



GPS/GNSS Interference Mitigation

56th Meeting of the CGSIC
GNSS+ 2016 Conference

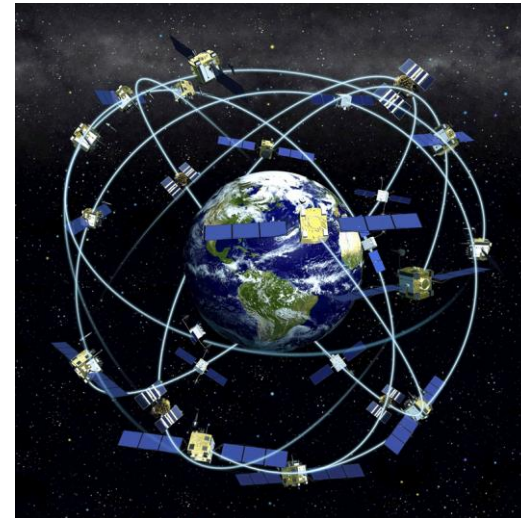
Portland, Oregon
September 12-13, 2016

Jan Van Hees
Business Development
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Septentrio



Our roots



Founded Septentrio in 2000.
Major partner & shareholder.
Premier semiconductor research institute.
Unique infrastructure and talent.
Spider in **strong eco-system**.

Long term strategic partner since 2002.
All Galileo test receivers designed and built by Septentrio exclusively (IOV & FOC).
Participated in numerous ESA projects in military, avionics & space.
Provided **in-depth understanding of GNSS**.

Company history



2000

Septentrio is founded as a spin-off from IMEC, world's premier semiconductor research center and still a strong partner & shareholder.



2002

ESA selects Septentrio as development partner for Galileo programs. Many firsts on Septentrio receivers, both IOV and FOC, including PRS.



2006

Altus is founded in Torrance, CA focusing on high end survey applications



2008

Veripos selects Septentrio receivers for its worldwide augmentation services.



2014

Antoon De Proft hired as new CEO, full acquisition of Altus.



2015

Selected by Unavco for PBO and other scientific activities



2016

Selected for NASA Global GNSS Network (GGN) and orbit determination activities



Key application markets

Machine Automation

Marine



Construction



Mining



Logistics



Agriculture



Autonomous driving



Survey and Mapping

Survey



GIS



Mobile Mapping



Unmanned Systems



Scientific/Reference

Reference Receivers



Timing Receivers



Space Weather



Aerospace/Defense

Aerospace



Defense





Easy-to-integrate



Reliability



Availability



Accuracy

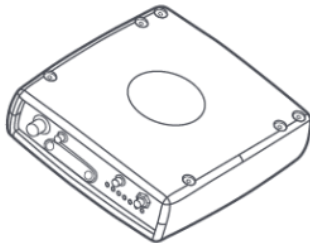
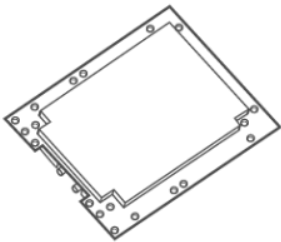


Technology

Our Products

AsteRx

Rover Receivers and OEM boards
for automation and machine
control



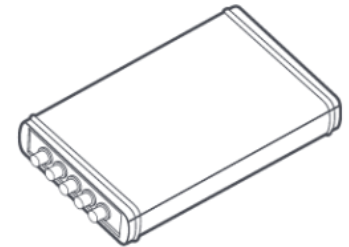
Altus

Smart antennas for
GIS and survey



PolaRx

Reference receivers for
science and networks



PolaRx5

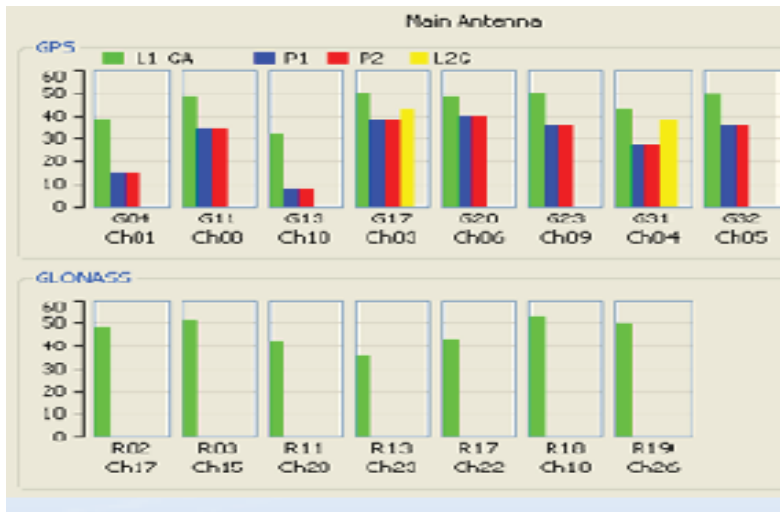
Tracks **all visible GNSS signals**, incl. E6
Best-in-class Measurement Quality
AIM+ Interference Monitoring
APME+ Multipath estimation & mitigation
Provides **unaltered data**
Low and **scalable** power consumption



