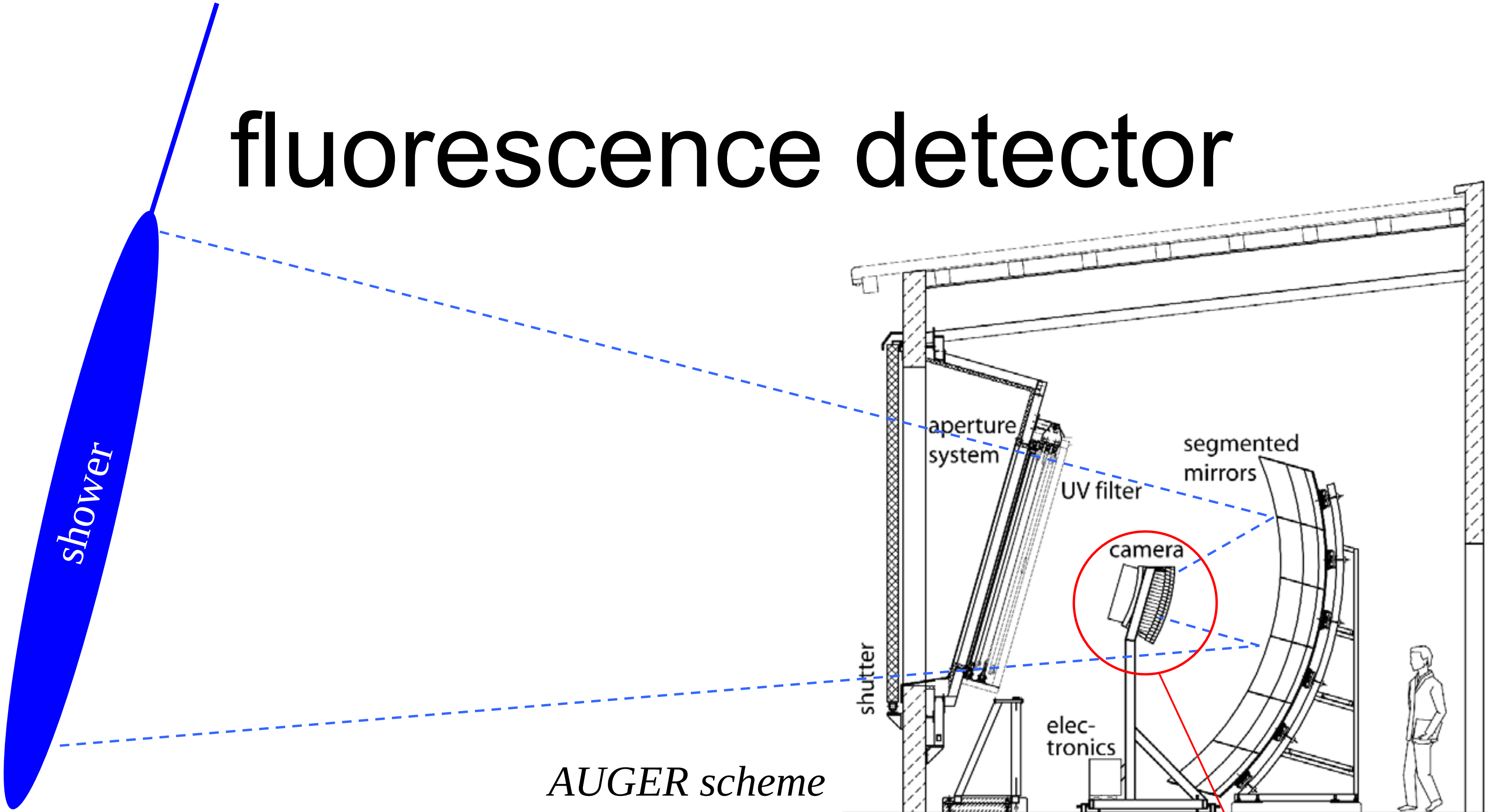
Anagrafica 2013

Progetto: NIRFE (Near InfraRed Fluorescence Eye)

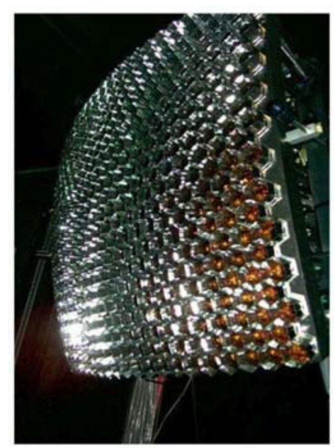
Responsabile Nazionale:	Enrico Conti - *INFN Padova*
Durata:	3 anni
Responsabile Locale:	Sergio Fonti – *Dip. Fisica*

