

STRIKE3

ist ein Projekt zum Schutz von GNSS:
GNSS-Interferenzen beobachten –
erkennen - charakterisieren – mindern

Standardization of GNSS Threat reporting and Receiver testing through
International Knowledge Exchange, Experimentation and Exploitation

- Ergebnisse der Langzeit-Beobachtungen
und Empfängertests –

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European
Global Navigation
Satellite Systems
Agency



POSNAV 2018

DGON Berlin
16. Nov. 2018

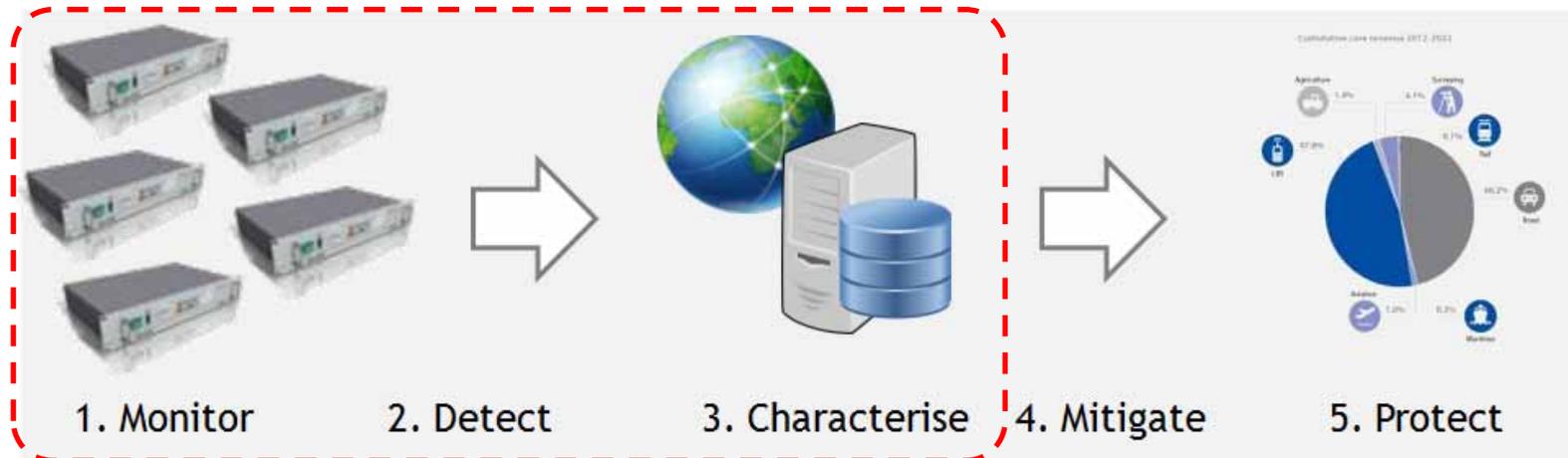
- Projekt gefördert von der Europäischen GNSS Agentur (GSA) im H2020 Framework Programm für F&E



- Dauer: 3 Jahre (1. Feb. 2016 bis 31.01.2019)

- Die Projektpartner:





- **Beobachtung von real auftretenden GPS Interferenzen**
 - **Aufbau eines internationalen Monitoring-Netzwerkes**
- **Erfassung und Charakterisierung der Interferenzsignale**
 - **DRAFT Standard for GNSS threat reporting and analysis**
- **Minderung der Störanfälligkeit durch Interferenzen**
 - **DRAFT Standard for assessing the performance of GNSS receivers under threat**
- **Validierung der Ergebnisse**
 - **Exemplarische GNSS-Empfänger-Tests**

At a range of infrastructures

- Major City Centres
- City-ring roads
- National timing labs
- Motorways/Road network
- Airports
- GNSS infrastructures
- Power stations
- Railway
- EU Borders
- Ports

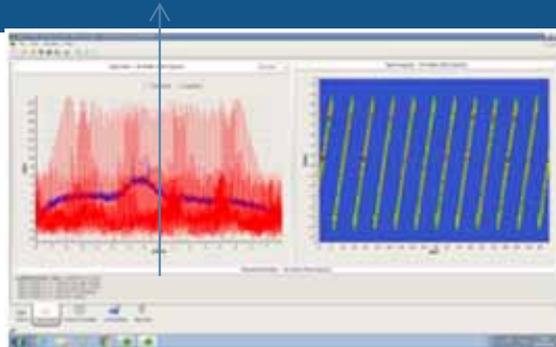
At a range of locations

- United Kingdom
- Sweden
- Finland
- Germany
- France
- Poland
- Czech Republic
- Spain
- Slovakia
- Slovenia
- Netherlands
- Belgium
- Croatia
- Latvia
- India
- Vietnam
- Thailand
- Malaysia
- New Zealand
- Canada
- Japan
- US (exploring)
- Singapore (exploring)

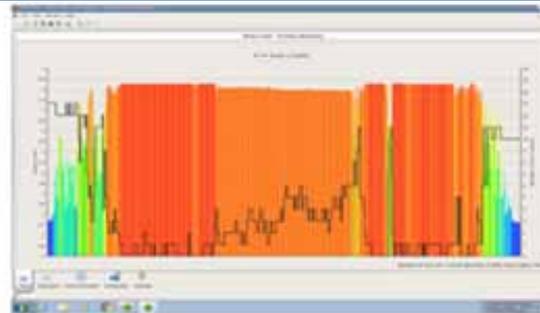
Involving a range of entities:

- Government agencies
- Frequency regulators
- Road operators
- Tolling operators
- Airport operators
- Air Navigation Service Providers
- Power grids
- Research

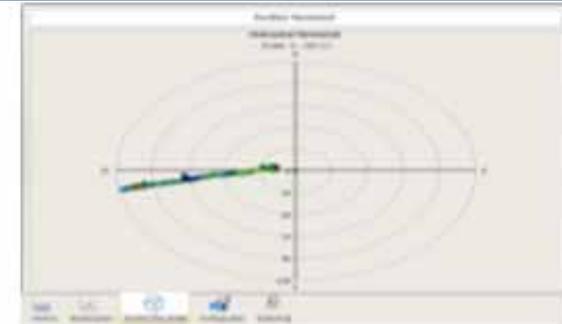




1. Spektrum/Spektrogramm



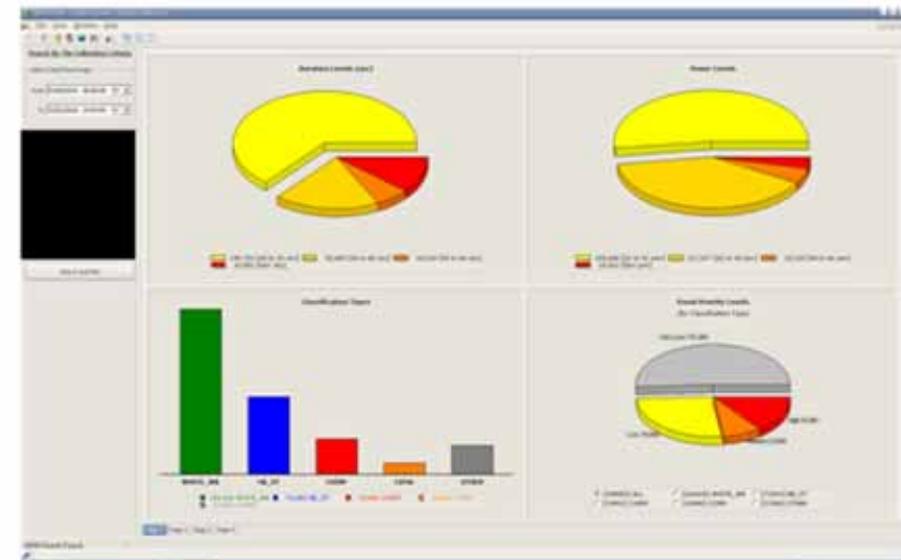
2. Leistungsprofil und Einfluss auf die Anzahl der Satelliten



