Tracking HEAT and CO calibrations and the effects on Xmax for the HeCo system

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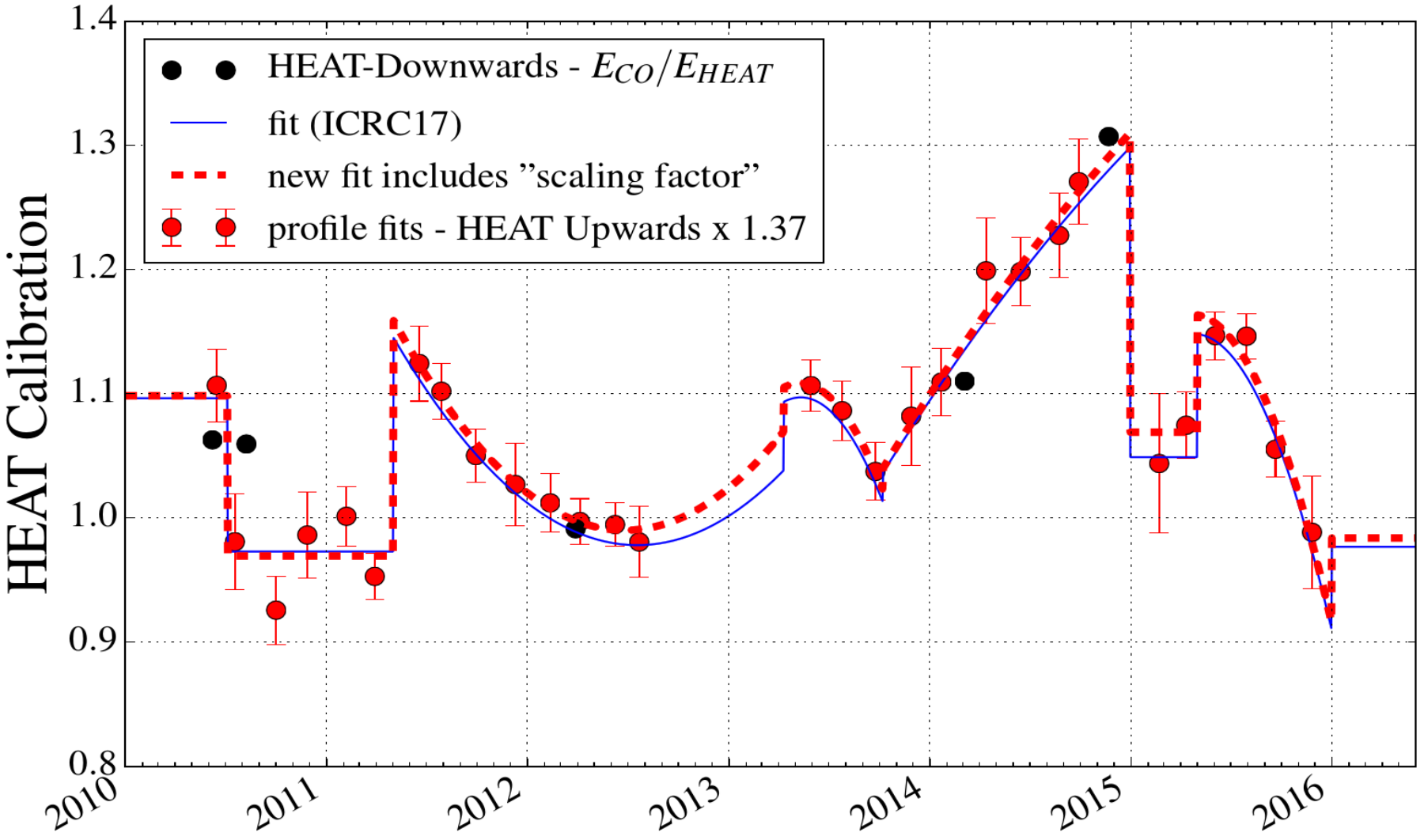
The He/Co energy cross-calibration

