

The BOUSSOLE project technical reports; report #7-20, issue 1.

BOUSSOLE buoy deployment & maintenance log.
May 11, 2015 - June 06, 2016

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BOUSSOLE project

ESA/ESRIN contract N° 4000111801/14/I-NB

Deliverable from WP#300/400

June 15, 2016

Foreword

This report is part of the technical report series that is being established by the **BOUSSOLE** project.

BOUSSOLE is funded/supported by the following Agencies, Institutions or Programs



European Space Agency



Centre National d'Etudes Spatiales, France



National Aeronautics and Space Administration of the USA



Centre National de la Recherche Scientifique, France



Institut National des Sciences de l'Univers, France



Université Pierre & Marie Curie, France



Observatoire Océanologique de Villefranche sur mer, France

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1. SCOPE OF DOCUMENT

The BOUSSOLE buoy deployment and maintenance log is a record of all events that occur from the deployment to the recovery of one of the two upper sections of the buoy.

The aim is to keep track of all maintenance operations, such as instruments cleaning or rotations, instruments malfunctions, incidents with the buoy structure, if any, biofouling development and so on.

This information is crucial to a subsequent correct interpretation of the data.

Keeping track of these events also allows their analysis in view of the permanent improvement of protocols.

The present report concerns "buoy deployment XVII", from May 11th of 2015 to June 6th of 2016.

2. DESCRIPTION OF OPERATIONS

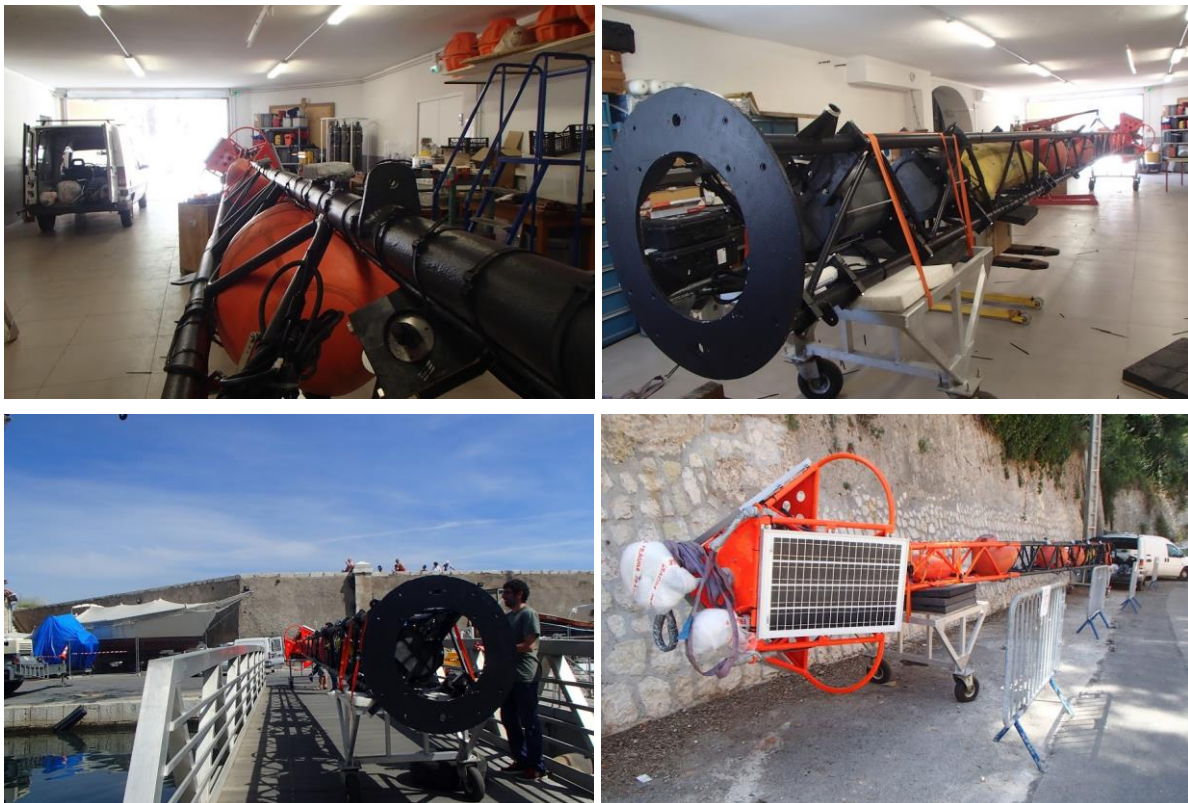
2.1 UPPER SECTION PREPARATION (2015-01)

The buoy System (buoy XVII called system #1) was partially delivered from Satlantic on January 7th, the two OCPs and related radiometers were delivered on March 23. The installation on the structure began soon after the first instruments arrival. The deployment took place on May 11th 2015.

The Buoy was equipped with sensors used for the deployment of the buoy XV recovered on March 14th 2014. The system was prepared in the CCI local in Villefranche-Sur-Mer. Some issues were encountered during test of the instruments. The **OCP_#040** showed anomalous dark values on the Lu channels. After two days of test the instrument stopped working and had to be sent back to factory for repair. The choice to use one of the OCP installed on the buoy at sea was taken. The hyperspectral irradiance at 4 m showed saturation during field test. The issue came from the configuration of the instrument integration time which was mistakenly set to not vary autonomously.

Copper sheets and pieces were again fixed wherever possible to avoid biofouling arising. Aluminium plates (3 mm thickness) have again been fixed on the back side of the solar panels to reinforce them. The schedule used in more recent deployments was kept. The system was tested for some days running both with solar panel or ground alimentation.

An intercalibration of all radiometers was performed before launch (see appendix) on February 3th 2016 and a further calibration check in the dark room was also realised (see appendix).





2.2 MOORING DEPLOYMENT

2.2.1 Monday 11th May 2015

The upper structure to be deployed was brought to La Darse port in Villefranche at local 3:15 pm with the help of 8 people from LOV. Once unloaded the old structure, the buoy was loaded on board the GGIX with the help of the CCI crane. The 4 arms were not assembled and were loaded on the ship with the annexe. The GGIX stayed in the villefranche bay for the night and the day after went to the BOUSSOLE site to complete the installation of the upper superstructure. At about 11h30 the ARGOS messages started being dispatched regularly. The Delrin sleeve of one of the buoy arms broke during its mounting and the arm was not installed and brought back to Villefranche a couple of days later.

At this date, buoy is equipped with

- DACNet #002
- CLC #002
- Junction Box #004
- Rads set: OCI #035_Eu4m, #040_Ed4m, #109_Eu9m, #047_Ed9m #095_Es, OCR #035_Lu4m and #038_Lu9m), MVDS #053, OCP #036(4m) and OCP 041(9m)
- Hyper spectral units HOCR-RW, #242_Lu9m, HOCR-IW #279_Es, , #405_Ed9, STOR-X #032.
- HS4 #H4070403
- Strain-100 #002

- **Transmissometers C-Star #1058-PR (9m)**
- **ECOFLNTUs #727 (9m)**
- **ARGOS beacon #18797 (prog id#26021)**
- **CTD #37SI 46113-5325**
- **Strain gauge OML CSSPE00356 (not operational)**
- **PAR #097**

The lower part of the buoy is still equipped with the two emergency ARGOS beacons.

2.2.2 Friday 29th May 2015

This day the private boat Lollipop from Darkpelican Company was rent in Villefranche. Three divers from OOV were on board with M. Golbol. When arrived at the BOUSSOLE site divers went at sea to mount the 4 m arm that was missing since the buoy deployment. The instruments on the arm were then connected to the system through their respective cables which were already installed on the buoy structure. Then optical sensors were cleaned and dark IOPs recorded (except the 9 m transmissometer). Instruments and solar panels on the buoy head were cleaned too. Data were downloaded through a direct connection at the nominal scheduled connection attempt. pCO₂ data at 3 m were downloaded too. Unfortunately the cover of the pCO₂ connector was lost at sea and a spare was not available. The 4 m transmissometer measured negative attenuation values.

At this date, buoy is equipped with

- **Hyper spectral unit #241_Lu4m and HOCR-IW #399_Ed4**
- **Transmissometers C-Star #1057-PR (4m)**
- **ECOFLNTUs #726 (4m).**

2.2.3 Tuesday 16th June 2015

At the end of this day the ARGOS messages started to be constant indicating a probable malfunctioning of the DACNet Microdrive.

2.2.4 Monday 22th June 2015

This day the private boat NOE from CAP KETOS Company in Nice was rent to go to the BOUSSOLE site with three divers. When on site divers went at sea to switch-off the battery and dismount the DACNet. Then the Microdrive was exchanged with a new one and configured to match the right instrument configuration. Fuses and internal battery were checked to be functional. Then the DACNet was mounted again on the buoy. The **OCP#036** at 4 m was dismounted too and replaced by the **OCP#040** recently received from factory after repair. Optical sensors were cleaned and the buoy battery switched on. The buoy restarted to work properly. No dark measurement was performed. Two colorant bags were fixed on the buoy structure close to the pCO₂ sensors at 3 and 10 m. The colorant is the same used for pCO₂ sensor measurements and will have to be recovered after about 1 month to

verify any drift in colorant concentration due to sun exposition. Data from the corrupted Microdrive were recovered on land.

At this date, buoy is equipped with

- OCOP#040 (4m).

2.2.5 Tuesday 07th July 2015

This day the private boat Lollipop from Darkpelican Company was rent in Villefranche to go to the Boussole site. Three divers from LOV were on board. Divers started with cleaning the underwater optical sensors and to perform dark IOPs measurements. Then the pCO₂ sensor at 4 m was dismantled and exchanged with a new one. The same operation was done with the pCO₂ sensor at 10 m and its cable was fixed along the structure till the top of the buoy. The CTD at 3 m was dismantled to be replaced with a recently calibrated one. However the same CTD was re-installed on the buoy since the new one could not be configured properly. The optical sensors, connectors and solar panels were also cleaned on the top of the buoy.

2.2.6 Tuesday-Wednesday 21-22th July 2015

These days are part of the B#161 cruise. The first day buoy data were downloaded via a direct connection on the top of the buoy. The sensors on the buoy head and solar panels were cleaned. pCO₂ data from the sensors at 3m and 10m were downloaded using the telemetry cable fixed on the top of the buoy. The second day divers went at sea to clean the instruments and perform dark IOPs measurements.

2.2.7 Tuesday 08th August 2015

This day the private boat NOE from CAP KETOS was rent in Nice to go to the BOUSSOLE site. 3 divers from LOV were on board (no scientific personnel on board) to clean the optical sensors and perform dark measurements.

2.2.8 Thursday-Friday 27th-28th August 2015

This days are part of the B#162 cruise. The first day divers went at sea to clean the sensors, to perform dark IOPs measurements and to take pictures. They also removed the two dye pockets fastened on the buoy at 3m and 10m. Buoy data and pCO₂ data at 3m and 10m were downloaded on top of the buoy. Surface sensors and solar panels were cleaned too. The second day surface sensor were cleaned again since they were still dirty (guano).

2.2.9 Friday 11th September 2015

This day the private boat NOE from CAP KETOS was rent in Nice. 4 divers from LOV were on board with VV. A first dive was made on the meteorological buoy *Cote d'Azur* to recover the Isus sensor at 40m for the DYFAMED group. Then we moved to the BOUSSOLE site and divers went at sea to clean the optical sensors and perform dark measurements. In the meantime optical sensor and connectors on the top of the buoy were cleaned too and data from the buoy and pCO₂ sensors downloaded.

2.2.10 Monday 21st September 2015

This days are part of the B#163 cruise. Divers went at sea to clean the sensors, to take pictures and to perform dark measurements of the transmissiometers and the backscattering meters. Buoy data were downloaded with a direct connection on the top of the buoy. pCO₂ data at 10m were downloaded. Sensors, solar panels and ARGOS and CISCO connectors were cleaned.

2.2.11 Monday 12th October 2015

This day the private boat NOE from CAP KETOS Company in Nice was rent to go to the BOUSSOLE site. Three divers from LOV were on board to clean the optical sensor (underwater and above water) and to perform dark IOPs measurements (no science personnel on board).

2.2.12 Friday-Sunday 17-18th October 2015

This days are part of the B#164 cruise. The first day the buoy was tilted and below its nominal buoyancy because of strong currents. A wireless connection with the buoy was attempted unsuccessfully. The second day the buoy was still tilted and below its nominal buoyancy, preventing data download.

2.2.13 Tuesday-Wednesday 10-11th November 2015

This days are part of the B#165 cruise. The first day the connectors, the solar panels and the surface sensors on the top of the buoy were cleaned. The second day divers went at sea to clean the sensors, to take pictures and to perform dark IOPs measurements. They also swapped the cables between the Eu and Lu connected to the OCP at 4m. Buoy data and pCO₂ data at 10m were downloaded on the top of the buoy.

2.2.14 Wednesday 2 December 2015

This day the SAGITTA III, recently delivered by the Dt-INSU to OOV for the replacement of the previous station boat (SAGITTA II), was used for the first time to go to the BOUSSOLE site. Three divers from private companies were on board. When arrived at the BOUSSOLE site divers went at sea to clean the buoy underwater sensors and to perform dark IOPs measurements. A tentative to install a 3 band Wetlabs fluorometer for Collin Roesler from the BEDOWIN University (US) was made. Unfortunately one of the fixation plate was lost and the instrument could not be installed.

2.2.15 Thursday-Sunday 10th and 13th December 2015

This days are part of the B#166 cruise. The first day divers went at sea to install a Wetlabs Triplet fluorometer from Collin Roesler on the 9m buoy arm, clean the optical sensors and to perform dark IOPs measurements. They also installed a nonfictional fluorometer on the buoy structure at 9m depth for tests on the biofilm for the Claustre group. The second day buoy data were downloaded on the top of the buoy. Surface sensors, solar panels and connectors were cleaned too.

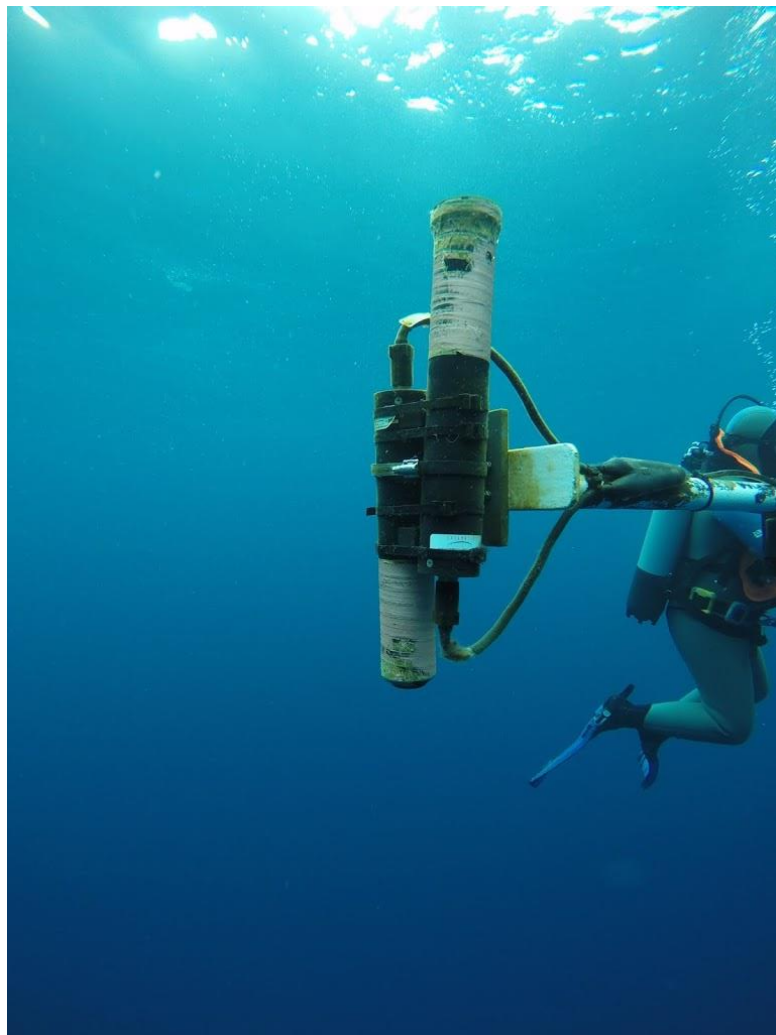
2.2.16 Wednesday 23th December 2015

This day divers from private company MARE NOSTRUM tried to go to the BOUSSOLE site for cleaning operations. The sea state worsened during

the transit and postponed the mission on 26th. On 26th the mission was again cancelled for bad weather, though data from Cote d'Azur meteorological buoy indicated workable conditions (0.5 wave height and <10 kn wind).

