Anagrafica 2014

Progetto: NIRFE (Near InfraRed Fluorescence Eye)

Responsabile Nazionale: Enrico Conti - *INFN Padova*

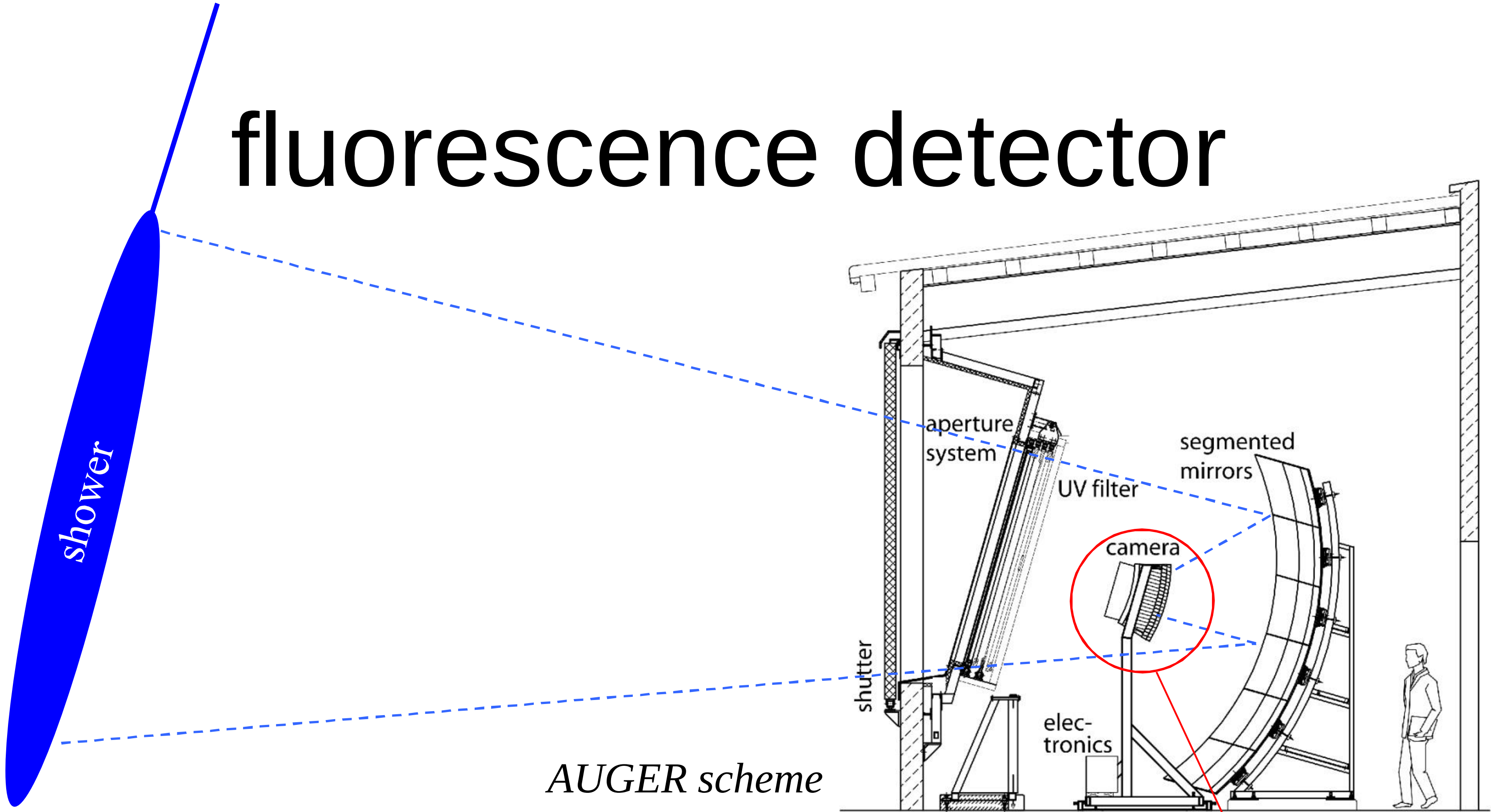
Durata: 3 anni

Responsabile Locale: Sergio Fonti ï *Unisalento*

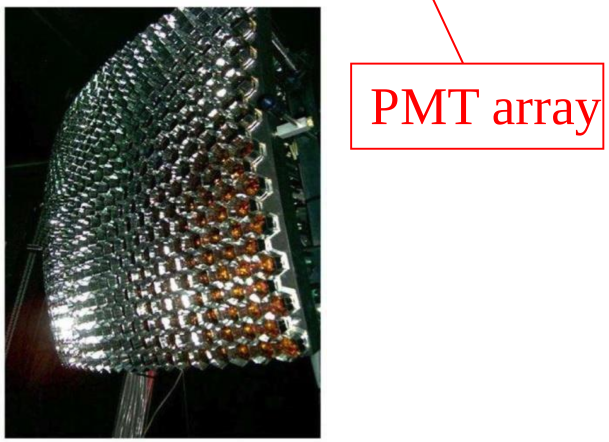
Cataldi Gabriella	INFN	Ricercatore	20 %
De Tomasi Ferdinando	Associato	Ricercatore	40 %
Fonti Sergio	Associato	Prof. Associato	40 %
Perrone Alessio	Associato	Prof. Ordinario	20 %