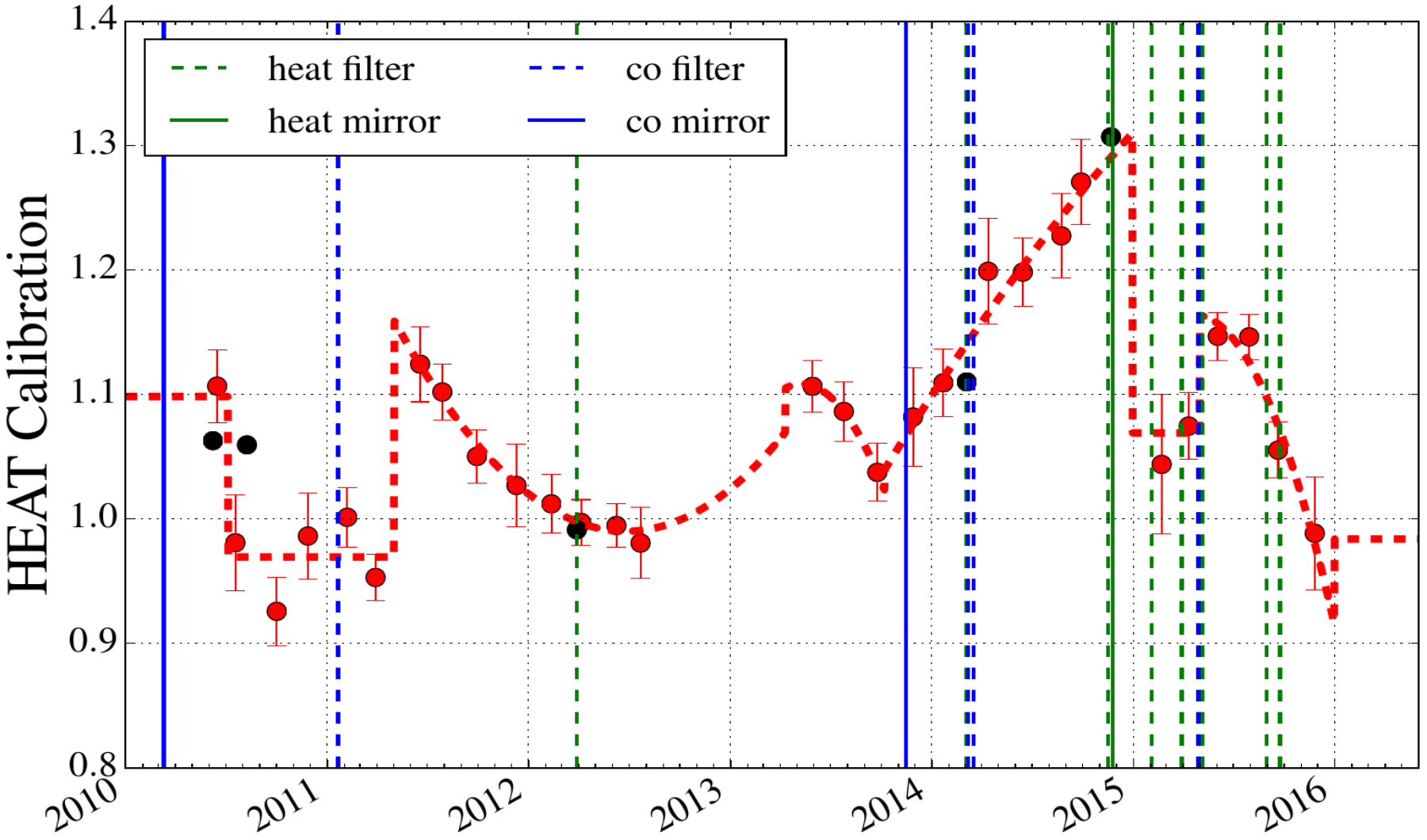
- The HEAT energy calibration is tracked using real showers that crossed HEAT and Co mirrors. In the profile fit, the **HEAT calibration** is included in the fit.

- The HEAT calibration is scaled ('scaling factor') to best match the direct **He/Co energy comparisons** obtained when HEAT operated in **downwards position**.