2.2.17 Wednesday 20th January 2016

This day the SAGITTA III was used to go to the BOUSSOLE site. VV was on board with three divers from OOV. Typical buoy maintenance was in program along with rotation of 2 pCO₂ sensors and CTD at 3 m. However the seas state did not allow to perform all the operations. A simple cleaning of the optical sensors and ARGOS beacon was realised and the hyperspectral sensors at 4 m realigned since they were found not pointing zenith/nadir from picture of the December intermediate cruise (see figure below).



2.2.18 Saturday 6th February 2016

This days are part of the B#168 cruise. When arrived at BOUSSOLE divers went at sea to recover the Triplet at 9 m and the 2 PCO₂ sensors at 3 m and 10 m. The 2 PCO₂ sensors were replaced with new ones. Only the sensor at 10 m was reinstalled with its cable though only winded and fixed on the buoy structure. Divers also cleaned the instruments, took pictures and performed dark IOPs measurements In the meantime data were retrieved on the top of the buoy

after an AK reboot. Solar panels, surface sensors and ARGOS connectors were cleaned.

2.2.19 Tuesday 8th March 2016

This day the ARGOS messages dispatch stopped. The last visit to the buoy was made the day before during the B#169 cruise though no maintenance was possible due to weather conditions.

2.2.20 Saturday 19th March 2016

This day three divers from OOV went to the BOUSSOLE site on board the PAPETEE from Mediterranee Peche Decouverte Company in Beulieu-sur-mer. Divers cleaned the optical sensors on the buoy and performed dark IOPs measurements. The ARGOS connector was cleaned too. The 3 band Wetlabs fluorometer for Collin Roesler was mounted again on the buoy. Its schedule was modified to Have 20 records every 15 minutes. One of the 3 solar panels was broken. The ARGOS dispatch revealed the buoy was not functioning.

2.2.21 Saturday 7th April 2016

This days diving operations at the BOUSSOLE site on board the PAPETEE ship. At the same time an emergency recovery of the sea glider previously deployed in the BOUSSOLE/DYFAMED area was organised. However the glider drifted too far from BOUSSOLE during its period at surface ant the diving was cancelled.

2.2.22 Wednesday and Saturday 13th and 16th April 2016

This days is part of the B#170 cruise. When arrived at the BOUSSOLE site, divers went at sea to remove the DACNet from the buoy for its repair and maintenance on board. Then, the Triplet at 9 m was recovered for data download and reinstalled during a second dive the same day after changing the battery and downloading the data. Divers also replaced the CTD located at 3 m depth with a new (eg recalibrated) one and cleaned the sensors. The DACNet could not be reinstalled during the second dive because the microdrive had to be changed. The microdrives that we had on board were not functioning. Surface sensors and solar panels were cleaned on the top of the buoy. A solar panel which was broken was replaced by a new one. The DACNet has been then repaired in the lab and reinstalled on the buoy during a second diving during the DYFAMED cruise 3 days later.

2.2.23 Tuesday 3th May 2016

This day is part of the B#171 cruise. When arrived at the BOUSSOLE site, divers went at sea to clean the optical sensors, to perform dark IOPs measurements and to take pictures. The Triplet fluorimeter at 9 m was recovered. Surface sensors and solar panels were cleaned. Buoy data were downloaded directly using the telemetry cable available on the top of the buoy.

2.2.24 Saturday 21st May 2016

This day 3 divers from LOV went to the BOUSSOLE site on board the PAPETEE to clean the optical instruments and perform dark IOPs measurements. The ARGOS connector on the buoy head was cleaned too and the ARGOS dispatch restarted.

2.2.25 Monday 6th June 2016

The buoy was turned off at about 8h50 UTC and dismantled from the lower structure from Léo Gimenez and other divers with the help of the GGIX ship from IXSURVEY. The buoy was then transported to the Villefranche port and unloaded with the help the CCI crane at 14h15. One of the delrin support for the arms broke during dismount. The buoy was then cleaned with Karcher before being stored into the CCI local. The buoy was dismantled in the following days and instruments were shipped for calibration on July 4th and arrived to the different companies within few days. The aluminium structure was sent to the BSS Company in Biot on July 1st.

3. QUANTITATIVE SUMMARY

The deployment lasted 392 days, among which 36 days were without data due to a failure of the microdrive.

4. INSTRUMENT SCHEDULE

1 minute acquisition every 15 minutes. The timing of the schedule was: light 03:00:00 to 21:00; dark 21:00:00 to 03:00:00. Store-X and CISCO were cut off during night.

5. ANY PROBLEMS ENCOUNTERED ?

- 1- The ARGOS dispatch stopped few times.
- 2- The CISCO connection was never used.
- 3- The microdrive failed twice.
- 4- Solar panels brake once.
- 5- The Hyperspectral instruments misaligned at a certain point.
- 6- The antifouling paint was almost completely lost.
- 7- One support for the buoy arm broke during deployment and a second one broke during recovery.

6. LESSONS LEARNED

- 1- The CCI crane can be safely used for the loading of the buoy upper superstructure on the GGIX.
- 2- Delrin supports for the buoy arms should be replaced after 2/3 deployments.

7. APPENDIX

The following page contains the results of the radiometers test the schema of the buoy, the list of the calibration files and the dark records of PAR and multispectral instruments.

Radiometer Test

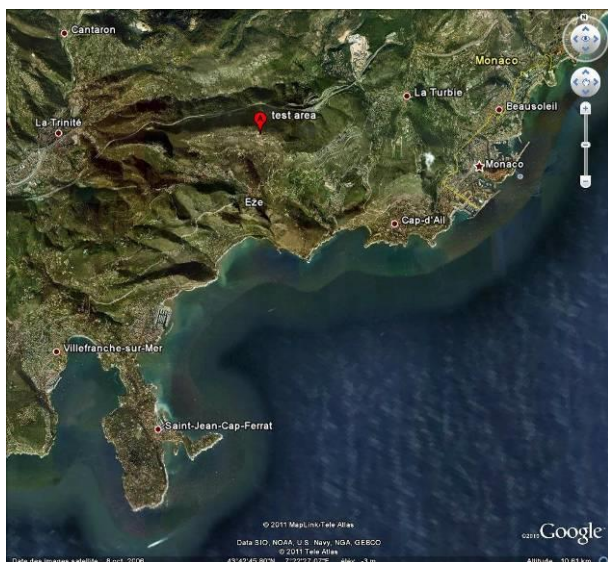
On April 1st 2015 a field campaign to test the buoy radiometers relative performances was organized at the Fort de la Revere. The fort is located at north of the Eze village at about 700m on the sea level (see images below), and near the fort there's a plane field free of obstacles that could cause shadow or glint above radiometers.

All the radiometers used for the buoy were fixed upon a table facing the zenith. The Lu and Eu sensors were covered with teflon caps produced at LOV.

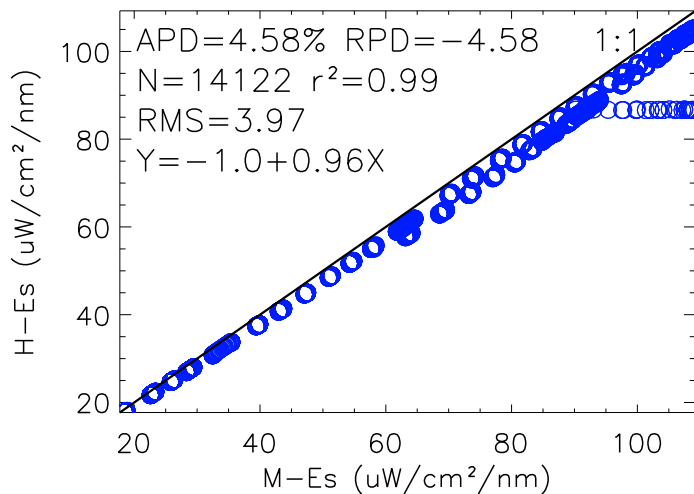
The instruments were all connected as for the buoy deployment (OCPs, DACNet, cables etc.) and powered with a battery, except the OCP 4 m (#040) which was out of order. The OCP 9 m was then used alternatively with the two multispectral set of radiometers. The system schedule was modified to acquire data every 10 minutes instead of 15.

Data were acquired for about 8 hours.

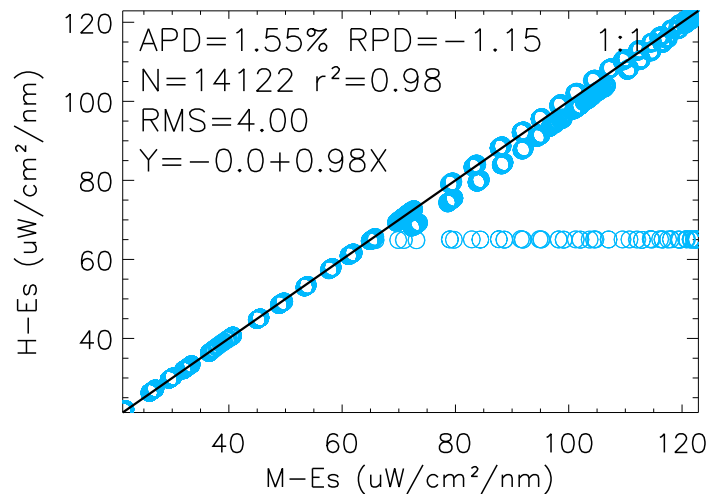
Sky conditions were good. The choice to compare single data by using the TIMETAG variable recorded in data files was maintained.



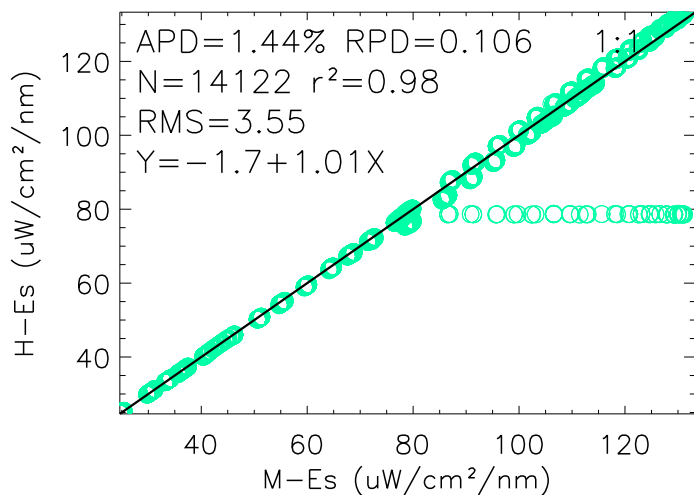
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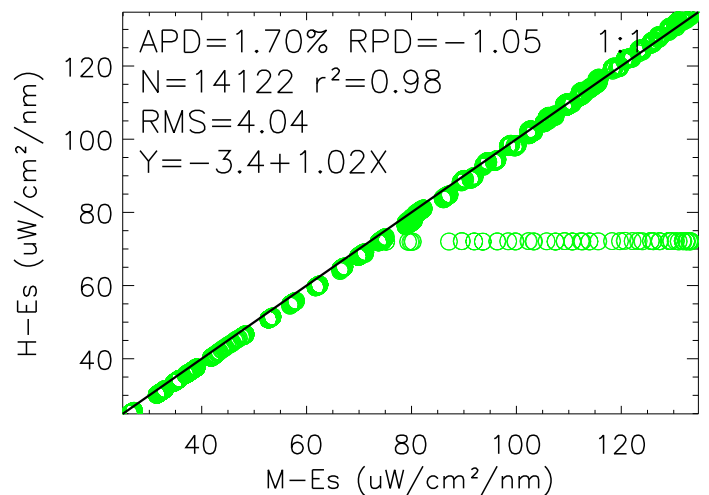
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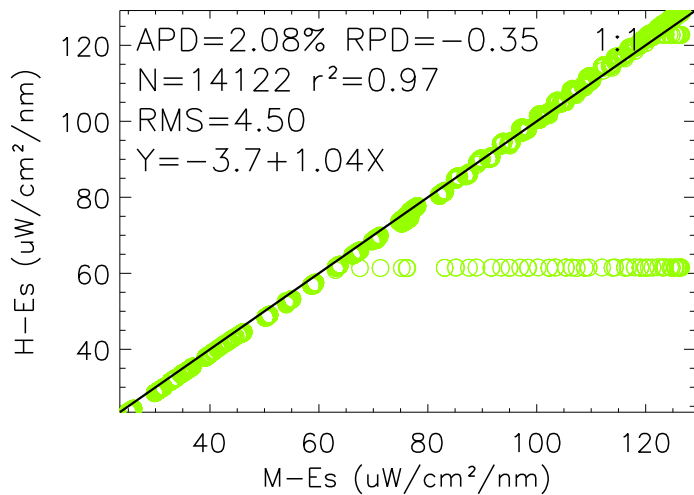
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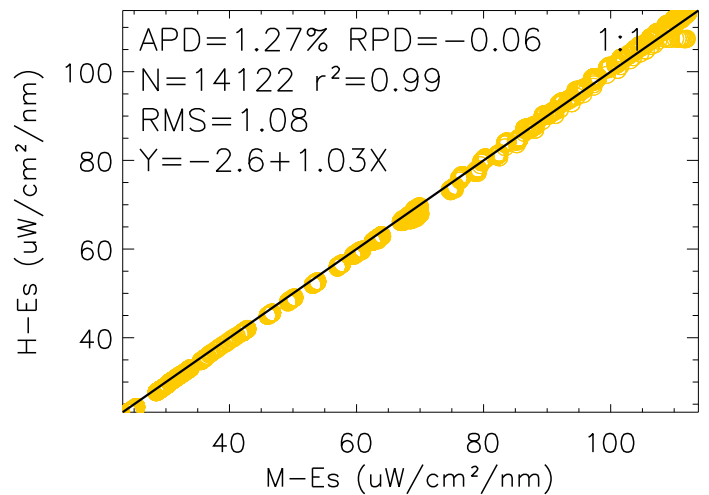
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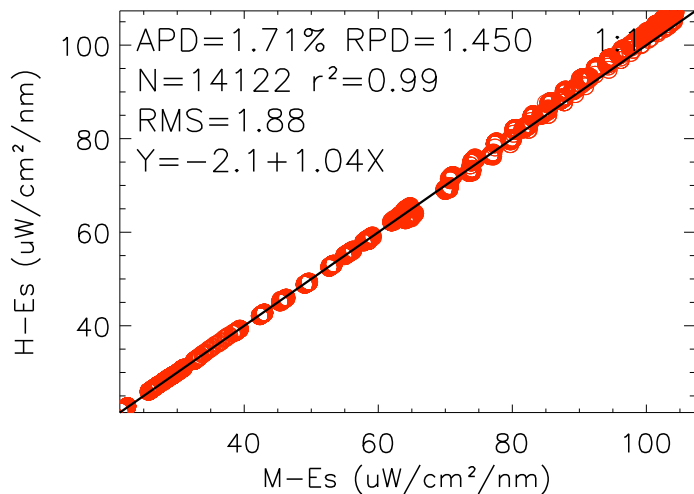
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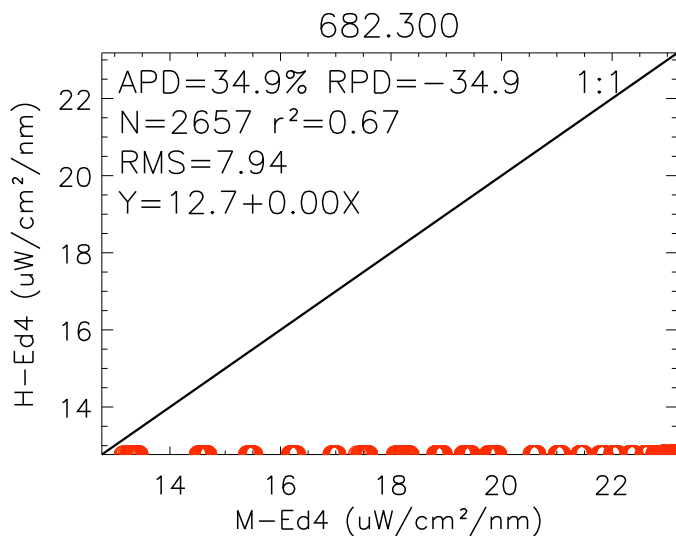
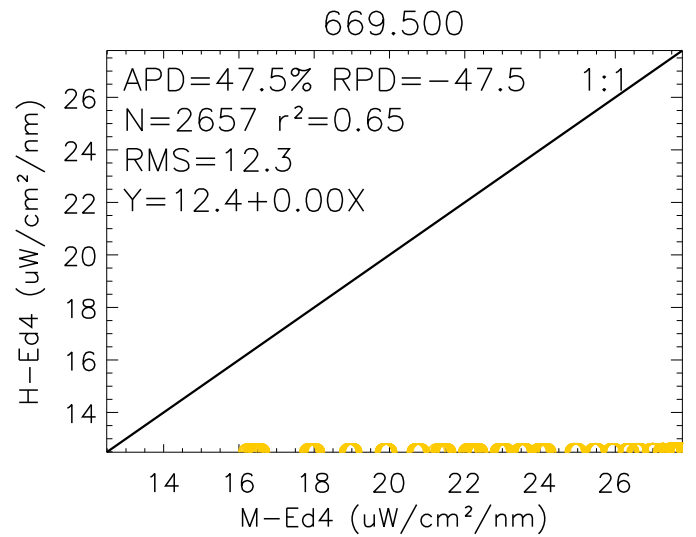
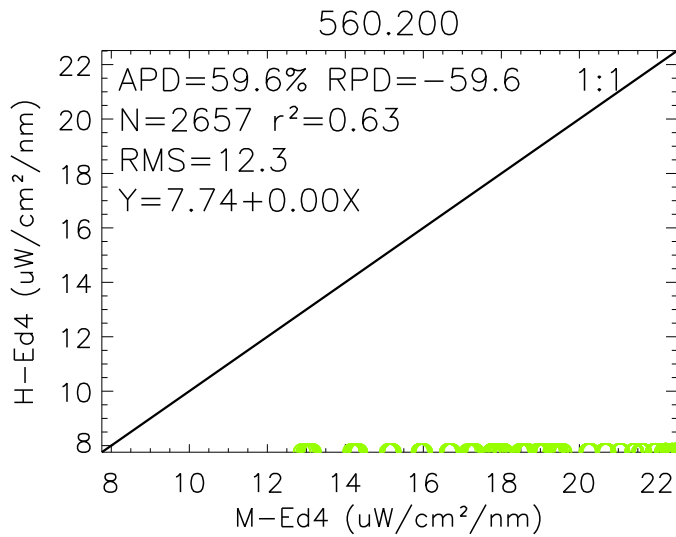
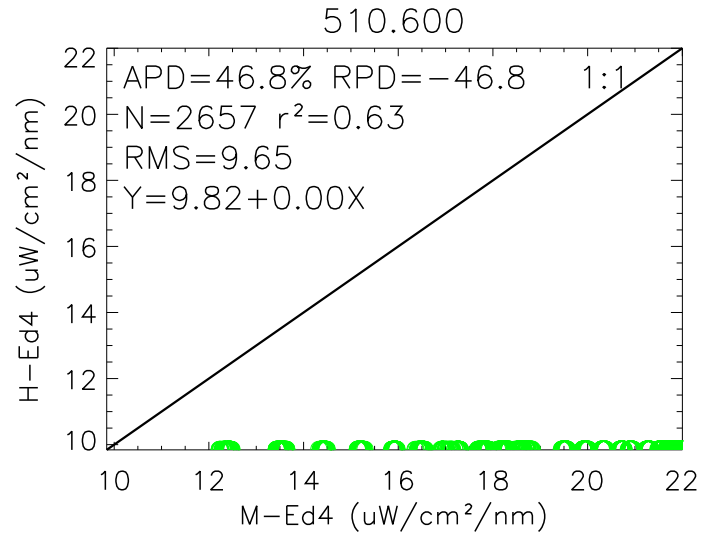
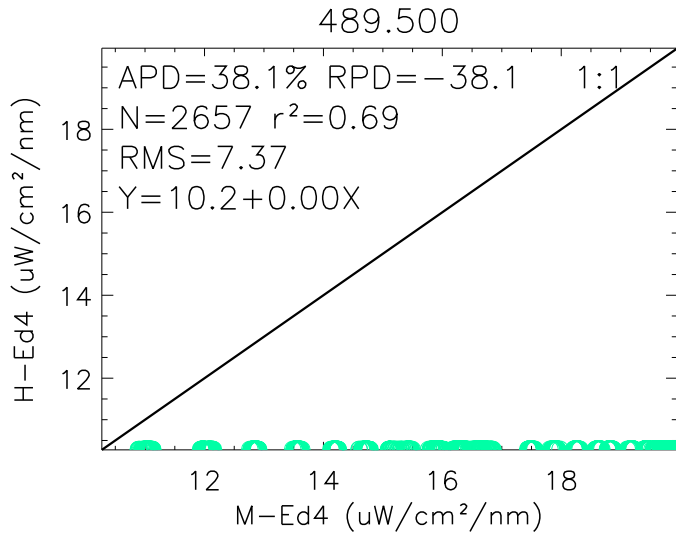
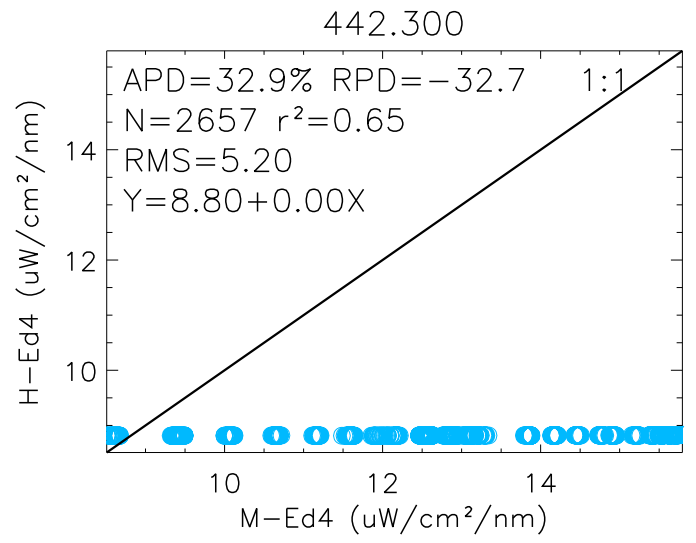
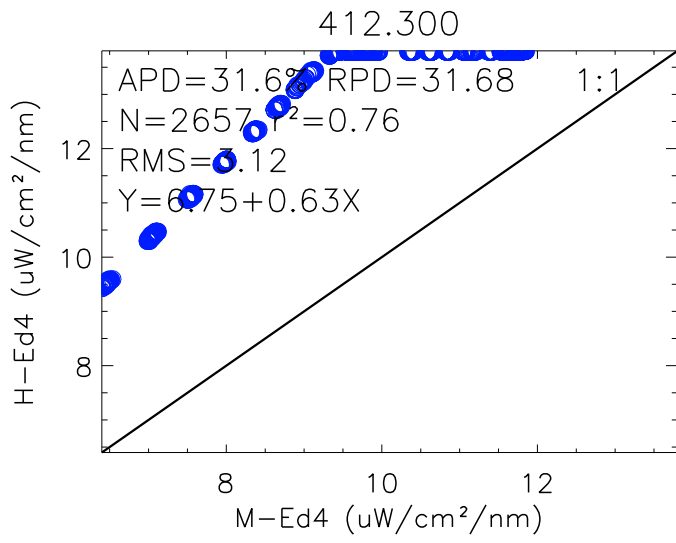