3. Beeinflussung der Genauigkeit

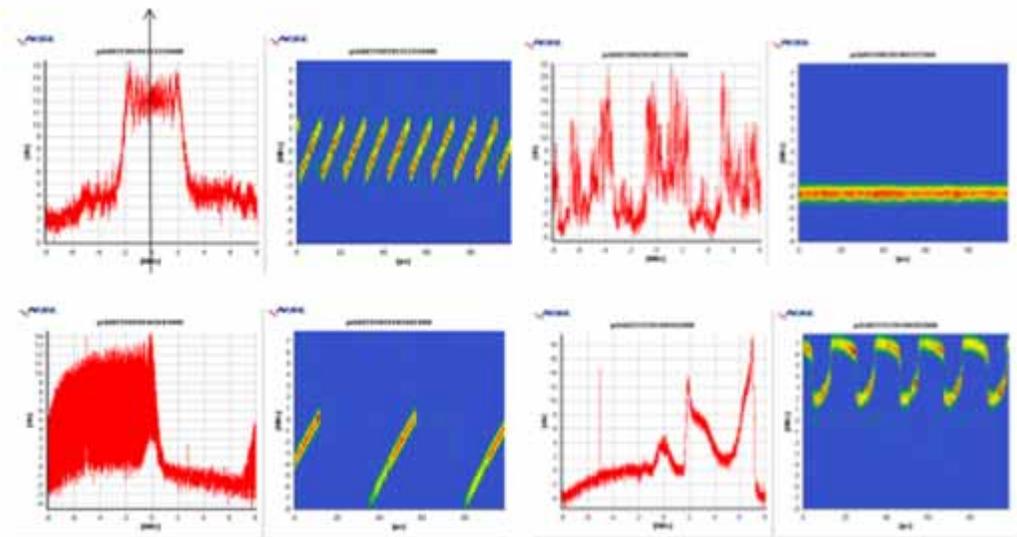


4. Statistische Trends per Ort/Gruppe/alle

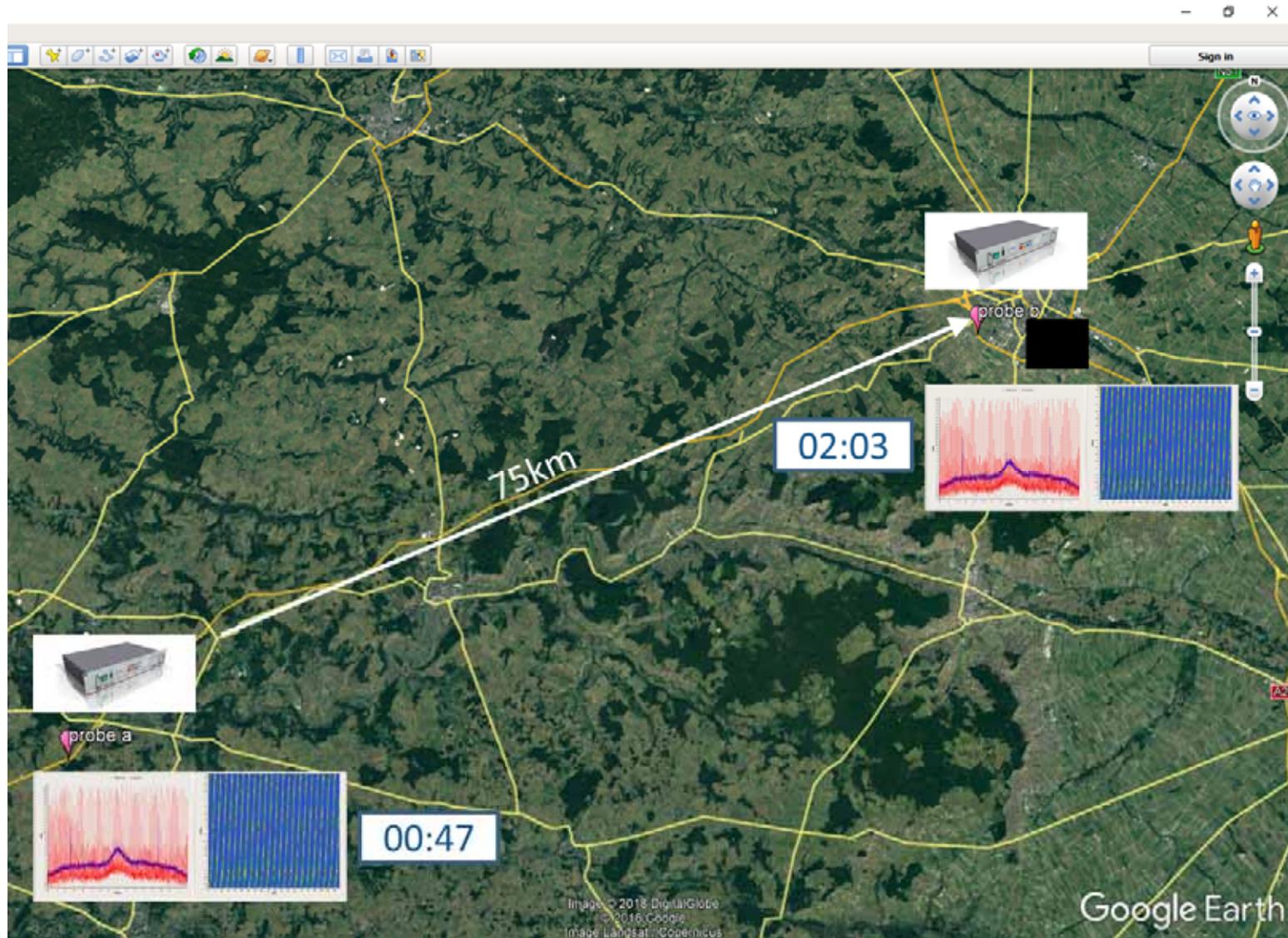


5. Gesamtstatistik per Ort/Gruppe/über alles

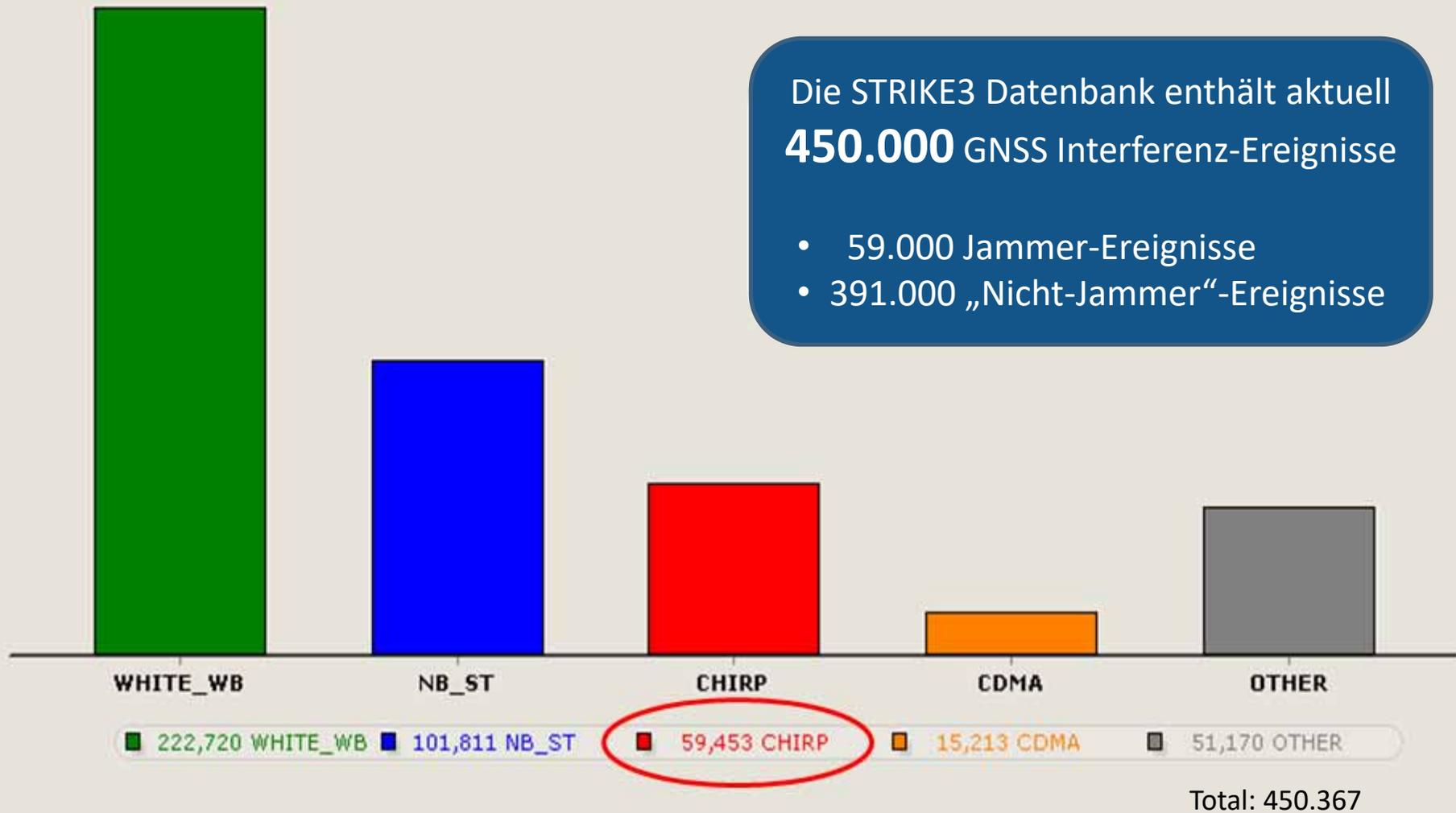
1. Größe, Leistung, Muster
2. Erkennung unterschiedlicher Muster
3. Klassifizierung der Signaturen
4. Identifizierung unterschiedlicher „Familien“
5. Identifizierung neuer „Familien“
6. Beweissicherung:
 - Erstellung eines Katalogs
 - Referenzen für zukünft. Ereignisse
 - Automatische Mustererkennung



Signalcharakteris. \Rightarrow Objektverfolgung



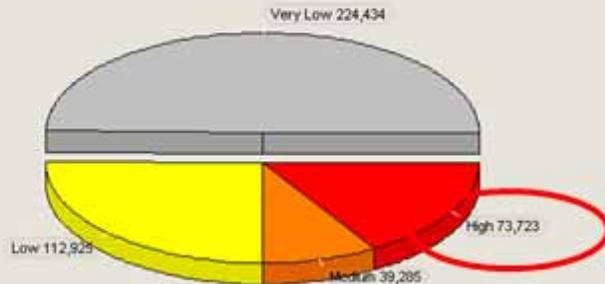
Classification Types



Ergeb.2: GNSS Ausfälle d. Interferenzen



Event Priority Levels
(By Classification Type)



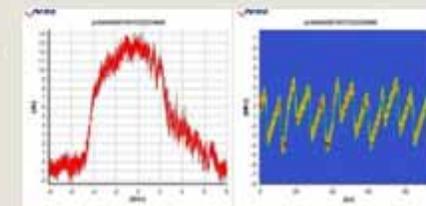
