

Operation Manual AMALi

Airborne Mobile Aerosol Lidar

Status Dec. 2018
Nadir mode

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Content:

- AMALi-Instrument parameters

- sub-units AMALi

- Start-up and shut-down procedures

- LAN connection settings

- Acquisition Software

- Overlap adjustment

- Potential error sources and check procedures:
 - pre-flight-check
 - in flight

- Abbreviations

AMALi-Instrument parameters

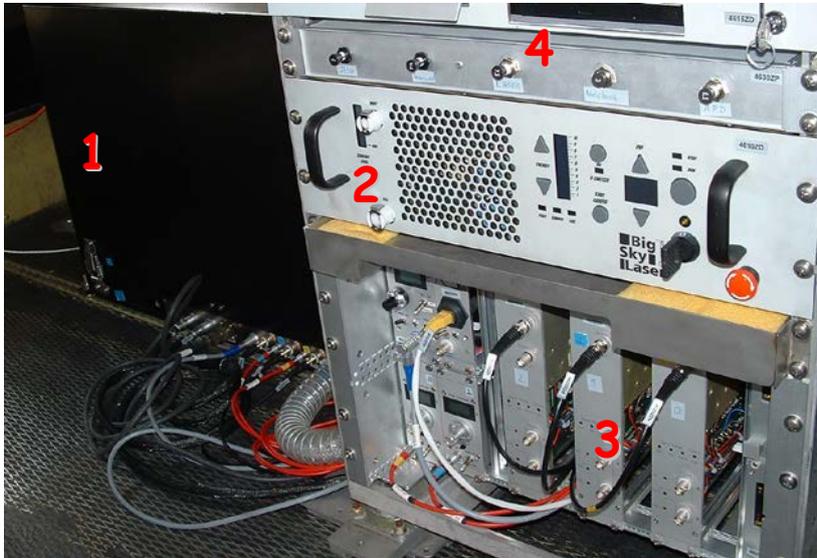
- aerosol backscatter lidar
- backscatter coefficient at 532 & 355 nm simultaneously
- depolarisation measurement at 532 nm

- vertical resolution: 7.5 m
- temporal resolution: typical 15 sec
- resulting horizontal resolution: typical 1 km

Instrument description:

Stachlewska et al., 2010, *Atmos. Chem. Phys.*, 10, 2947–2963, 2010
www.atmos-chem-phys.net/10/2947/2010/

Sub-Units AMALi:



- 1 Optics Unit (OU)**
- 2 Laser Controller (ICE)**
- 3 Data Acquisition (DA: Transient, HV)**
- 4 Breaker box**

- Optical Unit (1)
- Laser Controller (with power supply, cooling, parameter setting) (2)
- Data acquisition unit (3) consisting of photomultiplier HV supplies, transient recorders, communication unit to acquisition PC
- Between units 2 and 3 : Containment unit to collect leaking cooling fluid
- Breaker box: centrale power switches and breakers for AMALi units

The rack-units can be arranged in all ways within the rack.

- Further units: windows in teh fuselage with cover on top / behind roller door

For nadir-configuration: Flightlevel: 3000m , for lower flight levels the laser is not eye safe for observers on the ground; for higher flight levels problems might occur with cooling due to low pressure.

AMALi units can be flown in all flight levels when unpowered.

Startup Sequence AMALi in Polar 5 for nadir mode-operation

0. Pre-heating in the morning, once 230 V ac power available:
 - push "Heater" breaker, check that ventilation is running in OU (listen); within ca. 10 min observe temperature rise
 - optimal operation temperature in optical unit: 10 - 20 °C
 - Heating should stay on during flight.

1. Provide power supply: 28 V, 230 V

2. DA: check if switch on box that says "licel" is "on" and all HV on "remote"

3. AMALi breaker box: push fuses "Transient", "Laser", ("Heater" should be on from (0.) or started now). Heating should stay on during flight. Breakers can be operated any time w/o damage to the instrument.