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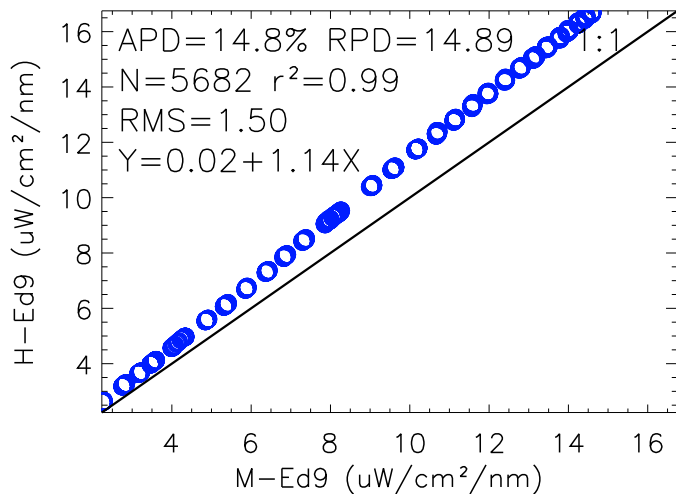


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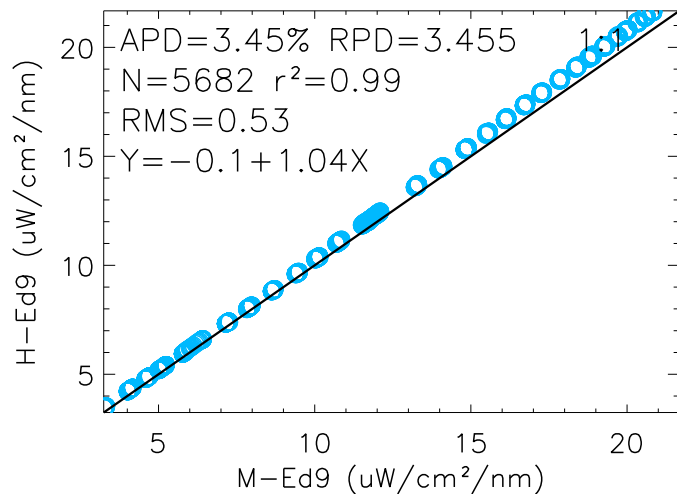




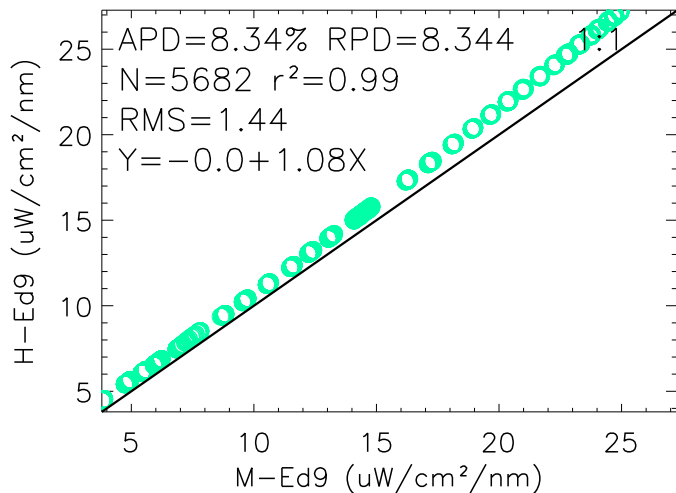
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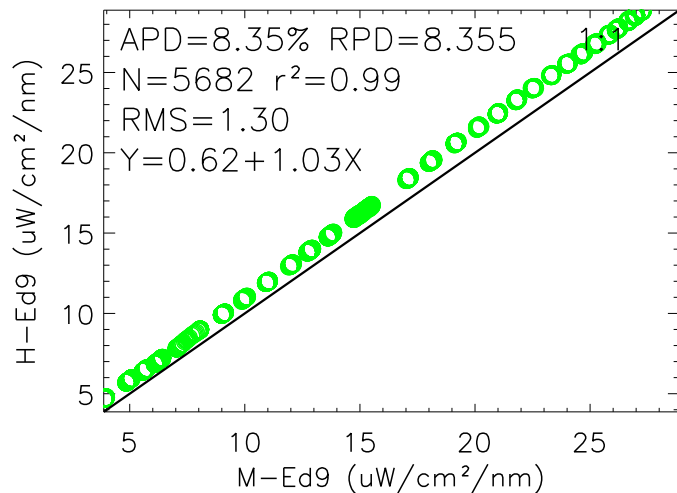
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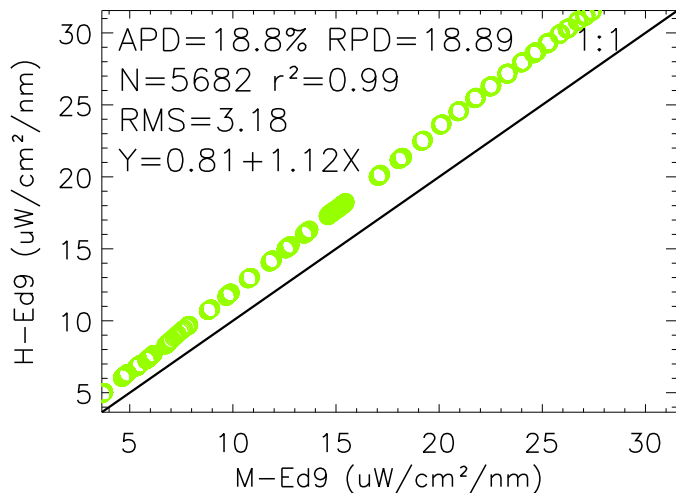
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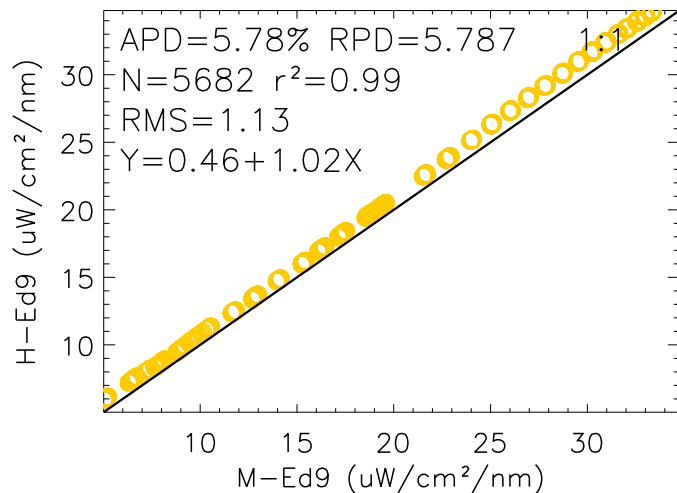
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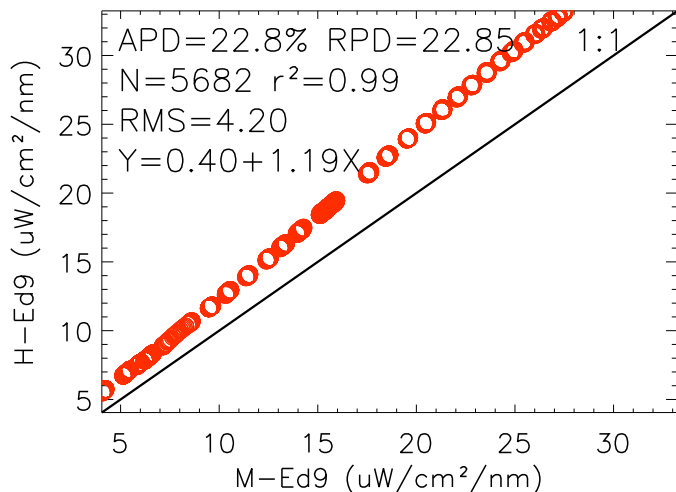
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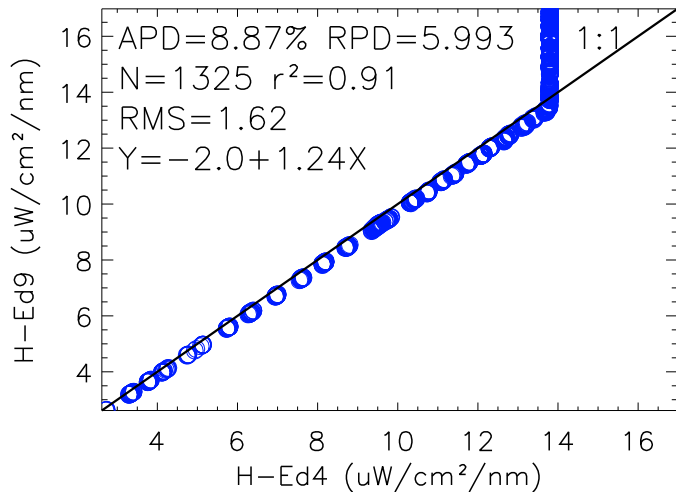
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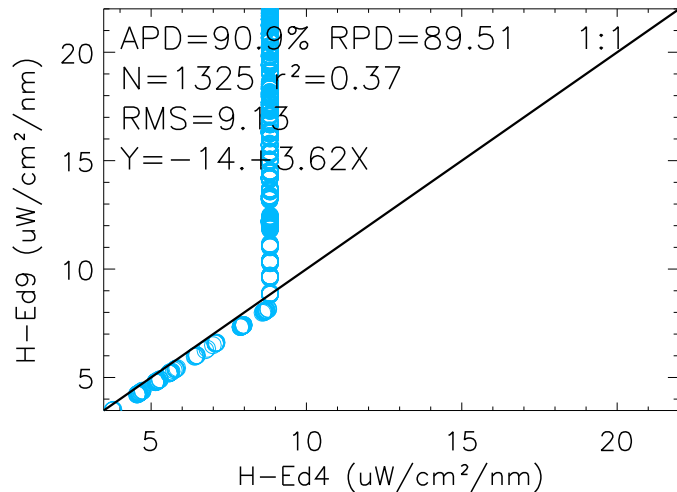
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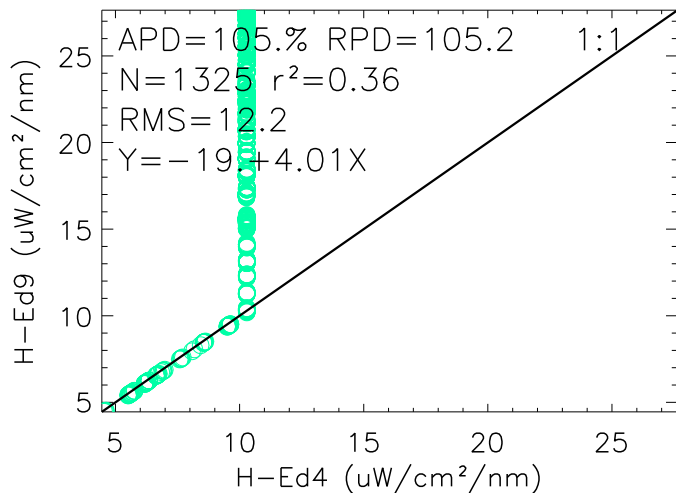
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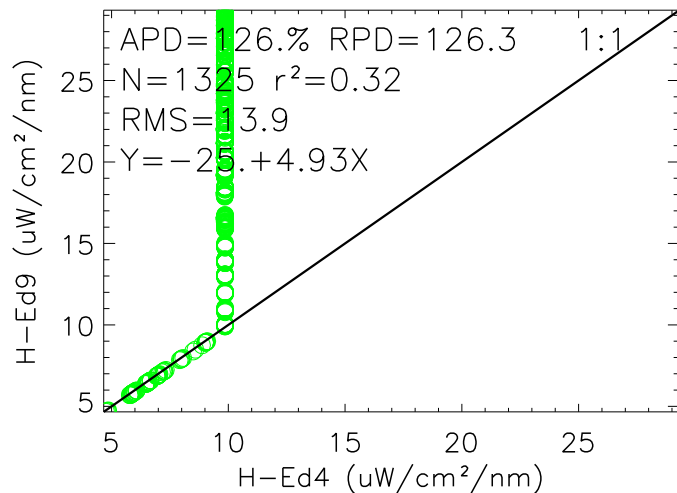
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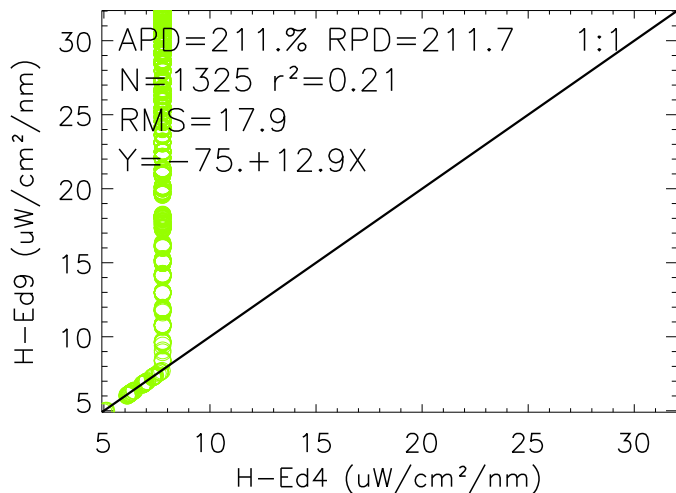
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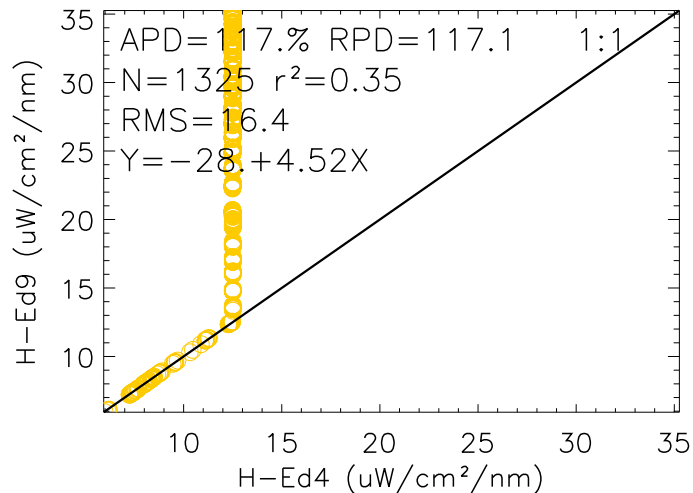
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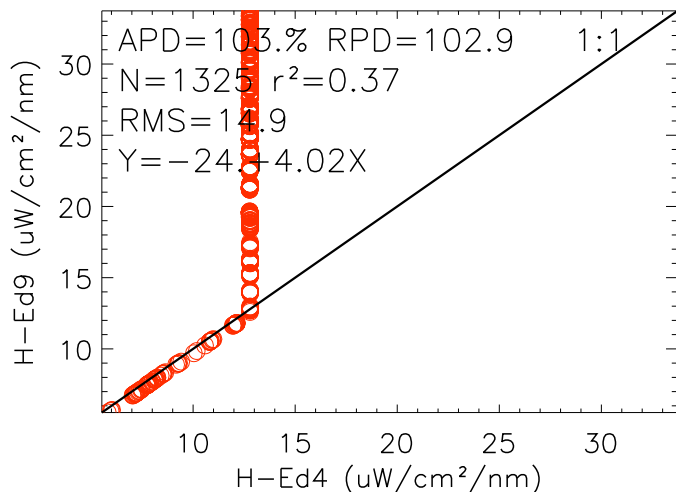
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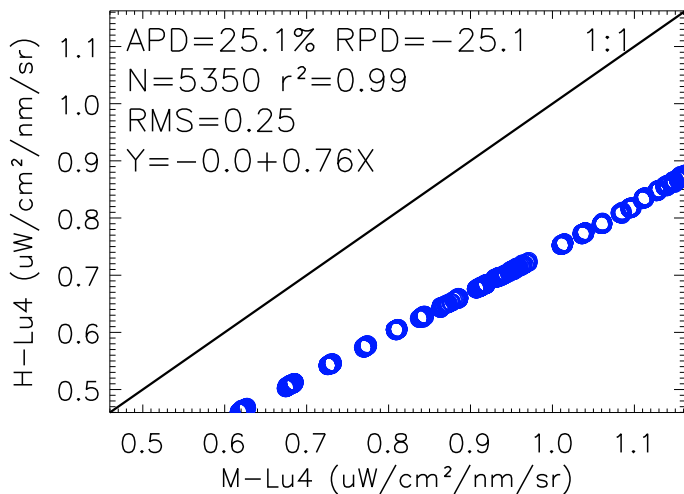
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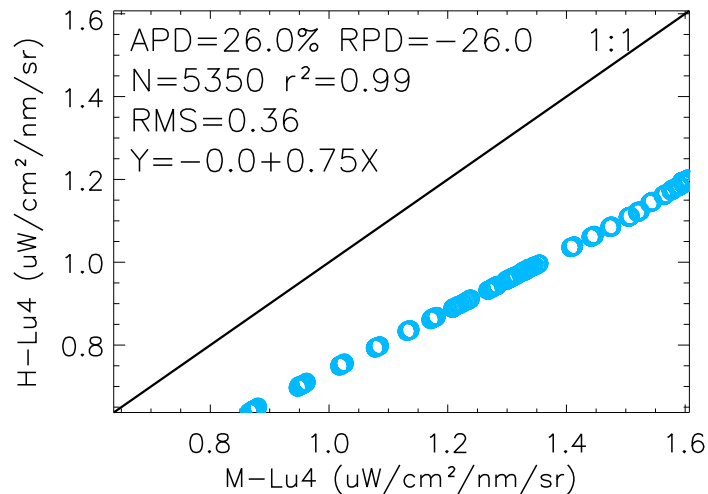
682.300