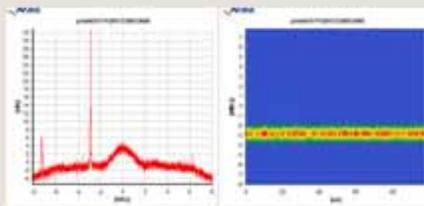
Classification Types



73.000 Ereignisse führen zum GNSS-Ausfall

- 59.000 Jammer
- 12.000 Narrow Band
- 2.000 andere Signale

[450367] ALL
 [222720] WHITE_WB
 [101811] NB_ST
 [59453] CHIRP
 [15213] CDMA
 [51170] OTHER

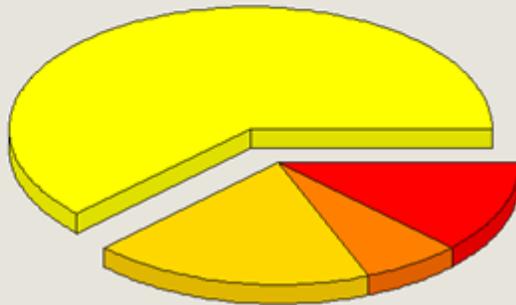


■ 1,065 WHITE_WB
 ■ 11,941 NB_ST
 ■ 59,453 CHIRP
 ■ 570 CDMA
 ■ 694 OTHER

Total: 73.723



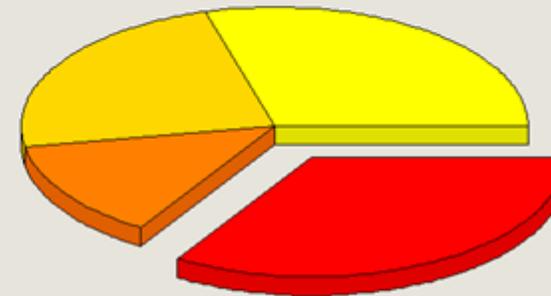
ALL events (450,363 events)



279,828 [00 to 20 sec] 85,832 [20 to 40 sec] 29,339 [40 to 60 sec] 55,368 [60+ sec]

Most events are very short durations
12% of ALL events are greater than 60 seconds

High Priority events (73,723 events)



21,640 [00 to 20 sec] 17,271 [20 to 40 sec] 9,883 [40 to 60 sec] 24,929 [60+ sec]

34% priority events are greater than 60 seconds

Some findings:

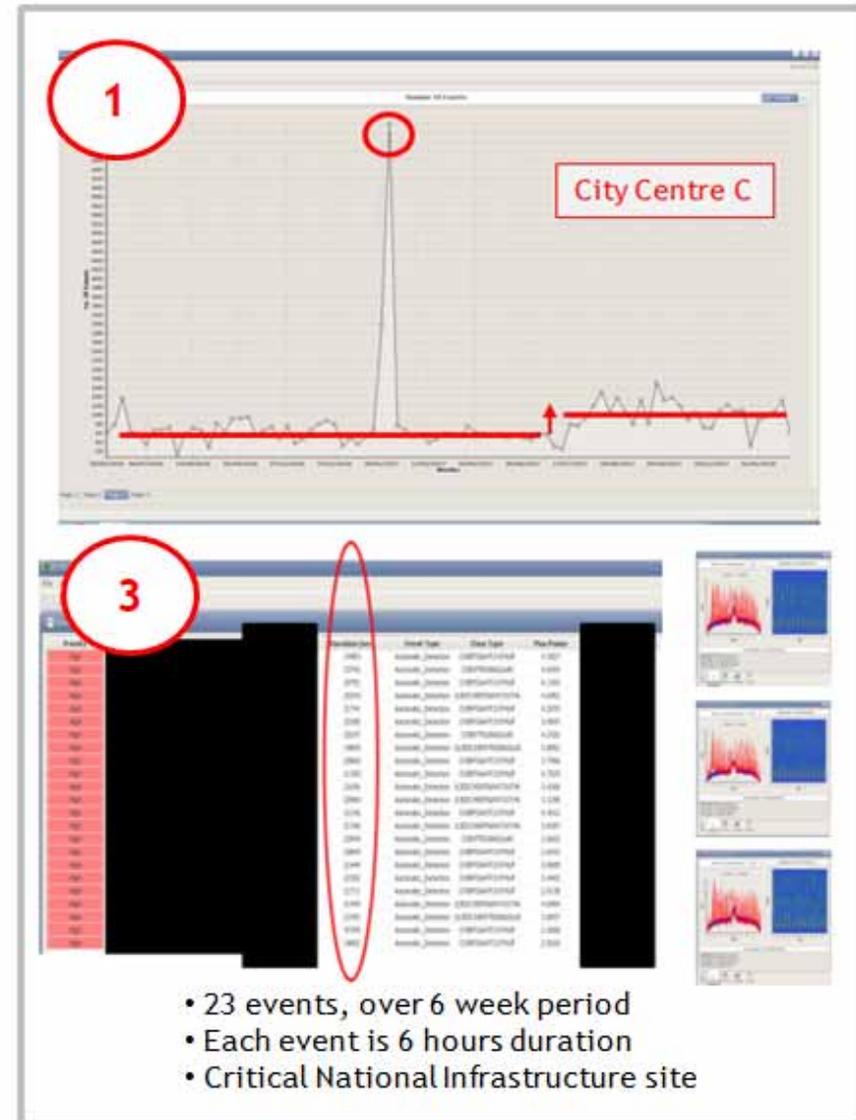
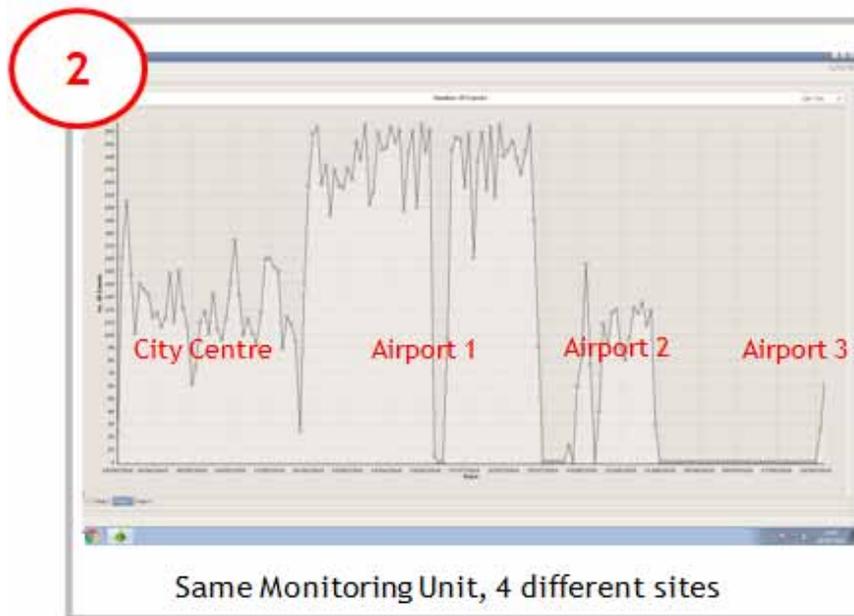
- 7191 events > 5 minutes
- 1112 events > 30 minutes
- 610 events > 60 minutes
- 5 events > 1 day
- Longest event = 5 days



Ergeb.4: Erkennung von Trends

STRIKE3

- Trends per Monitoring-Ort
- Trends per Infrastruktur
- Trends per Zeit (Woche/Monat/Jahr)
- Trends per Ereignisklasse
- Trends über Datenbankinhalt
- (*Trends per GNSS, per Frequenz*)



Ergeb.5: Vergleich der Orte

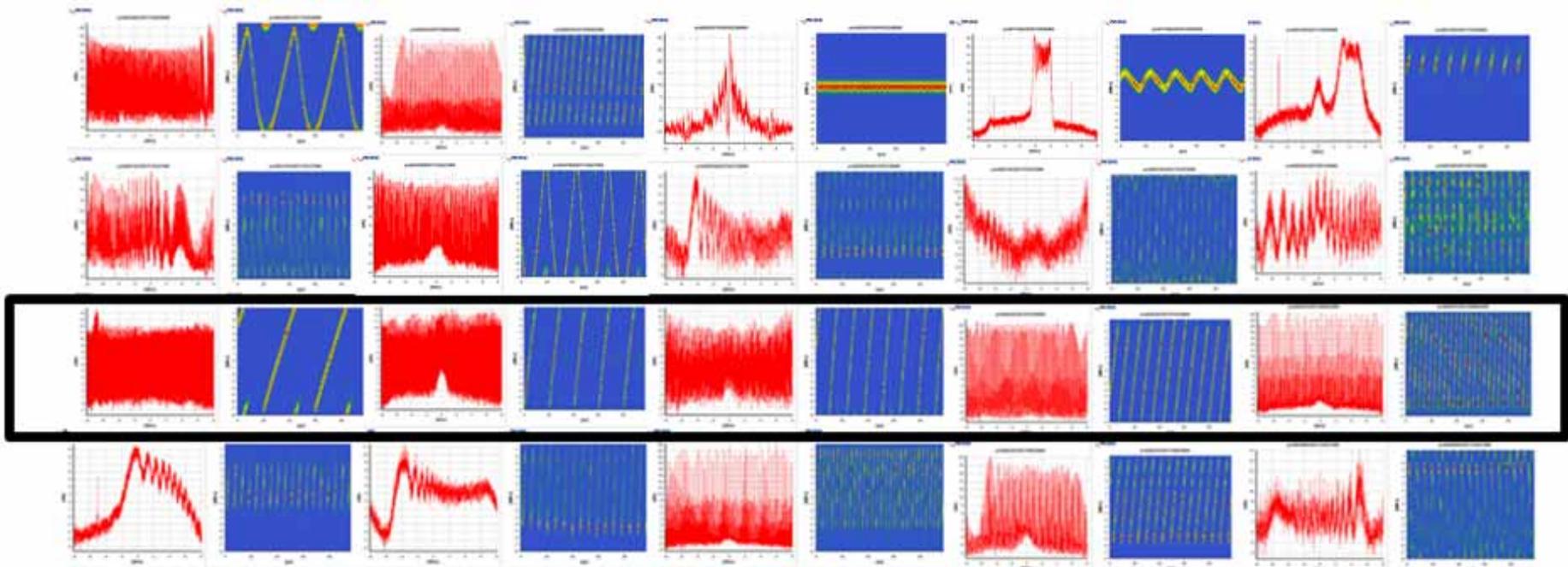


- Ergebnisse von **8 Installationen an Flughäfen**
- **Most are “national” airports. Most are air-side installations.**
- Daten von 30 Tagen (nicht unbedingt die selben 30 Tage)

	RFI events	Jammers	Jammer/events ratio	Duration > 60secs	GNSS denial	Denial/events ratio
National Airport	8716	95	1%	282	362	4%
National Airport	759	27	4%	200	211	28%
National Airport	2764	595	22%	395	753	27%
Regional Airport	556	31	6%	6	95	17%
National Airport	904	168	19%	158	182	20%
National Airport	776	19	2%	101	35	5%
National Airport	1819	73	4%	9	252	14%
National Airport	4519	133	3%	352	153	3%

- Hilfe bei der Diagnose bzgl. unabsichtlichen Störungen und Jammer
- Hilfe beim Vergleich der Daten von unterschiedlichen Standorten

