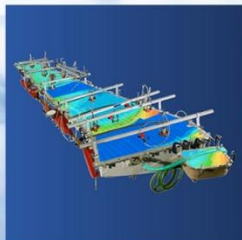


# ZODIAC DATA SYSTEMS

ZODIAC  
AEROSPACE



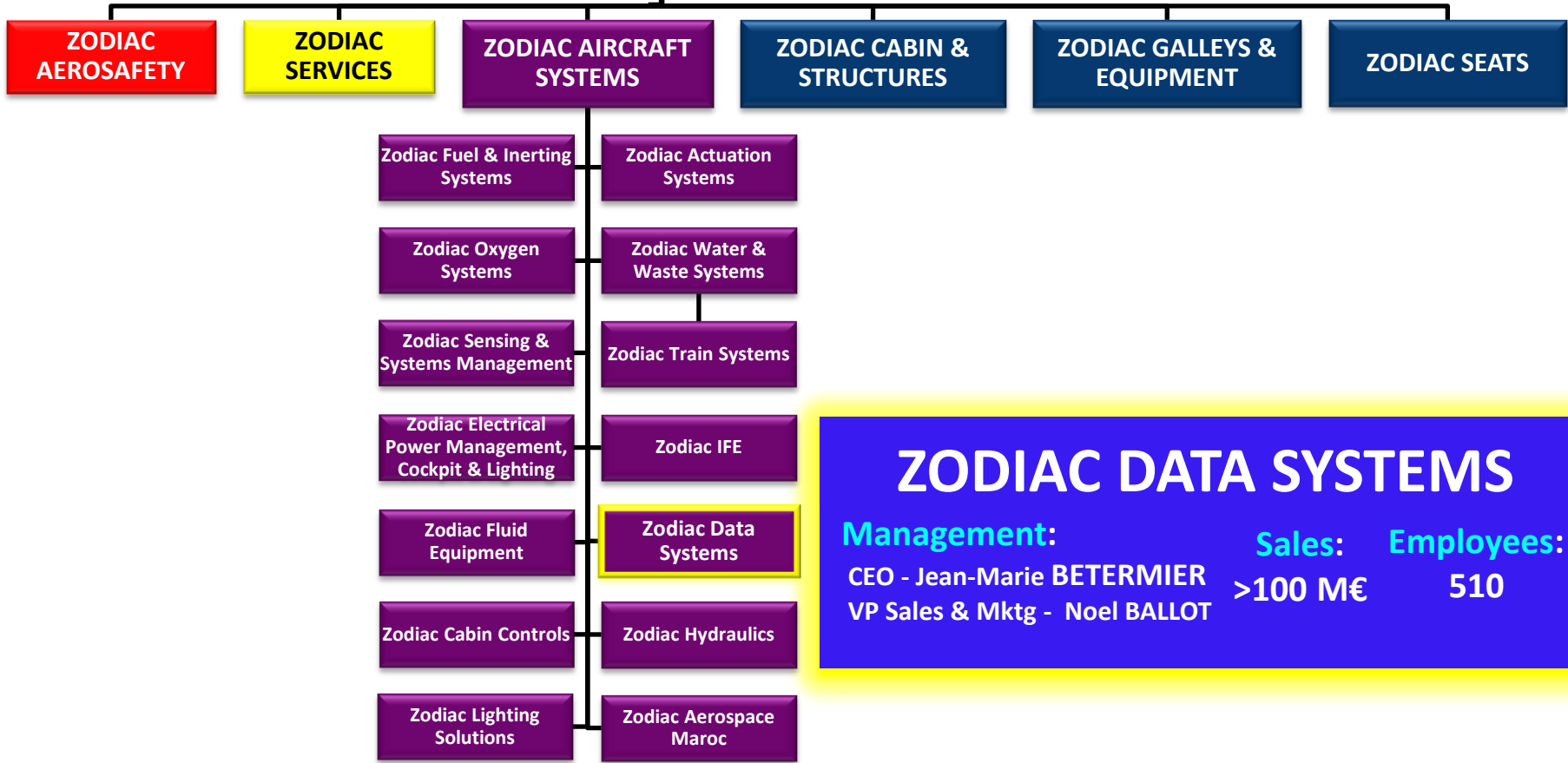
MASTERING THE ELEMENTS

ZODIAC  
AEROSPACE



# ZODIAC AEROSPACE

Stock exch: ZC (Euronext)    Sales: 3450 M€    Growth: 25%    Employees: ~ 26000



## ZODIAC AIRCRAFT SYSTEMS

# The CORTEX Family

One philosophy, Multiple applications



- PC-based telemetry equipment
- FPGA embedded-boards
  - Real time IF processing
  - High level of integration

TT&C,  
SCIENCE &  
DEEP SPACE

REMOTE  
SENSING

SATELLITE  
TRACKING

FLIGHT  
TEST

**CRT**

Command Ranging & Telemetry

- 3000 units worldwide

**DS**

Deep Space

- Optimized hardware for Deep Space communications

**HDR**

High Datarate Receiver

- Up to 2 Gbps
- 16 QAM & 32/64APSK

**DTR**

Digital Tracking Receiver

- Carrier&SQPN tracking up to 3 channels

**RTR**

Radio Telemetry Receiver

- Quad-band telemetry receiver

**RSR**

Radio Signal Recorder

- Fully digital IF recorder / reproducer

# The IFoIP Family

One hardware, Multiple applications



IFoIP equipment:

- FPGA embedded-boards
- Real time IF processing
- High level of integration



*Customized*

**SDR**

Software Defined Radio

- Customized applications

*Inspection*

**CSI**

Carrier Signal Inspector

- Detects the carrier
- Display the noise floor

*Monitoring*

**CSM**

Carrier Signal Monitoring

- Database & Alarm management
- Reporting

*Analysis*

**CSA**

Carrier Signal Analyzer

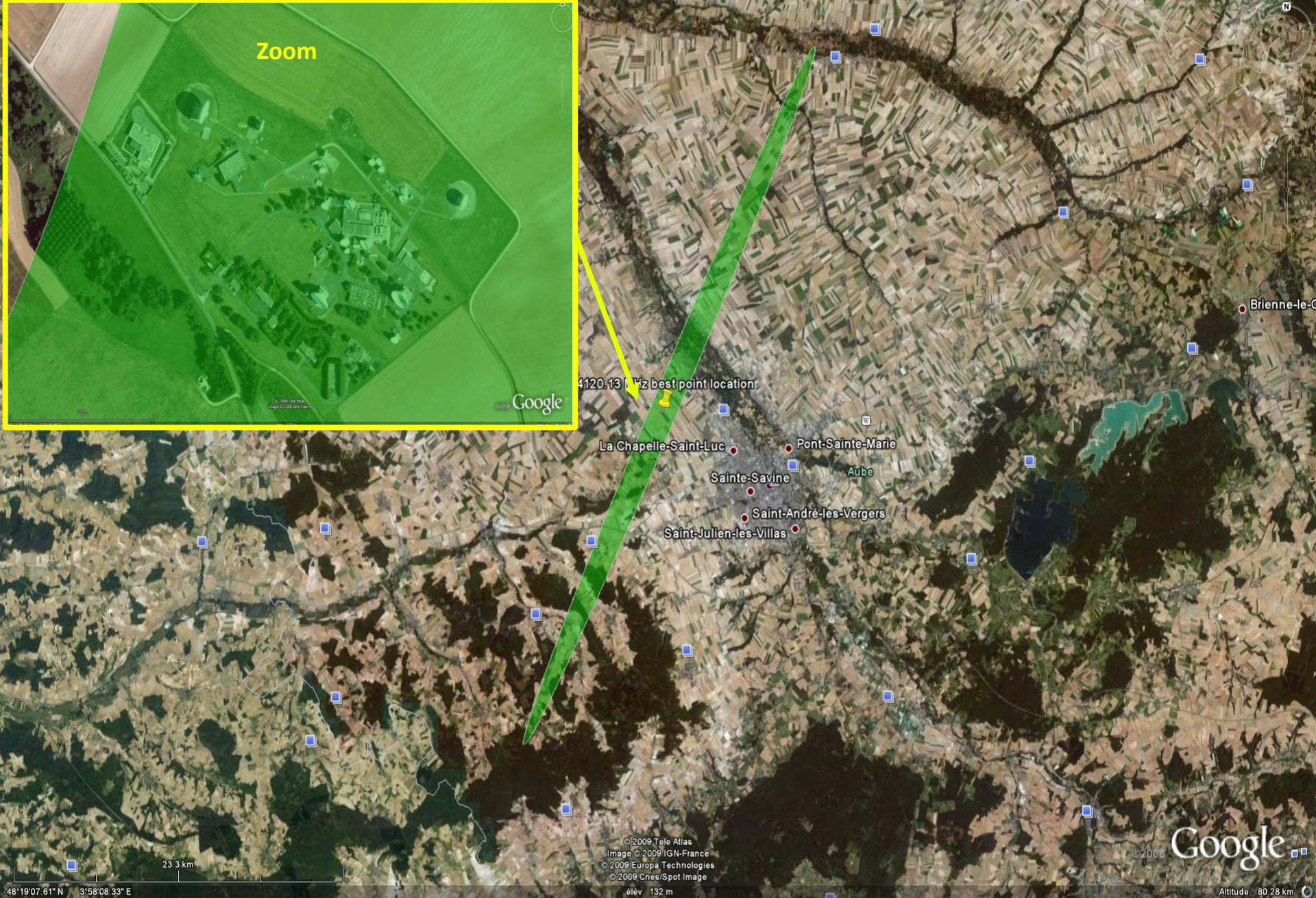
- Characterize carriers in blind mode
- Carrier under carrier