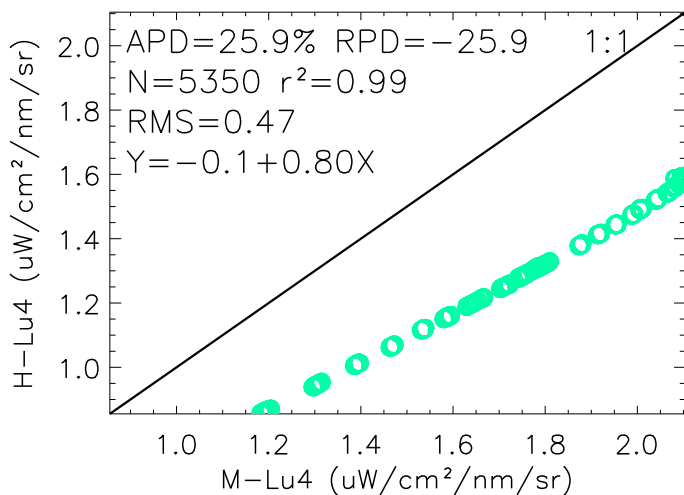
411.100



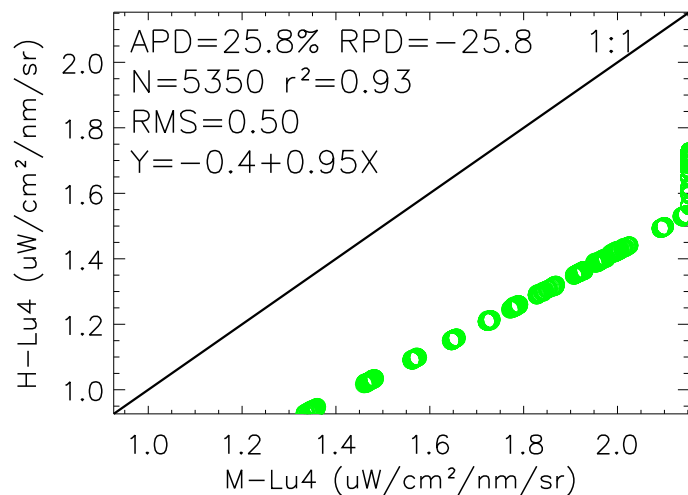
442.900



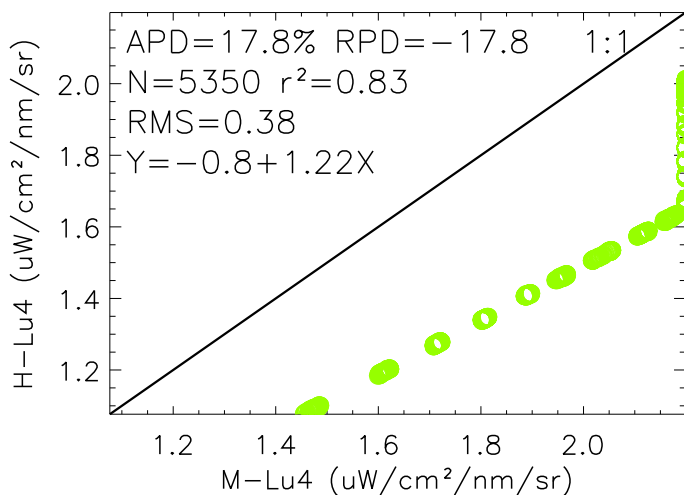
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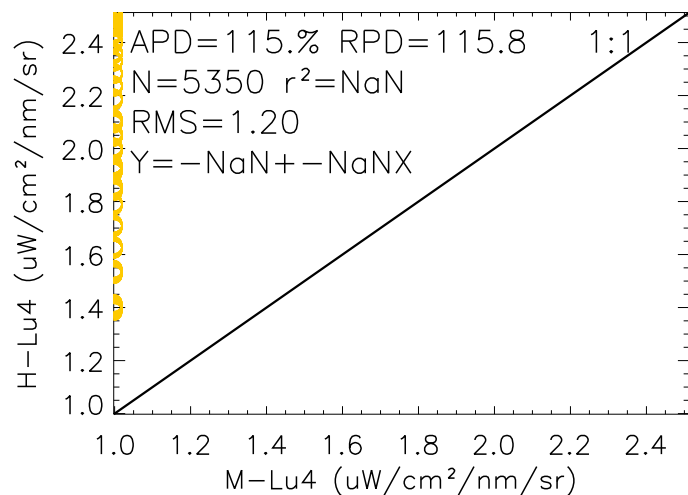
509.700