TEST PROTOTYPE

fluorescence detector



AUGER scheme

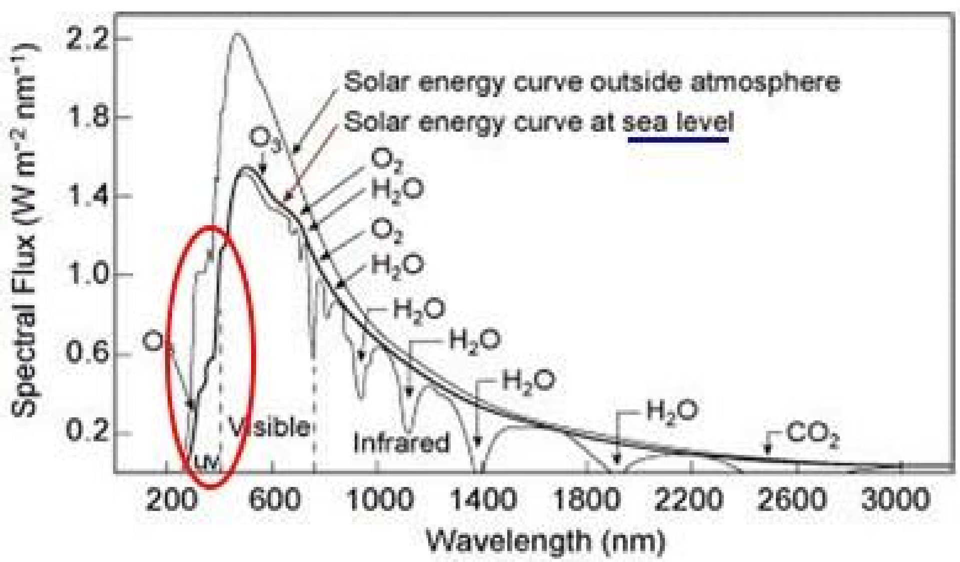


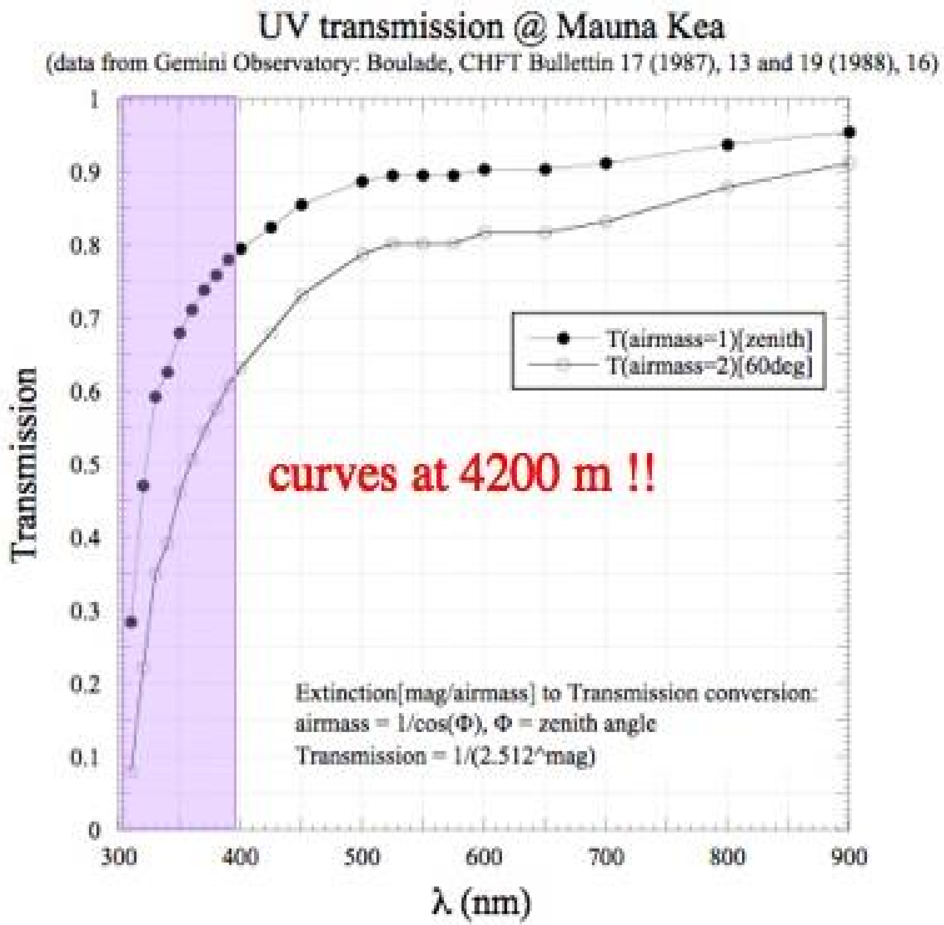
Å light emitted from the shower is collected by a large mirror and focused on a light detector composed by PMTs