*Geolocation*

**CGL**

Compact Geo Location

- Locate transmitters



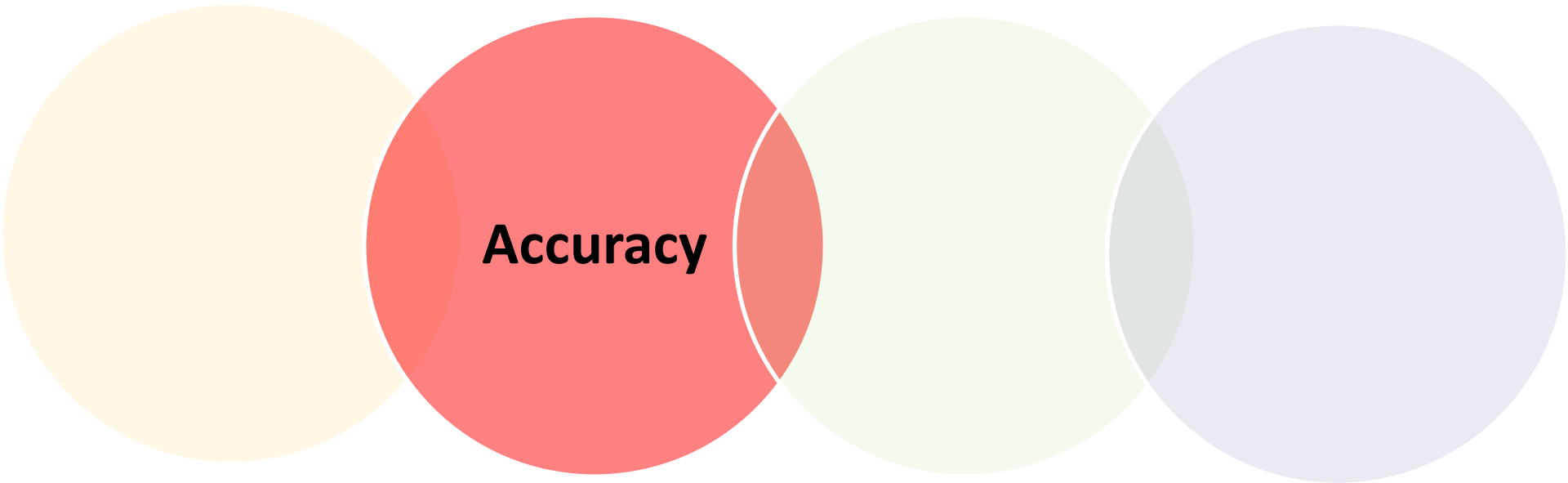
## ZODIAC AIRCRAFT SYSTEMS

This document is the property of ZODIAC DATA SYSTEMS. It cannot be duplicated or distributed without expressed written consent.

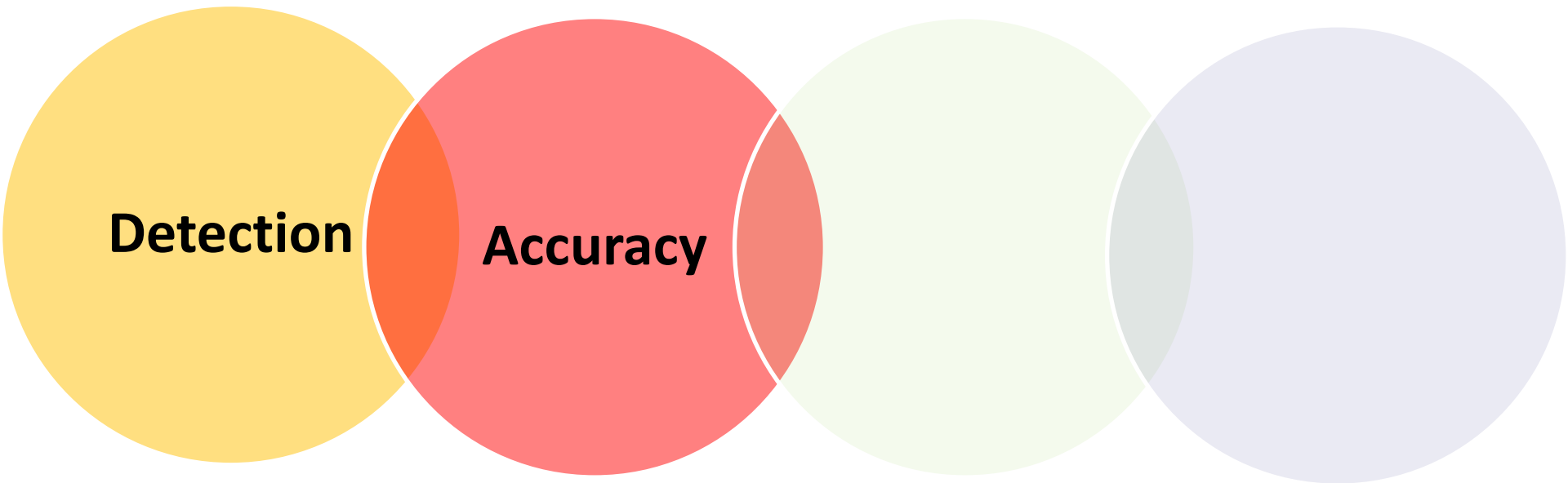
02/07/2013

- 5

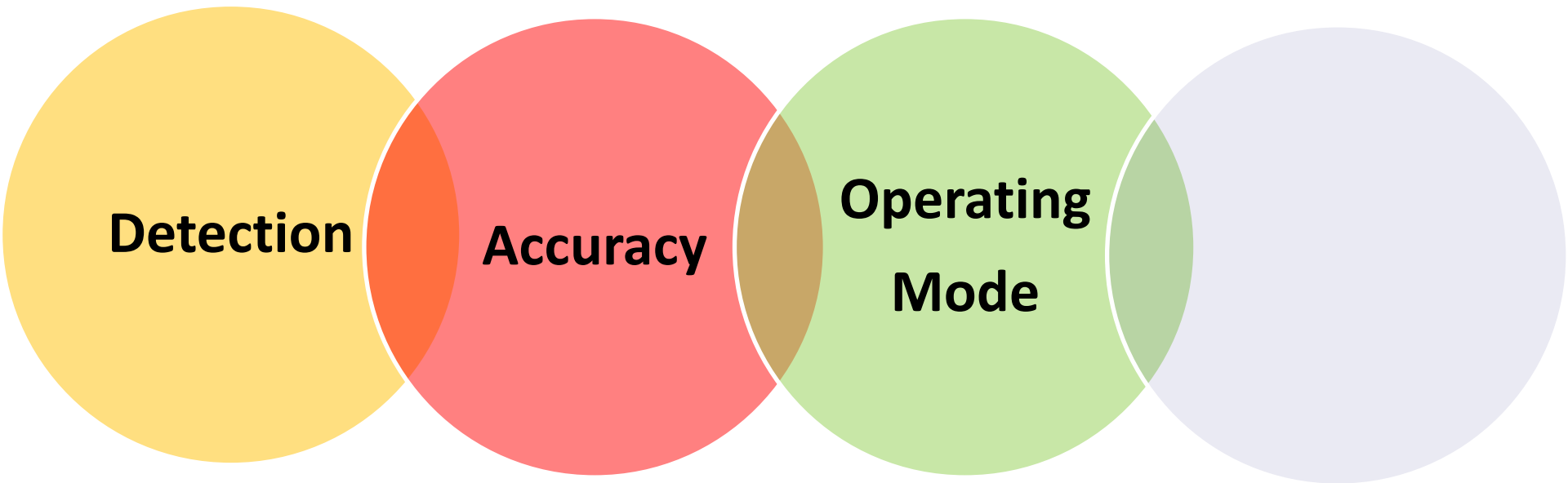
# Geolocation Performances Pilars



# Geolocation Performances Pilars

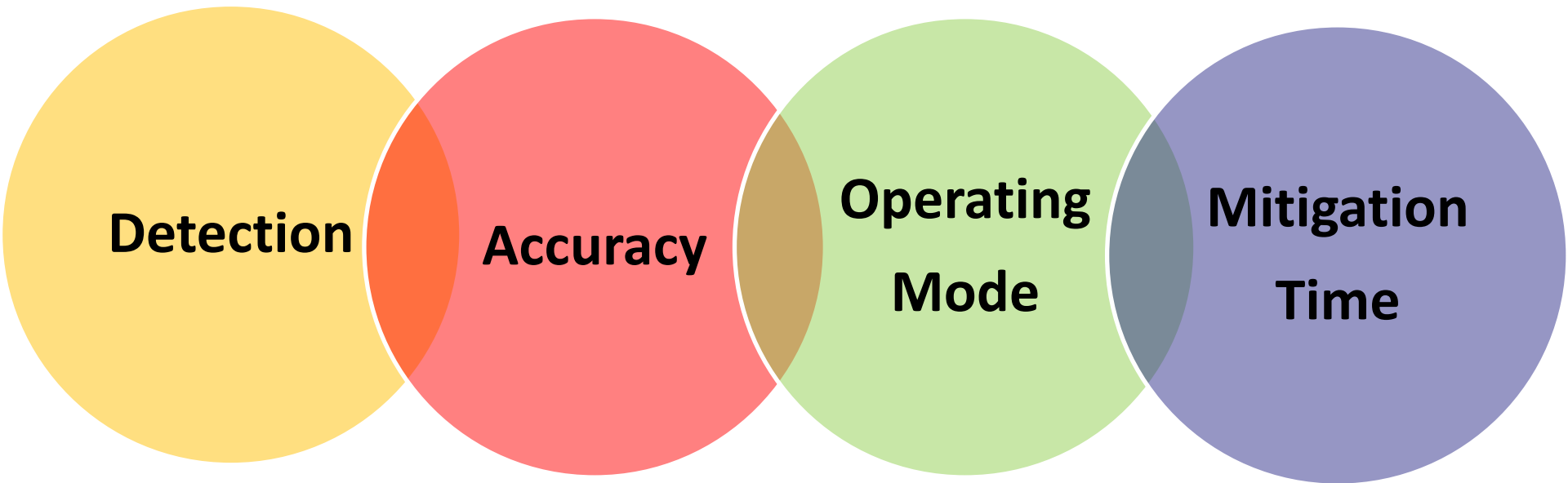


# Geolocation Performances Pillars





# Geolocation Performances Pillars



# CGL Performances

## Detection – Computation of accurate TDOA / FDOA

### Factors affecting detection

Size of the antennas and .....  
Satellites angular separation  
Mirror Satellite occupancy .....  
Satellite Characteristics.....  
    Phase noise  
    Local Oscillator drift  
    Acceleration  
Signal RF parameters.....