4. Laser power supply unit (Big Sky Laser "ICE"):
 - a. check emergency breaker (red button not pushed in)
 - b. turn key switch to "on": pump starts, simmering sound, **Keep running for > 5 min to remove air bubbles** in cooling system (if hose was disconnected: control flow lines for air bubbles, remove them by repeatedly switching the ICE off and on with a > 10 sec period)
 - c. check: energy setting: 9.5 units
pulse rep. frequency (PRF): 2 Hz
no Fault indicator lamp on
 - d. press "Run": Flash lamp starts
increase PRF slowly to 15 Hz
 - e. flash lamp should be flashing about 30 minutes before measurement start to stabilize the laser performance.
 - f. keep running in this mode.

5. **Data acquisition (DA):** start computer
 - if necessary modify *amali_nadir.ini* or *amali_zenith.ini* file, respectively (e.g. operator name)
 - The ini files are located in *C:\AMALI\Programme\Acquisition\configuration*

6. Start acquisition Software
 - a. Start acquisition programme *Amali*
 - b. Choose ("Zenith" or "Nadir" and press continue
(if error message appears from UTCstream.vi UTC server signal is missing, programme will run with computer time, not aircraft time)

7. Acquisition programme:
 - a. Trigger setup:
 - check *pretrigger delay* (20 μ s for nadir config., 5 μ s for zenith config.; resulting Q-switch delay from *lamp + pretrigger* has to be 135 μ s)
 - check *Master Trigger: "Laser"*
 - set *Q-Switch* here to "on" when laser shall start firing
(Laser starts only if both Q-Switches (software and ICE are set to "on")
(Laser should still stay idling with flash lamps only at this time, see 3d))

 - b. System Setup 2:
 - change first letter of data file name (flag for different measurements), if needed (This should be done for every new start of data acquisition during flight.)
 - c. System setup:
 - check communication status with DA: both lamps green? (TCPIP) *If not:* switch data acquisition of and on again, check Lan connection
 - HV for PMTs to "on" (min. 600V, max. 900V)

Nominal settings for zenith operation:

| | | | |
|------------|-----------------|------------------|--------|
| Channel | 532 nm parallel | 532 nm senkrecht | 355 nm |
| HV Voltage | 700 V | 900 V | 800 V |

If Voltage displayed at DA deviates from software setting: faulty HV supply: turn the respective HV supply off.

8. **Start measurement:**
 - a. push Q-Switch button on laser controller
toggle Q-Switch button at "Trigger Setup": **Laser starts firing now**
 - b. click "Start Acquisition" button in System Setup
 - c. check: data counting ?
Data transfer active ?

9. **During measurements:**

- window "Raw Signals":

" t0 auto " active?

unlock Signal axis, set maximum to 550 mV

upper right corner of window: click 532 (etc) signals for display

- windows with aerosol data:

"Auto scale" active? (button is green)

- start a new power point or excel file for collecting screen shots
(see "Protocol needs")

- check for raw data quality at least once after ca. 10 min operation:
overlap? (that is no sharp declines in return signal in clear atmosph.)
Saturation?

(that is no analog signal staying const at 550 mV in lowest range
if so: reduce HV on respective channel)

Raw signal display: you may set analog signal (lower x-axis) to 600 mV
you may adjust y-axis to 0 - 8500 (instead of 7500 - 0)
any display setting changes do not effect data acquisition

- record events in ppt slides, add screen shots

- optimal grafics display (Raw Signal):

x-Axis: 1.0 - 550 mV

10. **Shut down sequence:**

a. save aerosol data displays to ppt (use print screen: press "fn" + "alt"
+ "druck")

b. Stop Acquisition (in System setup 1)
HV off (3x), Q-Switch off.

c. Q-Switch off at laser controller

d. click "Exit Program" in System Setup

e. pull breakers

11. **Save data:**

save screenshots and comments into data directory before copying.

LAN Connection acquisition PC to data acquisition (DA):

Set PC (laptop) to fixed address for TCI/IPv4, no dynamic DCP

IP address for data acquisition:

Standard IP address (factory configuration):

10.49.234.233 for PC (the transient has 10.49.234.234)

Subnet mask 255.255.255.0

Modified IP address 2017:

Transient (DA): 192.168.75.234

PC: 192.168.75.143

These addresses are compatible with the Polar 5 LAN time server and allow operating time server and AMALi via the same Ethernet connection.