UV transmission in atmosphere

Å 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

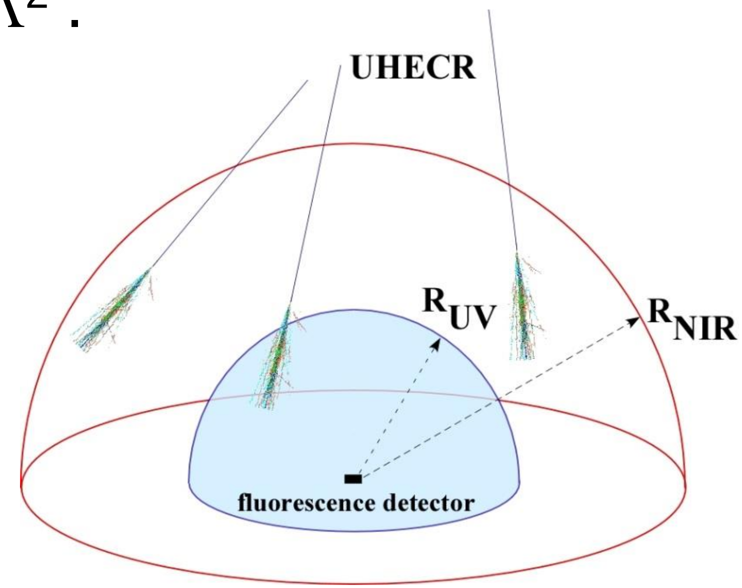
Å Introducing an extinction length $\Lambda(\lambda)$

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

the absorption of the air reflects into a short Λ. For UV, Λ ~ 10 km.

Å This has implications on the observable event rate, which goes approximately as Λ^2 .

Maximum useful range $R \propto \Lambda$



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

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

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

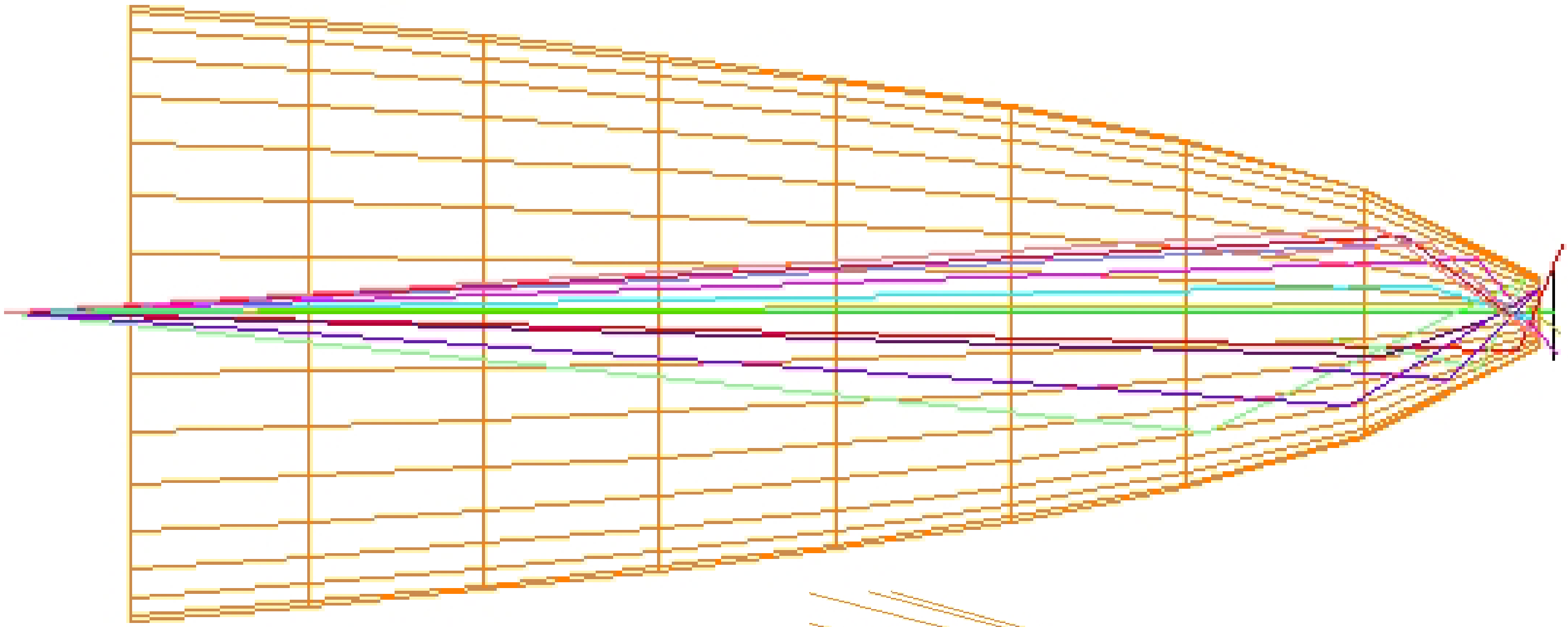
$$\frac{Y_{IR}}{Y_{UV}} = 0.21 \pm 0.03$$