Ergeb.6: Klassische Jammer-“Familien“

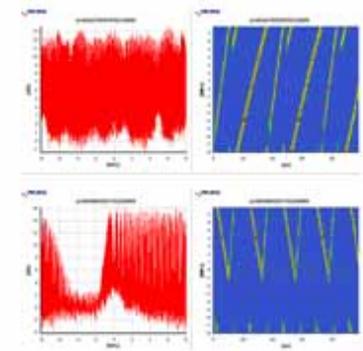


Es gibt viele unterschiedliche Jammer-Signale, charakterisiert durch:

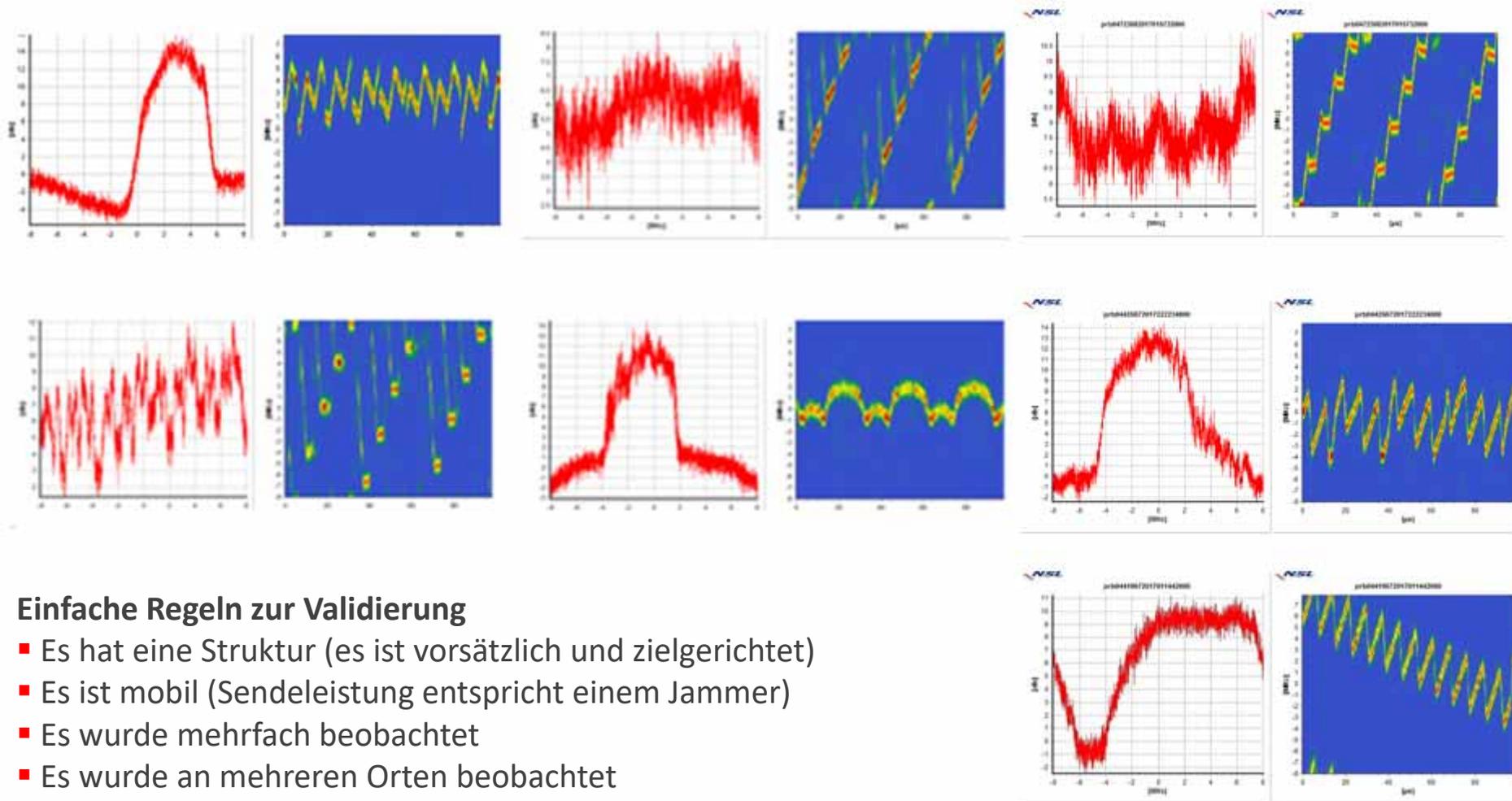
- Bandbreite, Leistung, Mittenfrequenz, Spektrum, ...
- Zusätzliche Parameter: Sweep-Rate, -Richtung, -Offset, ...



(Data + combinations of the above indicates 200-300 jammer families)



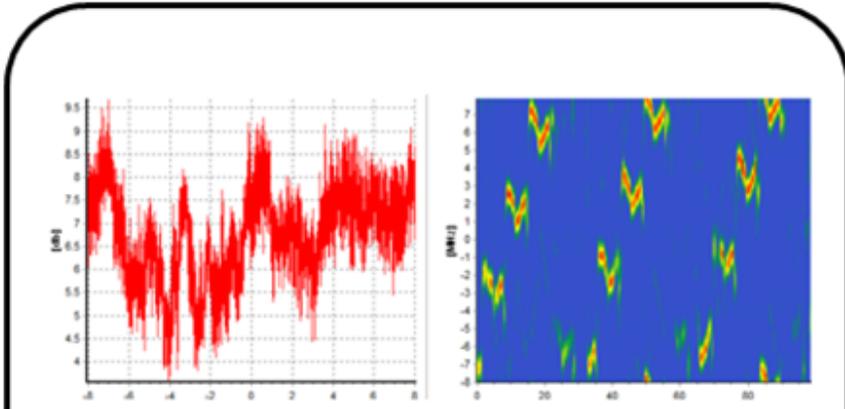
Ergeb.7: neue Jammer Signale



Einfache Regeln zur Validierung

- Es hat eine Struktur (es ist vorsätzlich und zielgerichtet)
- Es ist mobil (Sendeleistung entspricht einem Jammer)
- Es wurde mehrfach beobachtet
- Es wurde an mehreren Orten beobachtet