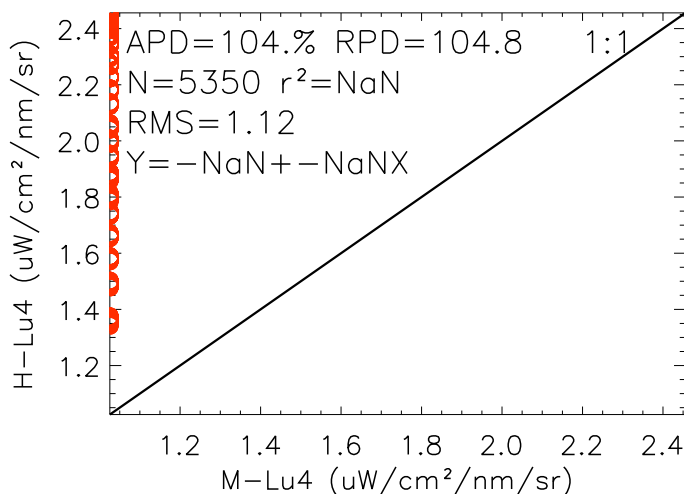
559.800

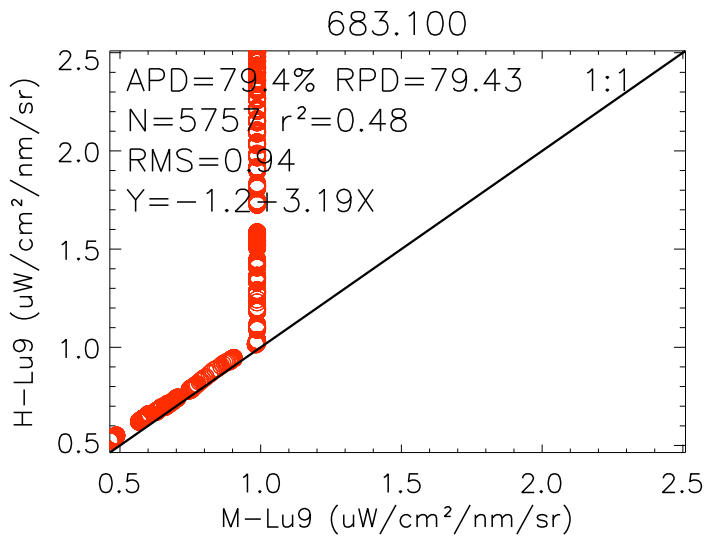
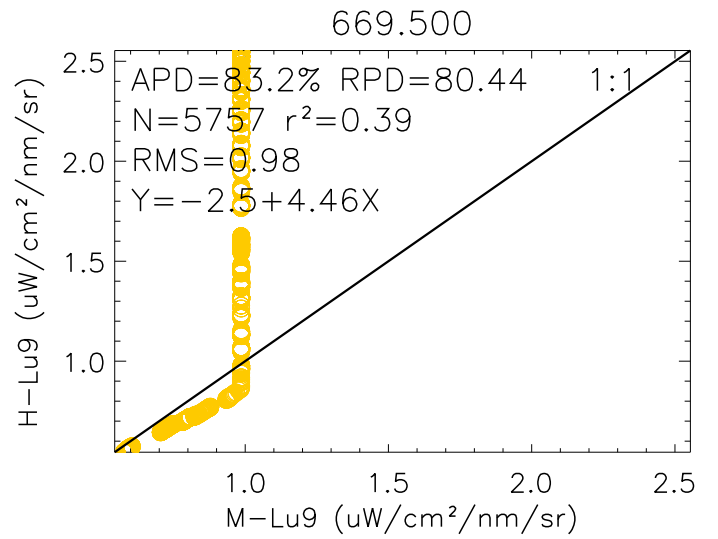
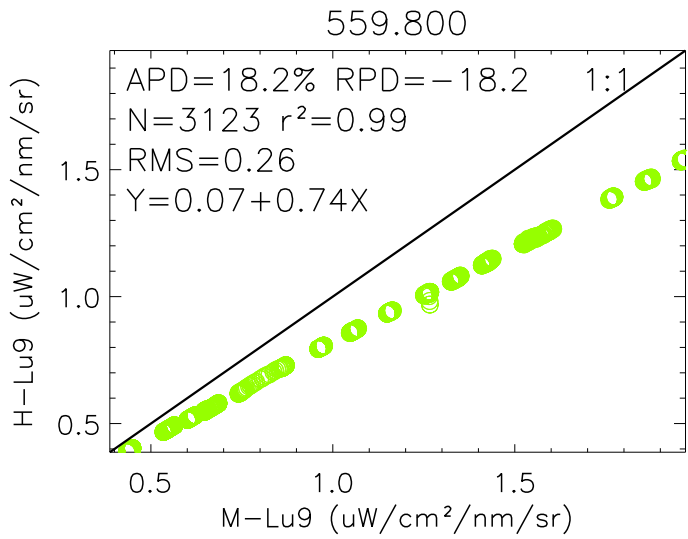
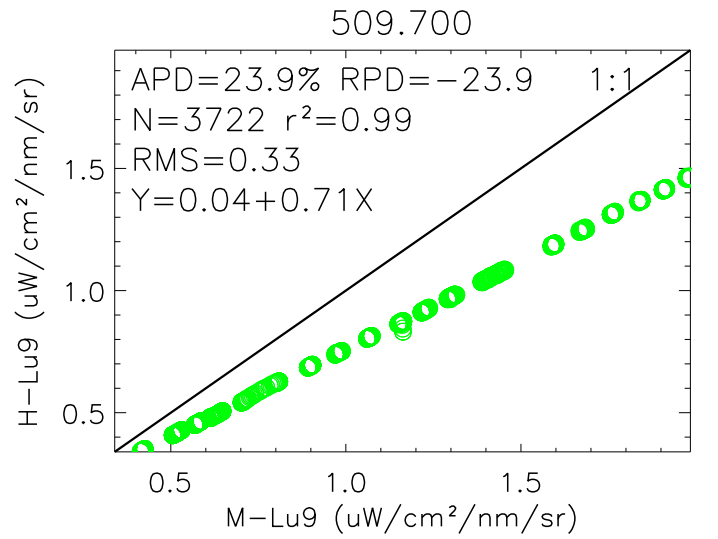
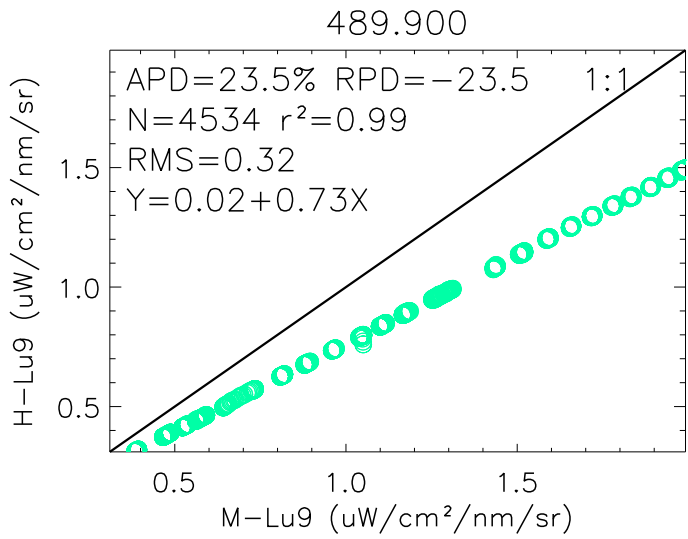
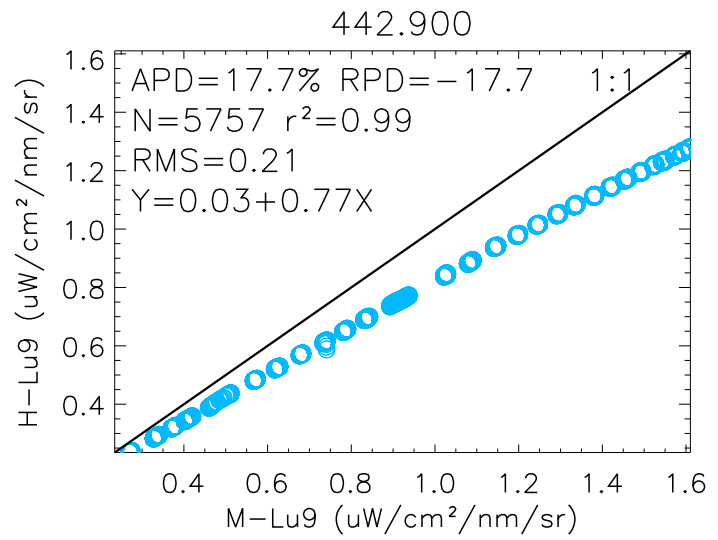
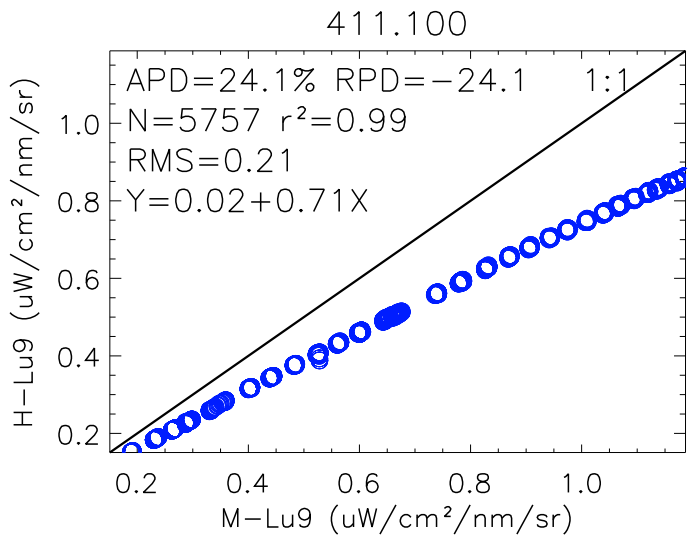


669.500

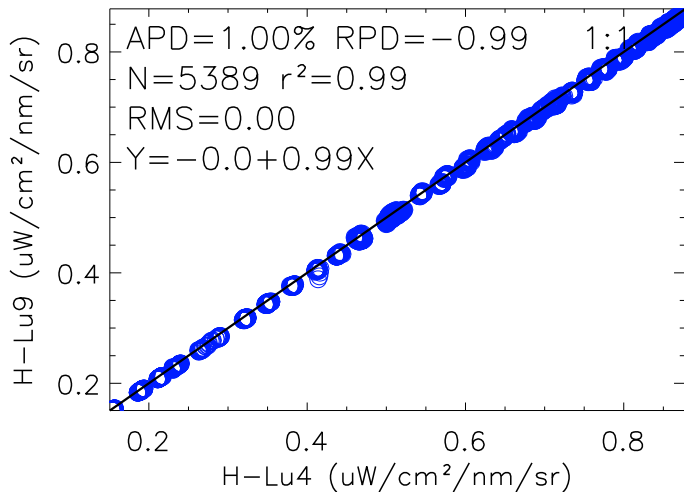


683.100

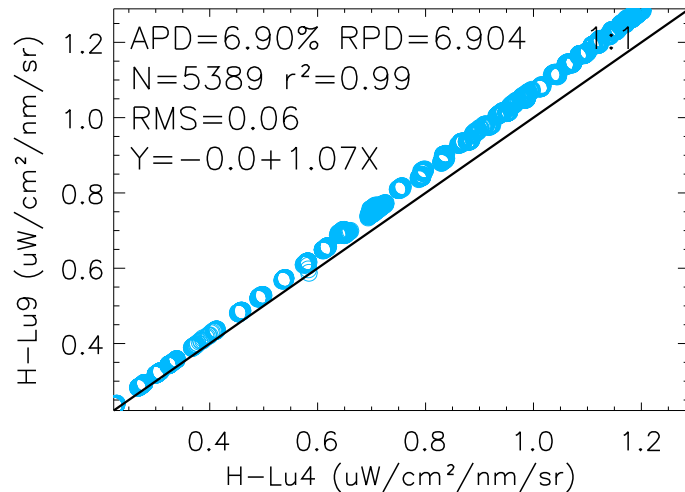




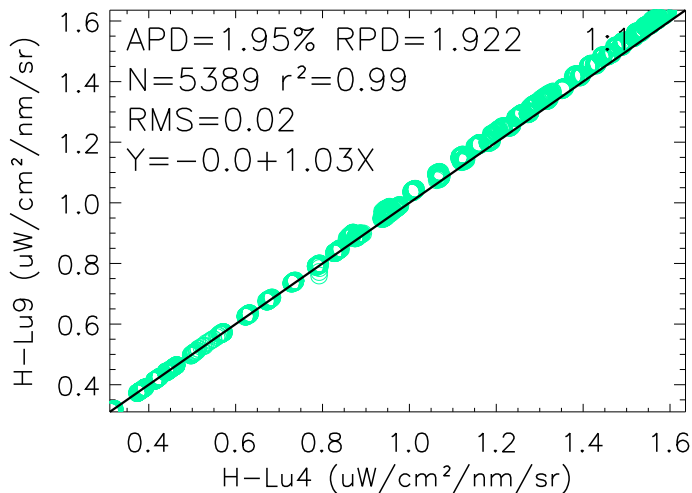
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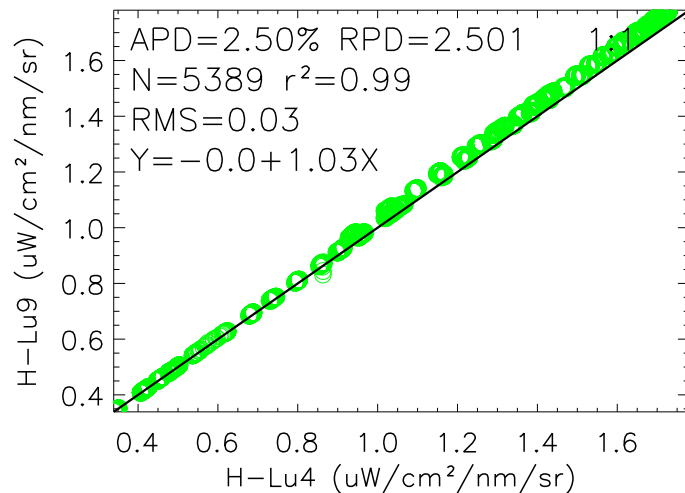
442.900



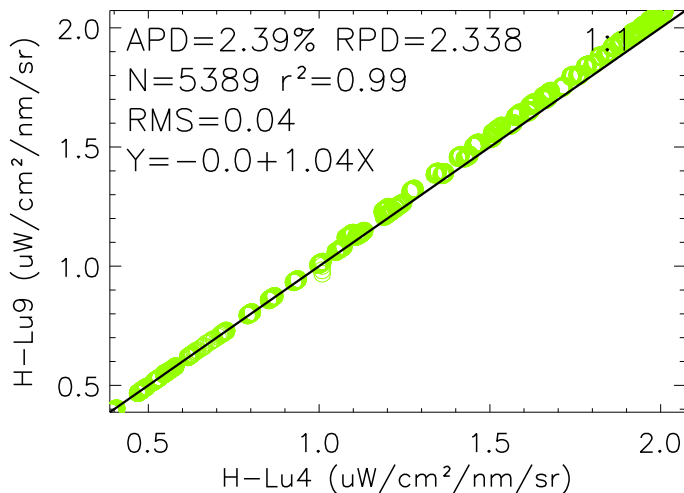
489.900



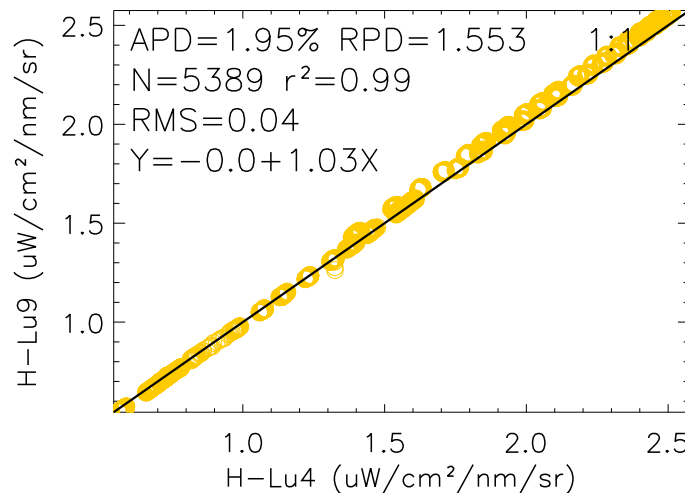
509.700



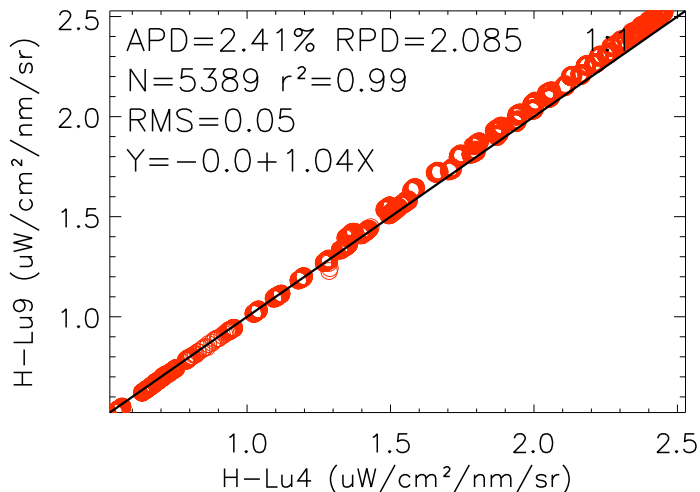
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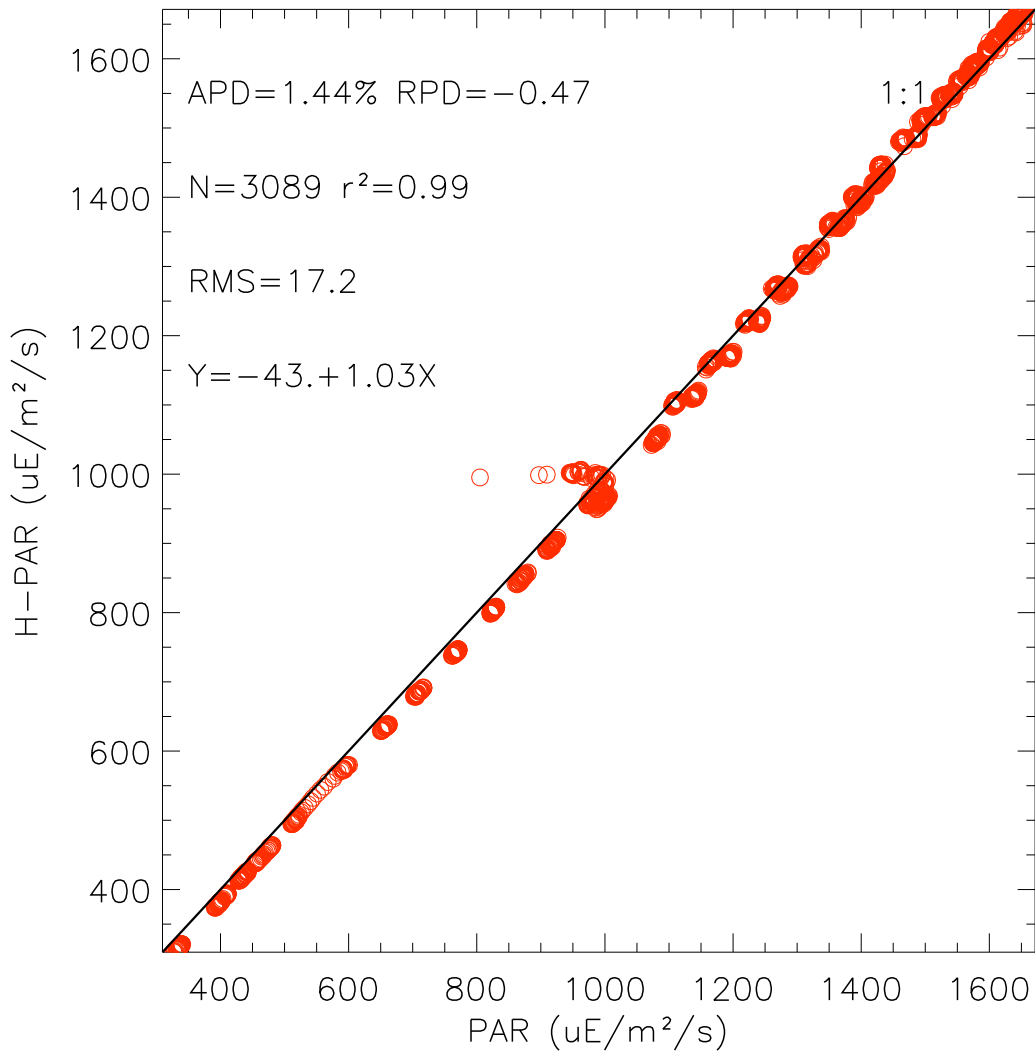