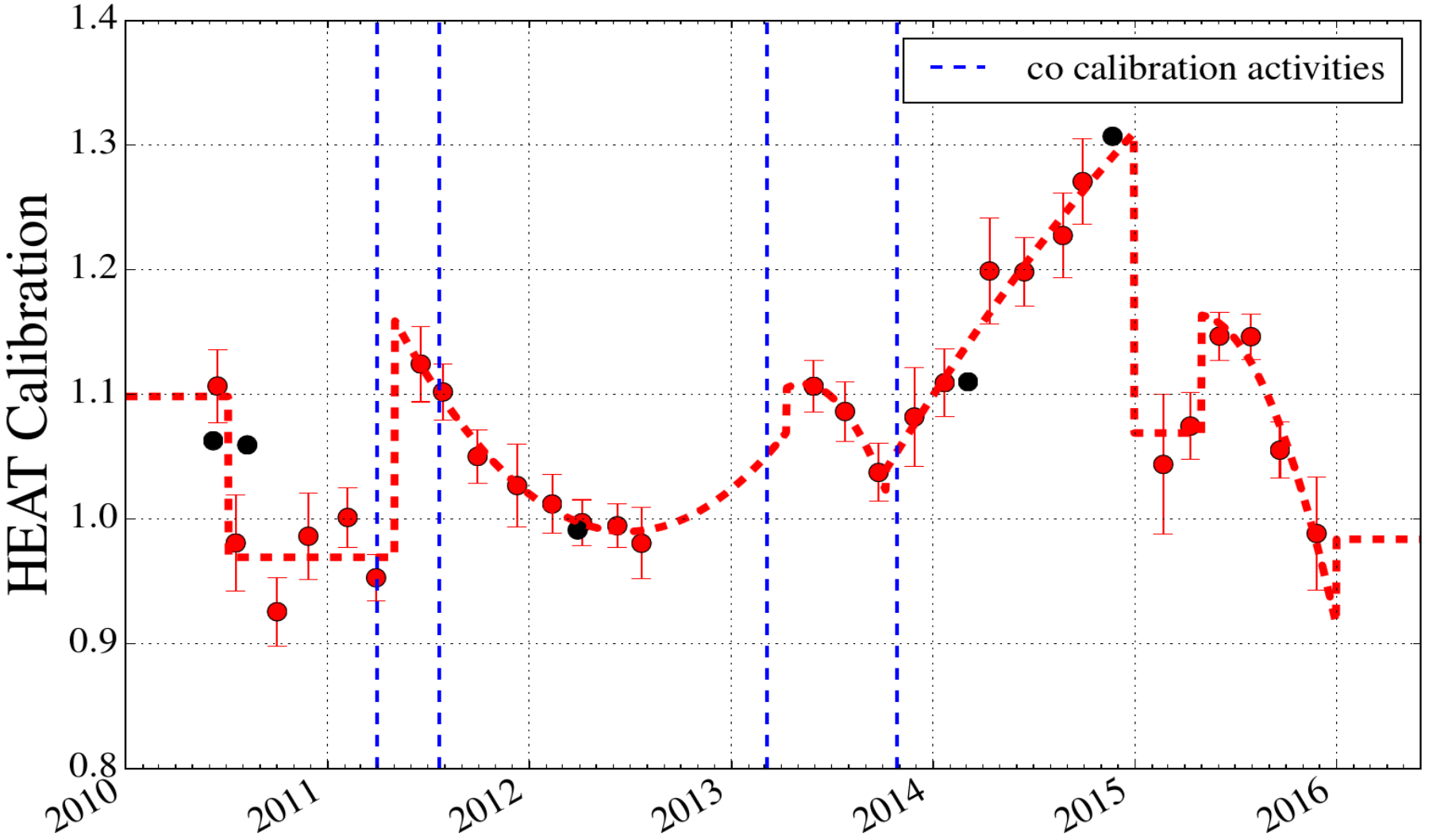
The He/Co energy cross-calibration

Correlation with mirror/filter cleaning activity?



The He/Co energy cross-calibration

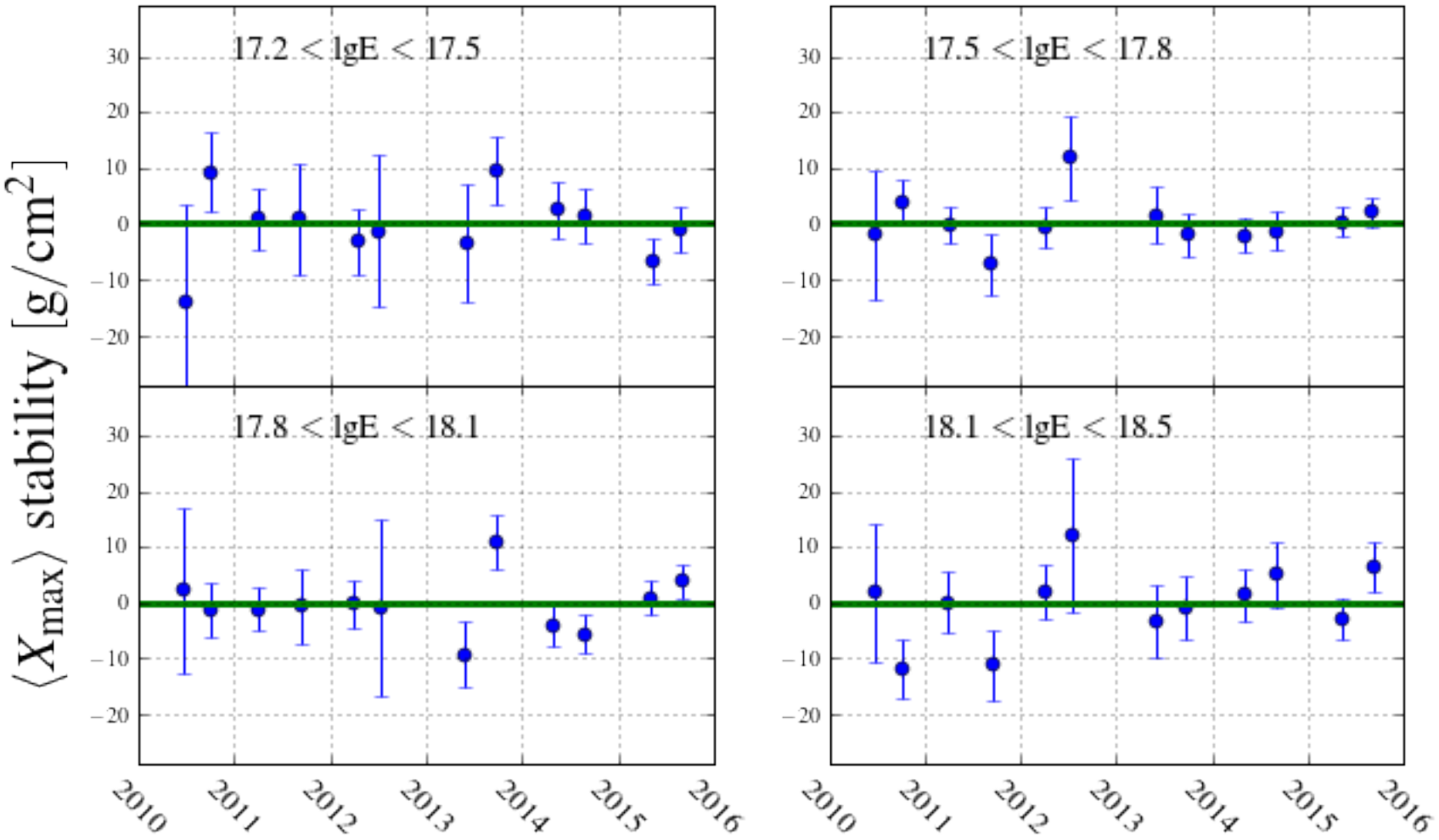
Correlation with calibration related activities?