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

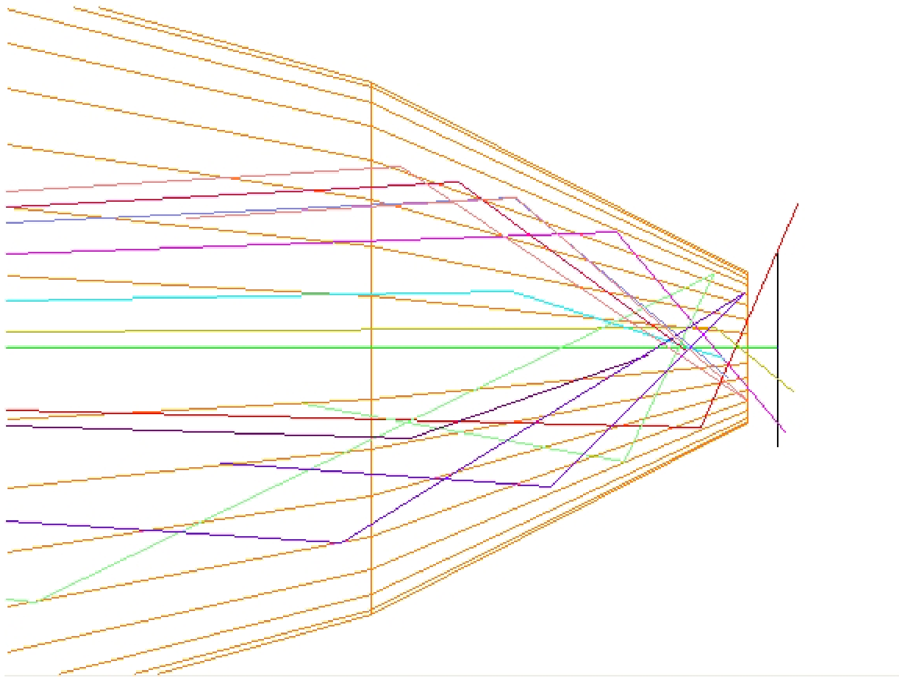
Y_{IR} (λ Ò1.1μm) = 1.4 *photons/MeV*

DETECTORS

- Å The detectors with the highest QE (>80%) are the InGaAs, semiconductors, which can extend down to 2.6 µm. But:
  - ï small area (< 1 cm^2);
  - ï no multiplication;
  - ï need low noise electronics.
- Å Avalanche InGaAs exist, Gain ~ 10^2, diameter Ò200µm.
- Å Photomultiplier: Hamamatsu produce PMTs with QE ~ 1% till 1.6 µm.
  Gain ~ 10^4-10^6, but small sensitive area and need LN_2.
- Å Si extends to 1.1µm because of the 1.1eV bandgap. After it becomes transparent.
  Si APD, gain ~10^4, area Ó 1 cm^2. Decent QE @ 1000-1100 nm.
- Å R&D in progress with different techniques to extend QE and/or increase QE @ 1.1µm (for example, ñBlack siliconò by SiOnyx)