GNSS Interference



Houston – we have a problem

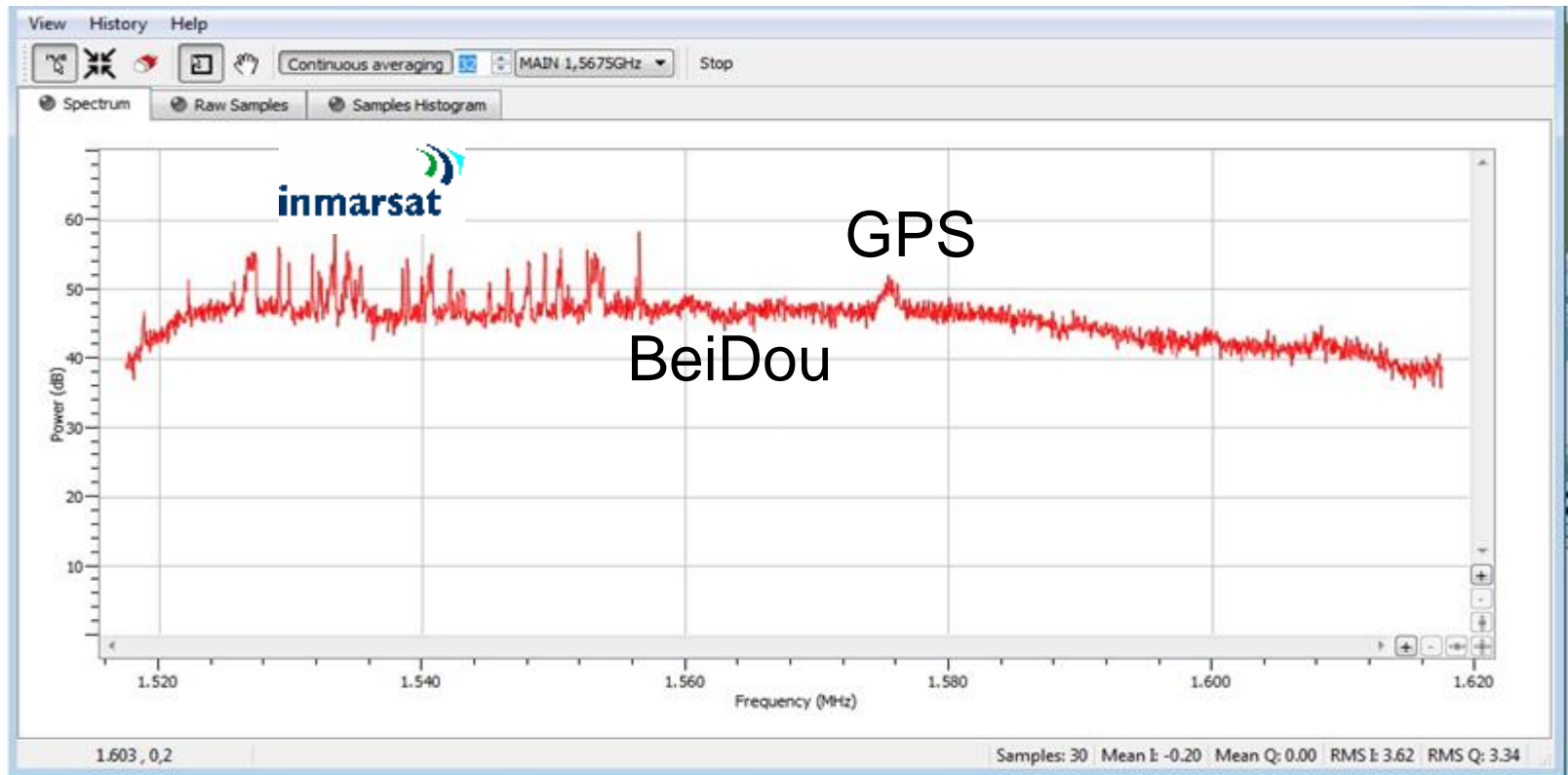


Ostend (BE)



Without Interference...

- Mostly Flat
- Example : L1 Band



Iridium interference

Satellite based DGNSS sensitive to Iridium interference and Inmarsat-C with various competitive receivers

(independent report from Chevron)

Iridium and Inmarsat C interference to DGPS



OE Moment
CVX Marine HES Contractor Meeting

Interference problems with DGPS signals



© 2011 Chevron

Narrow Band Interference

- **Radio Amateur Digipeater**

Hilversum (NL)