Stability of <Xmax> as a function of time

(four energy ranges)

Considering events that involved **only Coihueco**

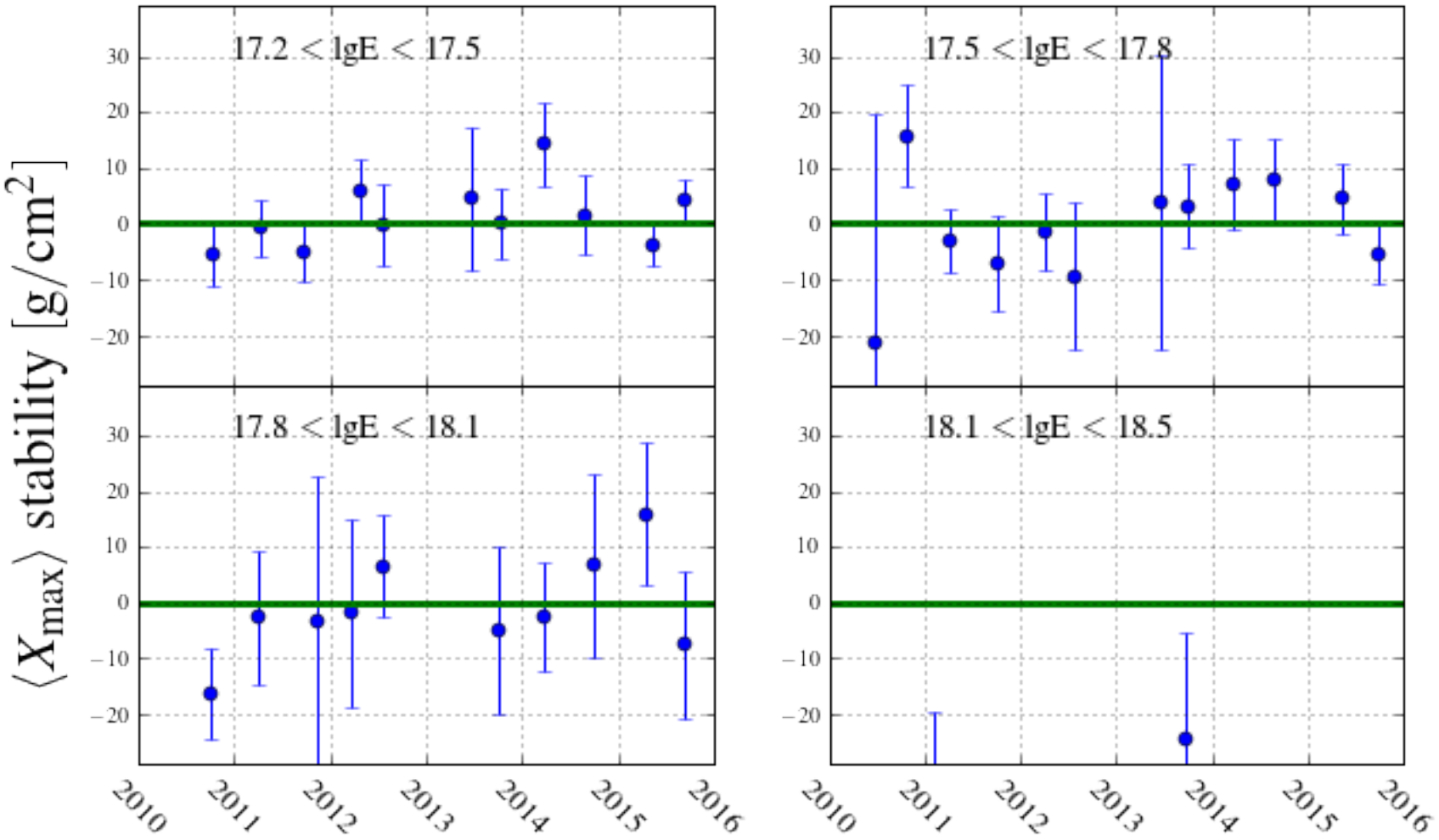


Green lines represent the average <Xmax>

Stability of <Xmax> as a function of time

(four energy ranges)