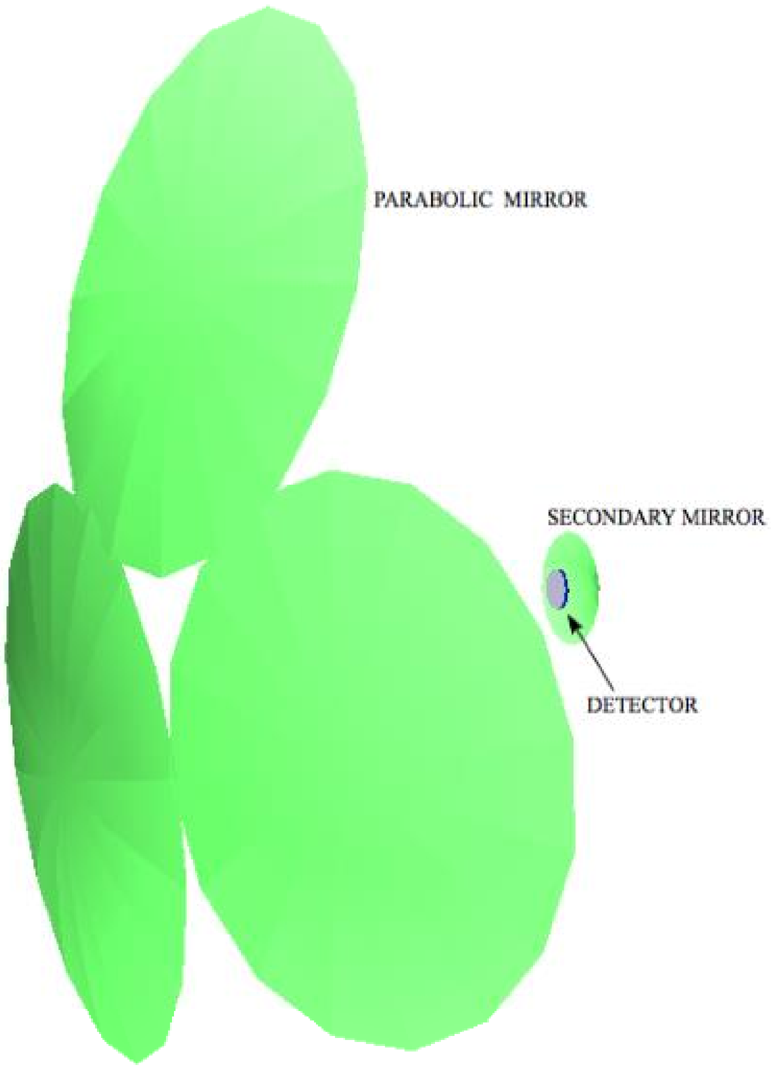


Possible solution (Sergio Fonti): using CPC (Compound Parabolic Concentrators)

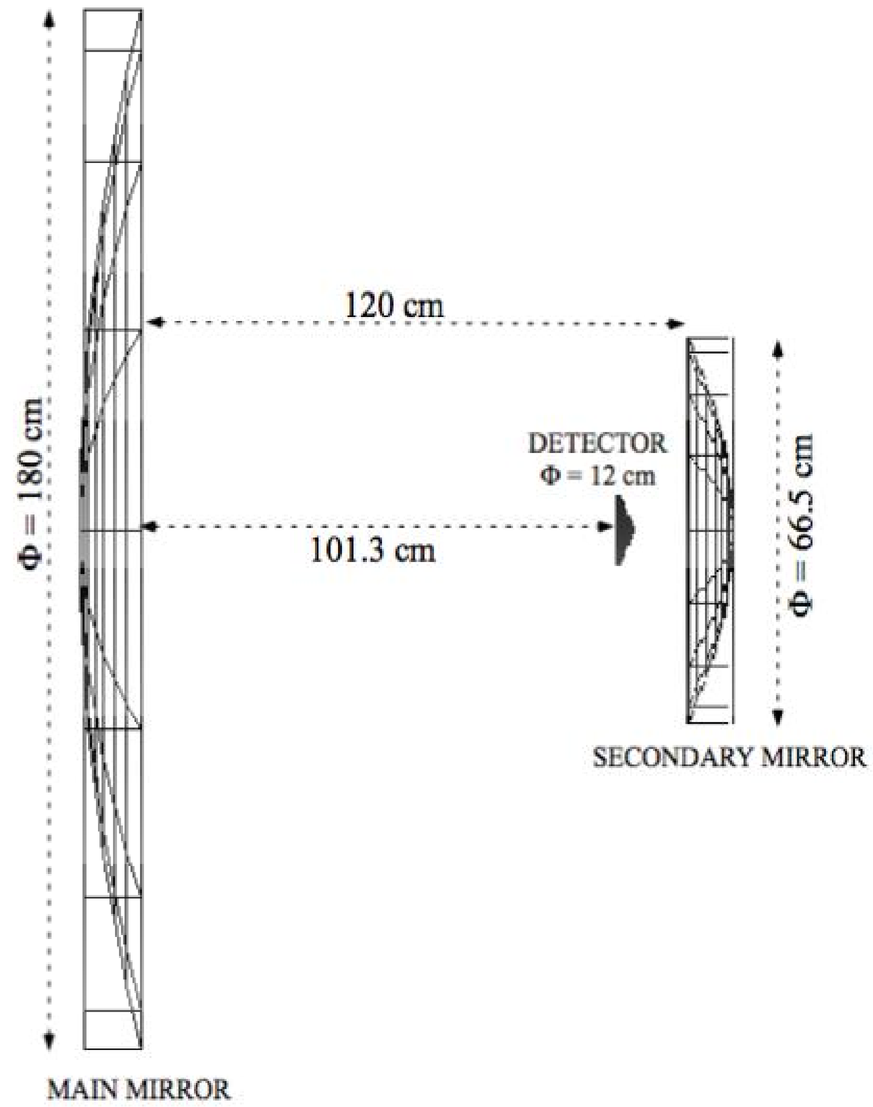


OPTICAL ARRANGEMENT

Three paraboloids (trifoglio)



