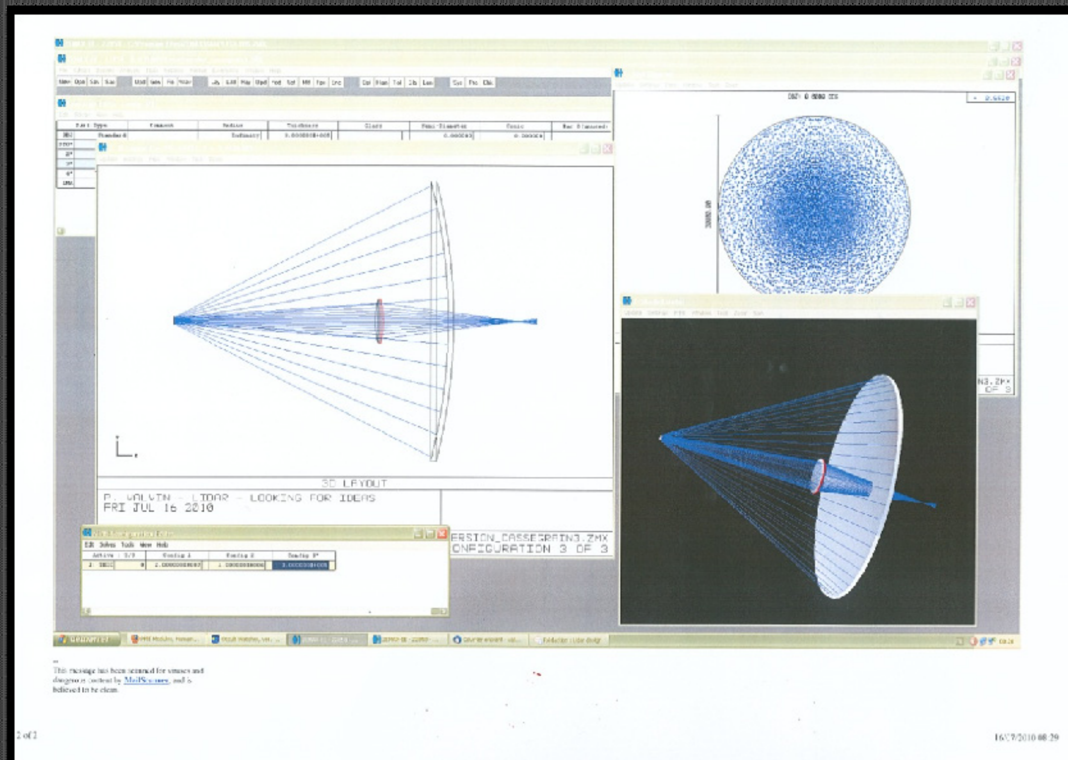
Optical Simulation studies

Based on the CLUE mirror specs :

- **Diameter 1.8m/f1**
- **Simulate performance**
- **Compare Cassegrain vs Optical fiber readout**
- **Optimize performance and Photon Detection**
- **Zemax Optical SW tool.**



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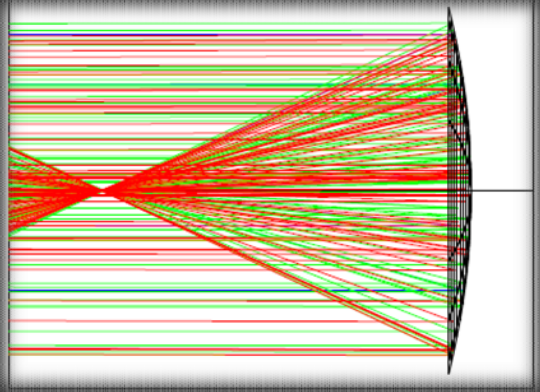
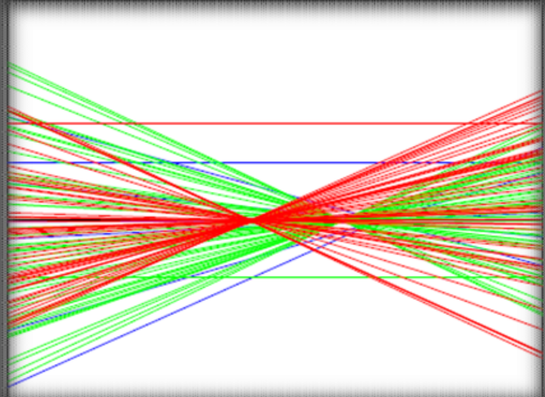
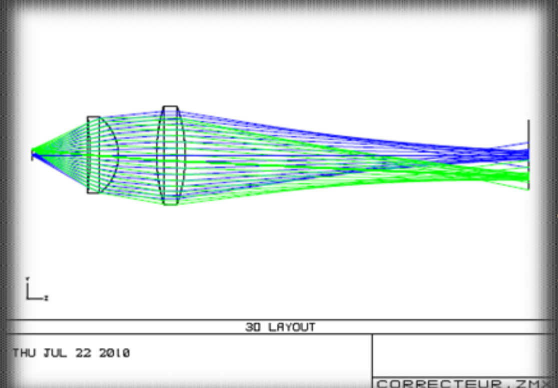
Option one