@ 500 m

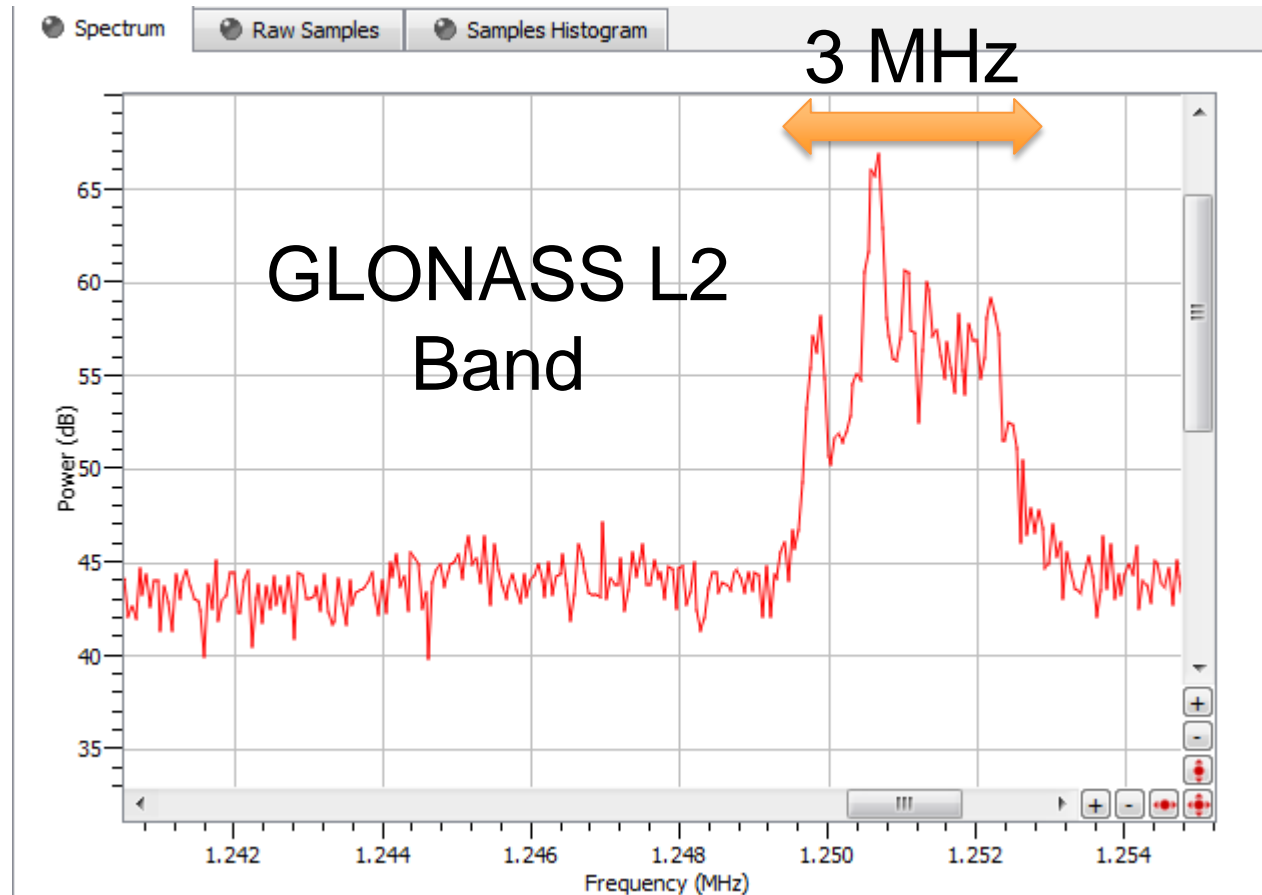


Bursts!

But Often Wider Bandwidth

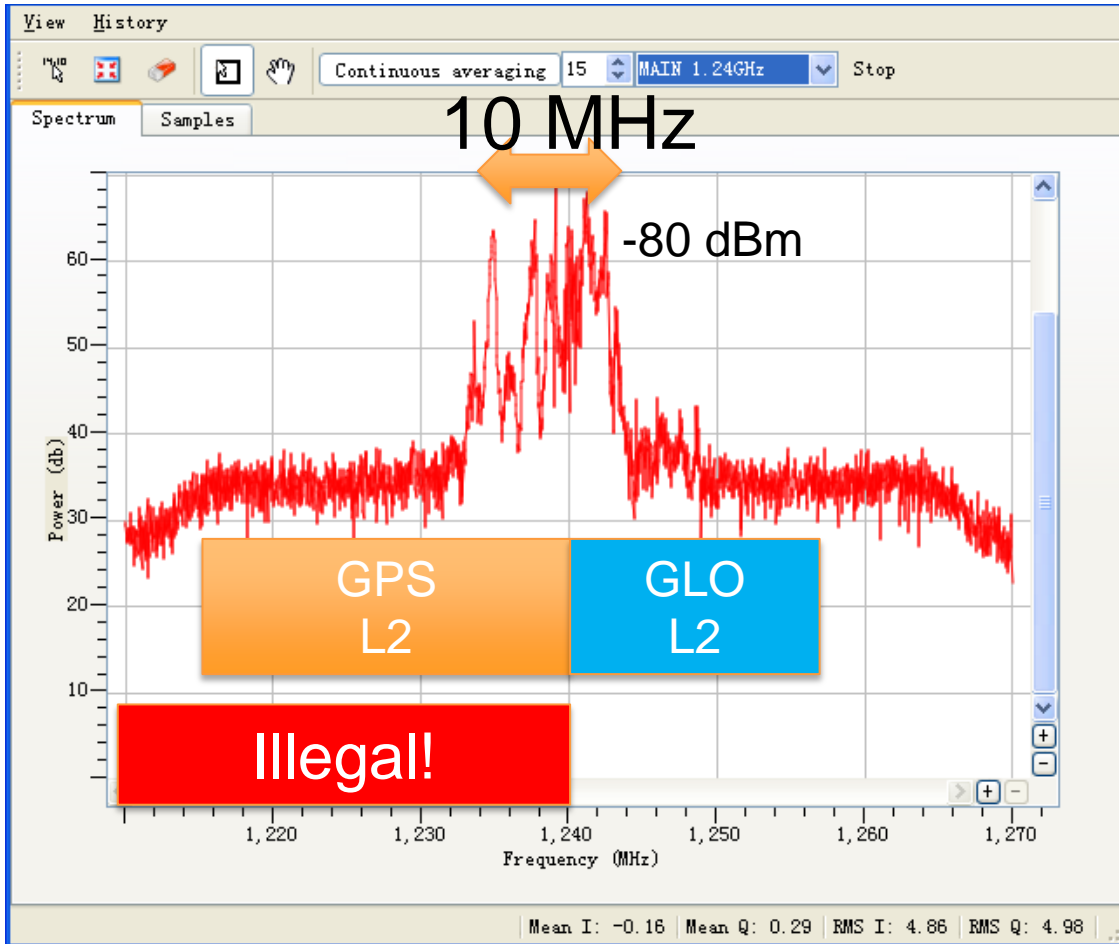
- Radio Amateur Television (ATV)