669.500

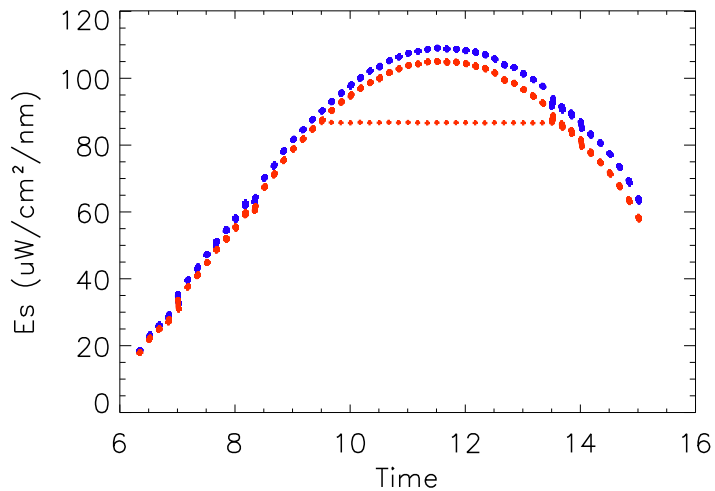


683.100

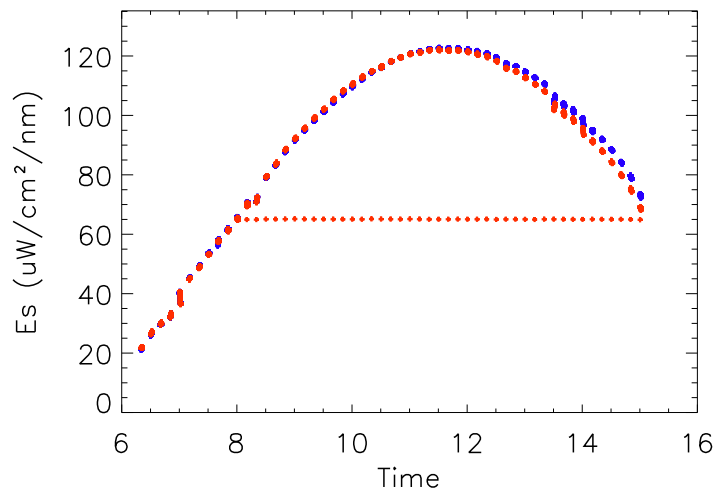




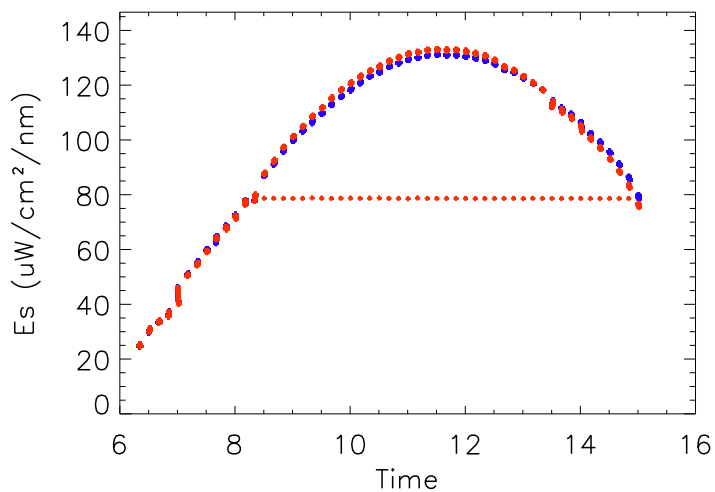
412.300



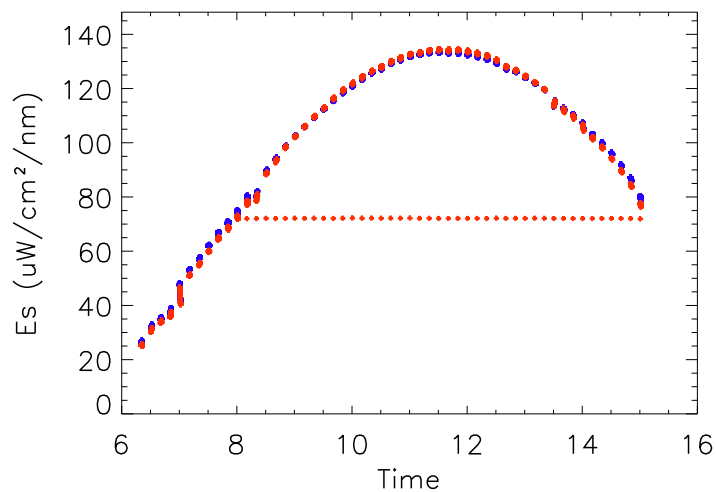
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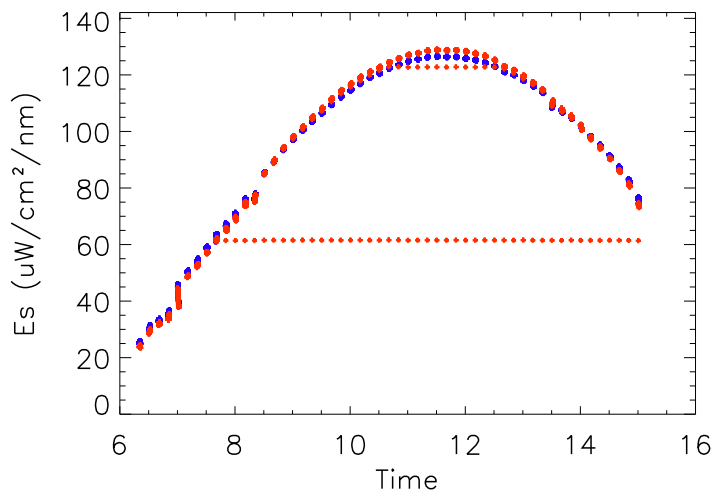
489.500



