CIMEL
ADVANCED MONITORING

Lidar II text Export format

Version 1.03a

1 General

LidarII software could export LiDAR data in a text format. Export could be done inline when system is acquiring data form LiDAR or in reloading acquired data and export them. The format is the always the same.

When the export is performed during acquisition it's always in append mode. The software only add lines to de file. There is no rewrite of the file.

The format is partially fixed:

- Lines are made of set of fields
- Field/columns separator is user configurable.
- Lines start always if a tag indicating content type of the line
- Decimal separator is dot ".".
- If a text field contains semi-colon it is encapsulated by double-quote:
  i.e. << …,CE372v121;"text ; with semi-colon";12;… >>
- Decimal number may use exponential notation. i.e.<< 12.34E-7 >>
- End of line is composed of <CR><LF> sequence like MSDOS
- Characters are always one byte size (no multibytes)
- There is no line size limit.

The content is user configured in the software:

- As describe above field separator is configurable (default is semi-colon ";")
- LiDAR data type (raw, photons/s, ….,LiDAR signal)
- Export of monitoring data

2 Text lines

Each line of the exported text start with a text tag indicating how to decode and interpret following fields. Each fields are separated by a user selected characters.

2.1. *Lines type*

LineType	Description	Optional/ Mandatory	Remarks
FILEV	File version	M	*8*
INSDEF	Instrument Definition	M	*8,1*
INSCFG	Instrument Configuration	M	*4,5,6,7*
	Channels descriptions		
DCLID	description channel lidar	M	*7,8,12*
DCMON	description de channel monitor	O	*8*
DCIMU	description channel IMU/GPS	O	*8*
	Calibrations		
DETPAR	Detector calibration parameters	M	*14*

OVL	Overlap calibration	M	*1,14*
AFPL	After Pulse calibration	O	*2,14*
	Data		
DP	data profile	M	*3,9,13,15*
DPSD	data profile standard deviation	O	*9,11*
DM	data monitor	O	*9*
DIMU	data AHRS / IMU	O	*9,1*
TP	telescope pointing	O	*4,5,9*
ASL	altitudes ASL of doors/bins	O	*7,9,11*
EVENT	Events	O	

	Remarks
1	measure => is a measure or a value, generally in decimal
2	In digital count : measure = measure - value
3	measurement unit depend of **OutValueType** from previous **DCL** related line
4	Italic fields are optional and may contains '/'
5	Angles are in degrees
6	Latitude and longitude are in decimal degrees
7	Distance, altitude and elevation are in meter
8	Text fields (Names) could not contains semi-colon nor double-quotes
9	Time is expressed in decimal days since the 00 January 1900 00h00mn00s (or 31 December 1899 00h00mn00s)
10	AHRS :Attitude and Heading Reference System ; IMU: Inertial Measurement Unit
11	When the line is present it apply to next **DP** line
12	Wavelength are in nm (nanometer). Door/bin time is in ns (nanosecond).
13	Sky Background is the mean of S used to compute SB. Sky Background is expressed in Photons/sec.
14	Provided calibration value are active at the given time
15	ErrorWarning : see Fields Codes

2.2. *Lines fiels format*

- **FILEV** ; FileVersion ; SoftName ; SoftVersion
- **INSDEF** ; Name ; Description ; NbrGroup ; NbrDataChannel ; NbrMonitor ; NbrAHRS
- **INSCFG** ; UsageCase ; Latitude ; Long ; Altitude ; Roll ; Pitch
- **DCLID** ; IdChannel ; IdGroup ; Name ; DoorsNbr ; SourceWaveLength ; ReceivWaveLength ; FWHM ; Polarization ; OneDoorRange ; OneDoorTime ; OffsetRange ; OffsetTime ; Constant
- **DCMON** ; IdChannel ; IdGroup ; Name ; ParamNbr { ; CodeMonitoring ; ParamName ; Unit}*xParamNbr*
- **DCIMU** ; IdChannel ; Name ; ParamNbr ; {CodeImu ; Unit ;}*xParamNbr*
- **DETPAR** ; IdChannel ; time ; Method ; P1 ; … ; P*n*
- **OVL** ; IdChannel ; time ; value[1] ; value[2] ; … ; value[*DCLID(id).DoorsNbr(Id)*]
- **AFPL** ; IdChannel ; time ; value[1] ; value[2] ; … ; value[*DCLID(id).DoorsNbr(Id)*]
- **DP** ; IdChannel ; time ; nbrPulse ; ProfileDuration ; OutValueType ; AfterPulseCorrected ; measure[1] ; measure[2] ; … ; measure[*DCLID(id).DoorsNbr*] ; SkyBackground ; Error/warning
- **DPSD** ; IdChannel ; time ; std_dev[1] ; std_dev[2] ; … ; std_dev[*DCLID(id).DoorsNbr*]
- **DM** ; IdChannel ; time ; WarningMap ; ErrorMap ; measure[1] ; measure[2] ; ... ; measure[DCMON(Id).ParamNbr]
- **DIMU** ; IdChannel ; time ; measure[1] ; measure[2] ; … ; measure[*DCIMU(Id).ParamNbr*]
- **TP** ; time ; Azimuth ; Zenith
- **ASL** ; IdChannel ; time ; measure[1] ; measure[2] ; … ; measure[*DCLID(id).DoorsNbr*]
- **EVENT** ; IdChannel ; time ; EventTag ; Comments