Berlin (DE)

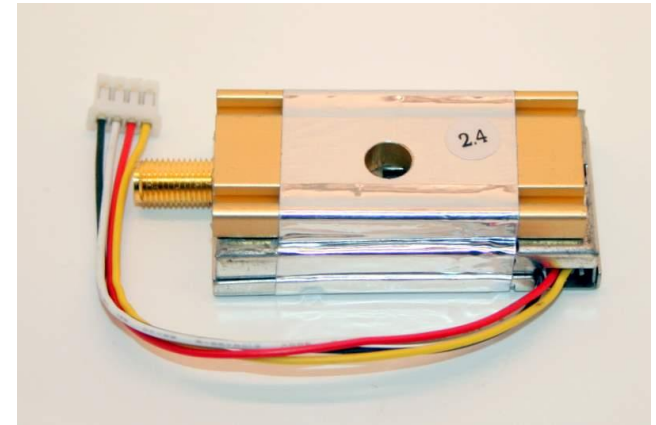


Utility Video Transmitters

China



“LawMate” Transmitter
Security Camera
R/C Hobby



1240 MHz
1Watt

➔ **Up to 30 km!**

Jammers



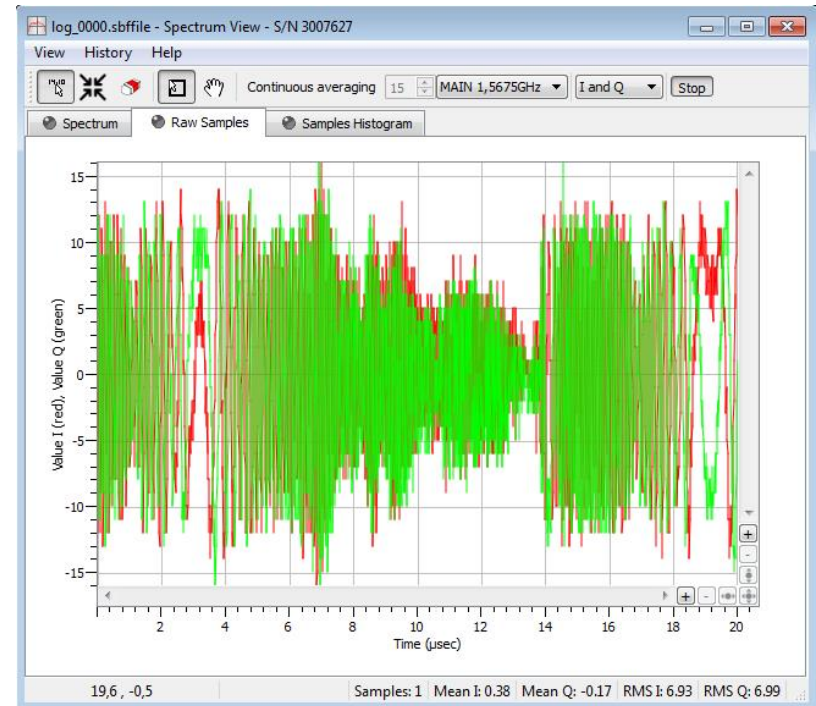
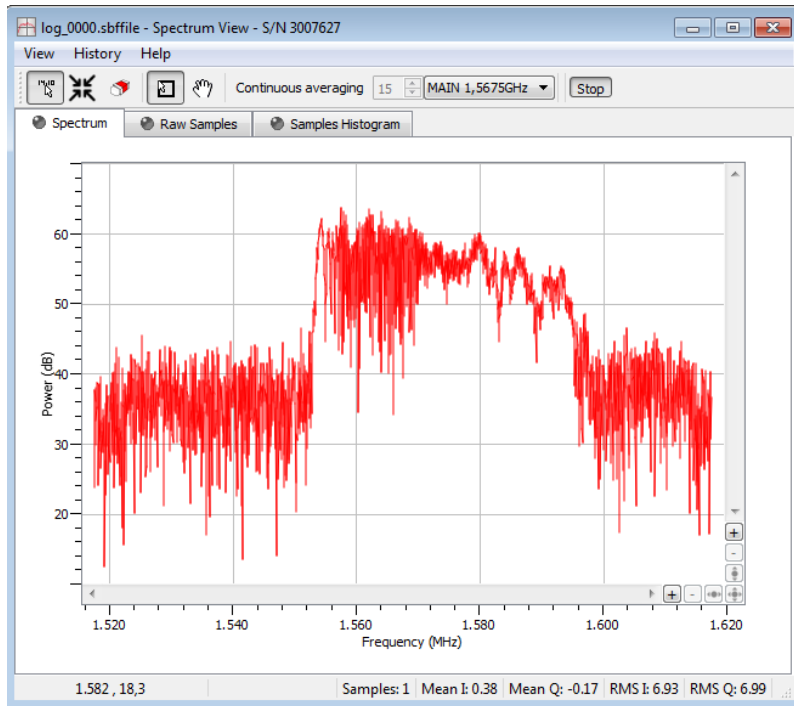
10 mW