Single paraboloid



The characteristics of the paraboloid are fixed:

Diameter 1800 mm Focal length 1800 mm

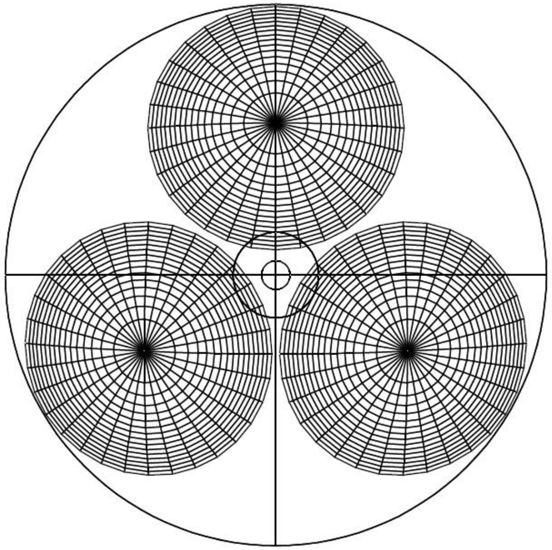
With these constraints the use of CPC proved to be not efficient and basically useless

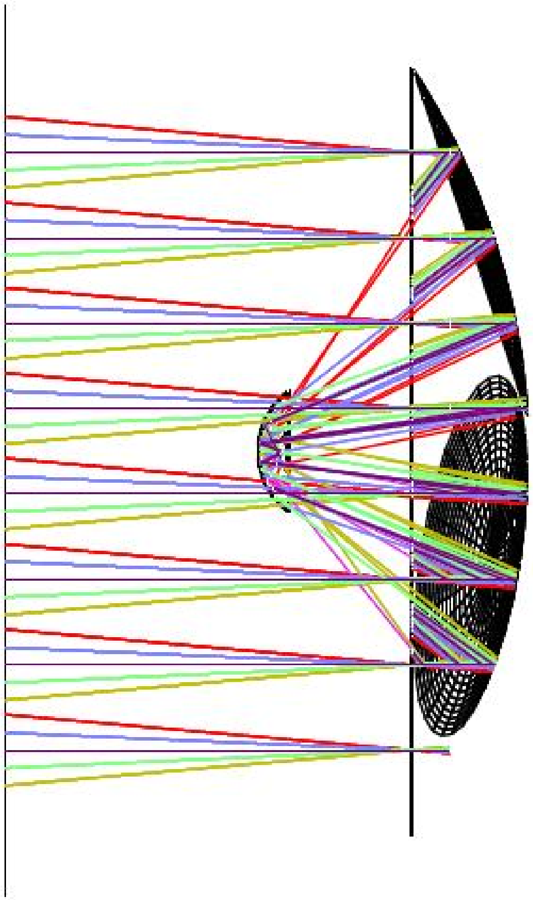
Alternative solution:

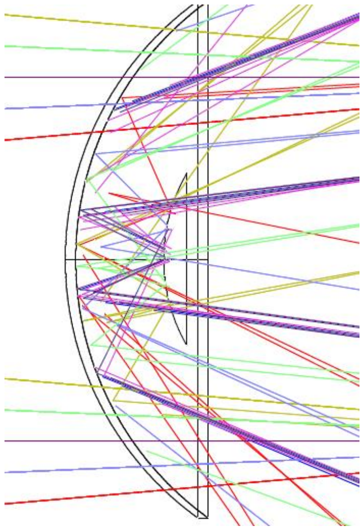
Use larger detectors (20 mm square instead of 10 mm)

Use a larger number of detectors (16 instead of 9)

Trifoglio







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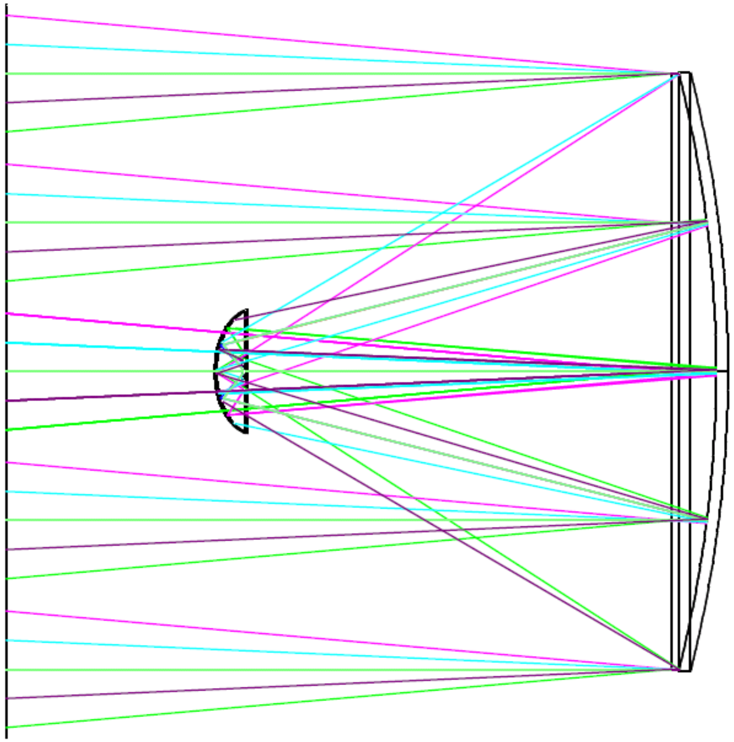