1.	De Tomasi Ferdinando	Associato	Ricercatore	40 %
2.	Fonti Sergio	Associato	Prof. Associato	40 %
3.	Perrone Alessio	Associato	Prof. Ordinario	20 %

fluorescence detector



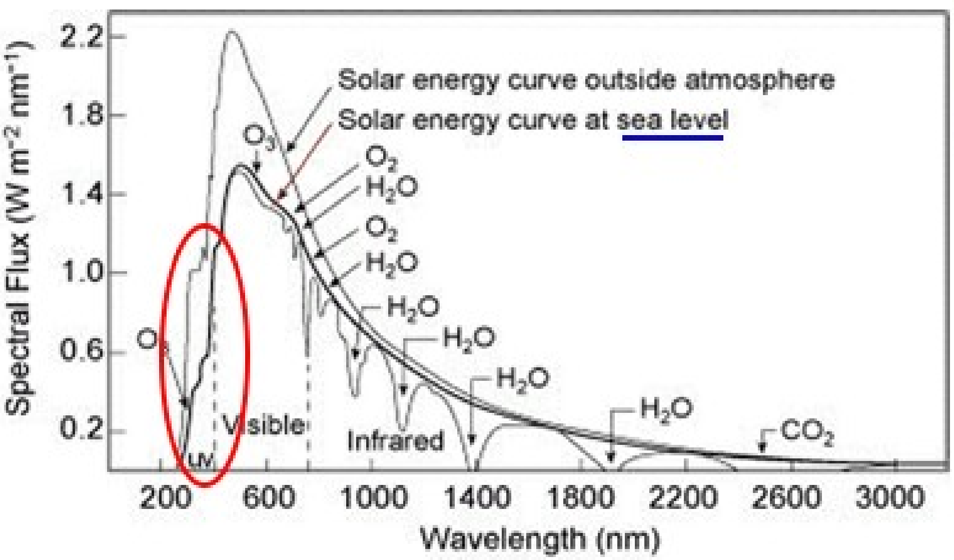
AUGER scheme

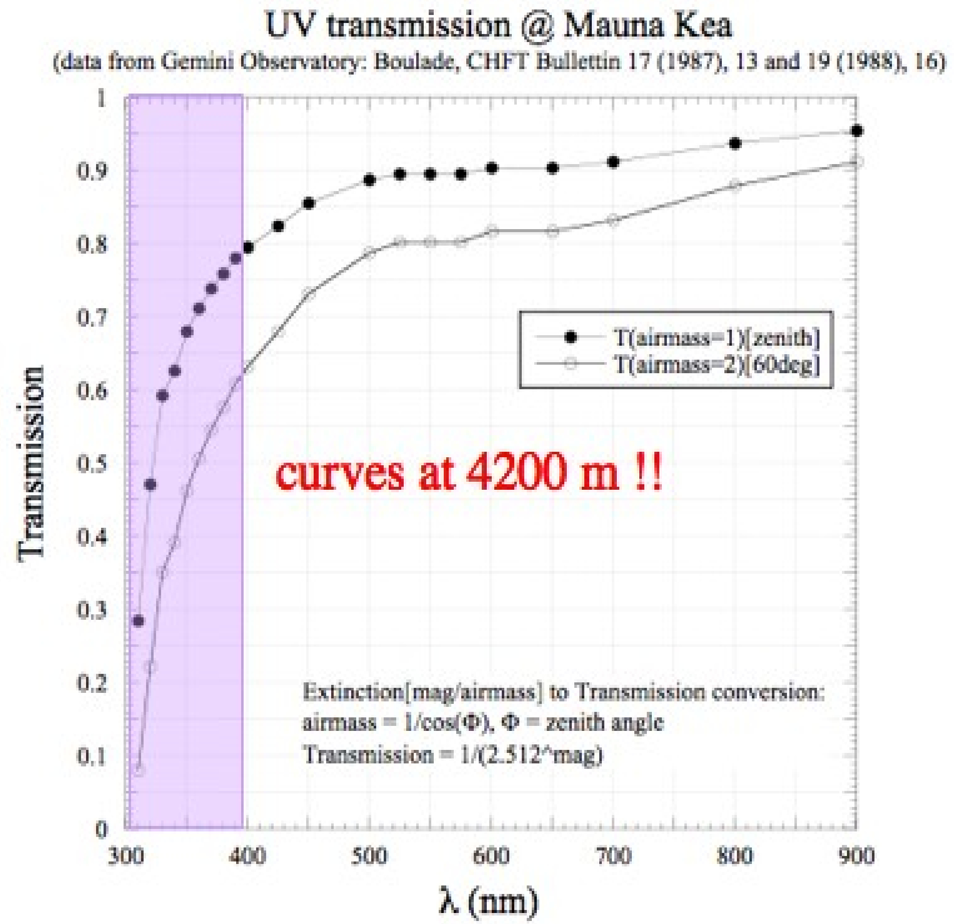


- light emitted from the shower is collected by a large mirror and focused on a light detector composed by PMTs

UV transmission in atmosphere

- UV light suffers from the problem of air transmission:
  - ➔ O_3 absorption
  - ➔ Rayleigh scattering ($\propto 1/\lambda^4$)
  - ➔ Mie scattering (scattering on aerosol particles)