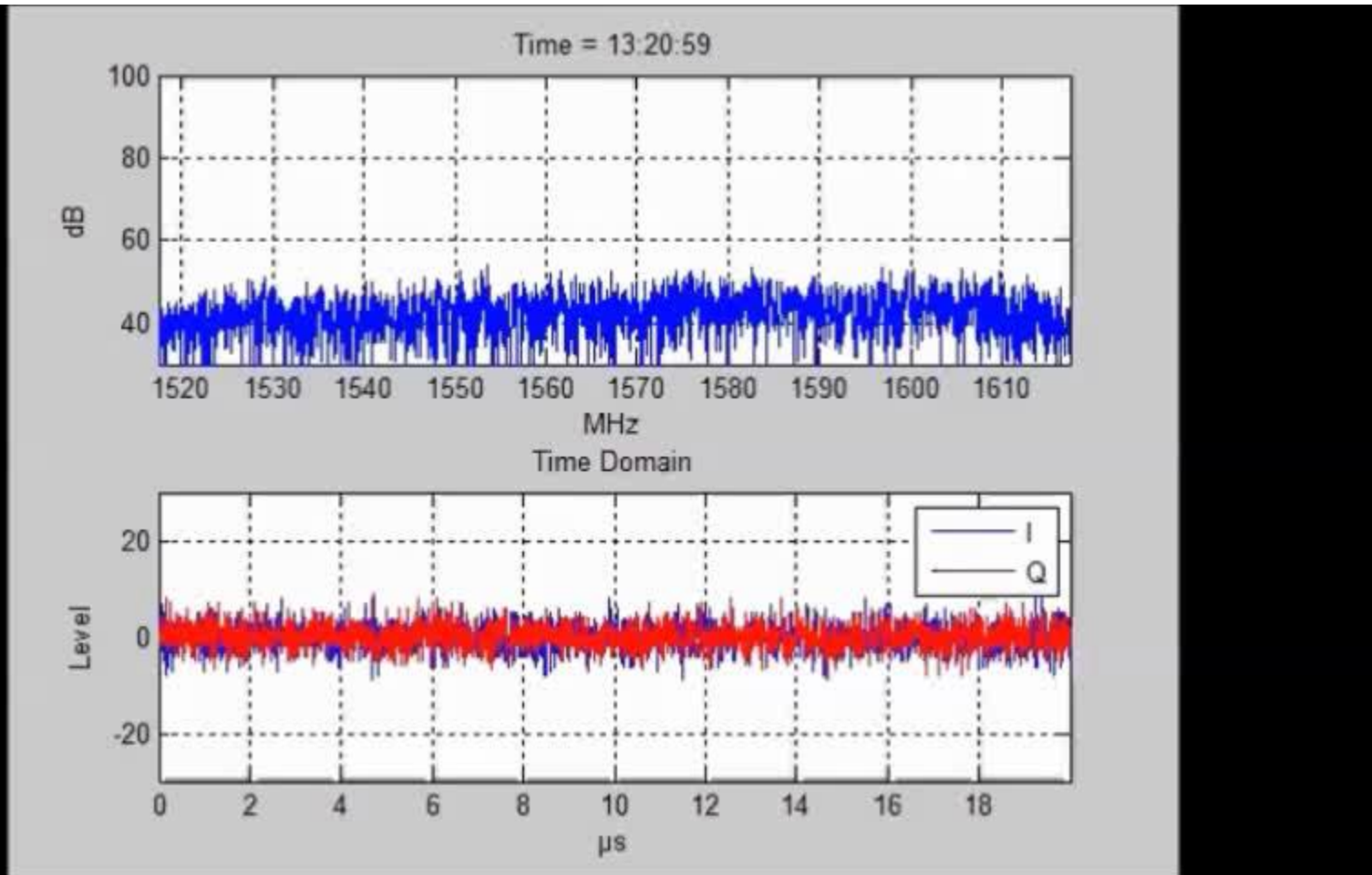
4x 300 mW

Jammers: Are They Really There?

- Yes, they are...



Jammer in Action (from customer log)



In-Band interference – DME

Distance Measurement Equipment (DME)

Tactical Air Navigation (TACAN)