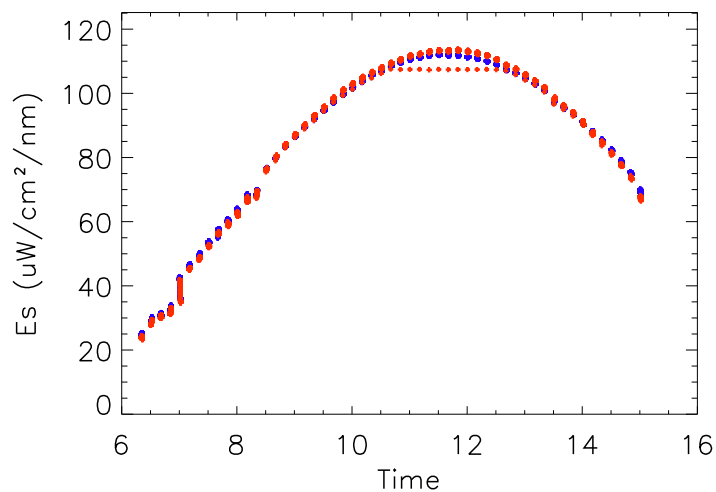
510.600



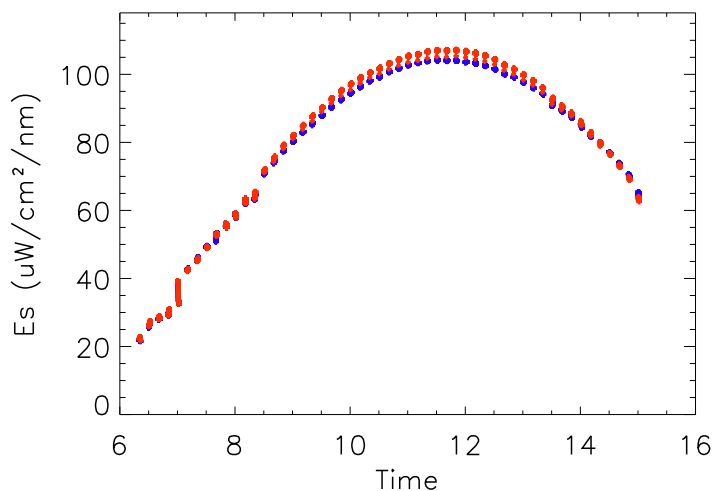
560.200



669.500



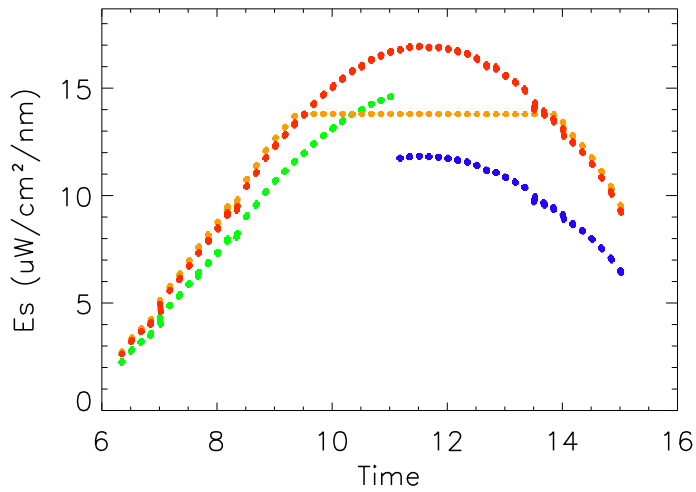
682.300



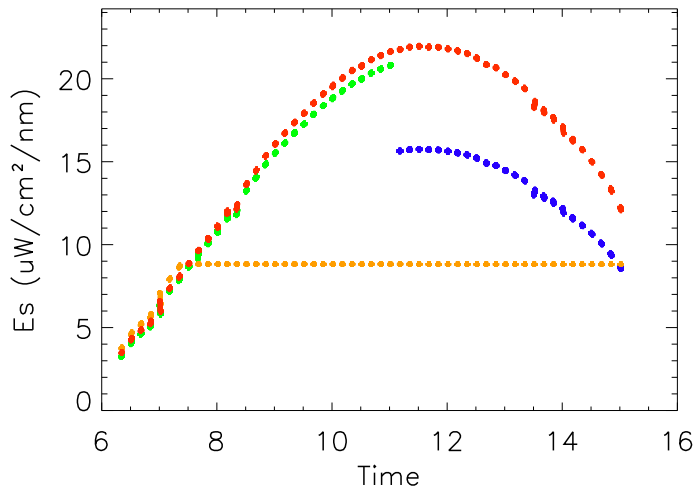
Multi-Es

Hyper-Es

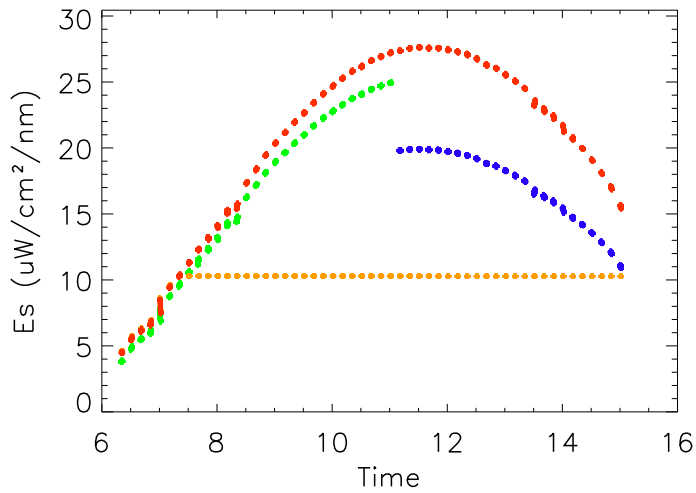
412.300



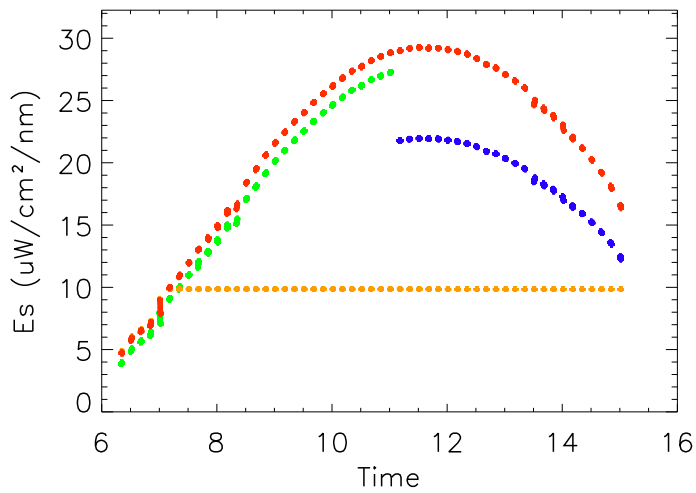
442.300



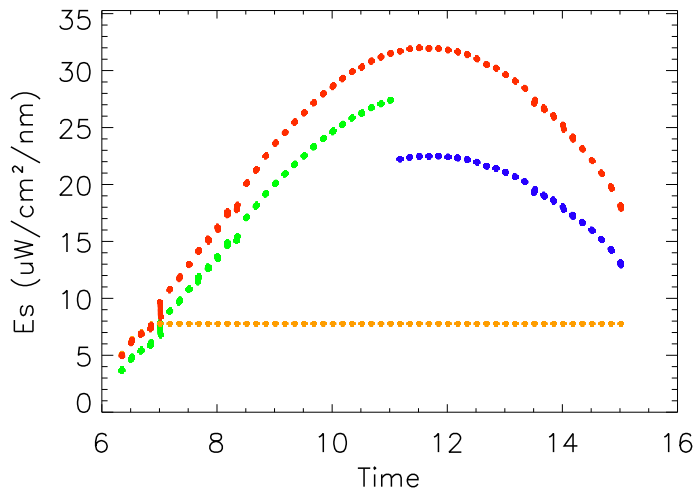
489.500



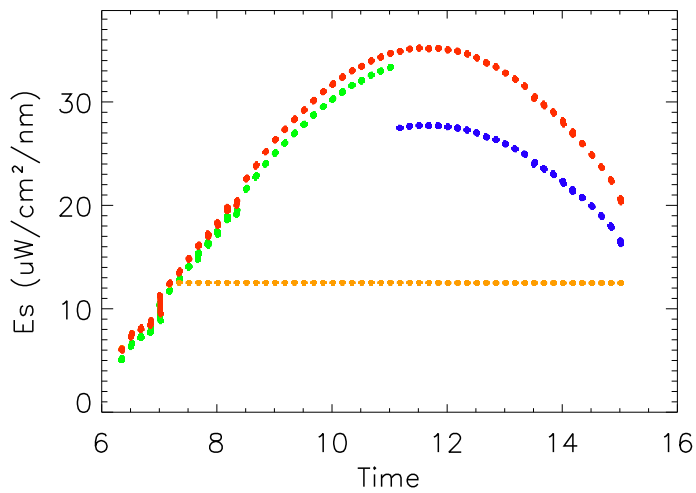
510.600



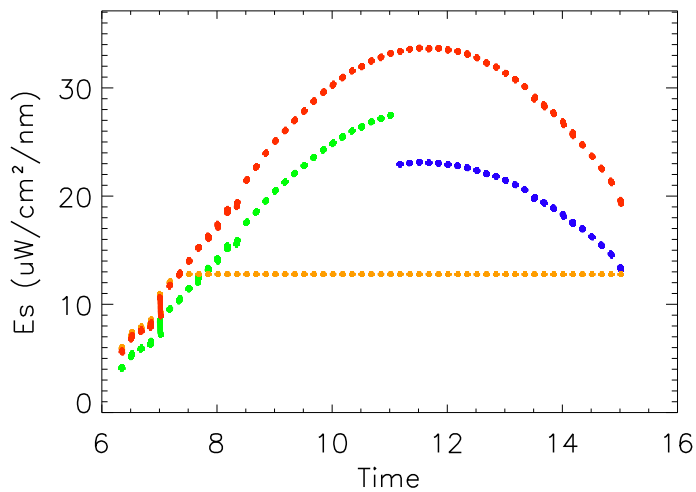
560.200



669.500



682.300



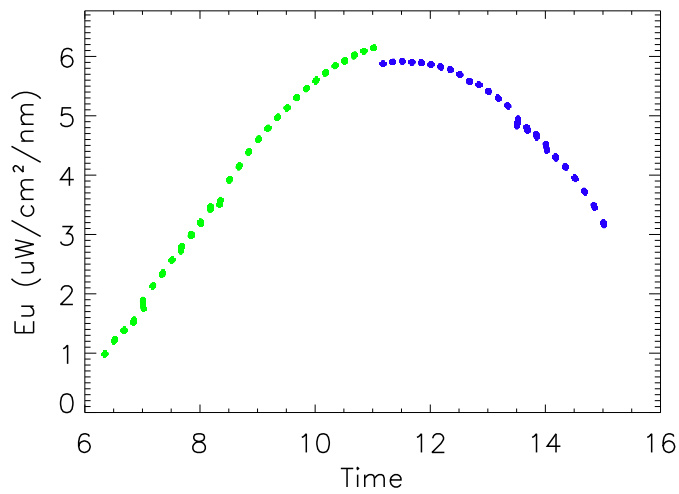
Multi-Ed4

Multi-Ed9

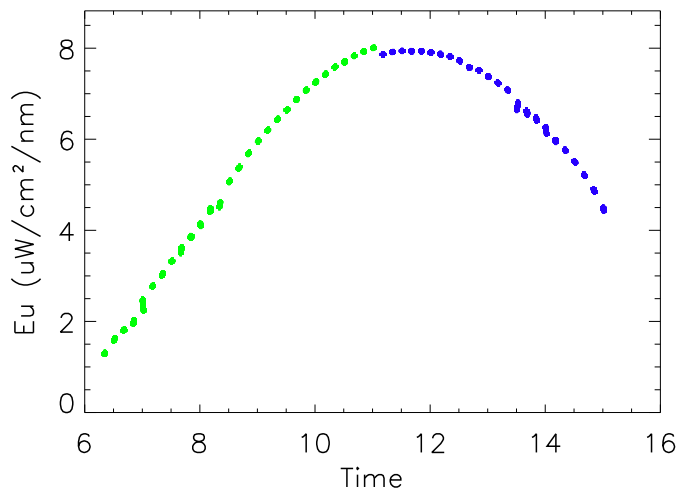
Hyper-Ed4

Hyper-Ed9

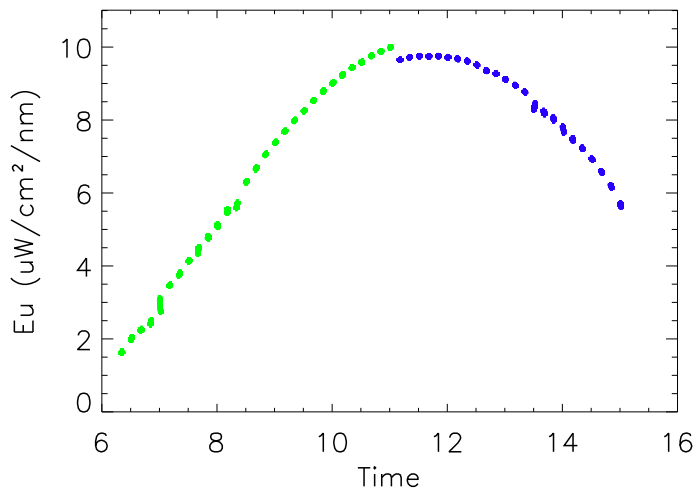
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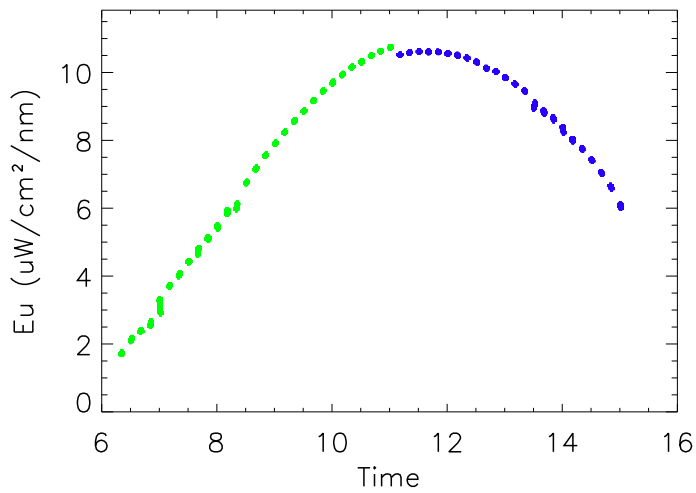
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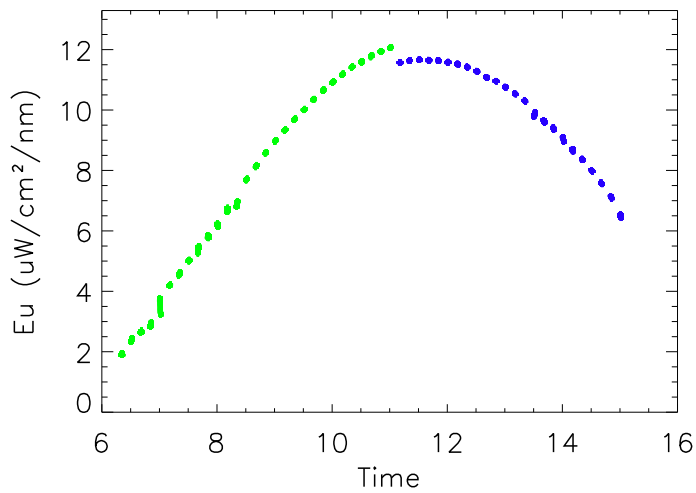
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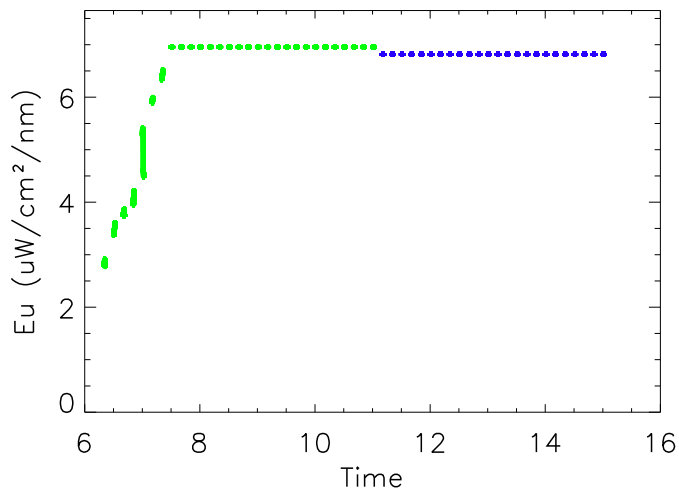
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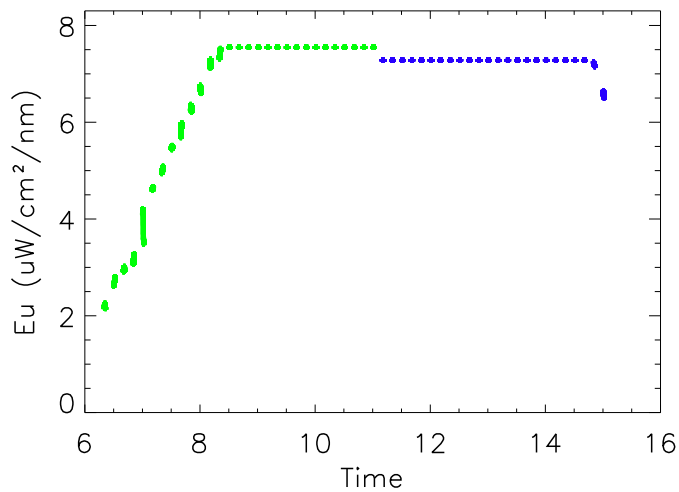
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669.500

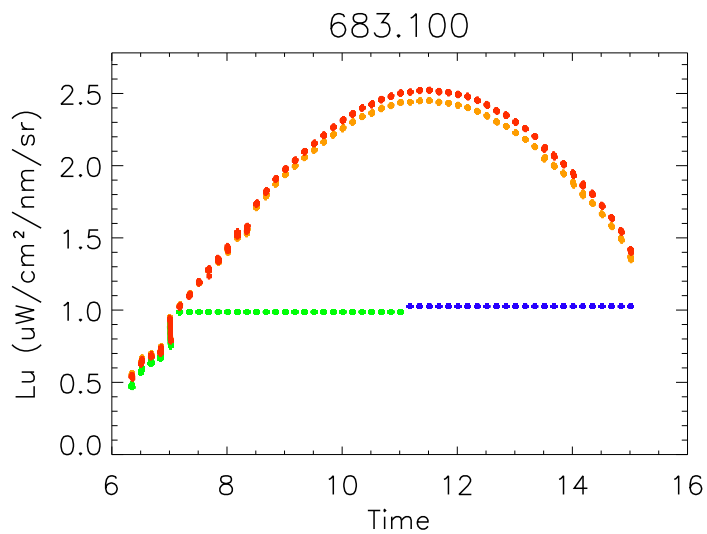
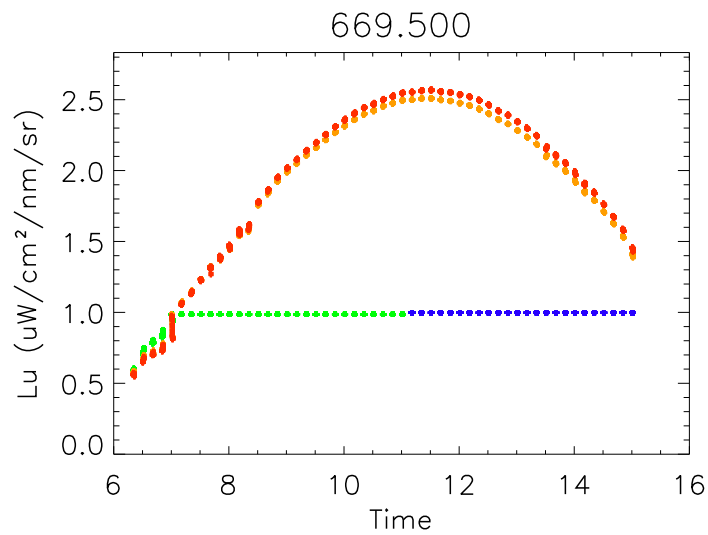
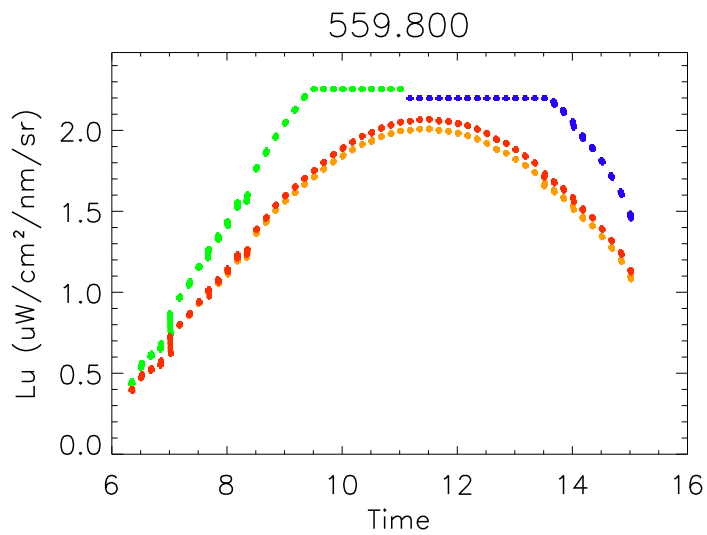
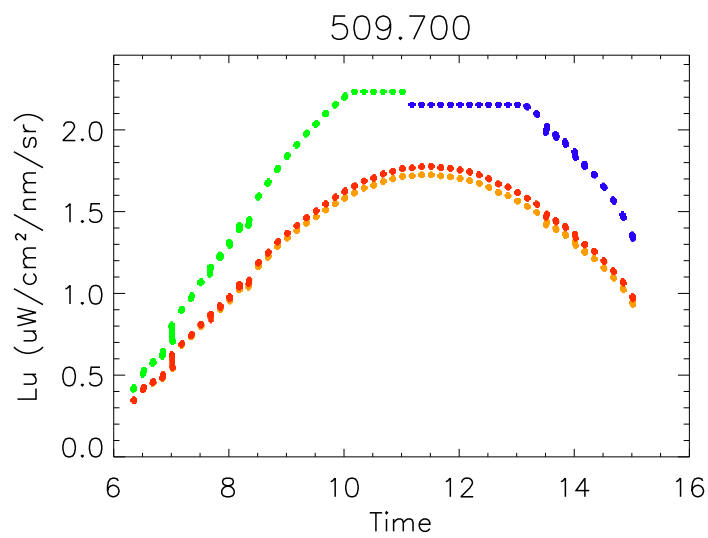
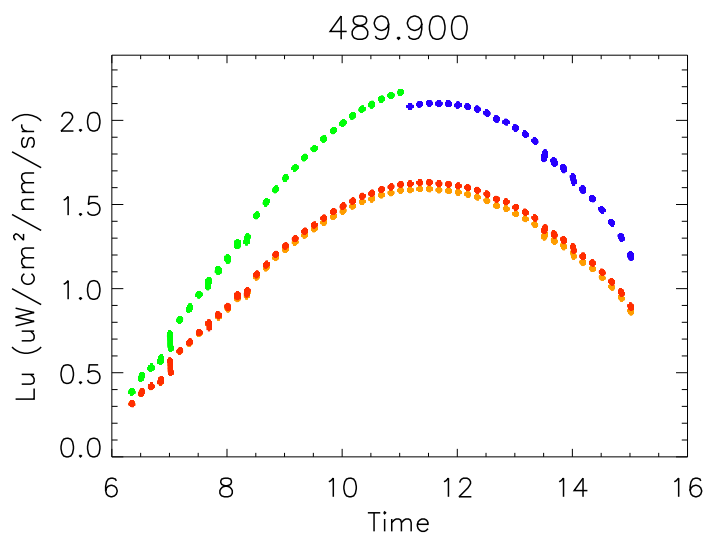
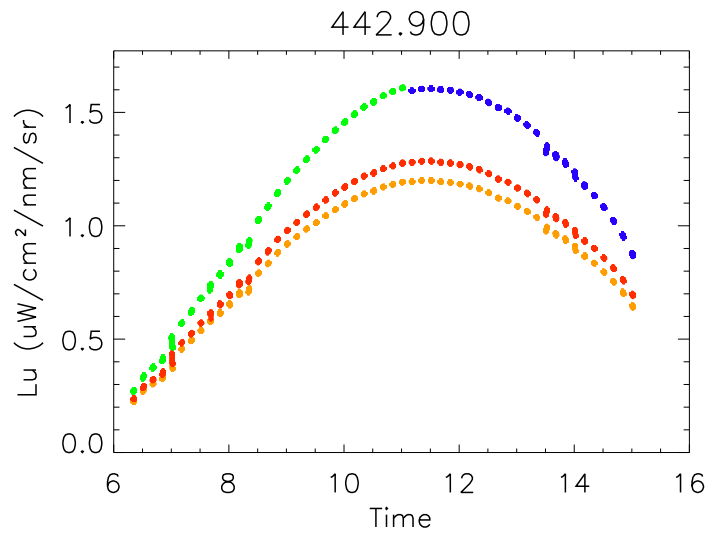
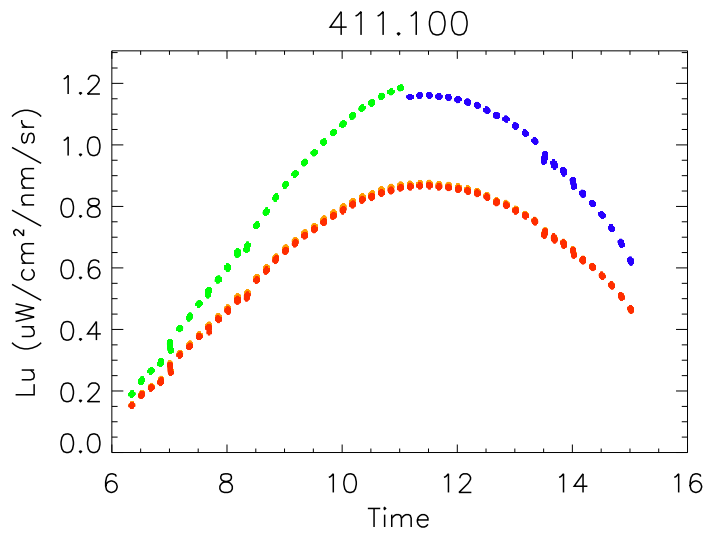