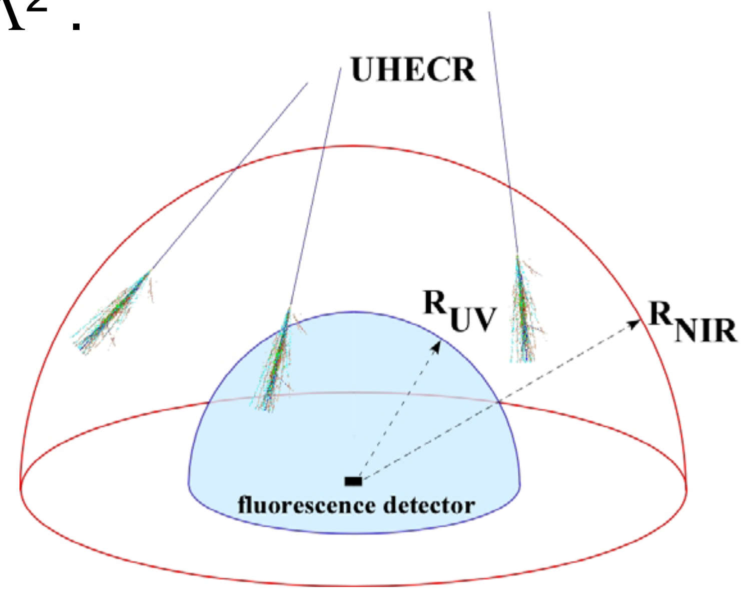
goal: increase event rate

- Introducing an extinction length $\Lambda(\lambda)$

  $$I(x) = I(0)\, exp(-x/\Lambda)$$

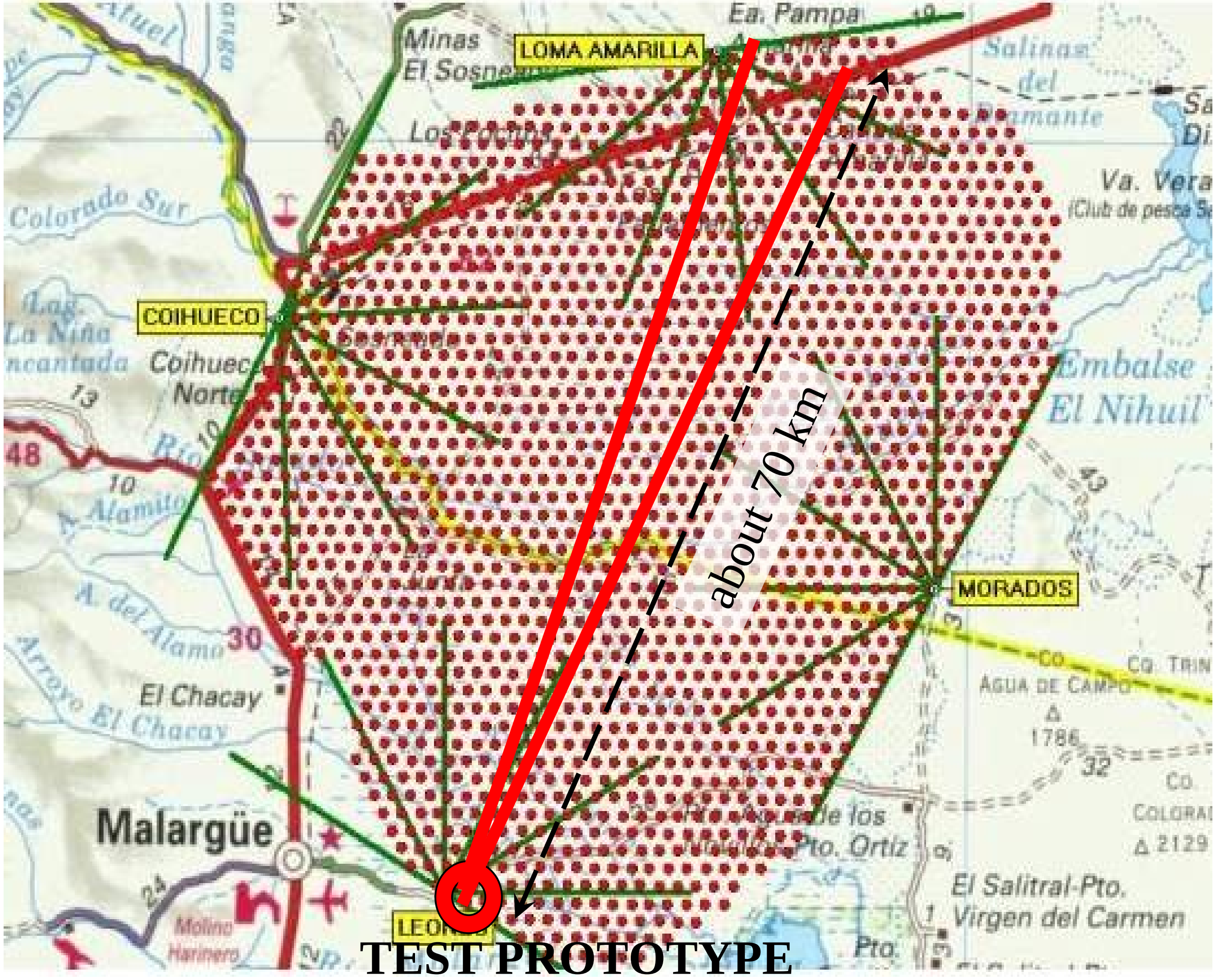
  the absorption of the air reflects into a short Λ. For UV, $\Lambda \sim 10$ km.
- This has implications on the observable event rate, which goes approximately as Λ^2 .

$$\textit{Maximum useful range } R \propto \Lambda$$



The ultimate goal of the NIR fluorescence is to increase a lot the observable event rate.