Share band with GPS L5 and GALILEO E5

2700 high-power pulse pairs sent per second

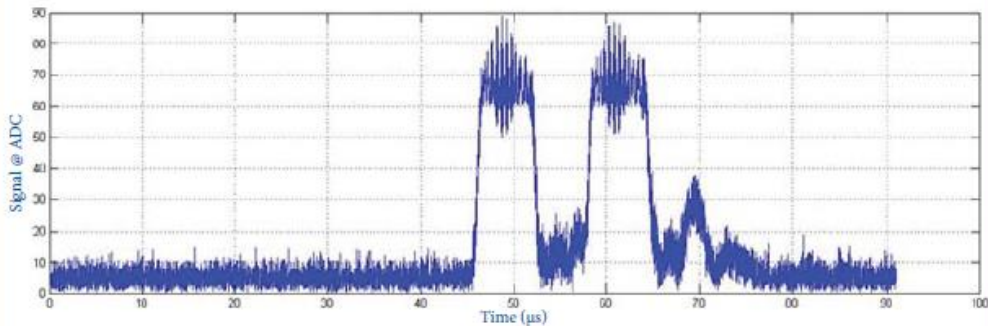
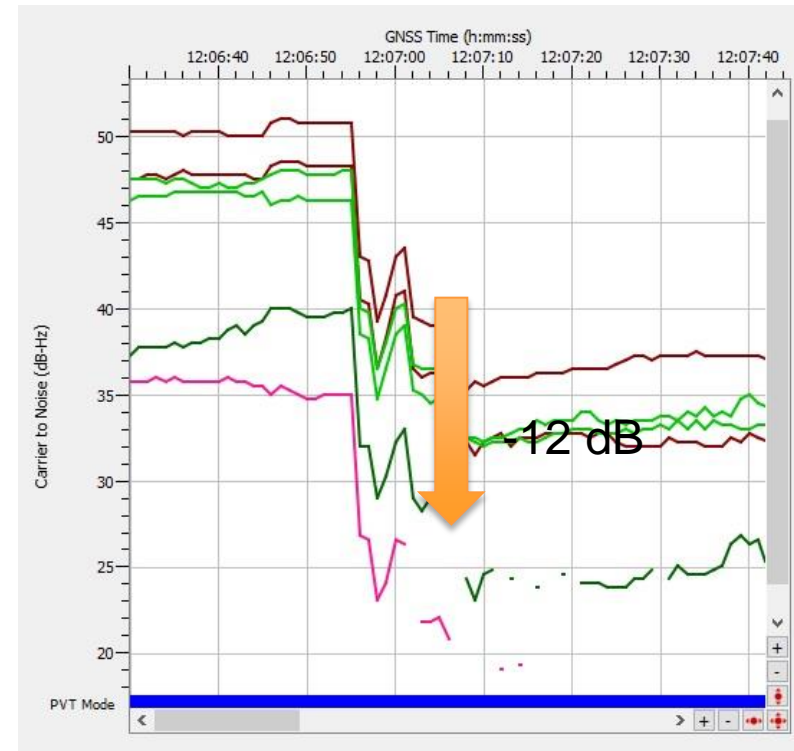


Figure 6. Pulse pair observed near DME beacon "BUB" (Brussels Airport) using Septentrio "Time Plot" tool



Integration interference

Example: C/No Loss if Camera On



See also presentation :

Interference Mitigation

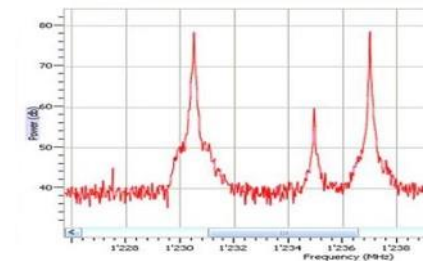
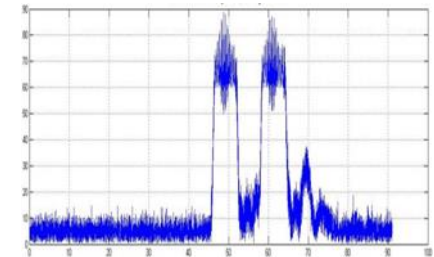
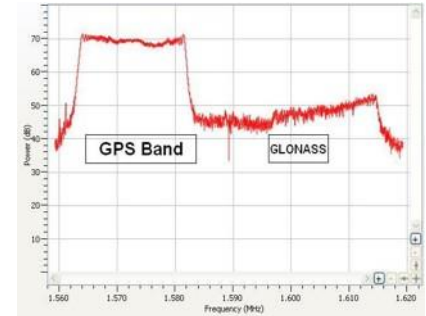
Advanced Interference Mitigation (AIM+)