Considering events that involved **only HEAT**

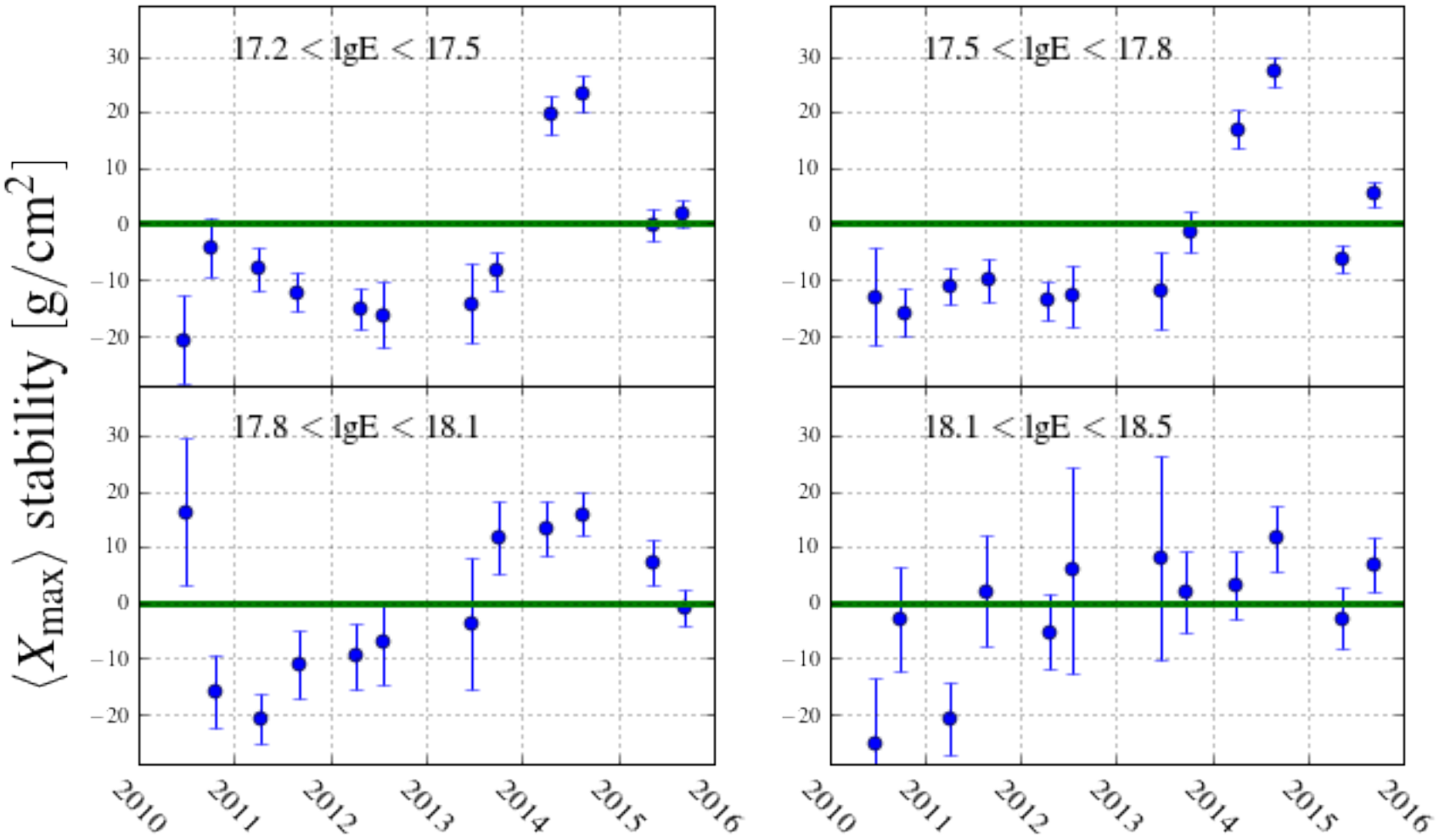


Green lines represent the average <Xmax>

Stability of <Xmax> as a function of time

(four energy ranges)