How to change DA IP settings:

Umstellen der IP-Nummer im AMALi-Transienten:

1. angeschlossenen PC mit der aktuellen IP-Nr betreiben:

AMALi-Software "TCPsetfixipadress" starten, neue IP-Adresse UND Net Mask eingeben,

ausführen (starten)

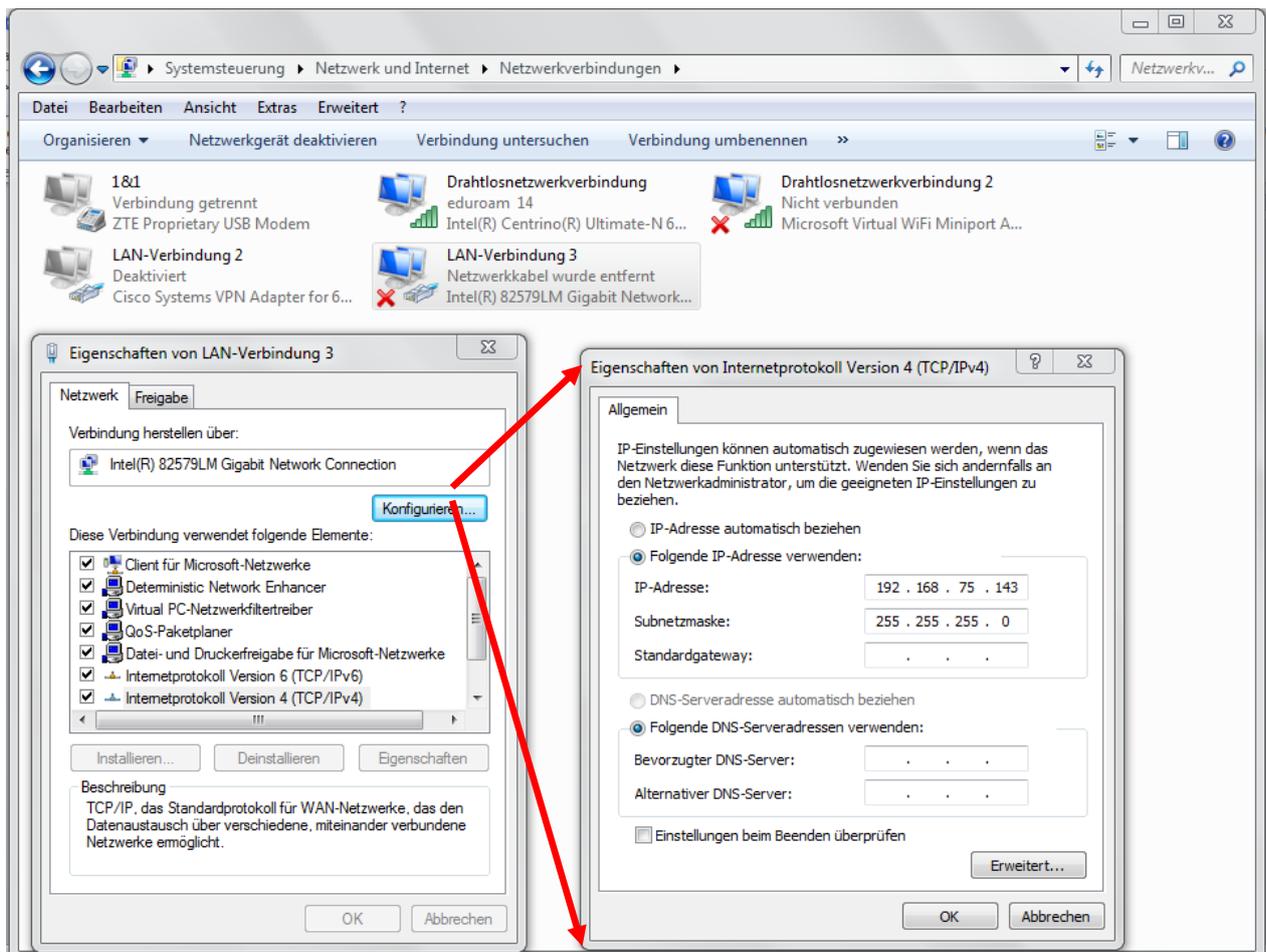
2. Transienten neu booten ("Kaltstart"),