683.100



Multi-Eu4

Multi-Eu9

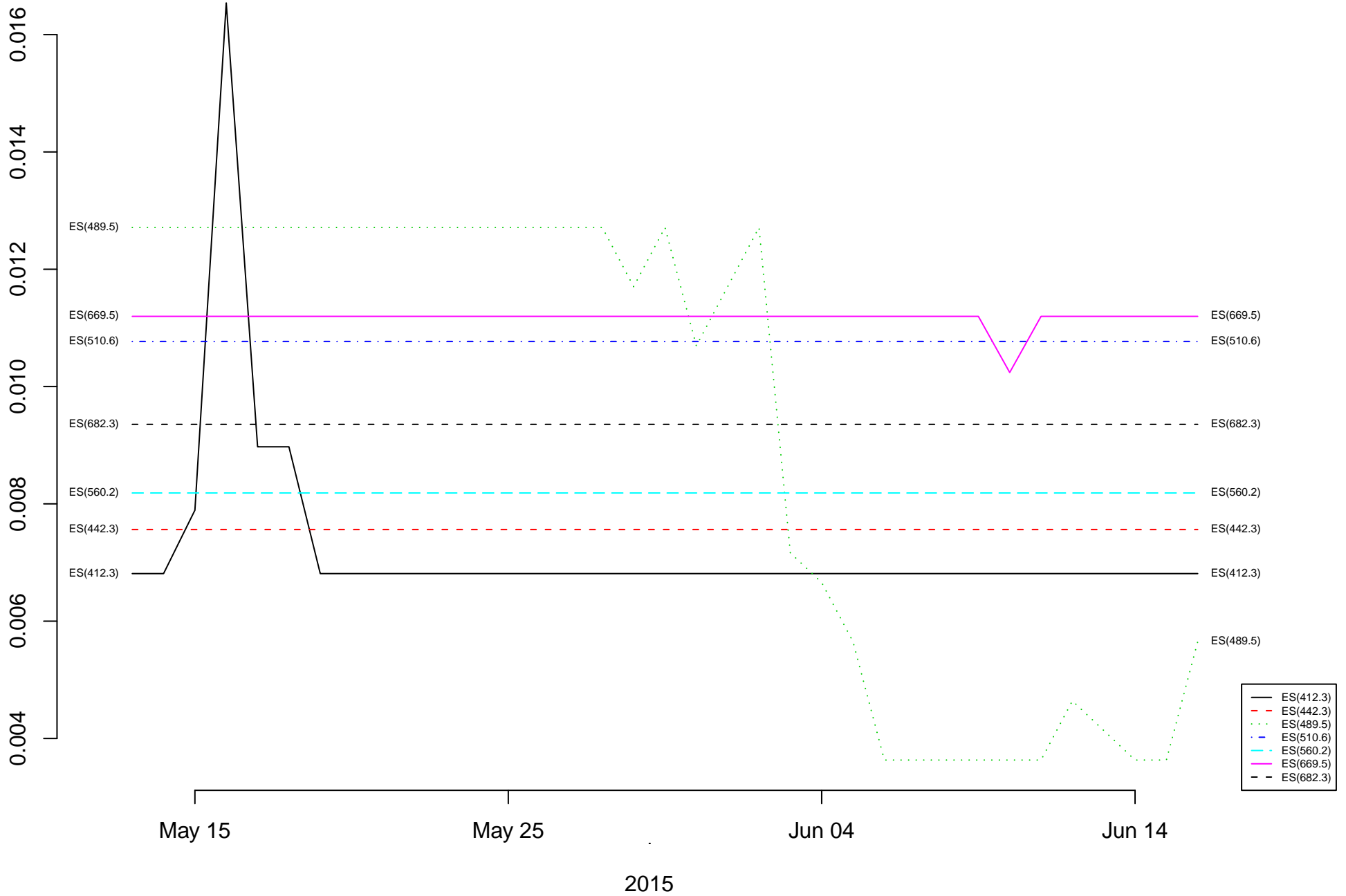


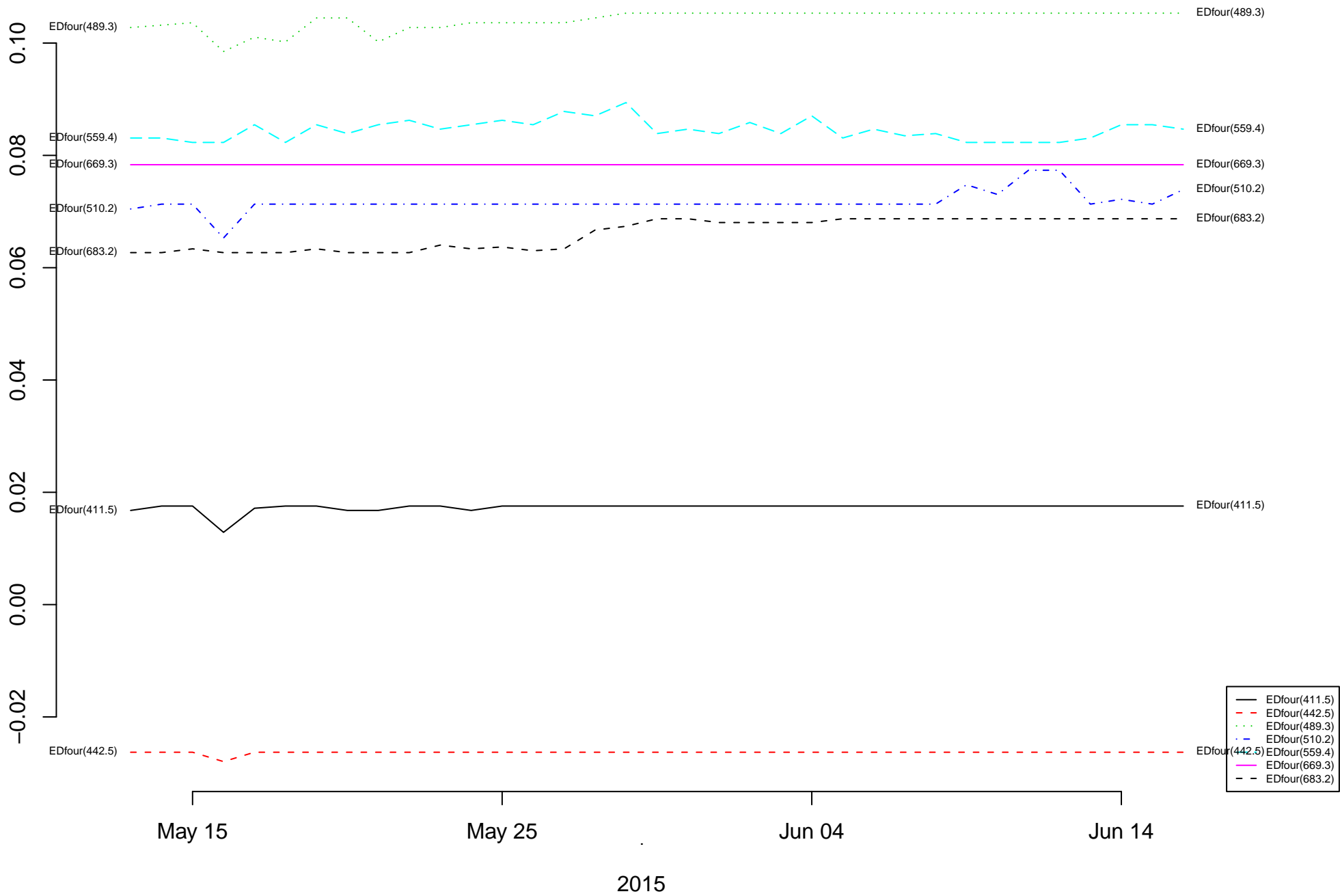
Multi-Lu4

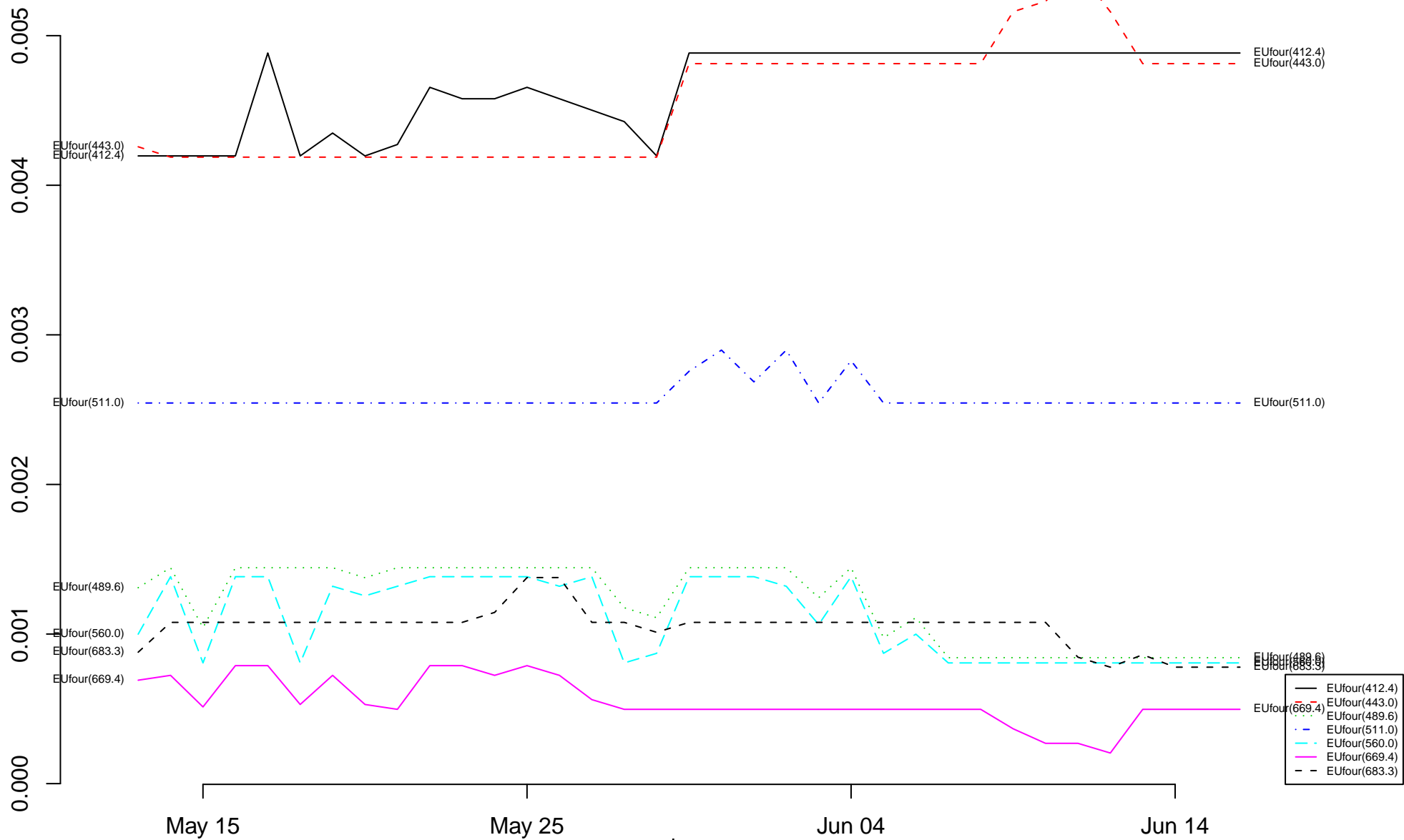
Multi-Lu9

Hyper-Lu4

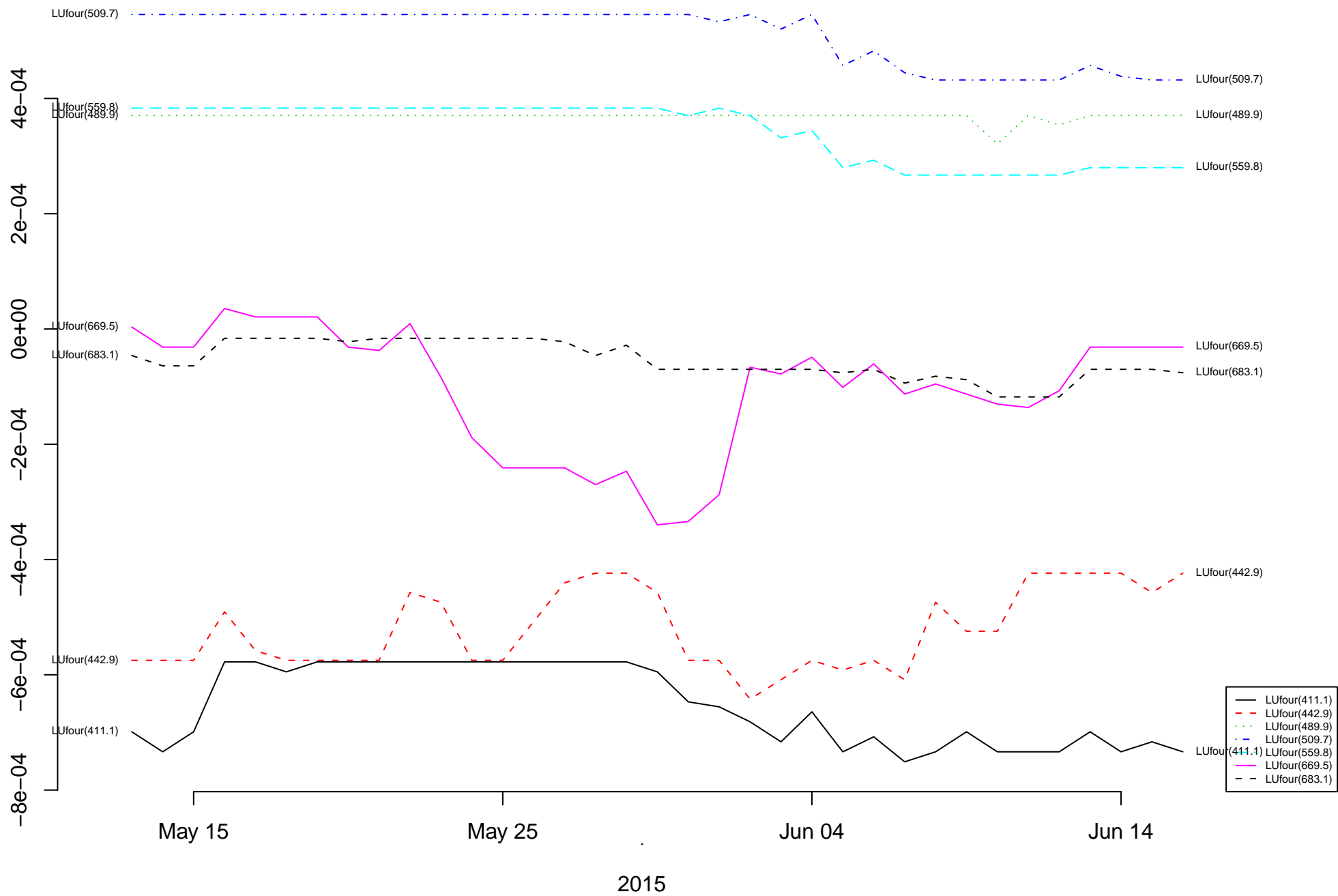
Hyper-Lu9

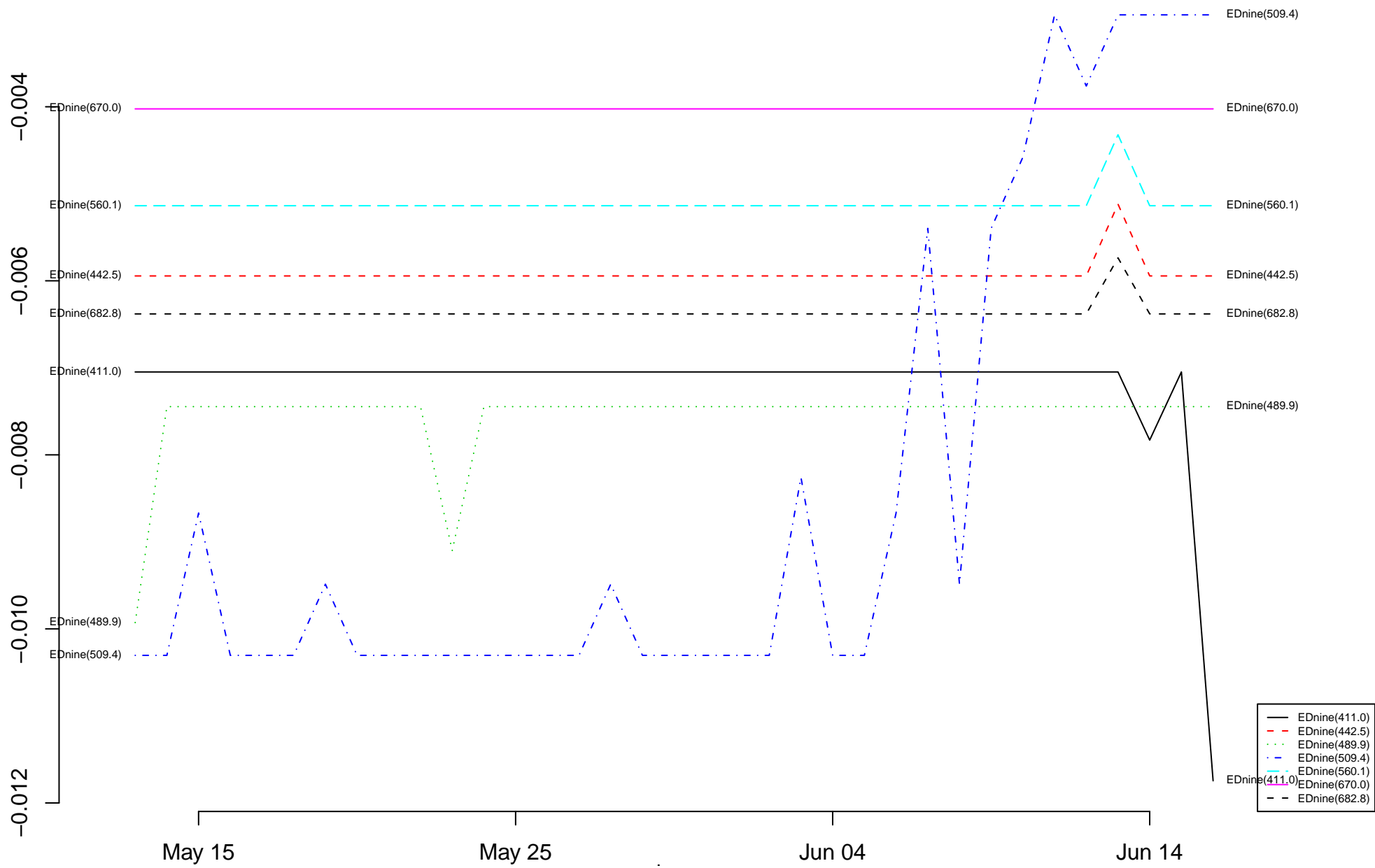






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