Notation:

- For this line format list the semi-colon is choose as field separator. There is no space around field separator.
- **Value[*n*]** indicate the **Value** with index *n*. Exemple for data from a lidar channel **value[*1*]** is the first door/bin.
- *Italic word* do not indicate the place of an argument but variable zone dependent of the named parameter.
- When an array of *n* elements is present it is noted as **element[*1*] ; element[*2*] ; … ; element[*n*]**.
- When a set of field is repeated it is noted as **{ field1 ; field2 ; … ; fieldn ;} x *repeater value***.
- When the line have a form "value[1];value[2];…;value[*xxxNbr*]" the number of elements is constant until the next description of *xxxNbr* (via a **DCxxx** line or the end of file)

2.3. *Lines type fields description*

Line Type	Field name	Description
any lines	IdChannel	Unique ID of related channel in the instrument. One channel ID is used for description, optional calibration and data.
	IdGroup	Unique ID of related group in the instrument. Channel of the same group share the same laser source.
	time	"Time of the element in floating point number since the 00 January 1900 00h00mn00s. 367.5 means 1901/01/01 12:00:00; 42384.8 means 2016/01/15 19:12:00"

FILEV	FileVersion	version of the file format (normalized)
	SoftName	Name of the soft that create this file
	SoftVersion	Version of the soft that create this file

INSDEF	Name	Name of the instrument as provided in instrument definition files. Normalized.
	Description	Description of the instrument
	NbrGroup	Number of group of channels in the instrument
	NbrData channel	Number for lidar data channels in the instrument (should be greater than 0)
	NbrMonitor	Number of monitoring channels in the instrument (may be 0)
	NbrAHRS	Number of Heading and Attitude channels in instrument

INSCFG	UsageCase	Kind of instrument usage (see related table)
	Latitude	Instrument latitude in decimal degrees (i.e. 48.82123). This is a field filled by user. South is negative.
	Long	Instrument longitude in decimal degrees (i.e.: 2.70132). This is a field filled by user. West is negative.
	Altitude	Altitude in meter above the mean sea level.
	Roll.	Roll in degrees
	Pitch	Pitch in degrees

DCLID	Name	Name of the channel
	DoorsNbr	Number of doors/bins for the channel. Will give also number of measures in data profile and values for OVL and AFPL calibrations
	SourceWaveLength	Source laser wavelength in nm.
	ReceiveWaveLength	Receive filters central wavelength in nm.
	FWHM	Receive filters full width at half maximum wavelength in nm.
	Polarization	Polarization filter of the channel related to the source (see corresponding table)
	OneDoorRange	About one door/bin distance in meter. All doors/bins have the same size.
	OneDoorTime	Size of one door/bin in nanosecond (ns). All doors/bins have the same size.
	OffsetRange	Distance of the start of the first door/bin. May be negative.
	OffsetTime	Time offset of the start of the first door/bin. Time between the laser pulse and the start the channel start to count. May be negative if the channel start to count before laser shoot.
	Constant	Lidar constant. Presently always 1.

DCMON	Name	Name of the channel
	ParamNbr	Number of parameters provided by the corresponding monitoring channel. The below triplet is repeated ParamNbr time
	CodeMonitoring	Unique code indicating the type of parameter provided (see related table)
	ParamName	Human name of the parameter
	Unit	abbreviation of the unit (see related table)

DCIMU	Name	Name of the channel
	ParamNbr	Number of parameters provided by the corresponding AHRS channel. The below pair is repeated ParamNbr time
	CodeImu	Unique code indicating the type of parameter provided (see related table)
	Unit	abbreviation of the unit (see related table)

DETPAR	Method	Method of detector linearization correction. See related table.
	P1	First parameter. Usage depend of the method.
	P[2..x]	Number and usage of parameters depend of the indicated method. See "*Detector correction method*" table.

