PoS PROCEEDINGS OF SCIENCE

Specification and Performance Studies in Near UV of HSRL Receivers for Atmospheric Monitoring in Ultra High Energy Cosmic Ray Observatories

Angelika GEORGAKOPOULOU [1]
National Technical University of Athens
Physics Department, National Technical University of Athens,
9, Heroon Polytechniou, ZIP 15780, Athens, Greece
E-mail: agelika@central.ntua.gr

Emmanuel FOKITIS (*NTUA*, fokitis@central.ntua.gr)

Stavros MALTEZOS (*NTUA*, maltezos@central.ntua.gr)

Alexandros PAPAYANNIS (*NTUA*, aplidar@central.ntua.gr)

Violeta GIKA (*NTUA*, guika@mail.ntua.gr)

Prodromos FETFATZIS (*NTUA*, p_fetfatzis@yahoo.gr)

Nikos MARAGOS (*NTUA*, maragnik@gmail.gr)

A High Spectral Resolution Lidar (HSRL) design study which will lead to a prototype is being developed for atmospheric monitoring in Ultra High Energy Cosmic Ray Observatories aiming to improve the accuracy of the measurement of the differential scattering coefficients of the aerosol and clouds in the UV region. The specification studies of the candidate Fabry-Perot receivers for the aerosol and molecular channel compatible with a pulsed SLM Nd:YAG laser at 355 nm are presented in this work. Finally, a feasibility study to use the Fizeau type interferometer as an alternative-more accurate performance study method is also described.

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[1] Speaker

1. Introduction

We present an experimental set-up for atmospheric monitoring, in order to determine the aerosol to molecular ratio. In the figure below we present the experimental configuration of the HSRL prototype and a theoretical calculation of the backscattering laser signal being received by a Newtonian telescope (see Fig. 1).

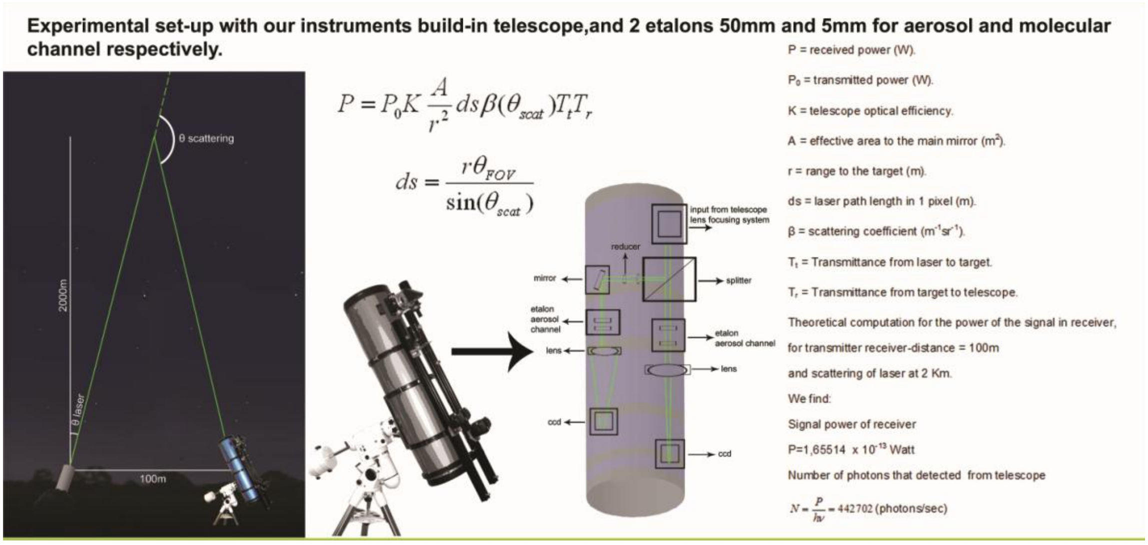


Figure 1. The experimental configuration of the HSRL prototype

1.1 Fabry-Perot method

The etalon plates have to meet the required performances, by means of parallelism and RMS flatness finesse over their reflective surfaces. Applying our recently developed method [1], we have measured the performance of the aerosol channel by recording fringe patterns by using a mercury multi isotopic light source in the near UV region mainly at 365 nm [2].