Ergeb. 8: Weiterentwicklung der Jammer-Industrie



Waveform detected at 4 STRiKE3 sites Europe and outside EU



2017



2017

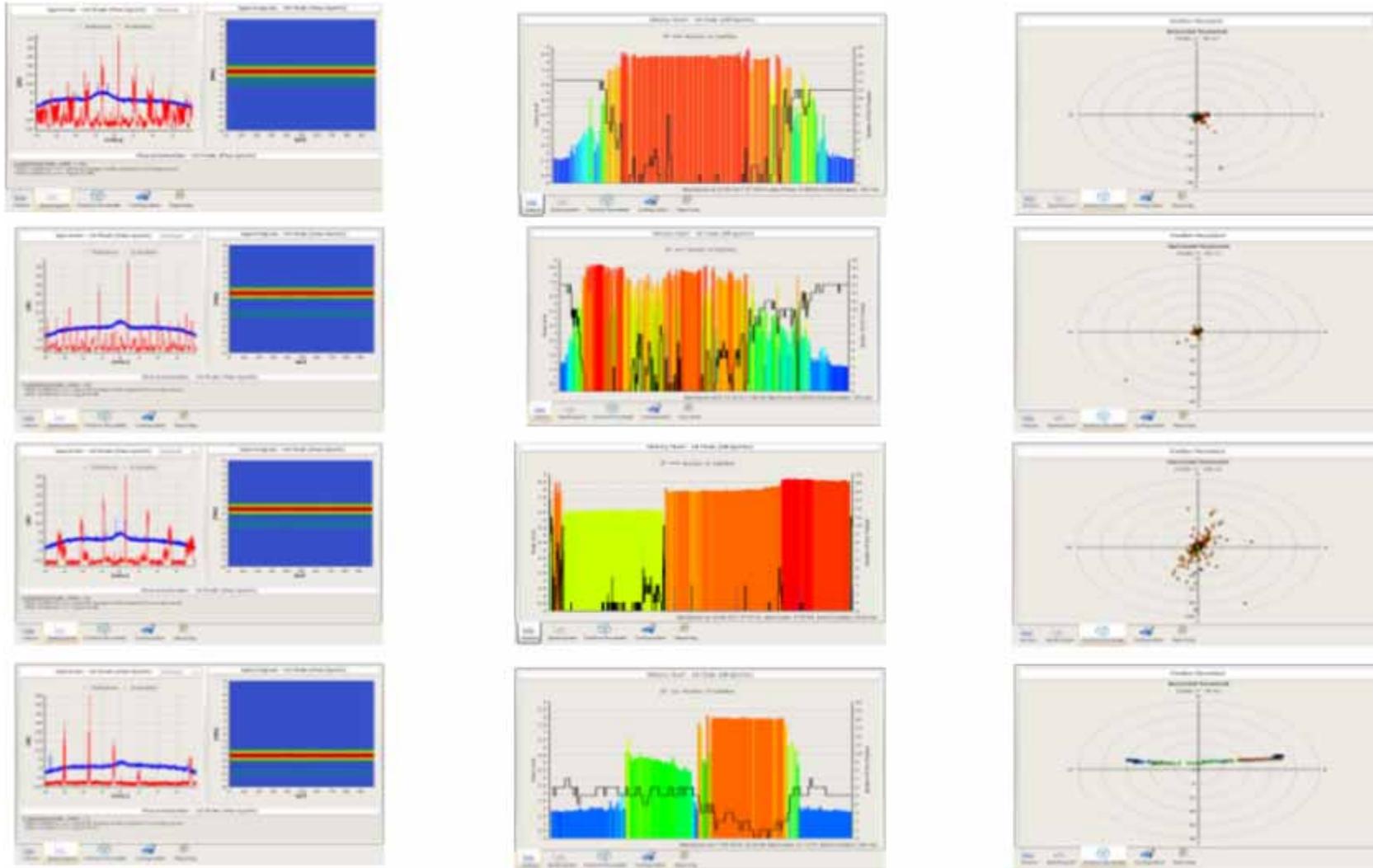
USB L1/L2 jammer



2018

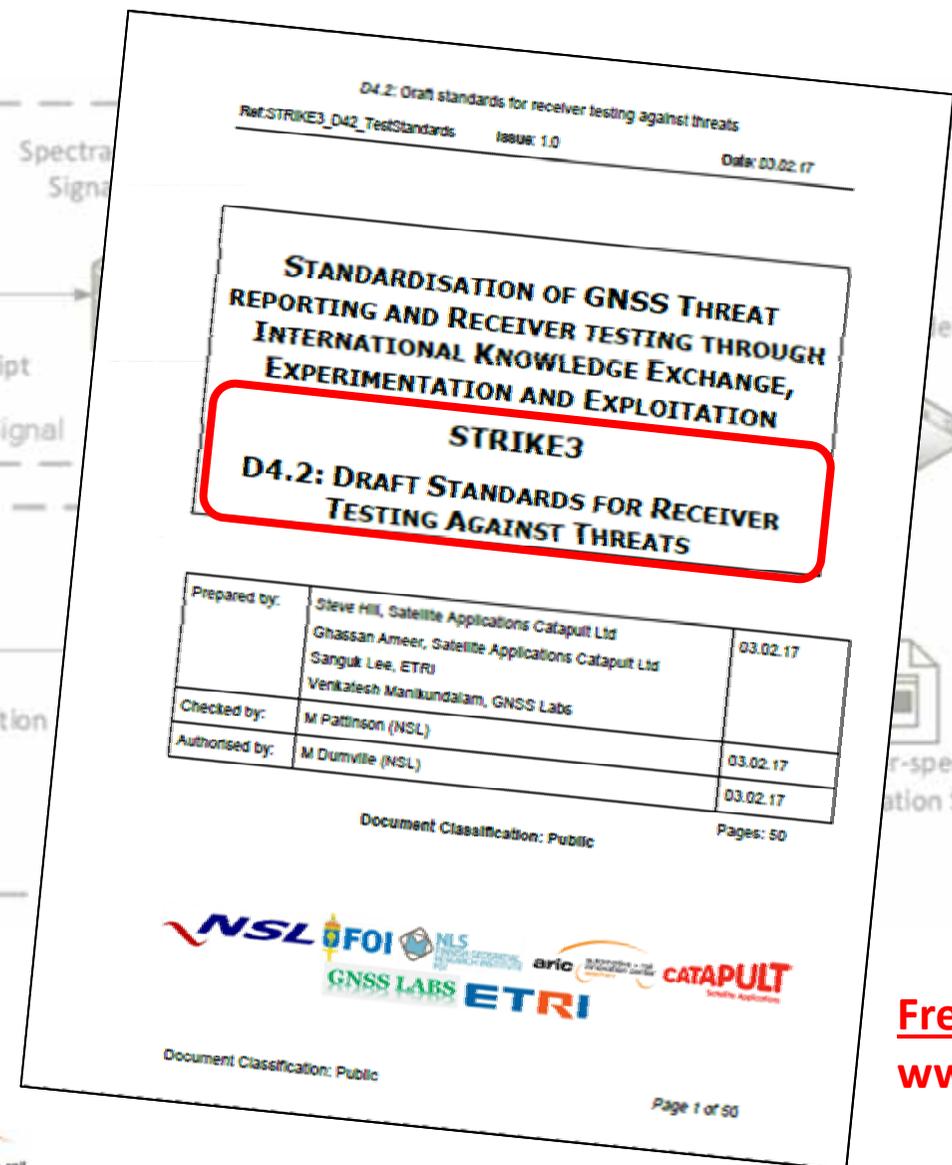
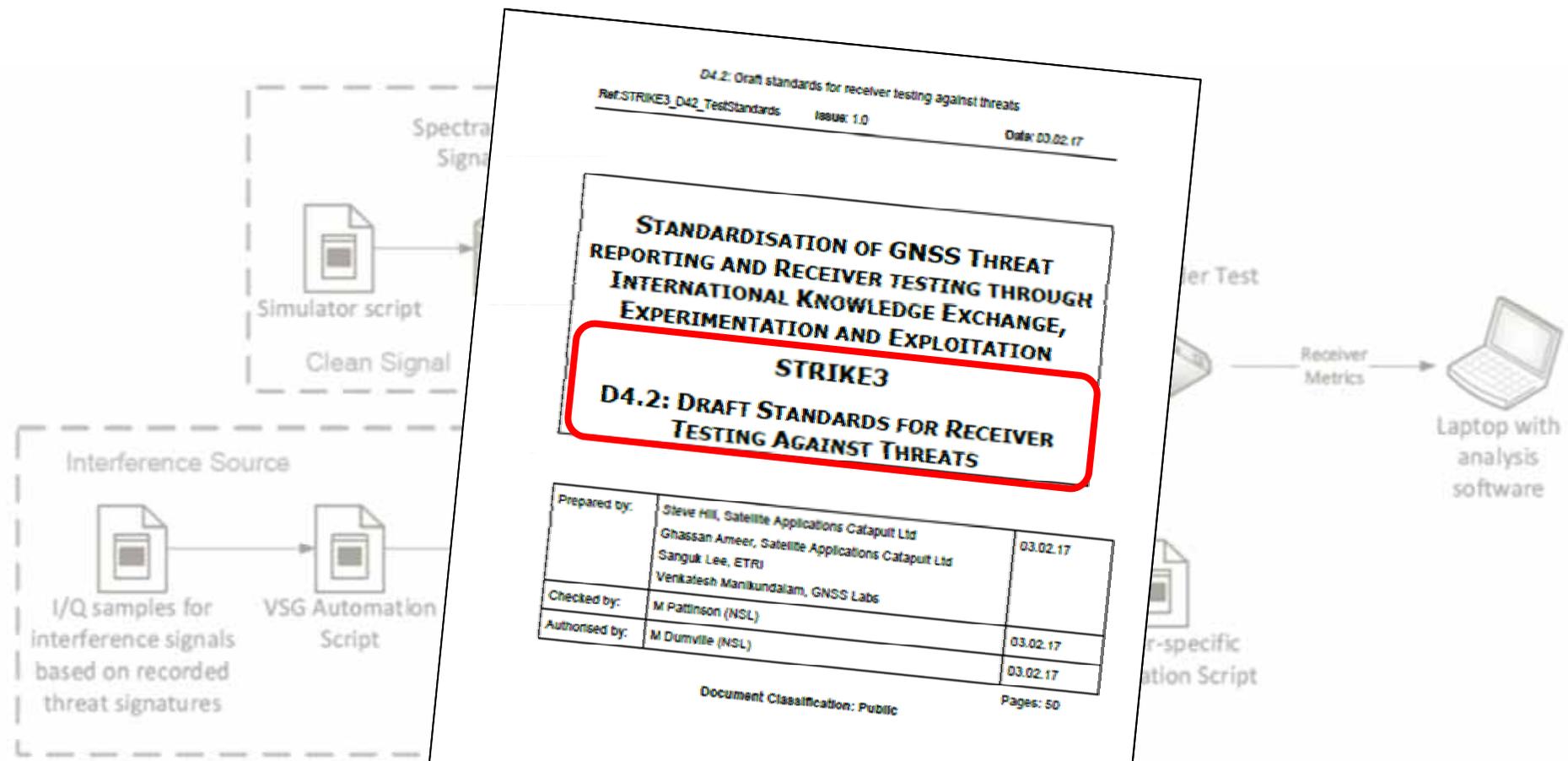
OBD "covert" jammer