just for example



NIR light yield

For the absolute light yield we need Y_{UV}. We take the (weighted) average of all measurements so far in the range *300-400 nm*, obtaining

$$Y_{UV} = 19.88 \pm 0.51 \; ph/MeV$$

Unfortunately

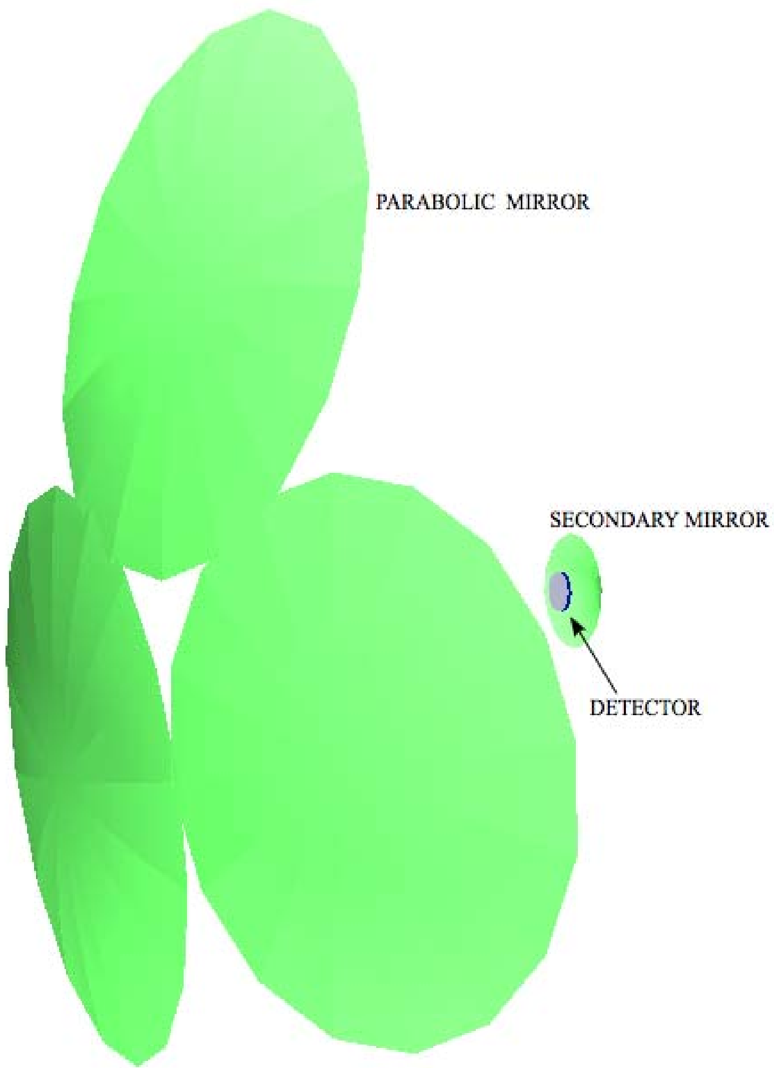
$$\mathbf{Y_{IR} = 4.17 \pm 0.53} \; \textit{\textbf{photons/MeV}}$$

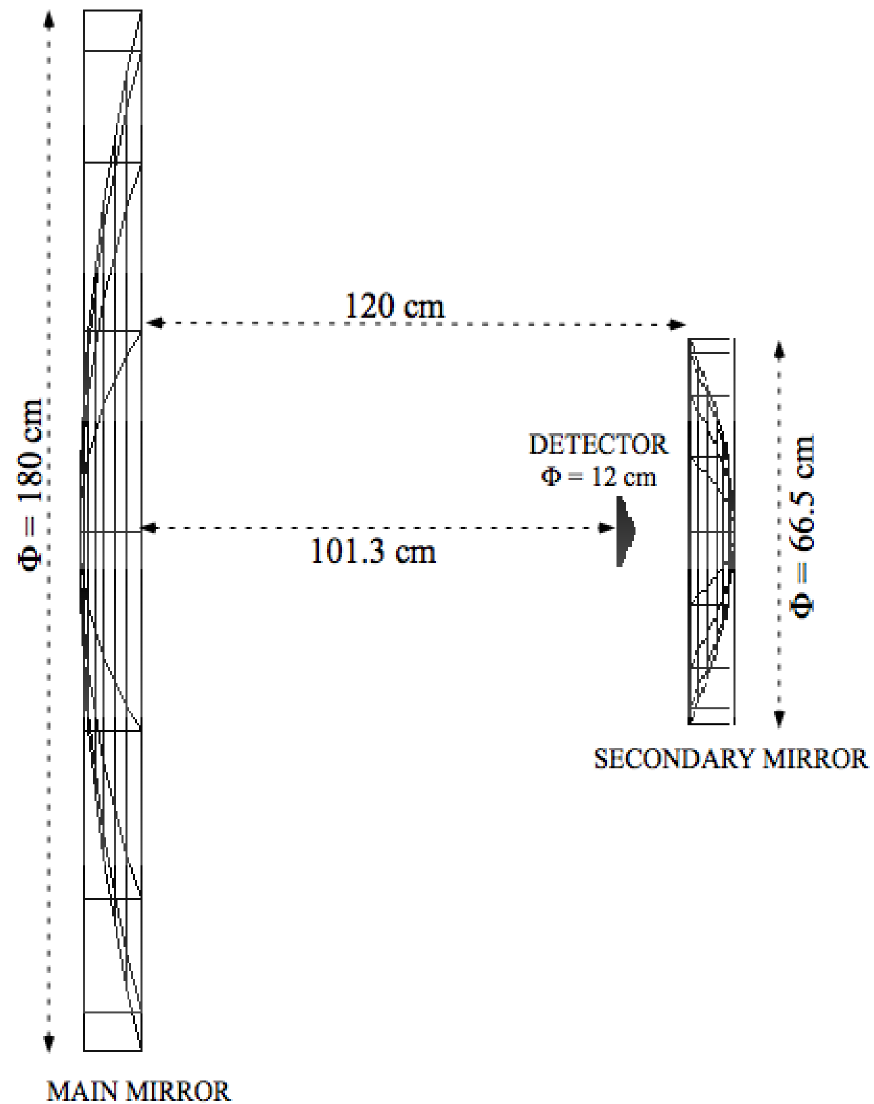
$$\frac{Y_{IR}}{Y_{UV}} = 0.21 \pm 0.03$$