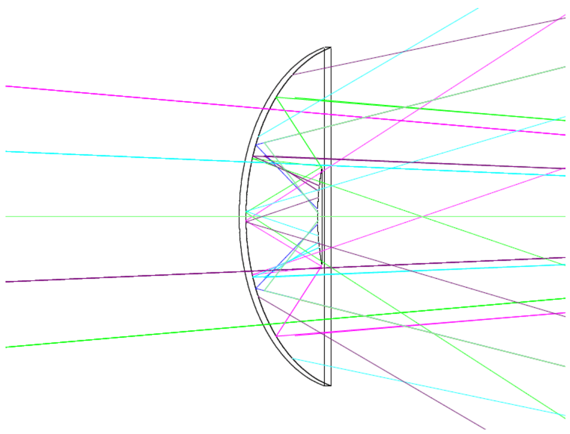

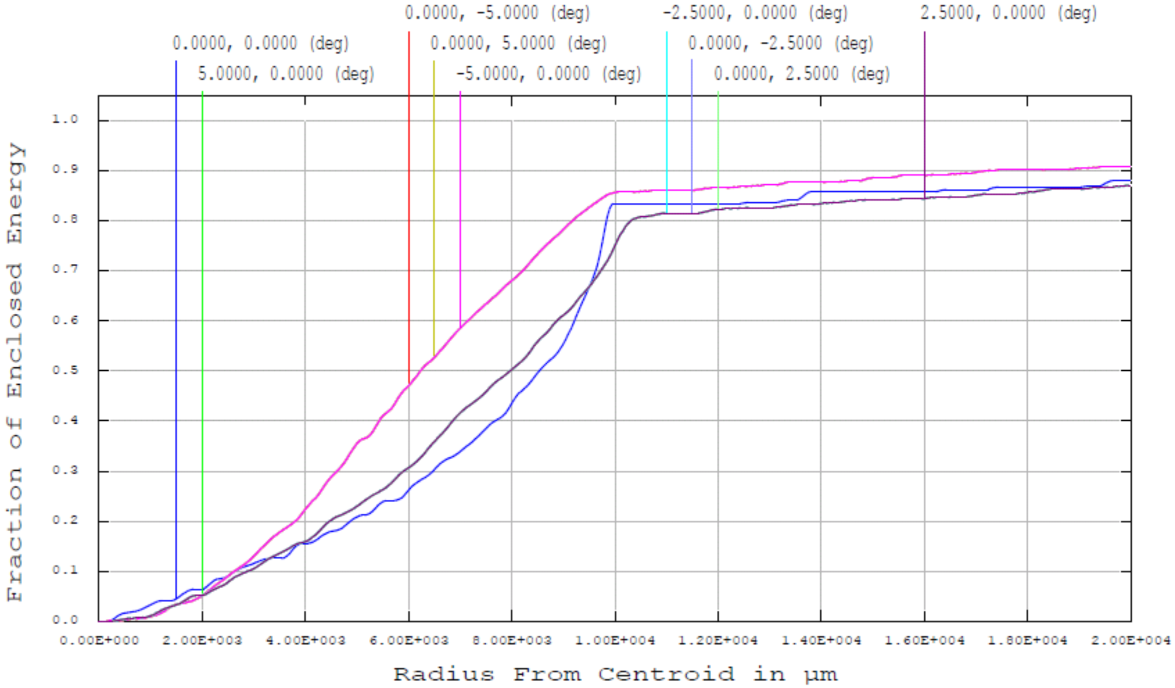

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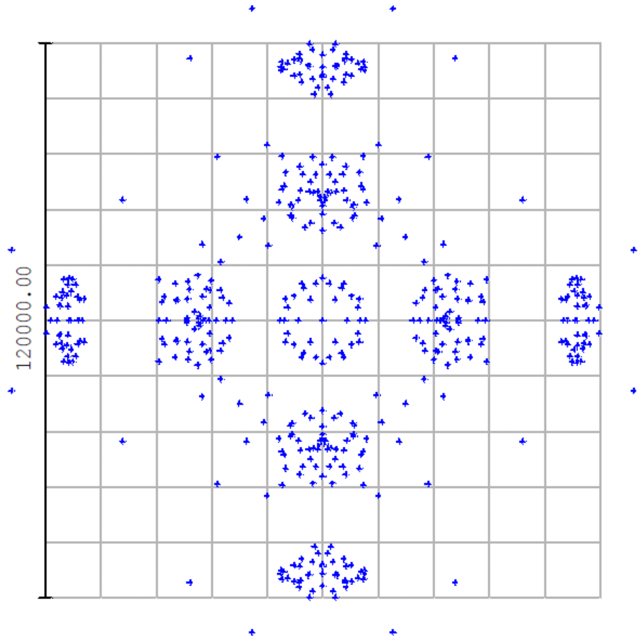
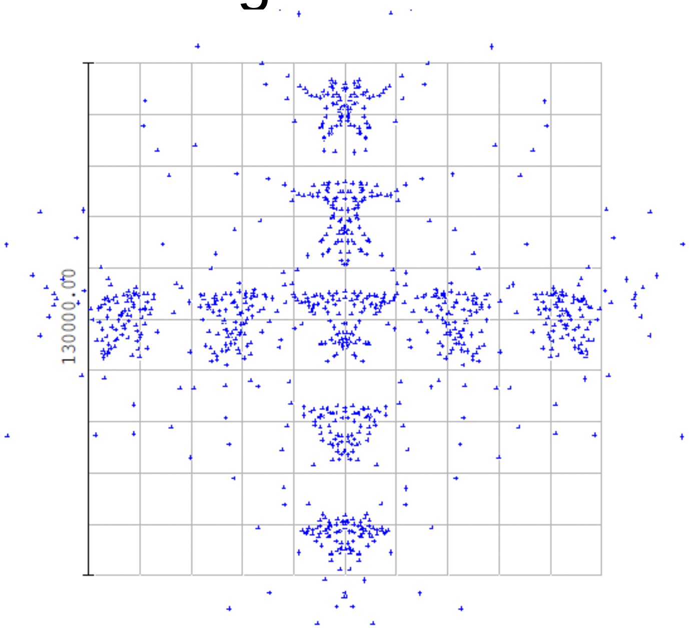