Ergeb.9: Unbeabsichtigte Störsignale



Erzeugung von Positionsabweichungen von bis zu 100 Meter

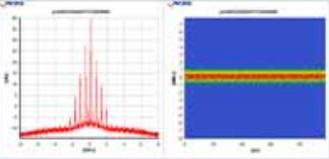
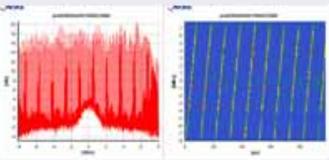
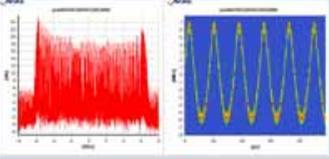
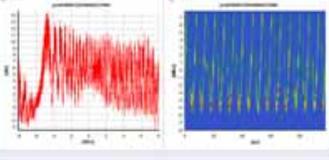
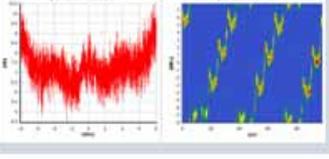
Ergeb.11: GNSS Threat Testing Standard



Prepared by:	Steve Hill, Satellite Applications Catapult Ltd Ghassan Ameer, Satellite Applications Catapult Ltd Sanguk Lee, ETRI Venkatesh Manikundalam, GNS Labs	03.02.17
Checked by:	M Pattinson (NSL)	03.02.17
Authorised by:	M Dumville (NSL)	03.02.17

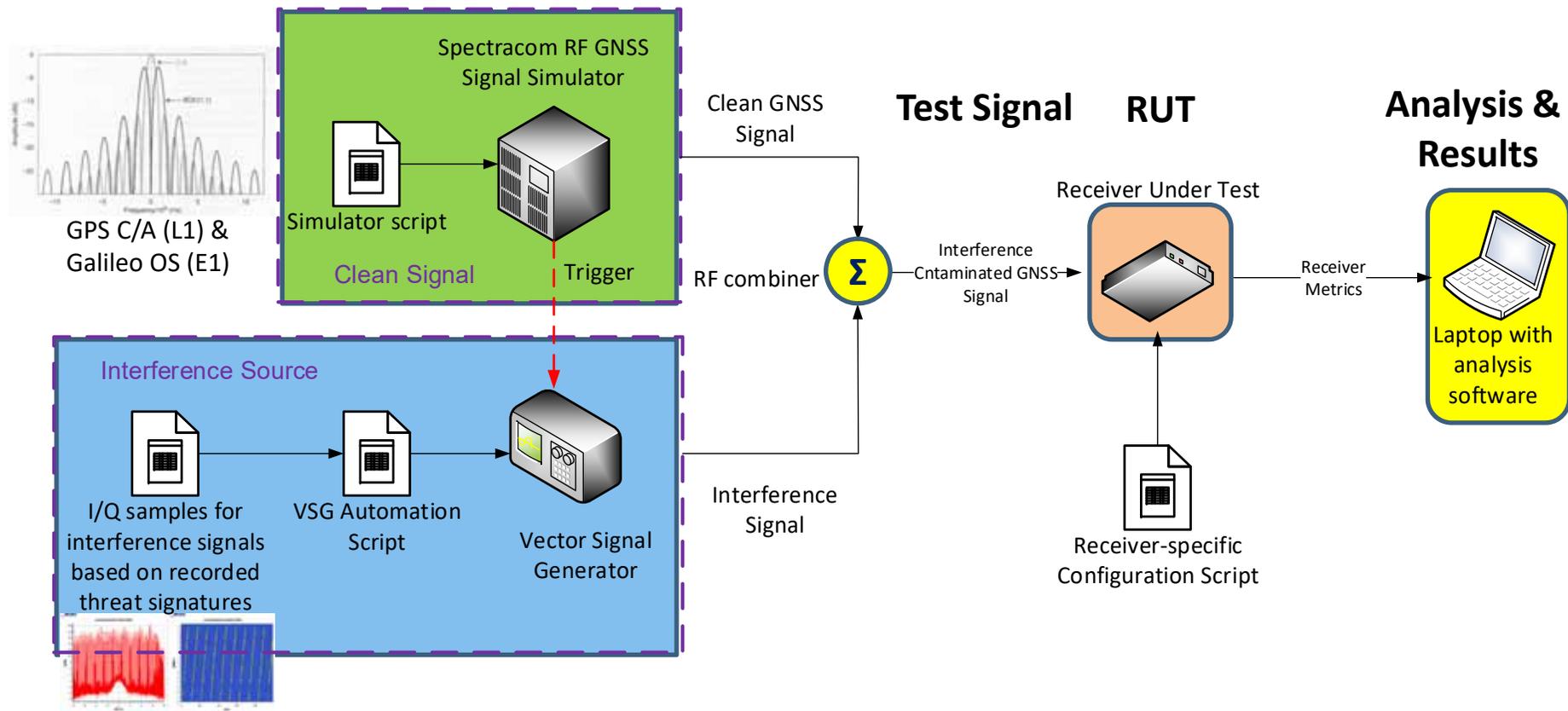
Frei verfügbar unter:
www.gnss-strike3.eu