If we limit the spectrum at *1.1µm* (Si bandwidth), then the light yield is

$$\mathbf{Y_{IR} (\lambda \leq 1.1 \mu m) = 1.4} \; \textit{\textbf{photons/MeV}}$$

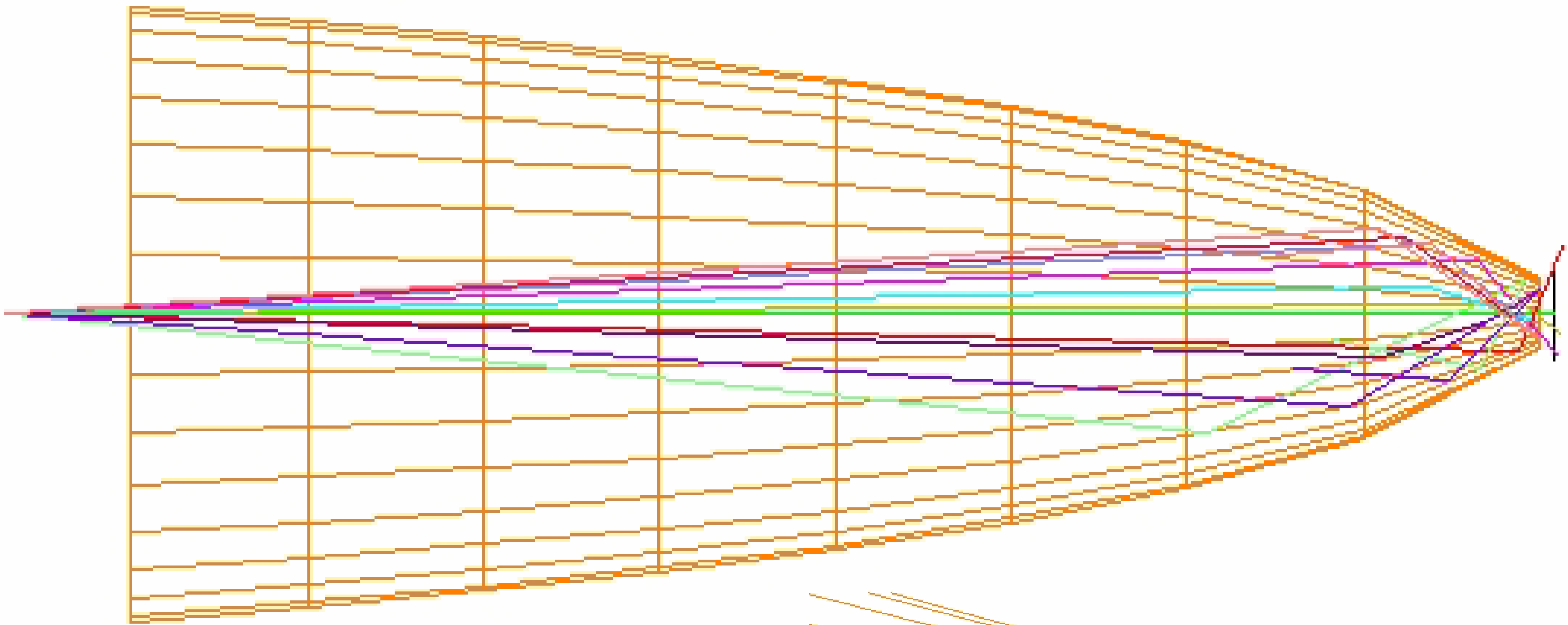
OPTICAL ARRANGEMENT

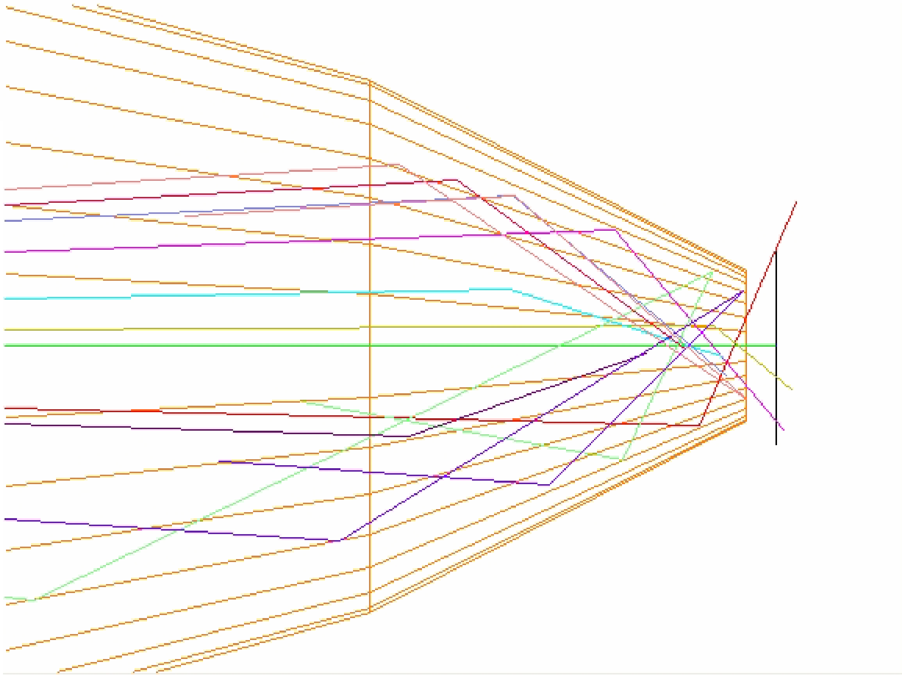




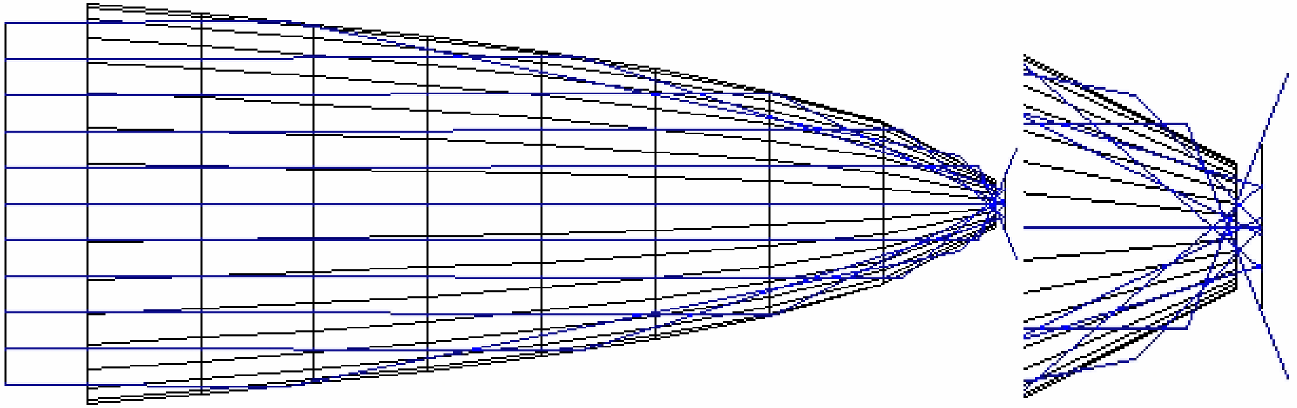
DETECTORS

- The detectors with the highest QE (>80%) are the InGaAs, semiconductors, which can extend down to 2.6 μm. But:
  - small area (< 1 cm^2);
  - no multiplication;
  - need low noise electronics.
- Avalanche InGaAs exist, Gain ~ 10^2, diameter ≤ 200μm.
- Photomultiplier: Hamamatsu produce PMTs with QE ~ 1% till 1.6 μm.
  Gain ~ 10^4-10^6, but small sensitive area and need LN_2.
- Si extends to 1.1μm because of the 1.1eV bandgap. After it becomes transparent.
  Si APD, gain ~10^4, area ≥ 1 cm^2. Decent QE @ 1000-1100 nm.
- R&D in progress with different techniques to extend QE and/or increase QE @ 1.1μm (for example, “Black silicon” by SiOnyx)