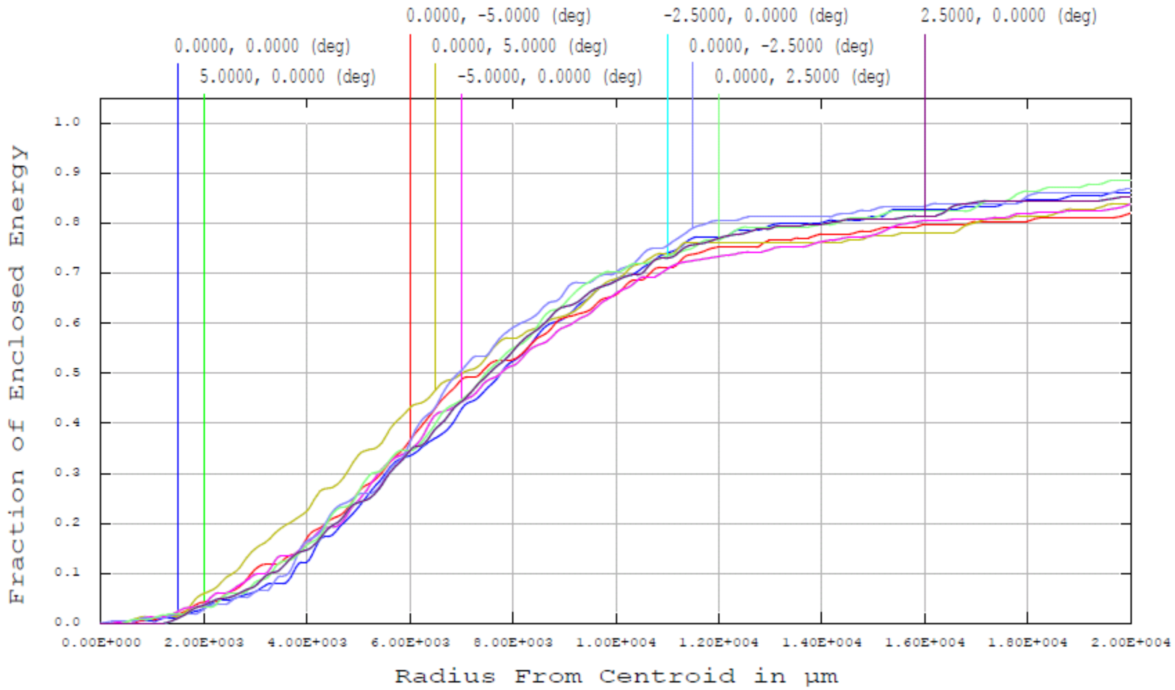


Trifoglio





FUTURE

Feasibility study of the secondary

mirror and the focal plane (Padova)

Update and optimization of

the optical design (Lecce)

Non ci saranno richieste finanziarie da parte di Lecce per il 2014