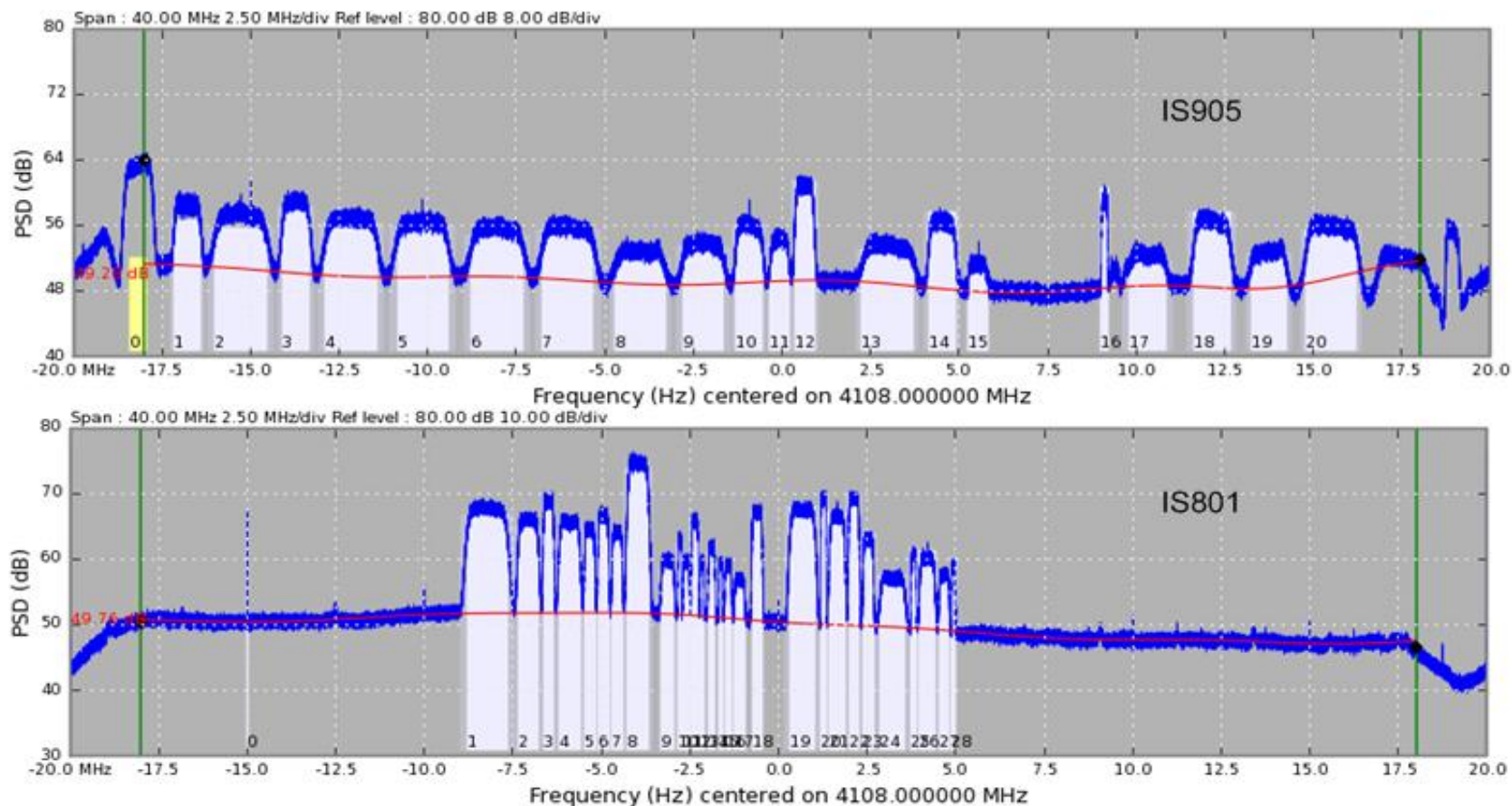
### ZDS supplies

- ➔ High processing gain  
Up to 81dB (depending on carrier param.)
- ➔ **Broad Carrier Cancellation capabilities**
- ➔ Improved Compensation Algorithms
  
- ➔ Highly flexible, high throughput digitizer architecture  
Ability to perform wide band recording during tens of seconds

# CGL Performances

**Detection** – Computation of accurate TDOA / FDOA

## Geoloc Examples

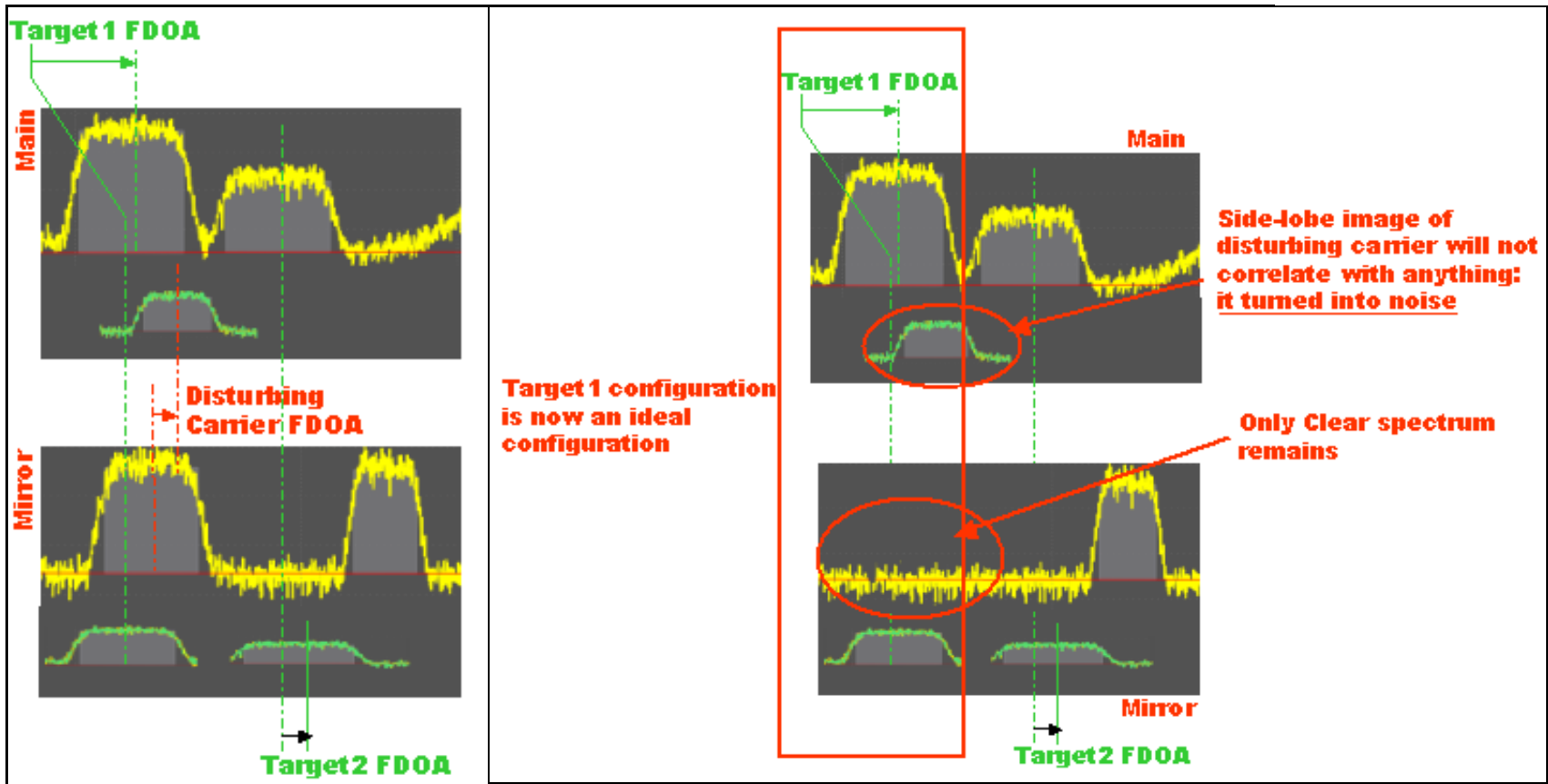


# CGL Performances

**Detection** – Computation of accurate TDOA / FDOA

## Carrier Cancellation

- Up to 60 MHz wide Carrier cancellation before correlation



# CGL Performances

## Location Accuracy – Resolution of the final position

### Factors affecting location accuracy

FDOA/TDOA accuracy.....

Ephemeris .....

Relative positions of the satellites .  
and position of the references

### ZDS supplies

- Hardware & Algorithm design to guarantee the best achievable processing gain
- **Ephemeris generation tools**  
Mono-site (Co-Orbits) / Multi-Site (passive)
- Expert system to analysis the most suitable measurement time and configuration

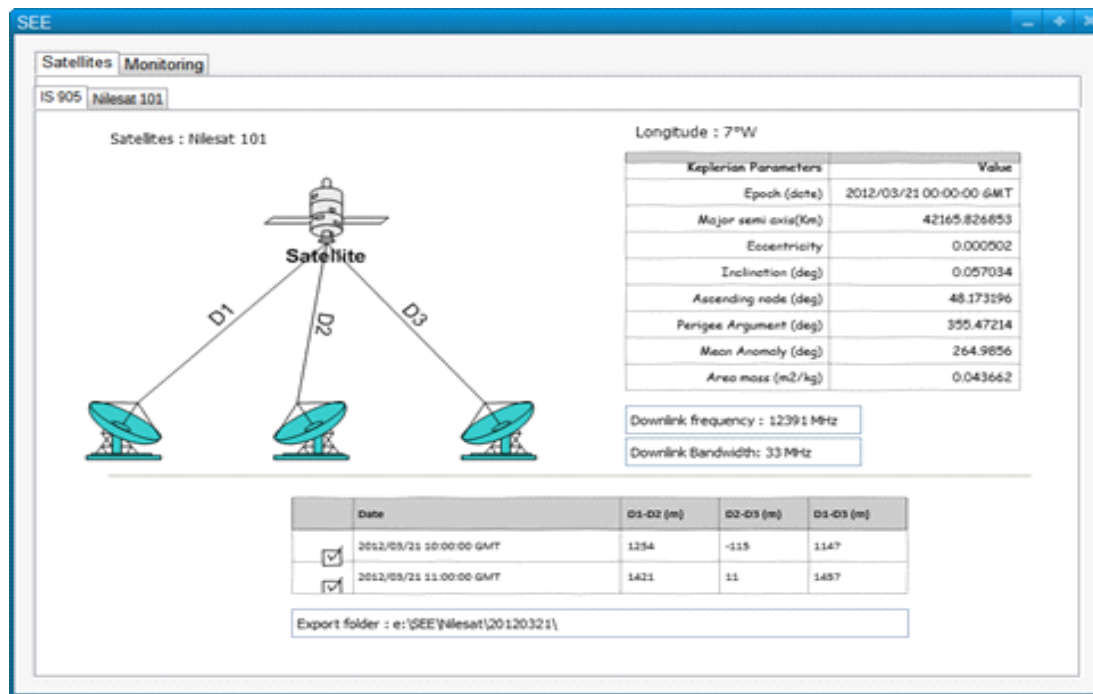
# CGL Performances

## Location Accuracy – Resolution of the final position

### Principles

Passive ephemeris estimation add-on to CGL geolocation system

The passive method for geostationary satellite ephemeris estimation is based on differences distances measurement between the satellite and three ground stations installed in three different locations with an average 300 km distance gap.