OVL	value[1..Doors Nbr]	There is one Overlap value per door/bin for the corresponding channel. Each value is the overlap factor for the corresponding door/bin number. It is a real number. *DoorsNbr* is fixed by the previous **DCLID** line concerning the same IdChannel.

AFPL	value[1..Doosr Nbr]	There is one After Pulse value per door/bin for the corresponding channel. Each value is the signal less offset for the corresponding door/bin number. It is a real number in photons/sec. *DoorsNbr* is fixed by the previous **DCLID** line concerning the same IdChannel.

DP	nbrPulse	Number of laser pulse accumulated in the profile
	ProfileDuration	About time of accumulation (including dead time between laser pulse). Real number in seconds.
	OutValueType	Type of the provided measure. Depend of parameters of software. See related table.
	AfterPulseCorrected	Different from 0 if signal is AfterPulse corrected.
	measure[1..DoorsNbr]	Each measure is computed accumulation for a door/bin. First door is source closest one. Processing and unit depend of OutValueType. *DoorsNbr* is fixed by the previous **DCLID** line concerning the same IdChannel.
	SkyBackground	Computed background signal eventually used for processing. Presently background is the means of uppers doors. Real in Photons/sec
	Error/warning	Error and warning during acquisition. See related table

DPSD	std_dev[1..DoorsNbr]	Standard deviation for each door. Presently not available.

DM	WarningMap	bitmap of monitoring parameter with value triggering a warning. Value is the sum of power(1, parameter number with warning)
	ErrorMap	bitmap of monitoring parameter with value triggering an error Value is the sum of power(1, parameter number with error)
	measure[1..DCMON.ParamNbr]	Value of parameter. Unit depend of parameter. See related table. *ParamNbr* is fixed by the previous **DCMON** line concerning the same IdChannel.

DIMU	measure[1..DCIMU.ParamNbr]	Value of parameter. Unit depend of parameter. See related table. *ParamNbr* is fixed by the previous **DCIMU** line concerning the same IdChannel.

TP	Azimuth	Azimuth of the telescope in degrees. Computed or measured.
	Zenith	Zenith of the telescope in degrees. Computed or measured. (0.0 is vertical sky direction. 90.0 is horizontal Azimuth direction). NYA

ASL	measure[1..DoorsNbr]	Altitude above the see of each doors/bins expressed in meters. Use INSCFG.Altitude or AHRS altitude, roll, pitch and AHRS attitude. *DoorsNbr* is fixed by the previous **DCLID** line concerning the same IdChannel.

EVENT	EventTag	Type of event. May be user note or instrument event. If IdChannel is null event is related to all instrument else it is related to the corresponding channel. See related table.
	Comments	Comments about the event. See related table

2.4. *Fields codes*

Specials conventions	
Code	**Description**
/	Field without/unknown value

Out Value Type	
Code	**Description**
R	Raw Signal
S	Number of Photons/s
SB	Background Corrected
SBR2	Photons/s Range corrected
OSB	Overlap correction
OSBR2	Lidar Signal

Polarization	
Code	**Description**
X	Perpendicular
I	Parallel
O	Without
/	Unknown

Error/Warning	
Value(Hex)	**Description**
0	OK
1	Warning (general) : Some data may contains errors (saturation, overlap, …)
2	Error (general) : Data are not usable and should be discarded (no laser pulse, …).

Final value is sum of value: i.e. Warning+error = 3

Monitoring Code (CodeMonitoring)	
Code	**Description**
TL1	Laser 1 Temperature
TL2	Laser 2 Temperature
UI	Internal Humidity
TI	Internal Temperature
UT	Humidity Telescope
TT	Temperature Telescope
PI	Inernal Pressure
T1	Auxiliary Temperature 1
T2	Auxiliary Temperature 2
T3	Auxiliary Temperature 2
EL1	Laser Energy Grp 1
EL2	Laser Energy Grp 2
V12_1	12V output 1
V12_2	12V output 2

AHRS/IMU/GPS Code (CodeImu)	
Code	**Description**
TIME	Time
LAT	Latitude
LON	Longitude
ALT	Altitude
NVEL	North Velocity
EVEL	Est Velocity
DVEL	Down Velocity
ROLL	Roll
PITCH	Pitch
HEAD	Head
RX1	Rotation X1
RX2	Rotation X2
RX3	Rotation X3