Septentrio receivers are designed to fight interference, combination of

- Special RF design
- Dedicated circuits in ASIC
- Special algorithms

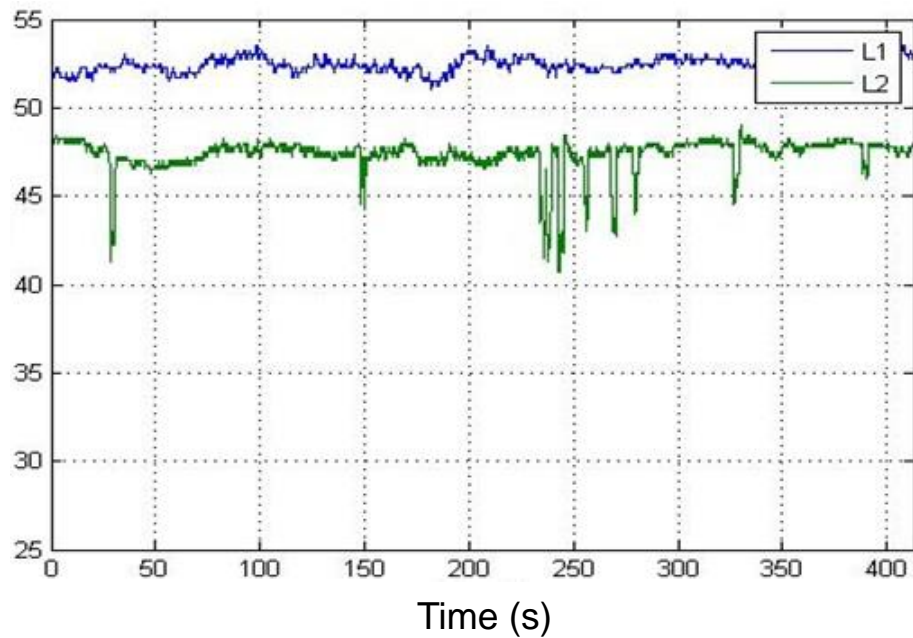
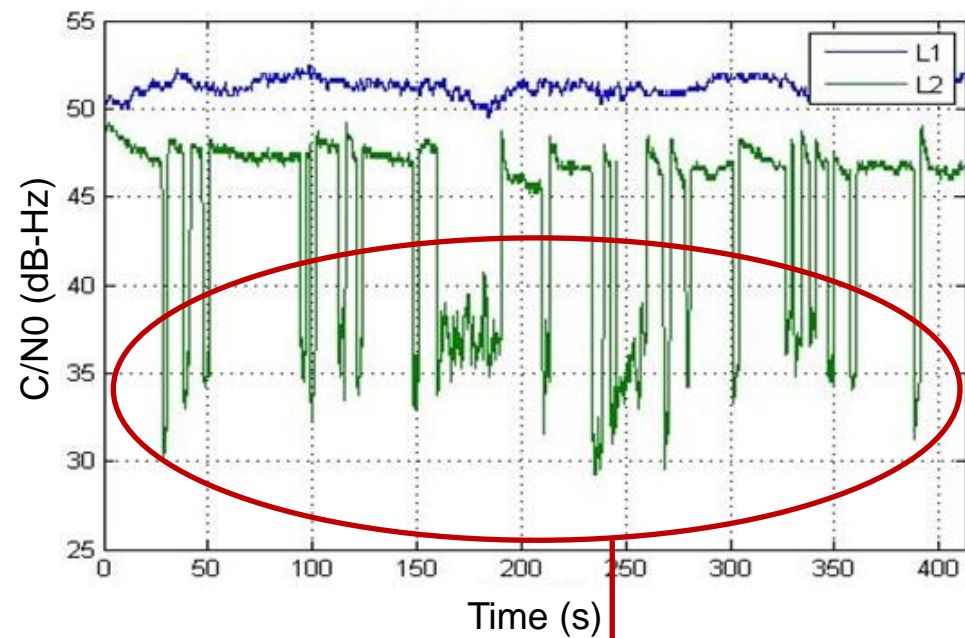
AIM+ (Advanced Interference Mitigation)

- protects against various sources of interference
 - Radio amateur and digital TV spurious peaks
 - Inmarsat and Iridium
 - Pulsed interference from DME around airports
 - Wideband interference from chirp jammers



Adaptive Notch Filtering in action

With notch filtering:



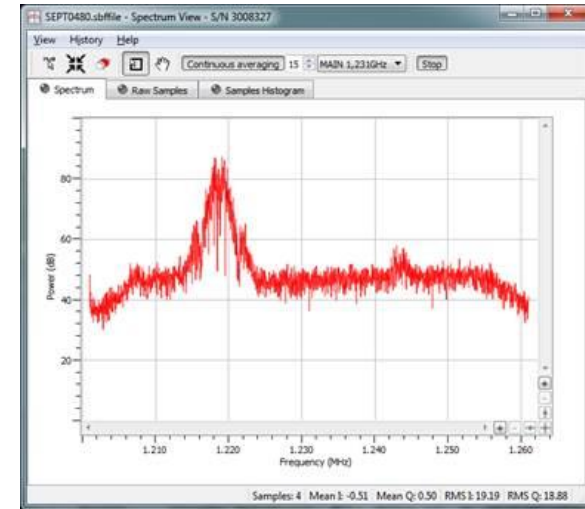
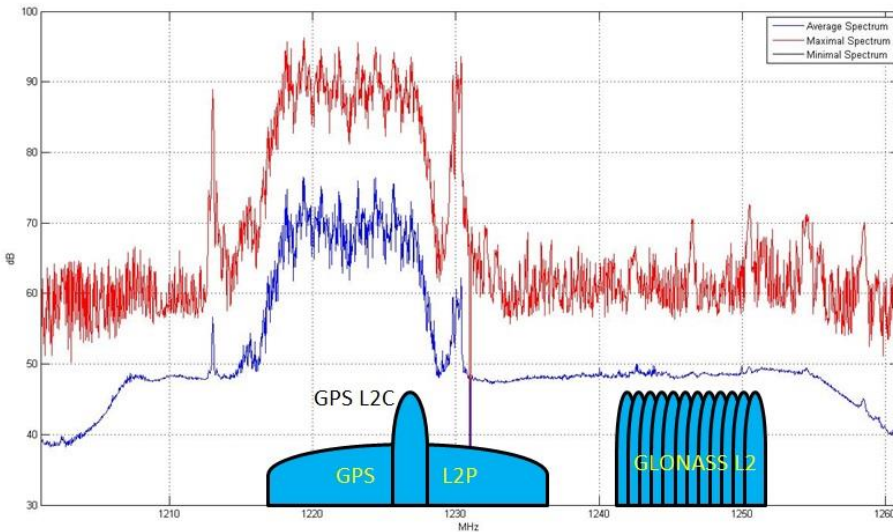
Digipeater