# CGL Performances

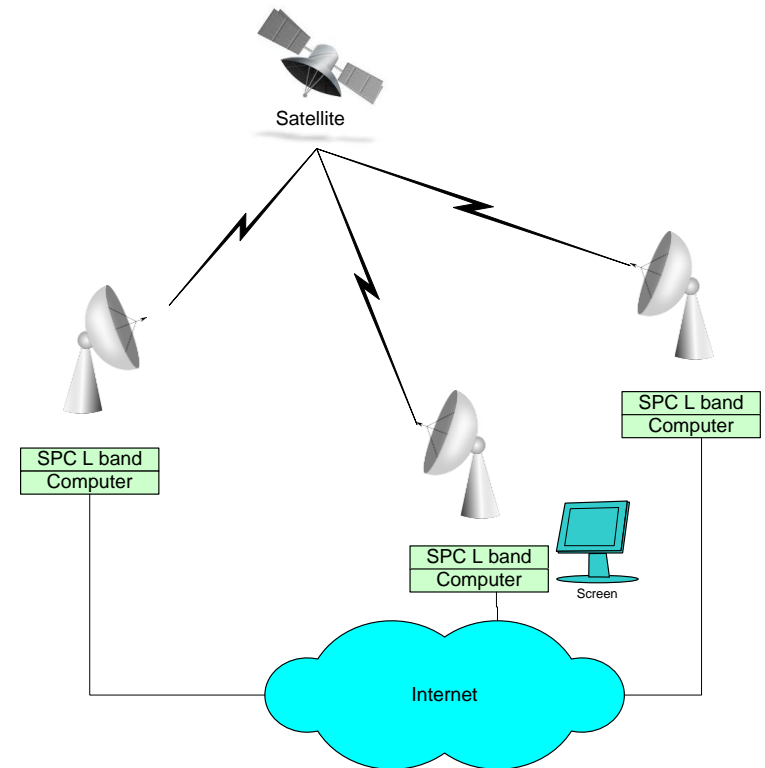
## Location Accuracy – Resolution of the final position

### Operating mode

The operating mode then solely relies on a single reference carrier.

The main purpose is to reach the accuracy at which one can use geolocation results without the use of additional reference transmitters.

The system continuously streams main/mirror orbital data to the geolocation system: after stabilization phase, up to date, accurate data are available upon triggering of a geolocation task



# CGL Performances

## Operating Mode - Easing-up the process

### Operating mode

#### Automated

Detection & Geolocation .....

Full transponder.....

Full Manual (Metrology Approach) ..

Distant Antennas .....

Interface with other applications .....

Multi sites .....

Autonomous system .....

→ One-Click Modes

→ **Macro Task Manager**

Geolocation-aware transponder monitoring  
Continuous Co-Orbit Estimation  
Multi-Carrier oriented Hardware Design

→ Expert mode

→ Multi-site GPS synchronisation

→ XML interfaces

→ Scalable system architecture

→ Stand alone system

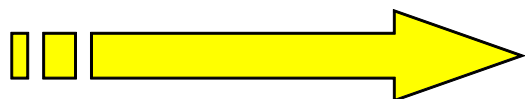


# CGL Performances

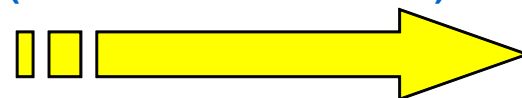
## Operating Mode - Automated MacroTasks Architecture

### Main principles

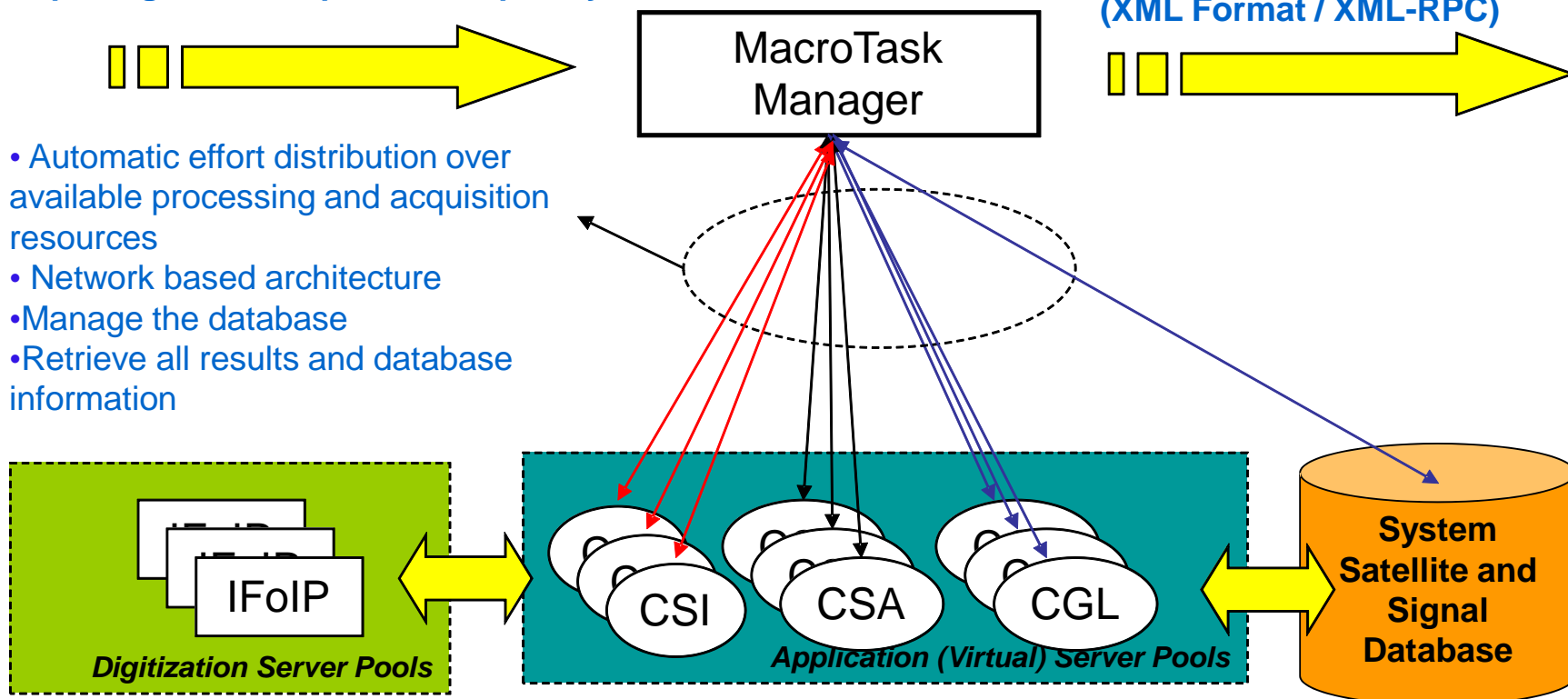
Input a given transponder frequency



Output Results  
(XML Format / XML-RPC)



- Automatic effort distribution over available processing and acquisition resources
- Network based architecture
- Manage the database
- Retrieve all results and database information



# CGL Performances

## Operating Mode - Automated MacroTasks Architecture

### Select your satellite and transponder

New task configuration wizard

Context and transponder

Context: Fixed satellites services

Transponder to process name: F2

Transponder properties :

- downlink center frequency = 12541.6700 MHz
- uplink center frequency = 14041.6700 MHz
- bandwidth = 72000.000 kHz
- frequency translation = 1500.0000 MHz

Others

[Reload transponders list](#)

[Interceptor properties](#)

< Back Next > Cancel

Selection of the Transponder to Geolocate  
(based on the Main Database)

# CGL Performances

## Operating Mode - Automated MacroTasks Architecture

Select your primary reference

New task configuration wizard

Task specific parameters

Main reference | Sampling parameters | Targets | Secondary references

Main reference: TLS-ASTRIUM-7A-12540.7-V - 12540.7382 MHz (EUTELSAT 7A )

Peak scan parameters: Edit

Process by: localhost:7765

Lock server for main reference process:

Forget analysis inside HyperLoc:

Others

[Reload references list](#)

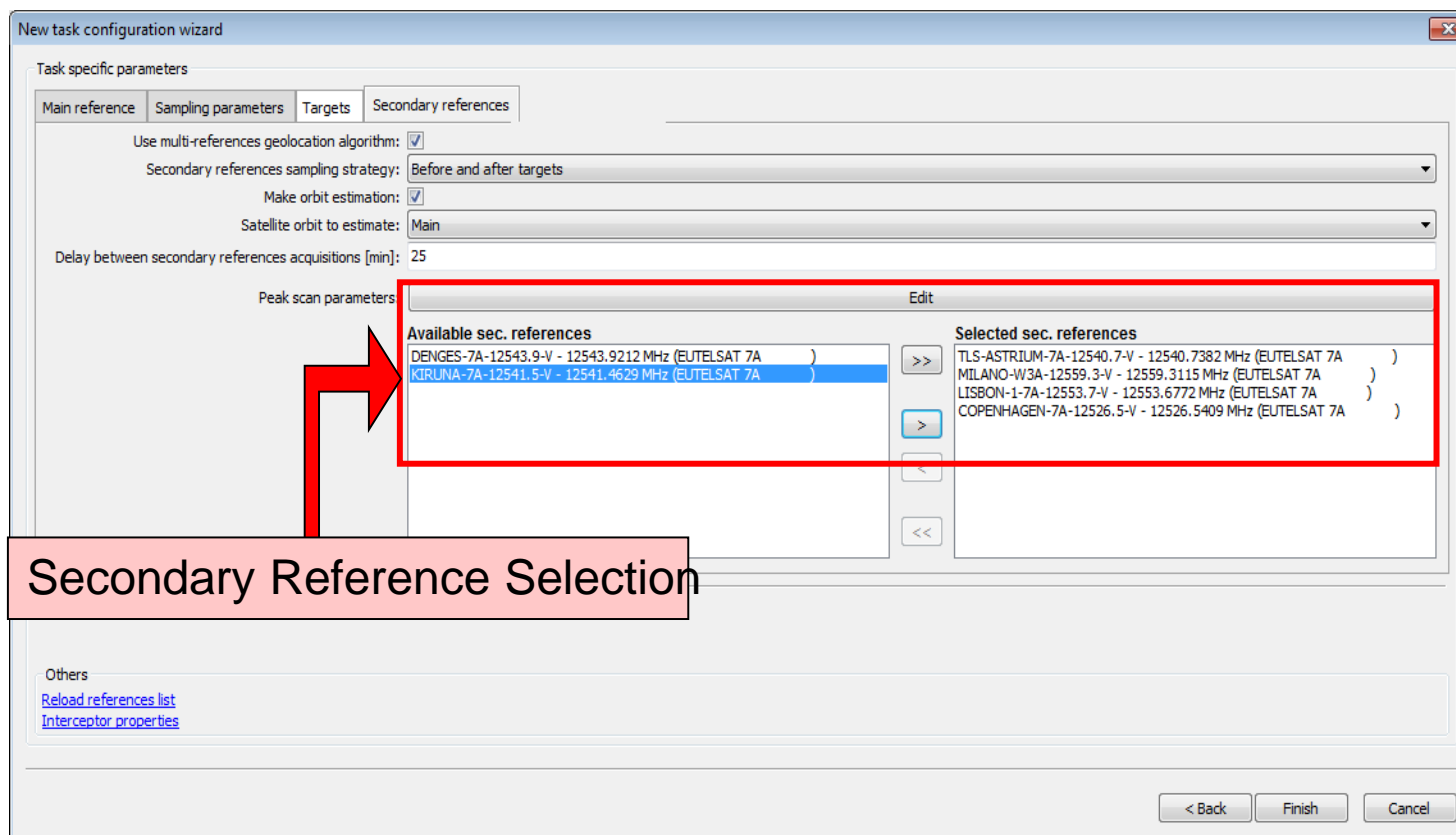
[Interceptor properties](#)