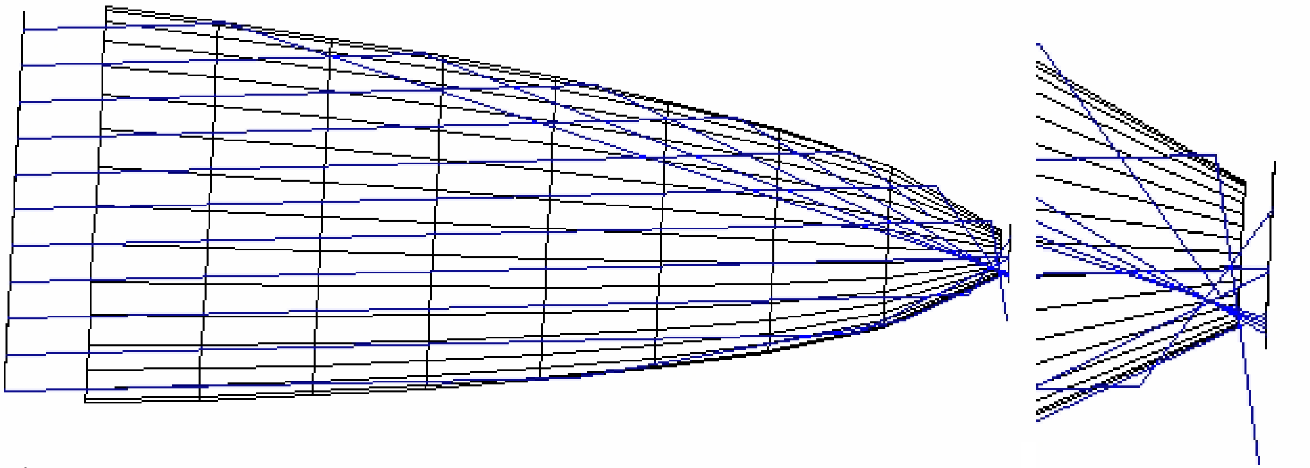




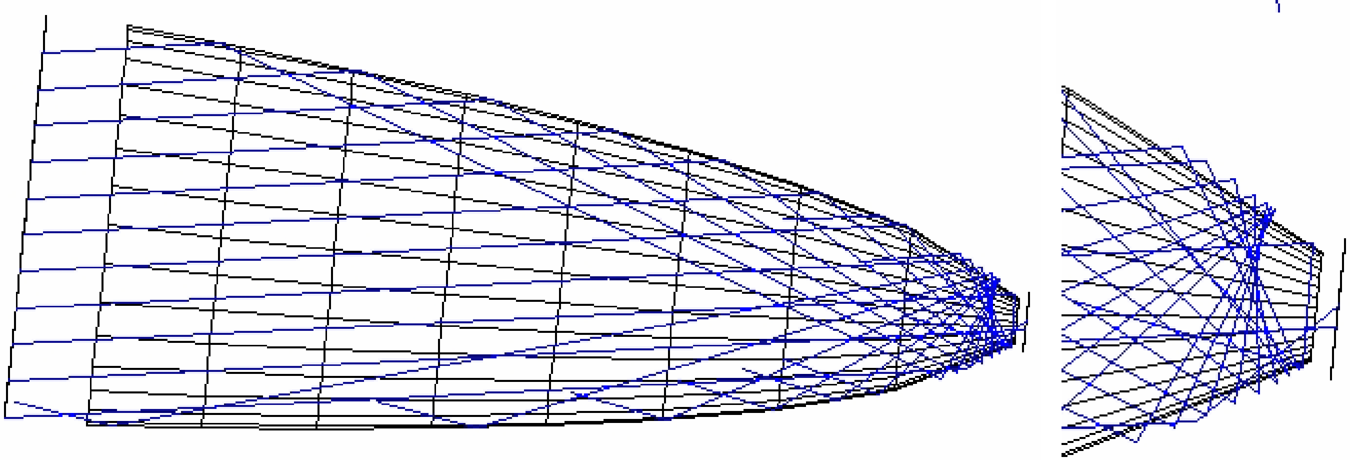
Possible solution (Sergio Fonti): using CPC (Compound Parabolic Concentrators)