Considering events that involved **HEAT + Coihueco**

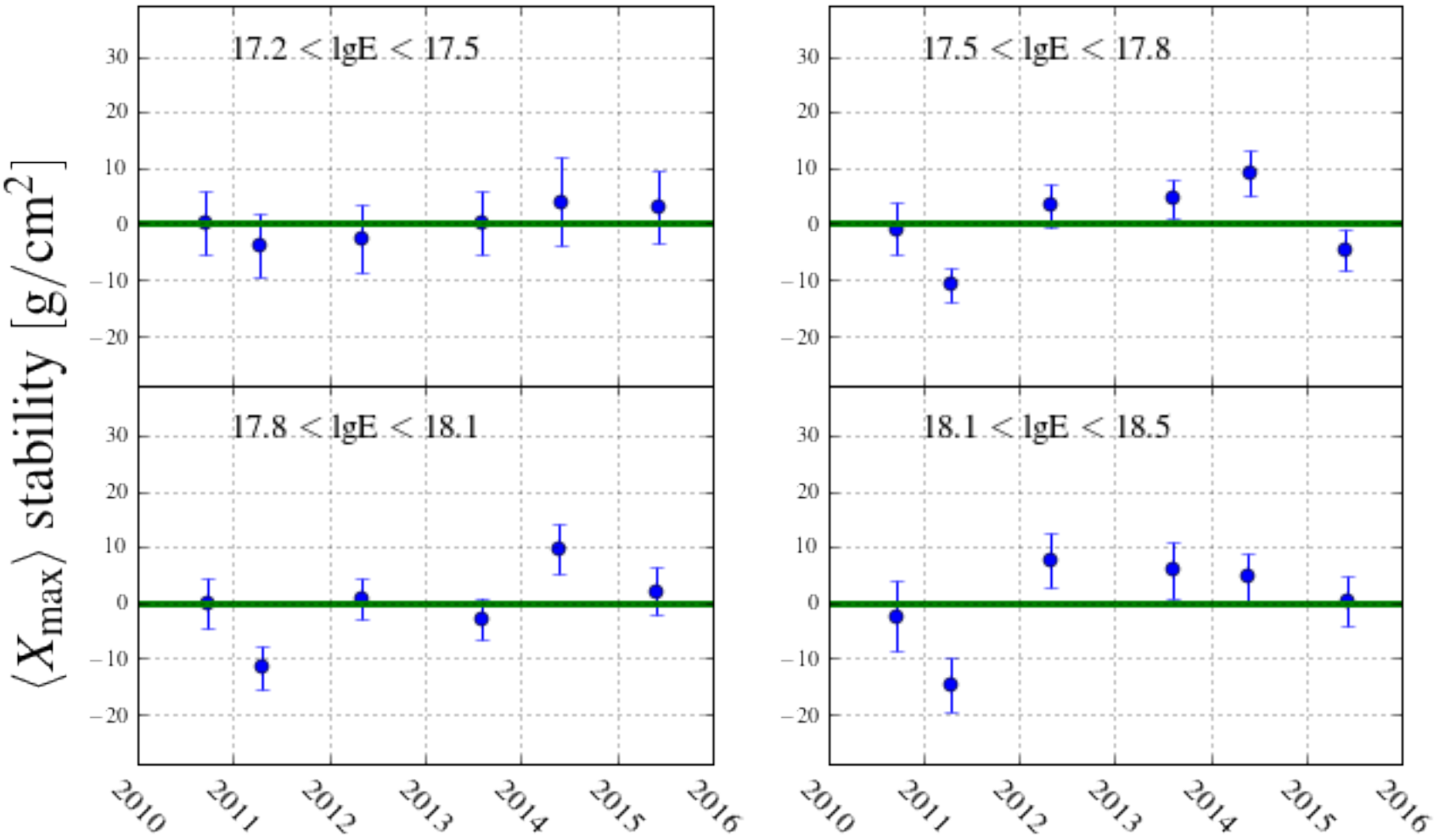


Green lines represent the average <Xmax>

Stability of <Xmax> as a function of time

(four energy ranges)