< Back Finish Cancel

# CGL Performances

## Operating Mode - Automated MacroTasks Architecture

### Select your secondary references

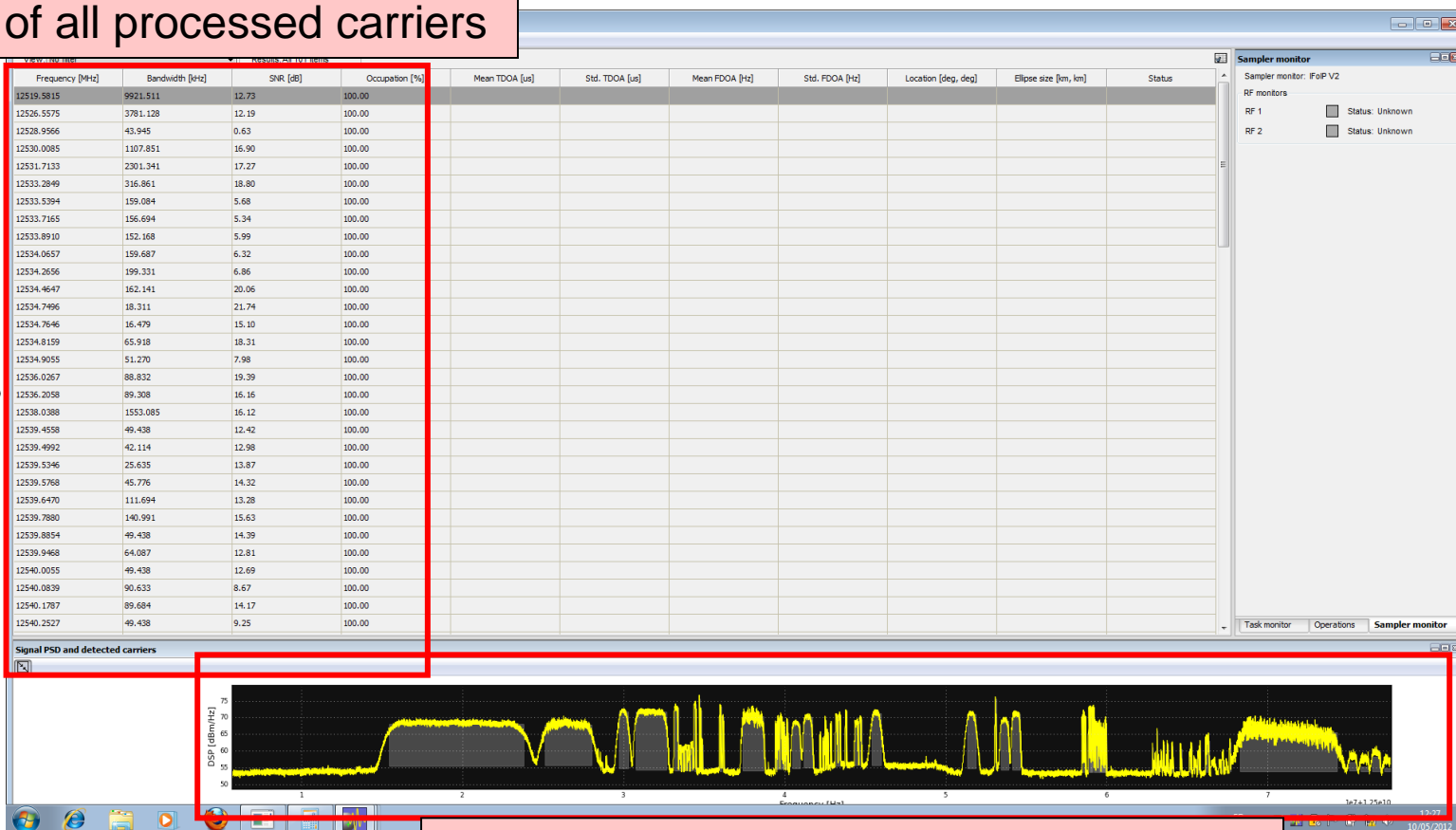


# CGL Performances

**Operating Mode** - Automated MacroTasks Architecture

**Select the carriers to locate**

Set of all processed carriers



Process Transponder Spectrum (72MHz)

# CGL Performances

## Operating Mode - Automated MacroTasks Architecture

### Results: positions & information on the carriers

#### Detailed Data for all carriers

Frequency [MHz]	Bandwidth [kHz]	SNR [dB]	Occupation [%]	Mean TDOA [μs]	Std. TDOA [μs]	Mean FDOA [Hz]	Std. FDOA [Hz]	Location [deg, deg]	Ellipse size [km, km]	Status
12544.4867	275.650	12.82	100.00	-89.0061	0.0530	-2564.0387	0.0012	(lat=44.166, lon=9.782 ( 10.05, 0.66)	Done	
12544.7235	178.011	13.76	100.00	-89.7308	0.0108	-2564.0409	0.0001	(lat=44.162, lon=9.737 ( 9.28, 0.21)	Done	
12545.7068	1113.143	15.54	100.00	-153.7759	0.0088	-2564.5132	0.0013	(lat=51.562, lon=5.163 ( 14.11, 0.22)	Done	
12551.6080	1077.389	16.06	100.00	-153.7738	0.0093	-2564.5335	0.0014	(lat=51.417, lon=5.175 ( 14.13, 0.23)	Done	
12553.1135	75.073	21.12	100.00	36.14194	0.1350	-2562.4589	0.0005	(lat=39.040, lon=-9.200 ( 7.77, 1.40)	Done	
12553.6750	730.872	14.63	100.00	-407.8210	0.0099	-2564.0017	0.0015	(lat=39.040, lon=-9.200 ( 9.31, 0.19)	Done	
12554.3897	714.873	16.70	100.00	36.18951	0.0114	-2562.5339	0.0017	(lat=33.806, lon=35.18 ( 9.07, 0.20)	Done	
12558.5072	56.763	15.82	100.00	-42.9005	1.2403	-2563.8813	0.0024	(lat=41.664, lon=12.52 ( 13.11, 11.75)	Done	
12558.5993	47.607	16.48	100.00	35.4334	0.1053	-2563.6039	0.0004	(lat=39.312, lon=16.97 ( 8.06, 1.09)	Done	
12558.6087	43.945	17.59	100.00	-44.2766	1.3261	-2563.8986	0.0046	(lat=41.894, lon=12.46 ( 17.53, 13.65)	Done	
12558.6804	92.451	16.40	100.00	-44.1919	0.7257	-2563.8815	0.0037	(lat=41.631, lon=12.44 ( 13.86, 8.06)	Done	
12558.9320	90.929	18.61	100.00	-43.3993	0.6131	-2563.8822	0.0030	(lat=41.640, lon=12.49 ( 12.56, 6.56)	Done	
12558.9964	34.790	19.31	100.00	-45.6492	1.3163	-2563.9021	0.0046	(lat=41.897, lon=12.37 ( 17.46, 13.55)	Done	
12559.0379	43.945	17.54	100.00	-43.8690	1.4015	-2563.9038	0.0049	(lat=41.952, lon=12.49 ( 18.37, 14.40)	Done	
12559.1082	87.891	18.54	100.00						Not detected	
12559.1226	32.959	18.97	100.00	-43.3345	1.5794	-2563.7462	0.0055	(lat=41.927, lon=12.51 ( 20.10, 16.00)	Done	
12559.2147	43.945	19.41	100.00	-44.3287	1.5824	-2563.7455	0.0055	(lat=41.890, lon=12.45 ( 20.10, 16.01)	Done	
12559.2523	27.466	12.94	100.00	-100.1996	0.4049	-2564.0321	0.0014	(lat=45.282, lon=9.075 ( 9.75, 4.73)	Done	
12559.3108	89.221	14.92	100.00	-98.3809	0.0931	-2564.0182	0.0004	(lat=45.074, lon=9.191 ( 8.00, 1.15)	Done	
12559.4328	141.074	14.20	100.00	-98.4817	0.0423	-2564.0243	0.0003	(lat=45.168, lon=9.186 ( 7.89, 0.50)	Done	
12559.5173	25.635	14.74	100.00	-98.7779	0.2581	-2564.0345	0.0009	(lat=45.334, lon=9.168 ( 8.23, 2.96)	Done	

