# CRIRES Science Verification Proposal

## Bound on time dependency of the fine structure constant.


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**Abstract:**

This is a re-submission of a previous granted CRIRES SV proposal: We wish to constrain variations in the fine structure constant, $\alpha$=e$^2$/hc, in the range z$\sim$ 2 with CRIRES using the [O III] doublet. As a pilot study we select one QSO as SV target. The project was put on hold as ELEV mode could only be comissioned during paranalisation ini Dec. 06. Total time required is 5h.


**Scientific Case:**

We wish to perform a pilot study for a dedicated survey with CRIRES to constrain variations in the fine structure constant, $\alpha$=e$^2$/hc, in the range z>2.

We will use the forbidden [O III] transitions at 495.9 and 500.7nm, as pioneered at lower redshifts by Bahcall et al. (2004). This strategy of constraining a time dependence of fundamental physical parameters is superior to the many multiplet method applied in earlier studies. In the later method systematic uncertainties are larger. Upper limits on the variation of the fine structure constant with cosmological epoch were already found by Brinchmann et al. (2004) using ISAAC detections of [O III] emission lines on z >2 quasars. However the ISSAC observations are limited by the factor 5-10 lower spectral resolving power when compared to CRIRES. Levshakov et al. (2006) could recently detect a time dependency of $\alpha$ for one quasar and found so far the most precise redshift bound to an oscillating behavior of the fine structure constant with time using UVES. It will be an interesting test to compare the accuracy achievable with UVES using a single line differential measurement (Fe II pairs) to what is possible with CRIRES and the [O III] method.

For the test we propose to observe as single target: Q 1148-001 at z = 2.073, H=17mag and strong [O III] doublet observed by Mc Intosh et al. (1999). The SV observations will be used to test our data analysis and to demonstrate and establish the CRIRES wavelength calibration to its highest accuracy possible.

**Required observing time**

We will perform 12 nodding cycles AB with DIT=600s, NDIT=1 setting as specified to reach a SNR $\sim$ 20. Such SNR ratio was already reached on the 15mag BD observed at shorter exposure times during ComI. Slit width shall be 0.4$''$. Reference star is to be selected or target otherwise.

Within the same observing template we will perform a lamp exposure to ensure best possible absolute wavelength calibration using telluric lines or the lamp spectrum. Necessary standard calibration star is assumed to be selected during the time we will perform the observation. Compared to the previous submission we need to increase the total observing time by by 25%. This is based on experience during

the last runs and improved version of ETC. The total observing time for this study is **5 hours.**

| **Target** | **RA** | **DEC** | **Magnitude** | $z$ | **Wavelength Band** | **DIT** | **NAB** |
|---|---|---|---|---|---|---|---|
| Q 1148-001[t] | 11 48 10.13 | -00 07 13.01 | 17.1 | 1.980 | near 37/1/n | 600 | 12 |
| Q 1104-181[b] | 11 04 04.95 | -18 05 10.07 | 16.2 | 2.318 | near 37/1/n | 600 | 12 |

[t] top priority

[b] back-up

**Note:**

Compared to previous submission we change the target caused by different visibility period. Targets are selected from Mc Intosh et al. Q1148-001 has highest priority as OIII line doublet is brighter.