3. auf PC im AMALi-ini neue IP entsprechend eintragen

4. AMALi Main starten: im Setup-Reiter 1 müssen beide Datentransfer-Lampen grün werden

(Bei Problemen: Im AMALi-Transienten-Rack ist ein reset-taster im Löchlein neben dem ethernet-anschluß, der setzt auf default IP zurück.)

LAN settings Windows 7:

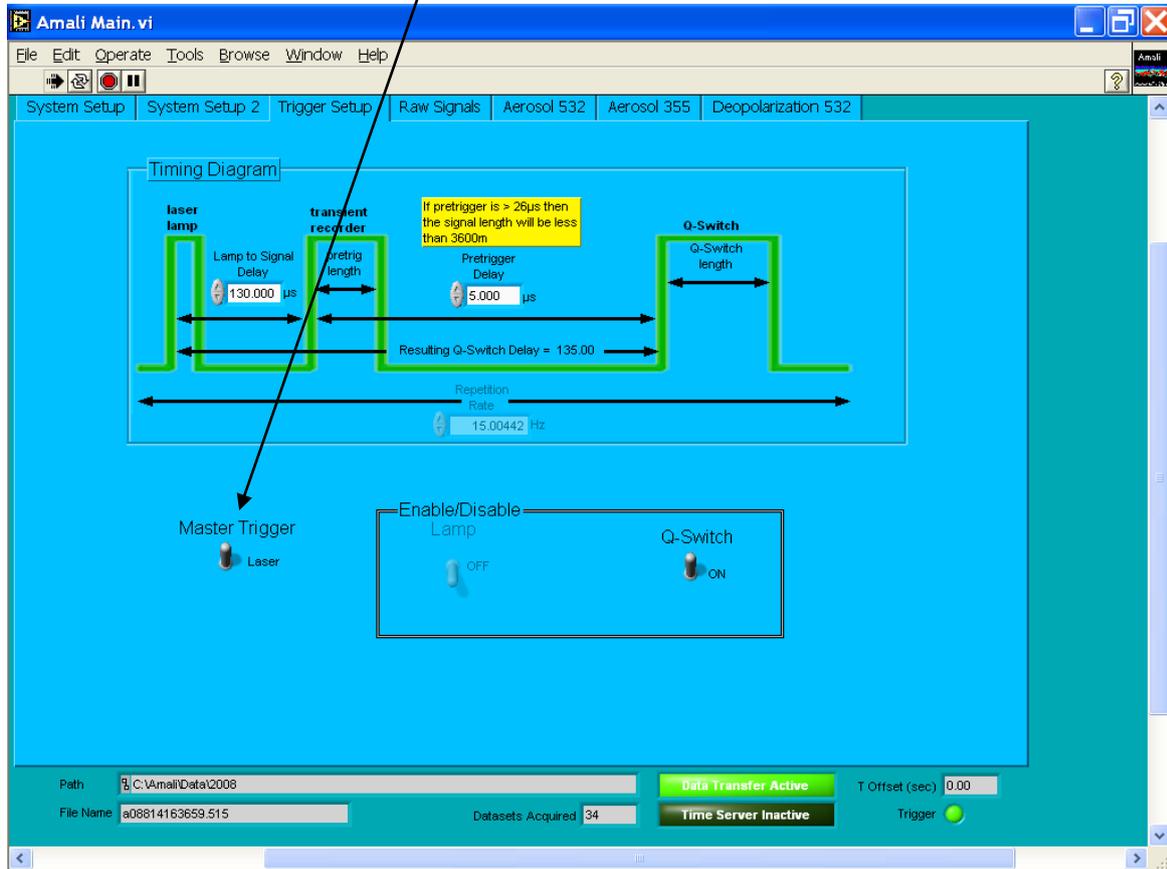


Acquisition software

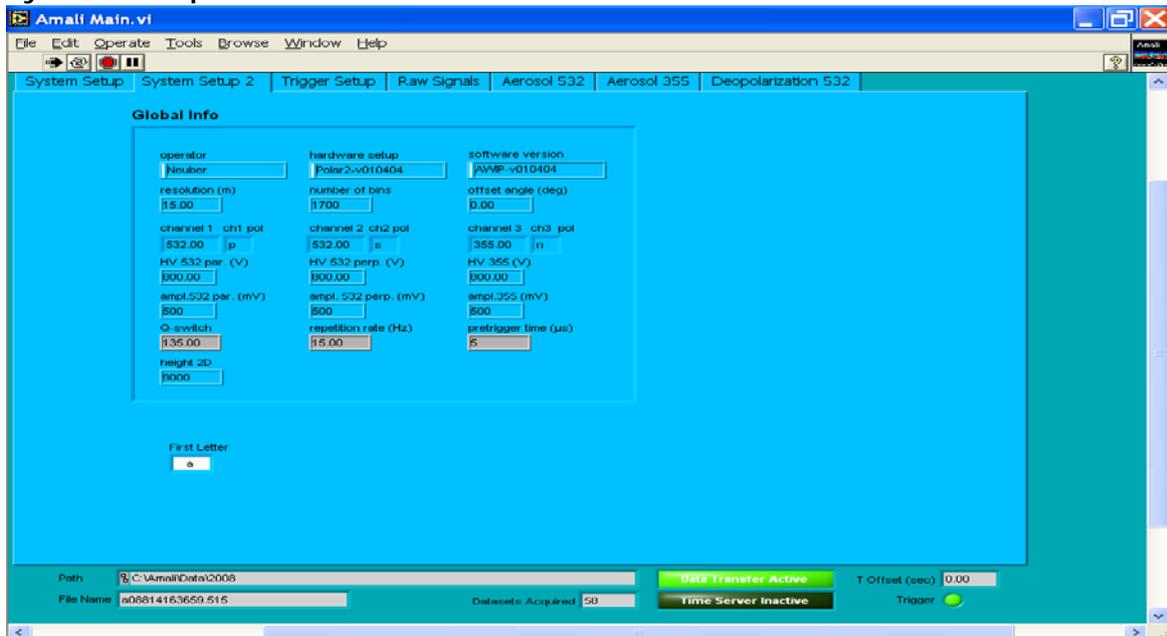
Onscreen displays AmaliMain.vi:

Trigger Setup:

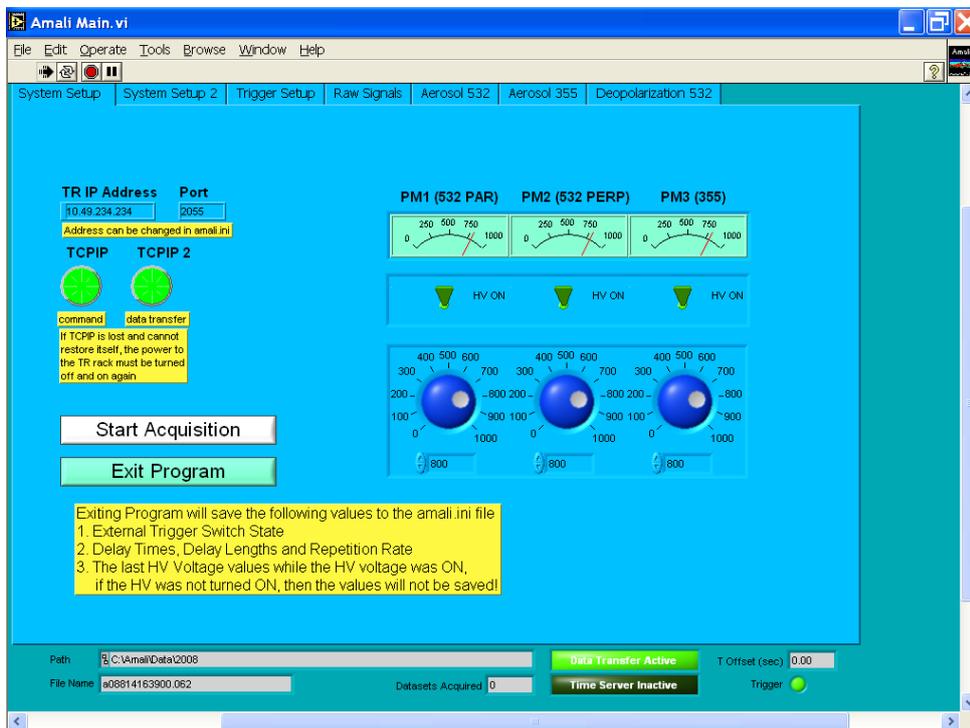
Master Trigger MUST be "Laser", otherwise fatal ICE overload:



System Setup 2:

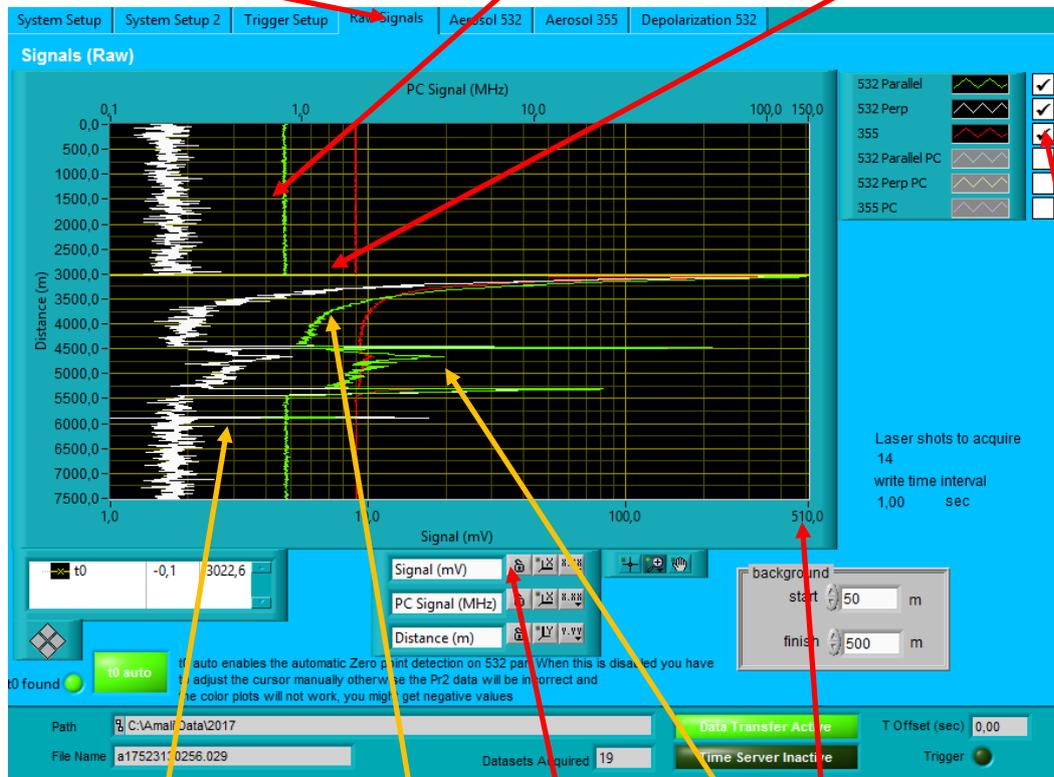


System Setup:



During flight (Graphic modifications don't change the data acquisition):