Fiber Newton Approach

- Altitude range 300-20000m
- Liquid Fiber 6mm Ø f/1
- Qe ~15%
- Collimation using 2-lens system
- Numerical Output 0.6
- Difficult to collimate for both Altitude extremes
- Still duable
- More analysis ongoing







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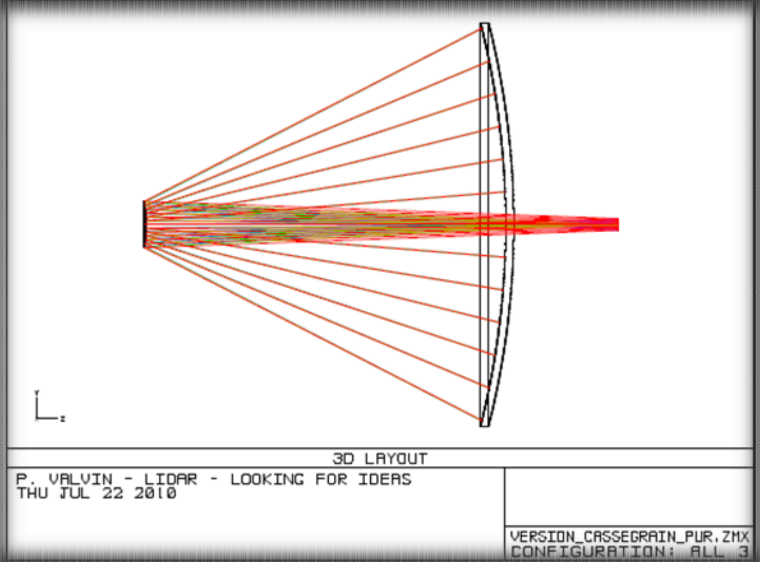
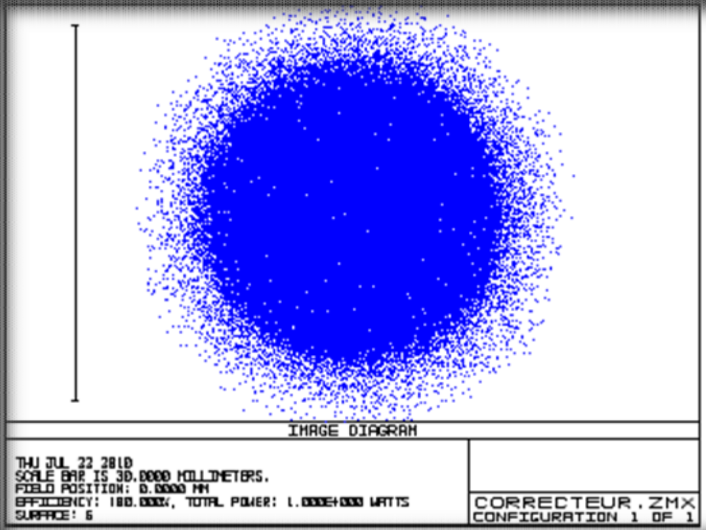
Option two

Cassegrain

- **Secondary Optics**
  - Parabolic 20-25cm Ǿ
- **Output Trace within 50mm**
- **Duable**
- **High Qe**
- **Costly**
- **More difficult to optimise**





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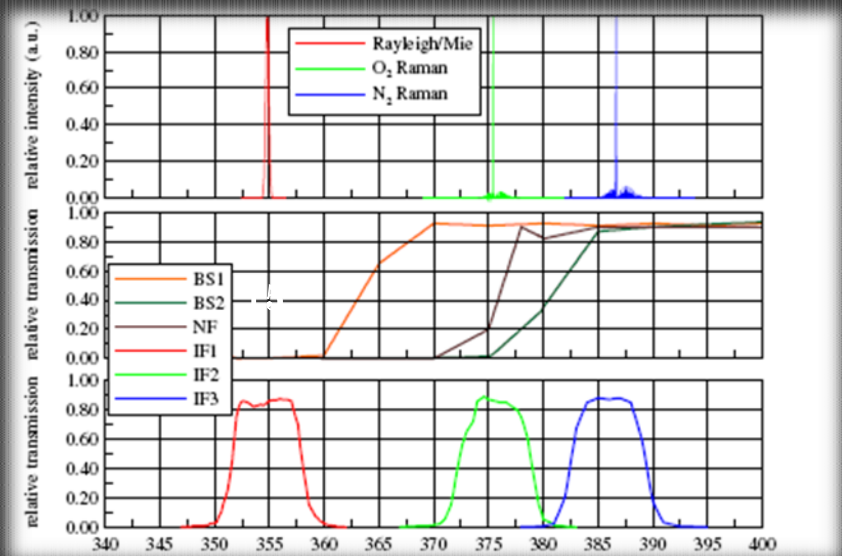
Working Bench

- Baseline CLUE Container
- LASER : Inlite II or Quantel CFR200 Mil spec.
- Register O_2&N_2 Raman Lines
- Barr Co. Raman optical Bench
- LICEL
- Photomultiplier R/O
- ACS Control SW
- *See also Alicia's talk tomorrow for another approach*



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Conclusions

After some years of experimenting we concluded that we have to opt for a Raman LIDAR capable of extracting the absorption coefficient α within a 2' run.

Three groups actually are pursuing this path and we eagerly wait (~2011) the outcome.