Considering events that involved **HEAT + Coihueco**

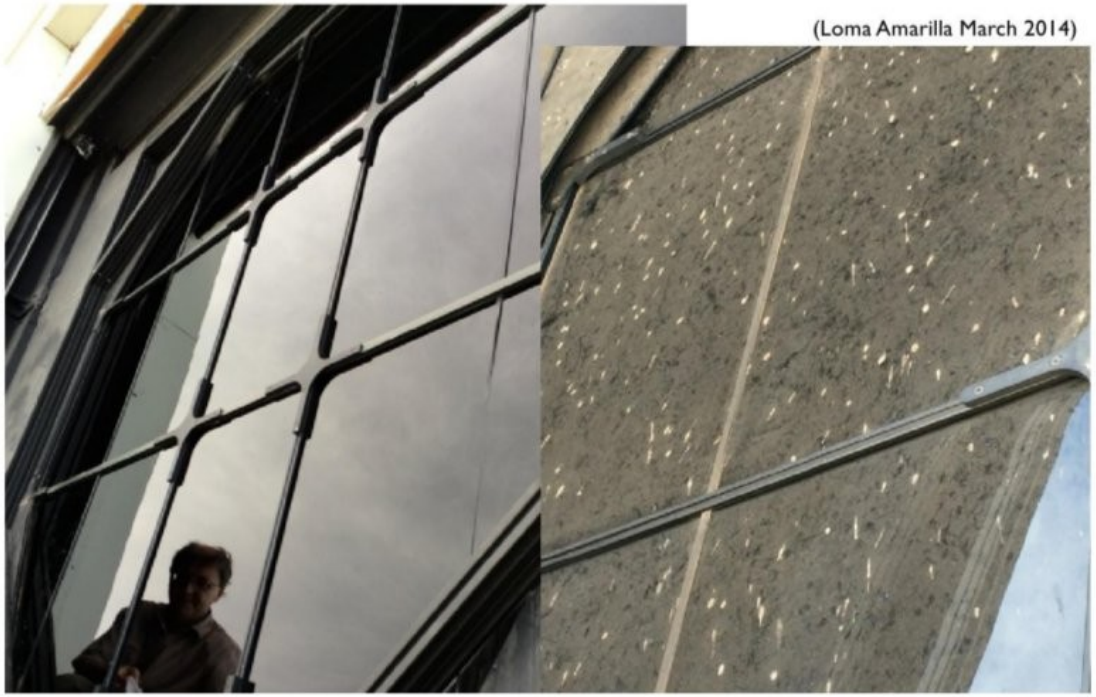


Green lines represent the average <Xmax>

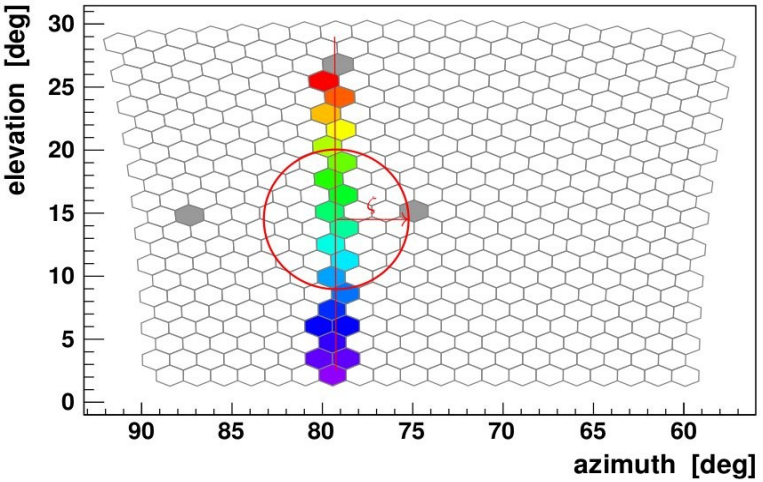
Re-reconstructing using the HEAT calibration function. The HEAT calibration function has been implemented in the Offline via FdCalibrator.xml

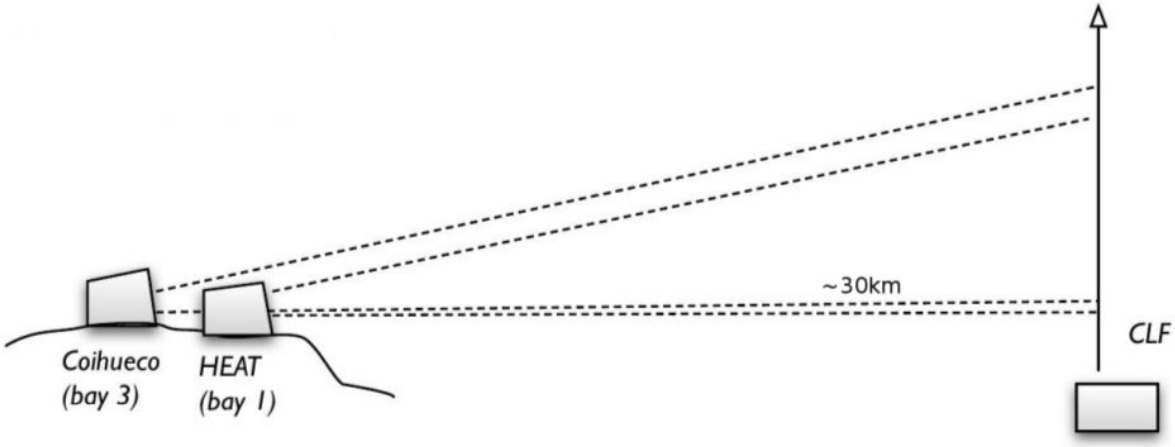
Investigation of optical properties of fluorescence telescopes of the Pierre Auger Observatory using laser data

Joachim Debatin, Kai Daumiller, Ralph Engel, Hans Klages, Radomir Smida, Lenka Tomankova, Michael Unger for the Auger Collaboration | March 6, 2015

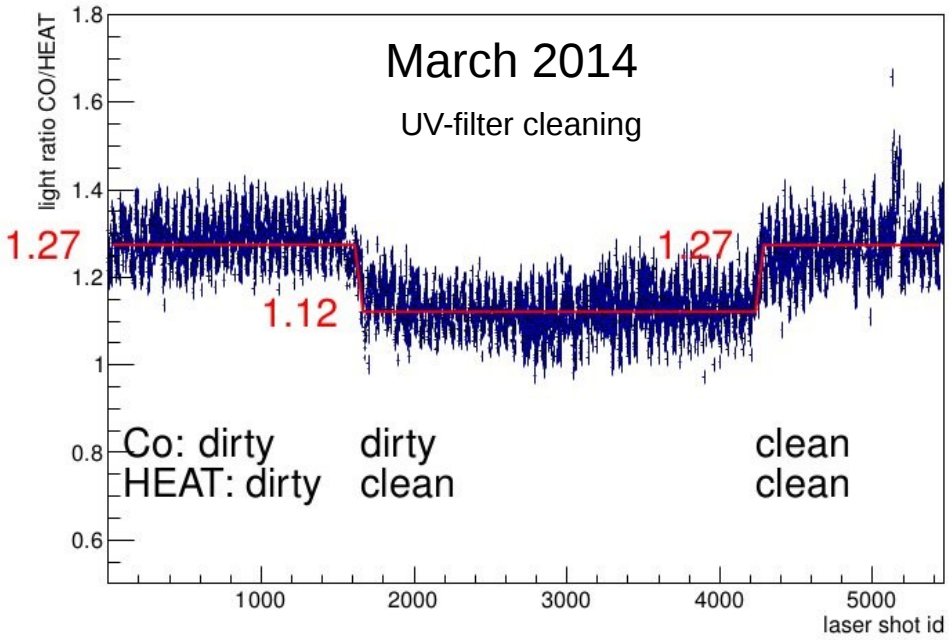


March 2014: UV-filter of Coihueco and HEAT cleaned.
November 2014 UV-filter and mirror of HEAT cleaned.