$i = 0°$

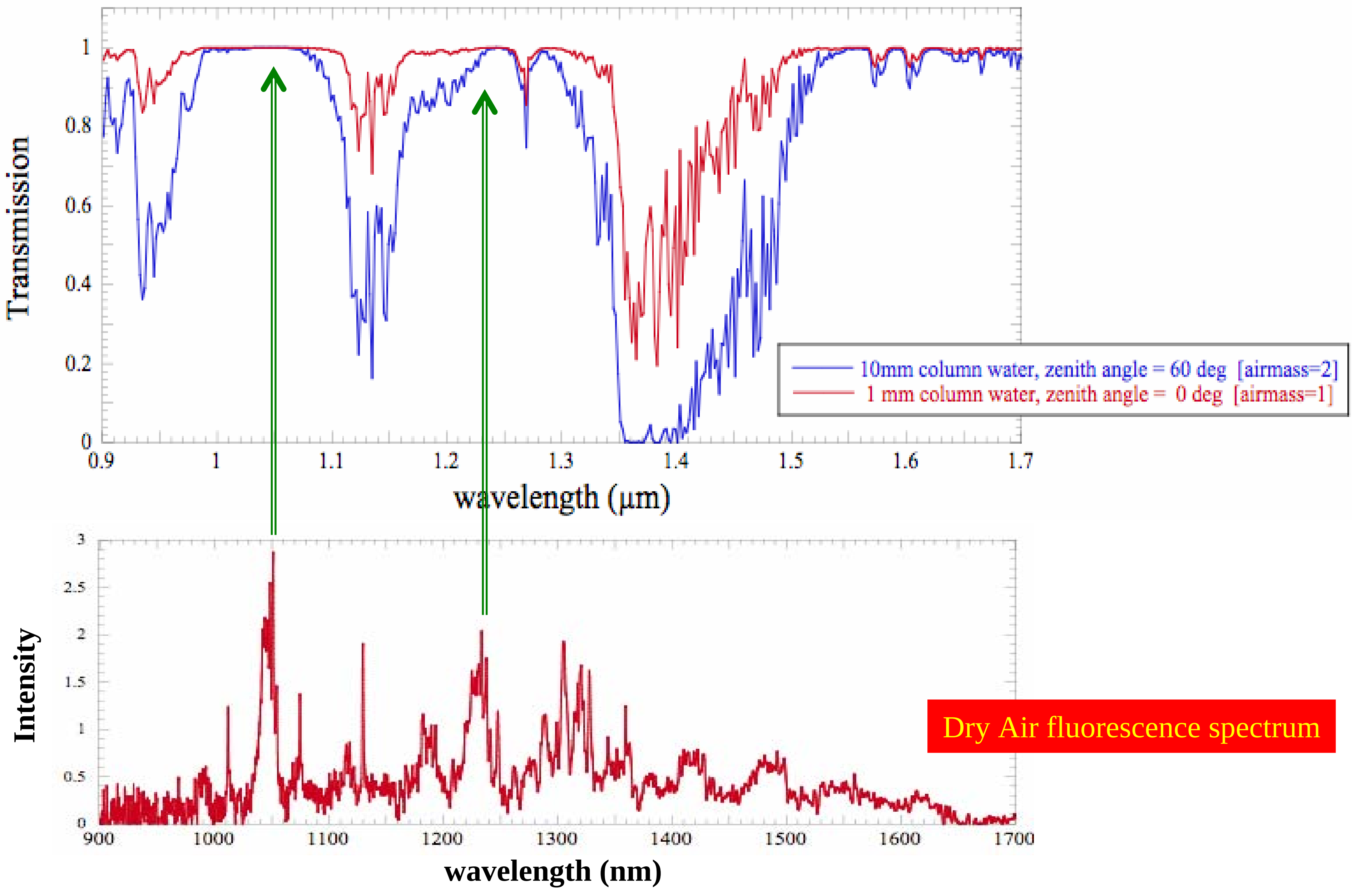


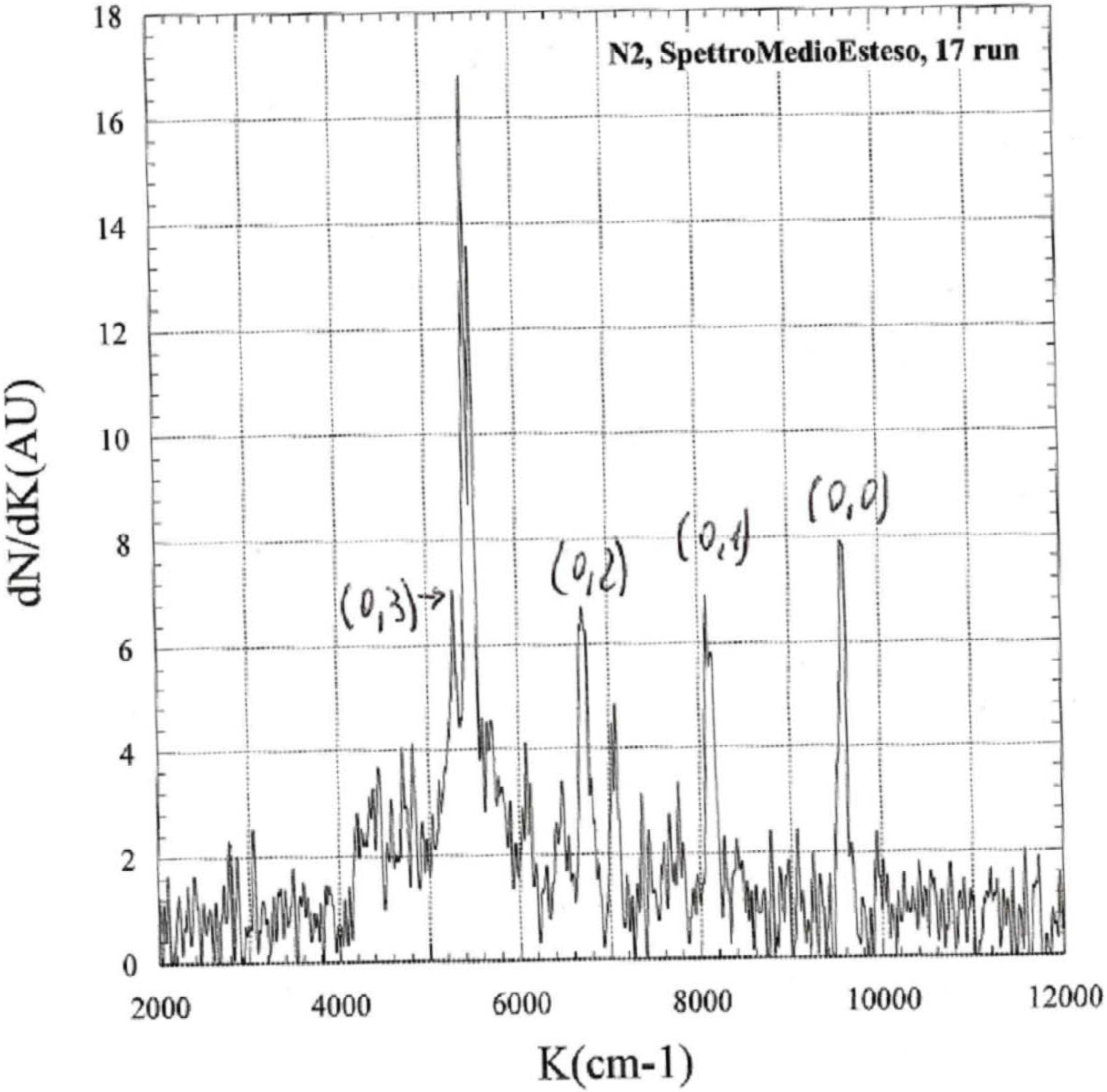
$i = 3°$



$i = 6°$

Atmosphere transmission and fluorescence





Lecce contribution (Alessio Perrone) is an analysis of the detectable lines of the main atmospheric components

FUTURE

Realistic and detailed definition of
the whole optical design (Fonti)

Theoretical analysis (Perrone) and
observational charcterization (De
Tomasi) of the atmospherical lines
in the IR region of interest

Richieste finanziarie per il 2013 ancora da concordare
con Padova (presumibilmente simili al 2012: 8 – 10 K€)