Operations

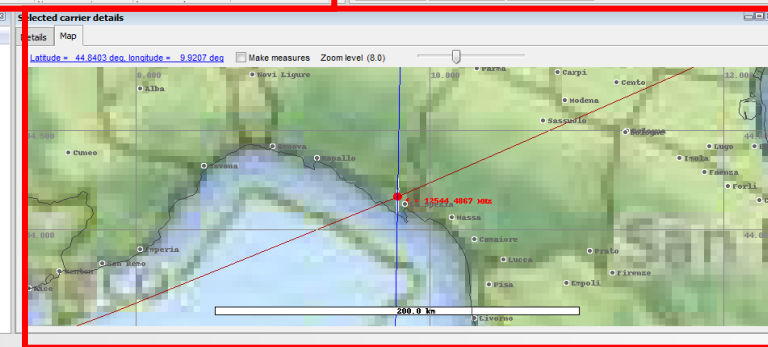
Main

Task started at 2012/05/10 12:26:44.6050000191 GHT+2

Completed

Messages Errors

reference server status : (1, 2012/05/10 10:27:14.5286476920 GMT, 2012/05/10 10:30:38.7420406529 GMT, 'Tracking')  
record dates : 2012/05/10 10:30:38.7901460420 GMT 2012/05/10 10:31:11.1020395824 GMT  
reference server status : (1, 2012/05/10 10:27:14.5286476920 GMT, 2012/05/10 10:30:38.7420406529 GMT, 'Tracking')  
record dates : 2012/05/10 10:30:38.7901460420 GMT 2012/05/10 10:31:11.1020395824 GMT  
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record dates : 2012/05/10 10:30:38.7901460420 GMT 2012/05/10 10:31:11.1020395824 GMT

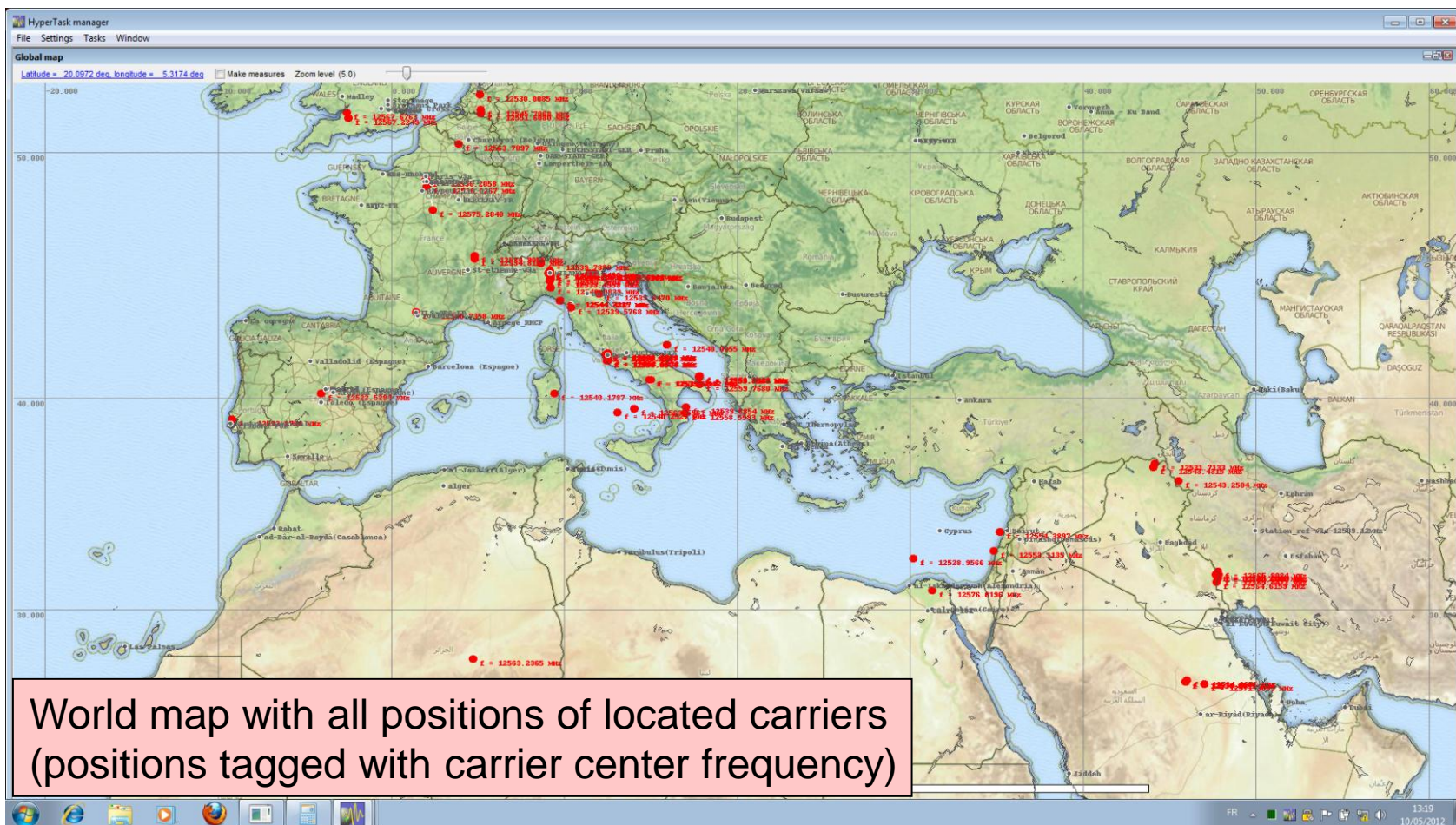


#### Map Details for selected carriers

# CGL Performances

## Operating Mode - Automated MacroTasks Architecture

### Results: positions on the map



# CGL Performances

**Mitigation time** – Automated interference detection and geolocation

## Mitigation time

Hardware performances .....  
Number of samples to process .....  
High processing .....  
Detection and Geolocation .....

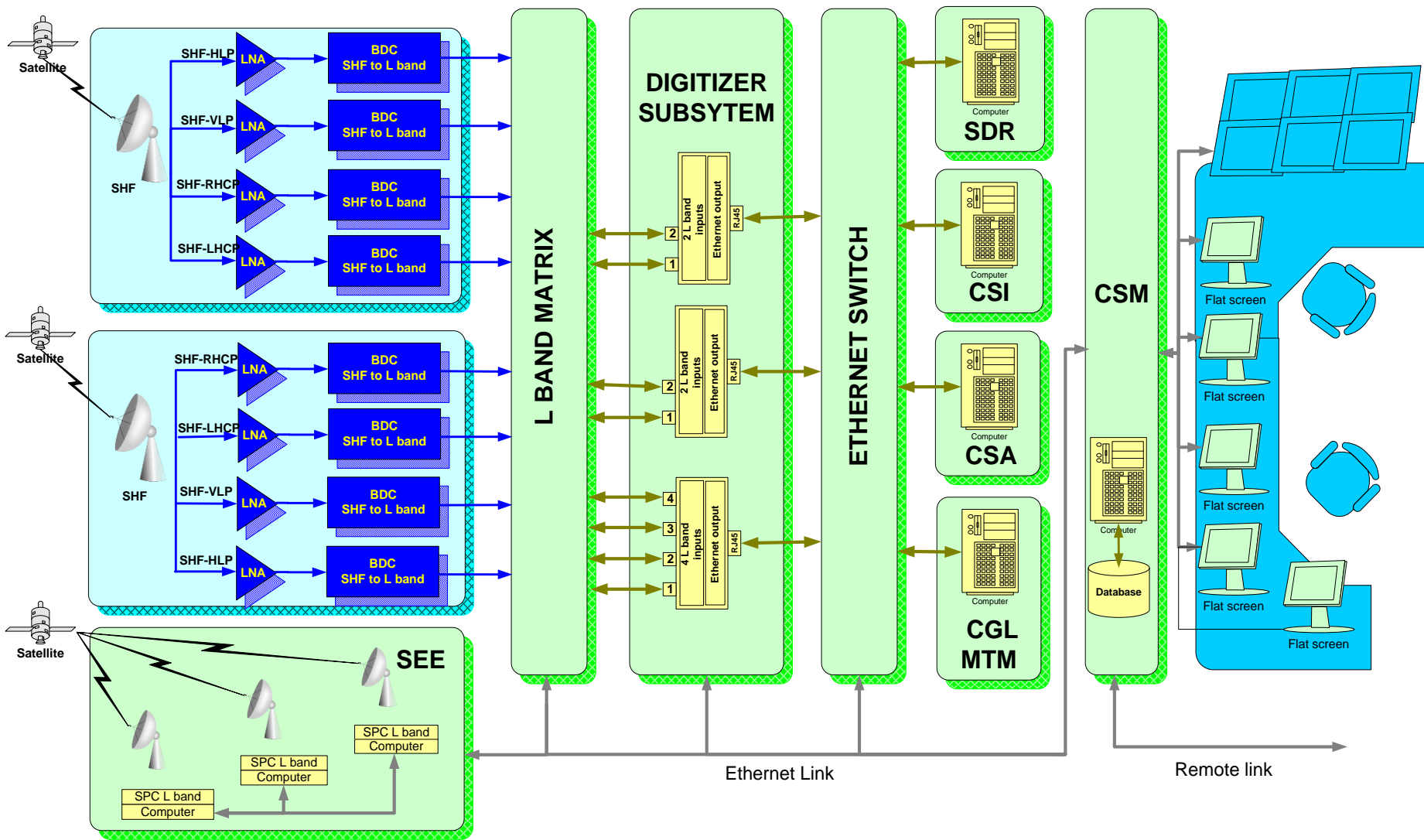
**ZDS supplies**

- ➔ Dedicated Hardware filtering architecture
- ➔ Multithreaded software
- ➔ 64-bit Multi-Core Optimized software
- ➔ **Automated detection and Geolocation included in the CSM feature**