Frequent signal/phase data loss on L2 inhibit RTK

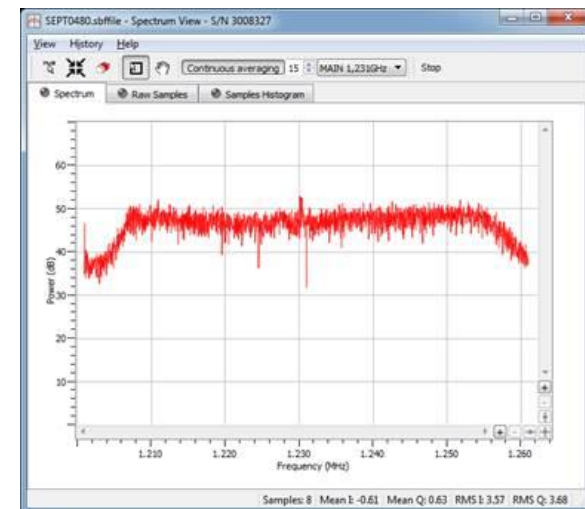
Wideband interference mitigation unit

Without AIM+

Real-life data (construction site near naval base):



With AIM+



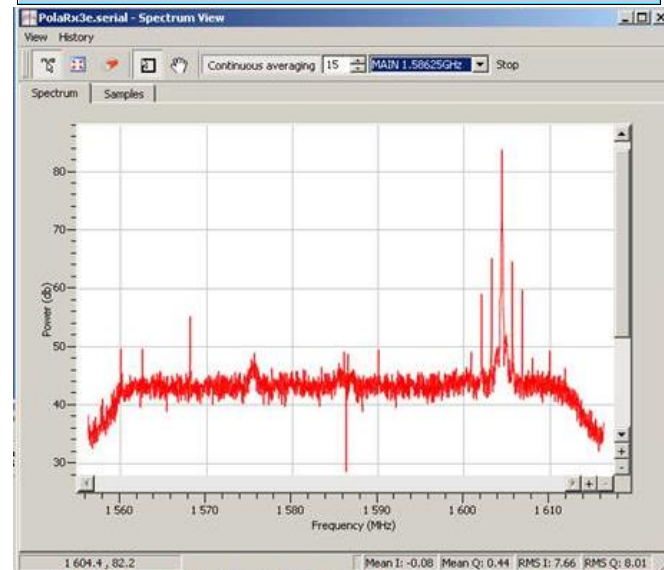
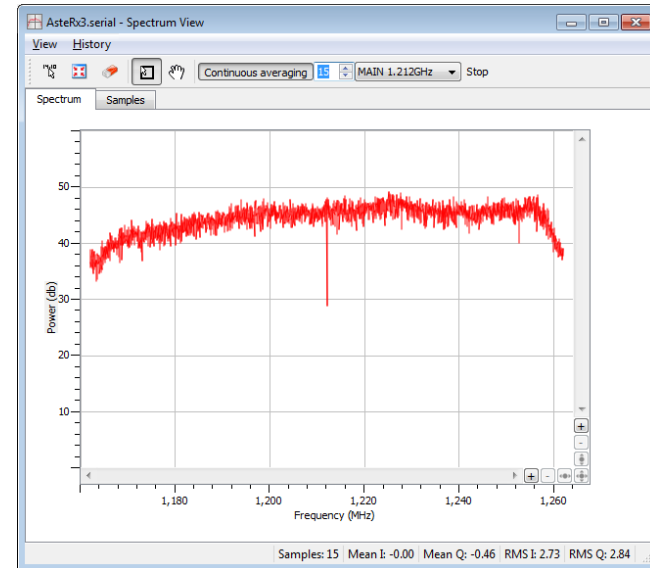
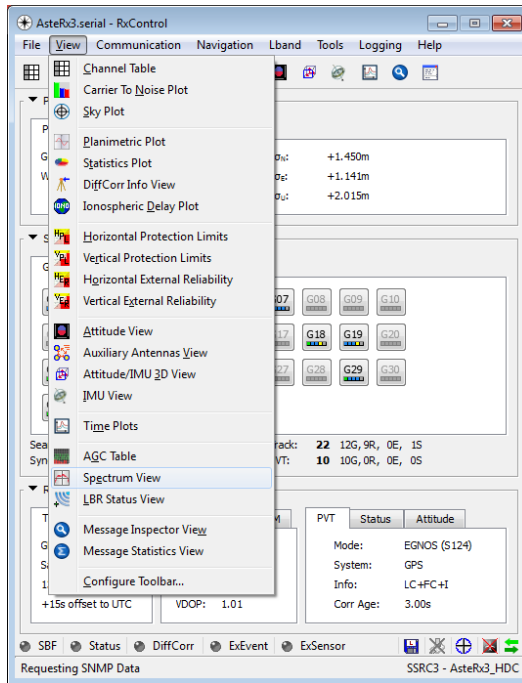
10 mW Chirp Jammer: No Mitigation



10 mW Chirp Jammer: PolaRx5



Diagnose interference problems - RxTools



Conclusion

- Interference is everywhere, and growing
 - Not just one problem – not just one solution
 - It keeps changing – requires ongoing attention
- Interference can be solved
 - Need to be solved in the receiver – antenna filtering often not enough / not practical
 - It's everywhere in the design, not an afterthought
- Suspect an interference problem ?
 - Talk to Septentrio – tackling interference since 2006

More information ?

visit presentation

“GNSS Interference in Unmanned Aerial Systems”

Wednesday, Sep. 14, 2:58 p.m - Room B117/118/119

or visit us in Booth #216



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