$$\frac{\lambda}{\Delta\lambda} = \frac{m\pi\sqrt{r}}{1-r}$$

$m = interference\ order$

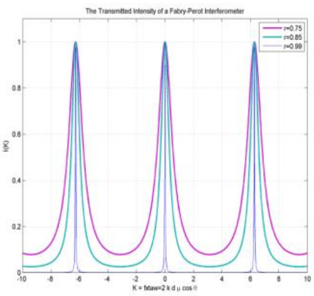
$(m \approx \frac{2d}{\lambda}\ for\ small\ angles)$

$r = reflectivity\ of\ etalon\ surfaces$

$Minimum\ distance\ between\ two\ spectral\ lines:$

$$\Delta\lambda = \frac{\lambda(1-r)}{m\pi\sqrt{r}}$$

$$free\ spectral\ range: \delta\lambda = \frac{\lambda^2}{2d}$$



$$F = \frac{4R^2}{(1-R)^2}$$

$Entry\ Intensity: I^{(i)}$

$Output\ Intensity: I^{(t)}$

$The\ finesse\ is:$

$$f = \frac{\pi\sqrt{R}}{1-R}$$

$$\frac{I^{(i)}}{I^{(t)}} = 1 + F\sin^2(\delta/2)$$

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1.2 Fizeau method

From the preliminary results obtained in prototype etalon plates, by means of deviations from ideal parallelism, we estimated a significant distortion on both substrates caused by the stresses developed by the deposited thin film layers. The resulted parallelism is of the order of $\lambda/4$ P-V for the whole area (70 mm in diameter). Using a narrower active area, i.e. 10 mm in diameter, we can achieve a much better performance up to $\lambda/30$ P-V.

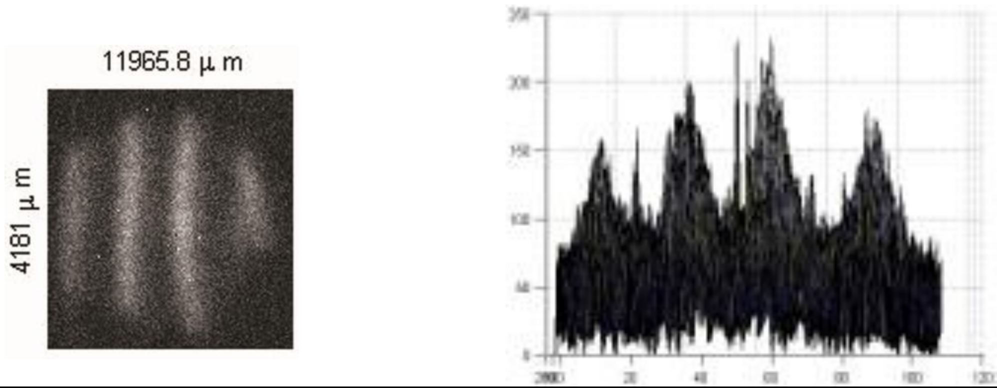

Figure 2.
Left: Laboratory test with Fizeau method. Photo of inteference fringes for coating mirrors with R=60% and laser 435nm.
Right: MATLAB representation of results. We find flatness better than *$\lambda/4$*.

1.3 Conclusions

A HSRL design study has been done in this work. Our goal is to develop a prototype for atmospheric monitoring appropriate for Ultra High Energy Cosmic Ray Observatories. Candidate Fabry-Perot receivers for the aerosol and molecular channel compatible with a pulsed SLM Nd:YAG laser at 355 nm have been characterized. Our study results using a Fizeau type interferometer characterization method seem promising.

References

[1] N. Maragos et al. Proc. of ICRC 2011.
[2] F.A. Jenkins, H.E. White, *Fundamentals of Optics* (1976).

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