# CGL Performances

## Mitigation time – Automated interference detection and geolocation

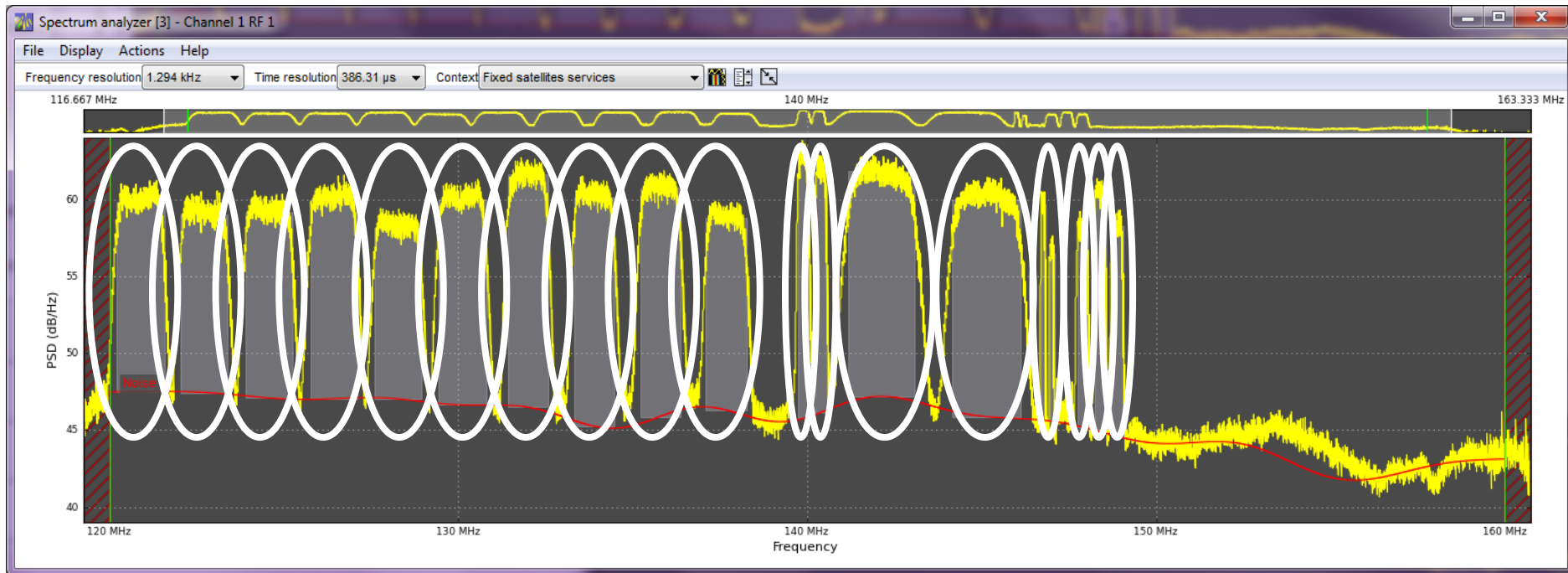


### ZODIAC AIRCRAFT SYSTEMS

# CSM Performances

**Learning mission** – Detection of all carriers

**Case of a new satellite**



- CSM uses CSI to detect carriers
- CSI sends list of detected carrier to CSM

# CSM Performances

## Learning mission – Analysis of all carriers

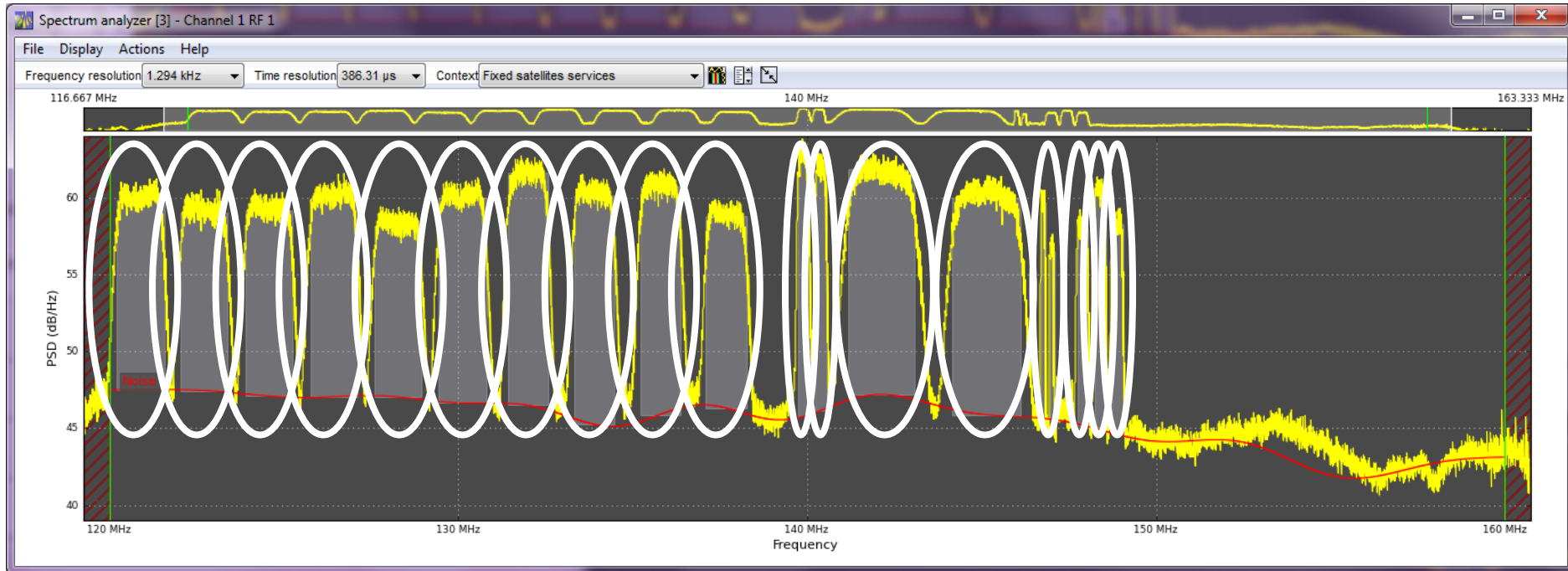
### Case of a new satellite

Id	Fc	BW	Bit rate	Symbol rate	SNR	Constellation	Inner code	Outer code	Overhead	Standard
6	132.01 MHz	1.57 MHz	2.048 Mb/s	1.17 MBd	15.6 dB	QPSK	CV(7,7/8)	None	None	IESS-309
7	133.89 MHz	1.67 MHz	2.048 Mb/s	1.17 MBd	14.5 dB	QPSK	CV(7,7/8)	None	None	IESS-309
8	135.79 MHz	1.79 MHz	2.048 Mb/s	1.17 MBd	12.2 dB	QPSK	CV(7,7/8)	None	None	IESS-309
9	137.68 MHz	1.59 MHz	2.048 Mb/s	1.17 MBd	12.6 dB	QPSK	CV(7,7/8)	None	None	IESS-309
10	139.9 MHz	557.45 kHz	512.000 kb/s	341.33 kBd	15.3 dB	QPSK	TPC 3/4	None	None	IESS-309
11	140.4 MHz	484.23 kHz	512.000 kb/s	341.33 kBd	14.5 dB	QPSK	TPC 3/4	None	None	IESS-309
12	142.12 MHz	2.87 MHz	3.072 Mb/s	2.05 MBd	15.1 dB	QPSK	CV(7,3/4)	None	None	IESS-309
13	145.14 MHz	2.69 MHz	3.072 Mb/s	2.05 MBd	14.6 dB	QPSK	CV(7,3/4)	None	None	IESS-309
14	146.77 MHz	169.68 kHz	128.000 kb/s	128.00 kBd	10.3 dB	QPSK	CV(7,1/2)	None	None	IESS-308
15	147.02 MHz	157.51 kHz	128.000 kb/s	128.00 kBd	9.9 dB	QPSK	CV(7,1/2)	None	None	IESS-308
16	147.9 MHz	447.67 kHz	512.000 kb/s	341.33 kBd	13.1 dB	QPSK	CV(7,3/4)	None	None	IESS-309
17	148.4 MHz	450.06 kHz	512.000 kb/s	341.33 kBd	15.4 dB	QPSK	CV(7,3/4)	None	None	IESS-309
18	148.9 MHz	447.5 kHz	512.000 kb/s	341.33 kBd	14.6 dB	QPSK	CV(7,3/4)	None	None	IESS-309

- CSM uses CSA to do for all detected carriers blind analysis and to fill database.

# CSM Performances

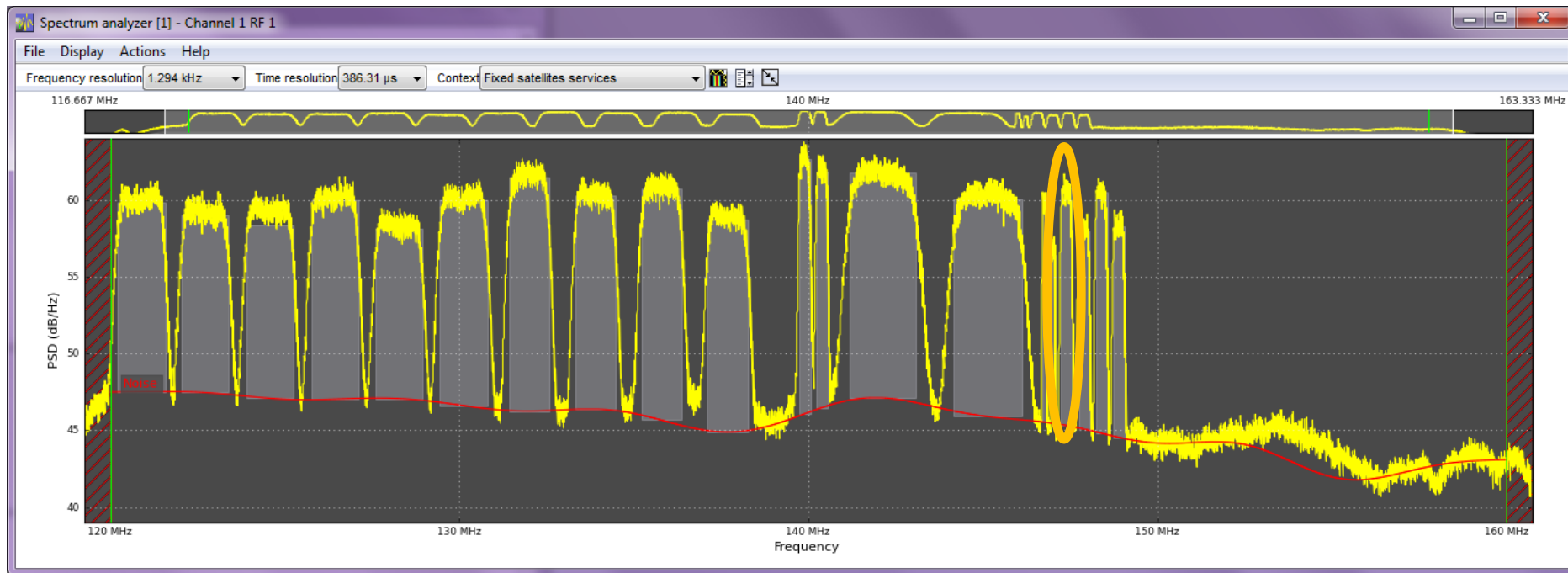
## Monitoring mission – Monitoring of all carriers



- CSM uses CSI to check Quality of service for each defined carrier
- CSI sends list of results to CSM

# CSM Performances

## Monitoring mission – Monitoring of all carriers



- CSI sends list of new detected carrier, also list of disappear carrier to CSM

# CSM Performances

## Monitoring mission – Analysis and Geolocation of interference

- For a monitoring mission, operator can defined tasks will be launch when a new carrier is detected, like:

- Blind analysis;

Id	Fc	BW	Bit rate	Symbol rate	SNR	Constellation	Inner code	Outer code	Overhead	Standard
16	147.4 MHz	458.69 kHz	512.000 kb/s	341.33 kBd	15.5 dB	QPSK	CV(7,3/4)	None	None	IESS-309

- Blind analysis + save results in database;
- Geolocation;
- Blind analysis + geolocation ...