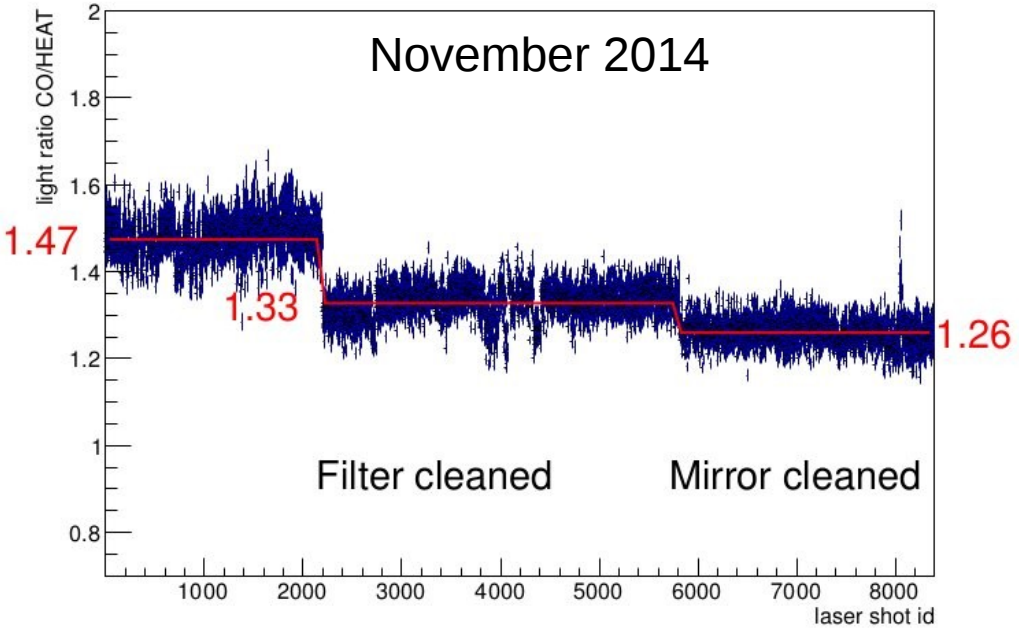




Laser energy and atmospheric variation identical for Coihueco and HEAT.



Step size: ~ 13%



Cleaned Filter: ~ 11% Cleaned Mirror: ~ 5%

Discussion

- The cleaning of filters and mirrors have an effect of around ~13%. This effect probably depends on how long it was since last cleaning
- The observed variations in the He/Co cross calibration is up to 30%. introducing a systematics in the Xmax reconstruction of about 30 g/cm^2 .
- The He/Co cross calibration has a strong time dependence.

What can we do?

- Schedule once a year FD shifts with Heat in downwards position (April or May)
- Stablish a protocol for cleaning mirrors and filters. Probably we need to clean more often the outside face of the filters.
- It might be possible to use inclined lasers (towards Coihueco) to monitor the He/Co cross calibration with HEAT in upwards position.
- Validate CalA calibration at HEAT telescopes.

4	6	03 2010	CB	"2 mirror segments cleaned"
4	123456	21 01 2011	C	"filters cleaned"
4	146	23 03 2011	BC	"mirrors cleaned (except two upper rows)"
4	123456	01 04 2011	BC	"broken calibration B and C"
4	123456	22 07 2011	BC	"calibration B and C repaired"
4	5	07 03 2013	B	"calB fiber on right side of camera (viewed from behind) was removed and replaced --> camera illumination is expected to have changed"
4	5	28 10 2013	B	"calB fiber on right side of camera (viewed from behind) was removed and replaced on 03 11 2013 --> camera illumination is expected to have changed"
4	23	15 11 2013	BC	"mirrors were cleaned using wet procedure"
4	3	07 03 2014	C	"Cleaned the filter of bay 3 on the outside, using first water with a little bit of dishwashing detergent, then window cleaner."
4	3	07 03 2014	C	"uv-filters cleaned"
4	12456	17 03 2014	C	"uv-filters cleaned"
4	12356	29 04 2015	C	"uv-filters cleaned"
4	5	06 11 2016	BC	"mirrors cleaned (by using a wet procedure) and realigned"

4	5	06 11 2016	BC	"mirrors cleaned (by using a wet procedure) and realigned"
				Heat
5	123	21 01 2011	C	"filters cleaned"
5	1	22 03 2011	B	"damaged upper right corner of mirror segment number 54 (left corner, lowest row)"
5	123	28 03 2012	C	"Cleaned filters at HEAT on the outside"
5	1	04 03 2014	C	"Cleaned the filter of bay 1 on the outside, using water with a little bit of dishwashing detergent"
5	1	16 11 2014	C	"Cleaned filter of bay 1 on the outside using water, fixing a loose piece of rubber between filter segments in the right bottom part"
5	1	25 11 2014	BC	"Cleaned the mirror of bay 1 with dry procedure, just blowing the dust away with nitrogen gas"
5	123	03 02 2015	C	"uv-filters cleaned"
5	123	30 03 2015	C	"uv-filters cleaned"
5	123	07 05 2015	C	"uv-filters cleaned"
5	123	31 08 2015	C	"uv-filters cleaned"
5	123	24 09 2015	C	"uv-filters cleaned"