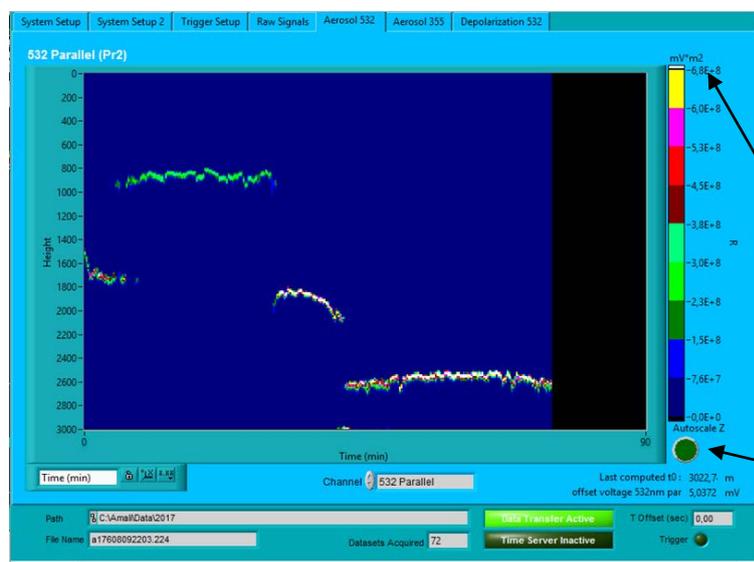
Raw Signal display, Pre-Trigger range, t0 detected (corresponds to Flight level)



Good lidar signal, showing structured cloud and ground return (2900 m below aircraft)

(at beginning, two settings: "open", larger then 510,0 (550) and check channels)

After some flight time (more than 10 min):



When Autoscale is off, adjust scale here

Set Auto Scale On (green) or off (very dark green, like this)

Overlapp adjustment

Can to be done only in zenith mode on ground, with cloud free atmosphere above.
Check for laser operation possibility with air traffic control.

1. Within optical unit: Connect mirror steering motor cables to connector "temp / mirror"
2. Prepare motor steering unit (transparent plastic box with joy stick):
 - connect control cable to connector "temp / mirror" on optical unit frame
 - provide 220 V to steering unit
 - toggle "motor" switch until motor C lamp is on, motor A, B lamps off
3. Start laser operation (see "Startup sequence")
4. Mirror steering motors have no decoders, they run on higher speed if joystick is more engaged.
5. Operate the mirror steering motors by moving the joystick up and down or left and right.
6. Observe lidar return signal ("raw signal") as it improves / decays as the laser beam is steered into / out off the telescope field of view.
There is a fairly long period with constant lidar signals while the beam is moving within the field of view of the telescope. Try to adjust into the middle of this "plateau" in both directions of the joy stick.

Trouble shooting AMALi

| Event | Reason | Action |
|---|---|--|
| 1. Fault indicator laser | Interlock open: | |
| | - cover lid | Close cover |
| | - low cooling level | Add coolant |
| | - too warm | Let cool down, keep ICE running without flash lamp |
| | - shorted circuit | Service |
| 2. Laser does not flash | interlock | See 1. |
| | Lamp broken | Service |
| 3. Laser flashes, but doesn't fire | One of two Q-Switches off | Set switches on ICE and in acquisition programme |
| | Any cover still on optical unit or aircraft exit ? | Remove |
| 4. Data acquisition does not count data | Acquisition not started | "Start Acquisition" |
| | Laser does not flash TCPIP between PC and DA broken (Status red) | (see 2.) - Reset DA by power off / on at breaker box - Restart program - shut down and restart DA and PC completely |
| 5. Data is coming, but looks "flat" | Laser doesn't fire | See 3. |
| | PMTs without power | Power to DA ? Set HV to on (System setup) |
| 6. Data is coming, but looks awkward | Missing laser - telescope overlap | Adjust (service) |
| | Signal in saturation | Adjust PMT HV (600 - 900V) |
| 7. Onscreen display missing or bad | Missing t0 | Set "t0 auto" on (green) in Raw Signal window |
| | Bad scaling | Set "Autoscale Z" on (green) |

Abbreviations:

| | |
|-------|--|
| DA | Data-Acquisition |
| ICE | Laser supply unit |
| OU | Optical Unit |
| PM(T) | Photomultiplier(-Tube) |
| PRF | Pulse repetition Frequency |
| HV | High Voltage |
| TCPIP | Ethernet-protocoll for the Data-Connection between DA and PC |