# CGL Latest technologies

## Roadmap – Coming up in the future

### New request

TDMA signal .....

Ka Band.....

Spotted satellites .....

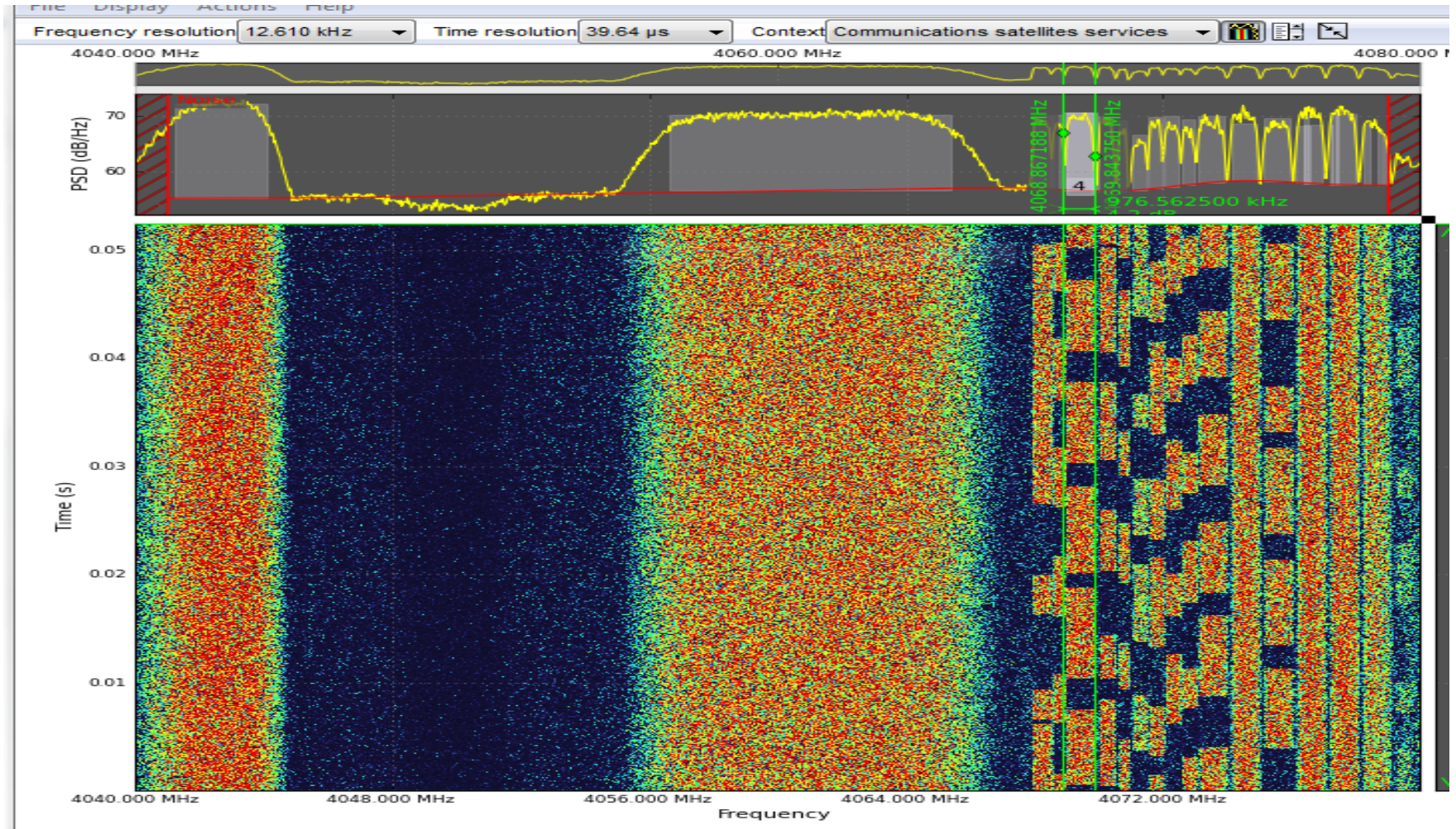
### ZDS Upcoming Features

- **Geolocation of the users**
- Better accuracy with One Sat
- Downsizing system configuration

# CGL Performances

## Roadmap – Geolocation of TDMA users

### In TDMA context

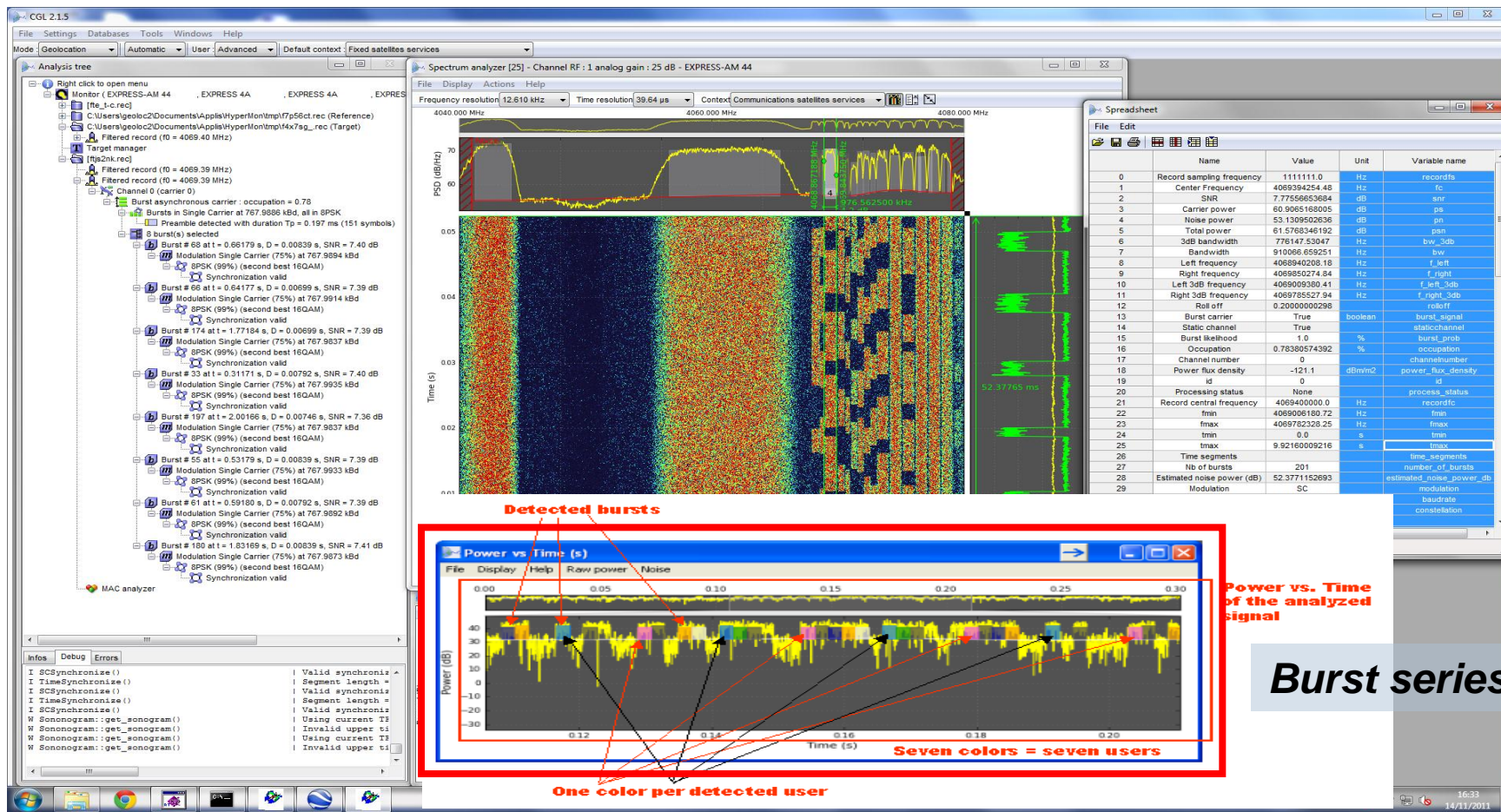




# CGL Performances

## Roadmap – Geolocation of TDMA users

### In TDMA context



# CGL Performances

## Roadmap – Geolocation of TDMA users

### In TDMA context

Geolocation manager : C:\Projects\Geoloc\Clients\EDGE Networks\Dana\ForDana\TDMA\_ExpAM44-Ku.mtl

Select target measurement for geolocation

From date  to date  from frequency [MHz]  to frequency [MHz]  Filter

Sampling date	Frequency [MHz]	Located at (lat, lon) [deg]	Ellipse size [km]	Process information	T
2011/11/14 16:45:18.4723012447 GMT	11008.0916	( 61.294, 57.867 )	( 629.89, 1.26 )	Standard geolocation done.	:
2011/11/14 16:45:18.4723265171 GMT	11008.0916	( 47.422, 16.373 )	( 140.47, 3.15 )	Standard geolocation done.	:
2011/11/14 16:45:18.4723446369 GMT	11008.0916	( 47.489, 16.413 )	( 141.36, 11.75 )	Standard geolocation done.	:
2011/11/14 16:45:18.4723582268 GMT	11008.0916	( 57.805, 60.022 )	( 854.49, 30.35 )	Standard geolocation done.	3
2011/11/14 16:45:18.4723794460 GMT	11008.0916	( 27.276, 2.629 )	( 373.66, 8.33 )	Standard geolocation done.	:
2011/11/14 16:45:18.4723794460 GMT	11008.0916	( 39.546, 4.721 )	( 214.36, 6.19 )	Standard geolocation done.	:
2011/11/14 16:45:18.4723970890 GMT	11008.0916	( 35.782, -0.569 )	( 252.03, 7.66 )	Standard geolocation done.	:
2011/11/14 16:45:18.4724235535 GMT	11008.0916	( 32.459, -5.537 )	( 291.48, 9.71 )	Standard geolocation done.	:

One single  
central frequency

Several distinct  
locations

# CGL Performances

## Network example – Geolocation of TDMA users





**Thank you !**