Units	
Code	**Description**
DC	degree Celsius
deg	angle degrees
deg/s	degree/second
%	Percent
m	meter
m/s	meter/sec
V	Volt
A	Ampere
empty	without unit
W	Watt
B	Boolean
Ph/s	Photon per second

ErrorMap / WarningMap	
SubCode	**Description**
1	Error /Warning on parameter 1
2	Error /Warning on parameter 2
4	Error /Warning on parameter 3
8	Error /Warning on parameter 4
16	Error /Warning on parameter 5
32	Error /Warning on parameter 6
…	Error /Warning on parameter …
Code	**sum of SubCode**

UsageCase	
Code	**Description**
UNK	Unknown
FIXE	Fixe / Static
CAR	Car
PLANE	Plane
BOAT	Boat
SPACE	Space
ANT	Ant

Detector correction method		
Code	**Description**	**#Parms**
0	APD HTDS with 3 parameters	3

EventTag	
Code	**Description**
USN	User Event (Comments field is user dependent)
SAP	Start of After Pulse Calibration Profile
EAP	End of After Pulse Calibration Profile (Comments field could be Finished or Aborted)
SPL	Start of Polarization Calibration Profile Comments field contains angle of filter in degrees)
EPL	End of Polarization Calibration Profile Comments field could be Finished or Aborted)

3 Measures

The LiDAR instrument have one or several channels. There is three types of channels: lidar channels, monitoring channels, IMU/GPS/positioning channel.

There is always at least one lidar channel. Other channels are optional.

3.1. *Lidar channel*

A lidar channel establish profiles of diffusion of the atmosphere. It send short laser pulses in the atmosphere and measure the “quantity” of light that atmosphere feedback along quantum of time (doors or bins). For each quantum of time it save the “quantity” in a dedicated slot of time. The process is repeated multiple times and “quantity” for the same slot are accumulated. Periodically these slot sums are transferred to the file as profile of doors/bins and reset to zero. Doors are sent from the closest to lidar to the fares. The accumulation time is configurable by the user in the software export parameters dialogue.

Before to be transferred to the text file, these “quantity” could be converted to photons/sec, corrected from the after pulse (measure of the internal contamination of light due to laser shoot path), sky background (constant light coming from outside of the instrument: ie sun), overlap (instrument geometry) and then the distance to become a LiDAR measurement. The process applied to measures are user configurable in the export parameters dialogue.

Time quantum (for example 100ns) is also expressed in distance for user facility (100ns is about 15m: time for the light to go to a point and come back).For instrument with AHRS/IMU this may also be expressed in altitude using AHRS/IMU altitude and attitude. In this last case the altitude is provided for each door of profile with a line (code ASL) just after lidar profile (code DP and DPSD).

Depending of channel the lidar may start quantum computation before or after the real laser shoot. This information is provided as OffsetTime (and in distance OffsetRange). All doors are shifted of this OffsetTime/OffsetRange. i.e. for a channel with a time quantum of 100ns if the offset is 200ns (30m) the first door is between 200ns and 300ns (30m to 45m), the second door is between 300ns and 400ns (45m to 60m) and so. Offset could be negative!

Channels are grouped when they share the same laser source (Group ID). Acquisition of the channels of the same group are synchronized. Different groups may or may not be synchronized.

Remark: Currently the standard deviation is not present.

3.2. *Monitoring channels*

LiDAR instrument could have one or several monitoring channels. These monitoring channels gives information about the life of the instrument like temperatures of lasers or ambient humidity. These measures are tagged with a fixed code (CodeMonitoring) and could be used by post processing software. The acquisition cadence is not related to lidar channels.

3.3. *AHRS/IMU/GPS channel*

LiDAR may be connected to external or internal sources of localization and/or attitudes (like inertial central of a plane or GPS). When this channels are present and activated this information are provided on a special channel (DIMU).

4 Annexes

4.1. *Revision of document*

Version document	Export File Version	Version Soft	Date	Changes
1.00	1.0	2.00		Initial
1.01	1.1	2.03	10/10/2016	Add *Error/Warning* field to **DP** lines
1.02	1.1	2.04	16/11/2016	Add EVENT line type Add Offset time & range for **DCLID** lines Rename IMU in AHRS New structure of document
1.03a	1.1	2.04	31/01/2017	Monitoring lines are named **DM**. Add information about length of lines with array. Rename field/table **Errorwarning** as **Error/Warning**. Clarify how to manage error/warning and give some examples. Update page headers. Typo.