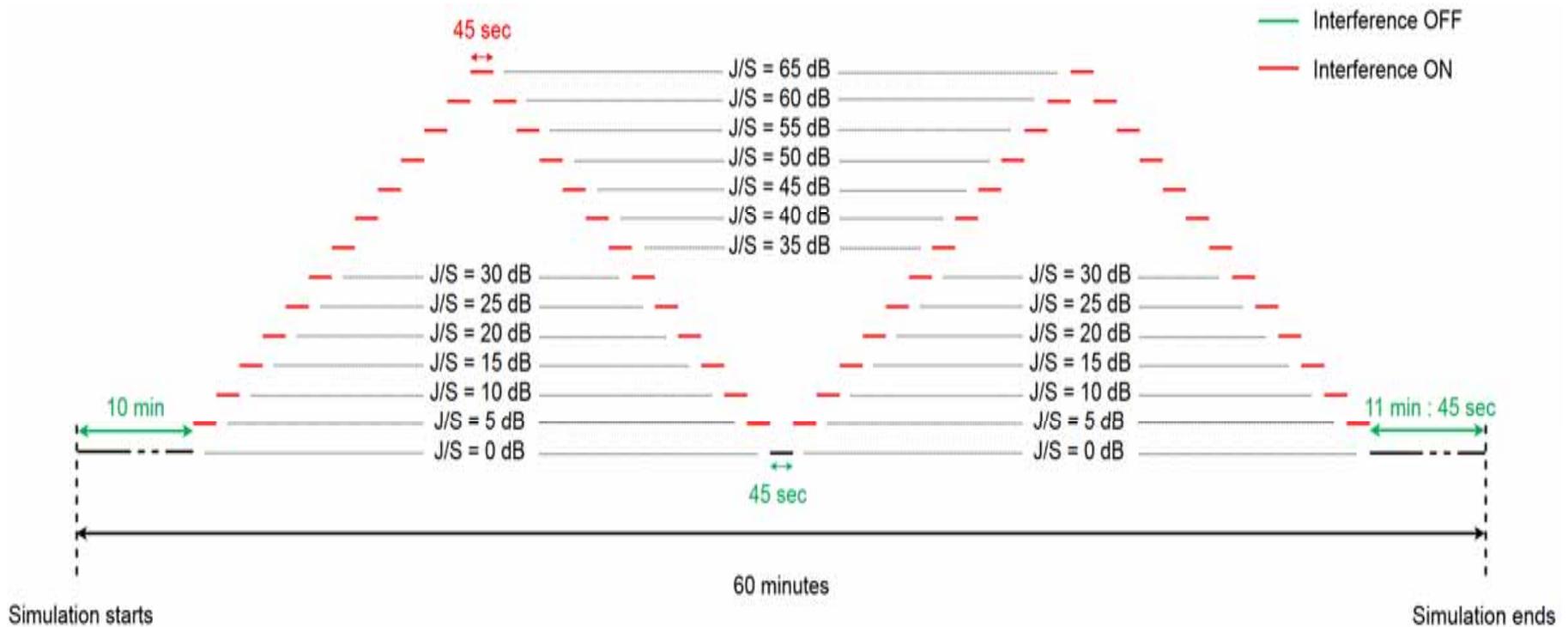
Type of signal	Example Plots	Reason for choice
Narrow band on L1		Example unintentional(?) signal – this type seen on multiple occasions and at multiple sites
Wide Sweep – fast repeat rate		Very common (total number of events, and number of sites)
Triangular wave		Common (and number of sites)
Triangular		Common (and number of sites)
Tick		Increasingly common. Evolving threat (new type).

Die GNSS Empfänger-Industrie sollte sich auf diese weit verbreiteten Wellenformen zur Erhöhung der Störfestigkeit konzentrieren

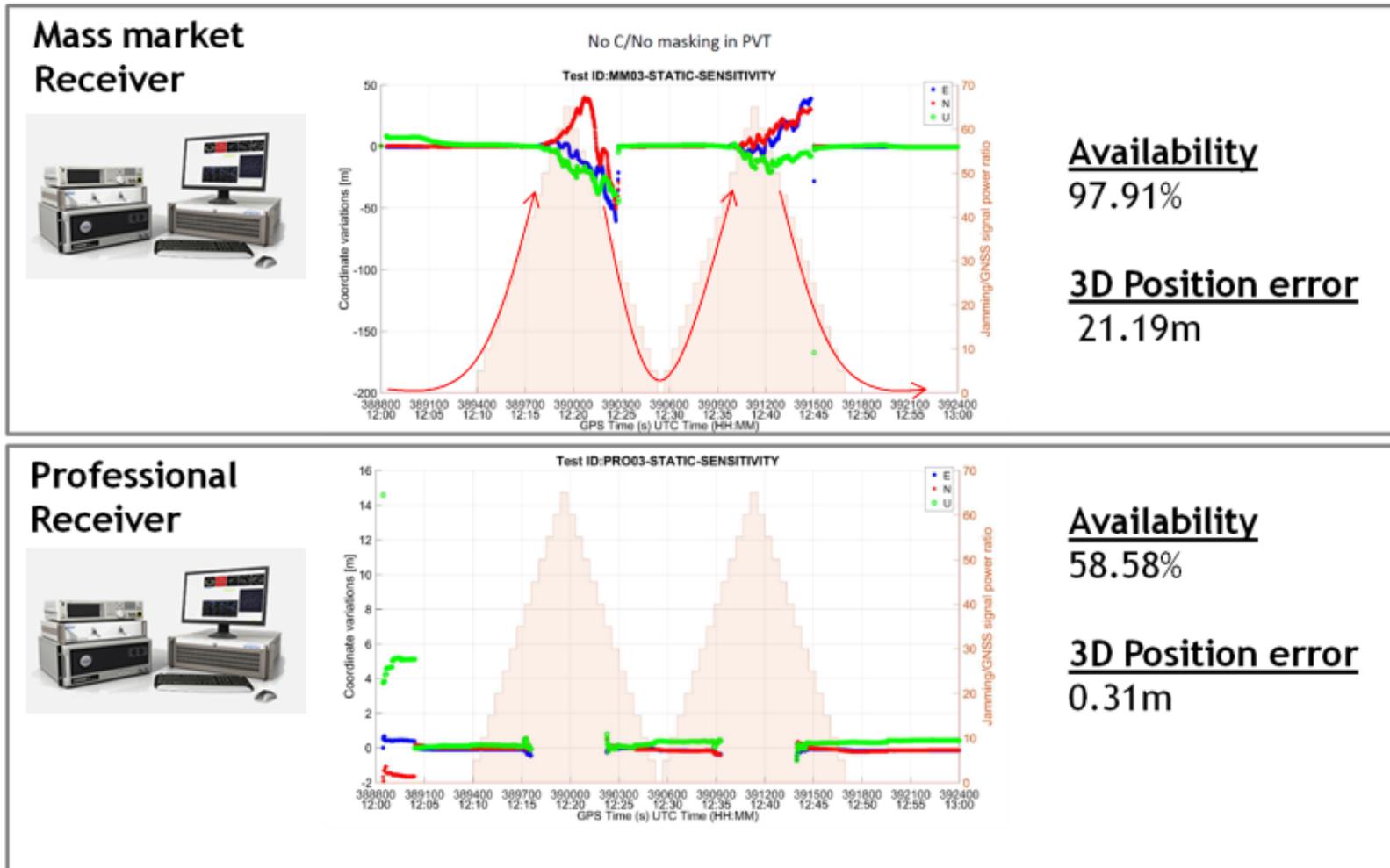
- Labortests mit simulierten GNSS-Signals (60°N / 24°E / 30m)
 - Einfach zu kontrollieren und wiederholbar
- Interferenzsignale werden den reinen GNSS-Signalen zugemischt



Testprofil für Empfindlichkeitstest

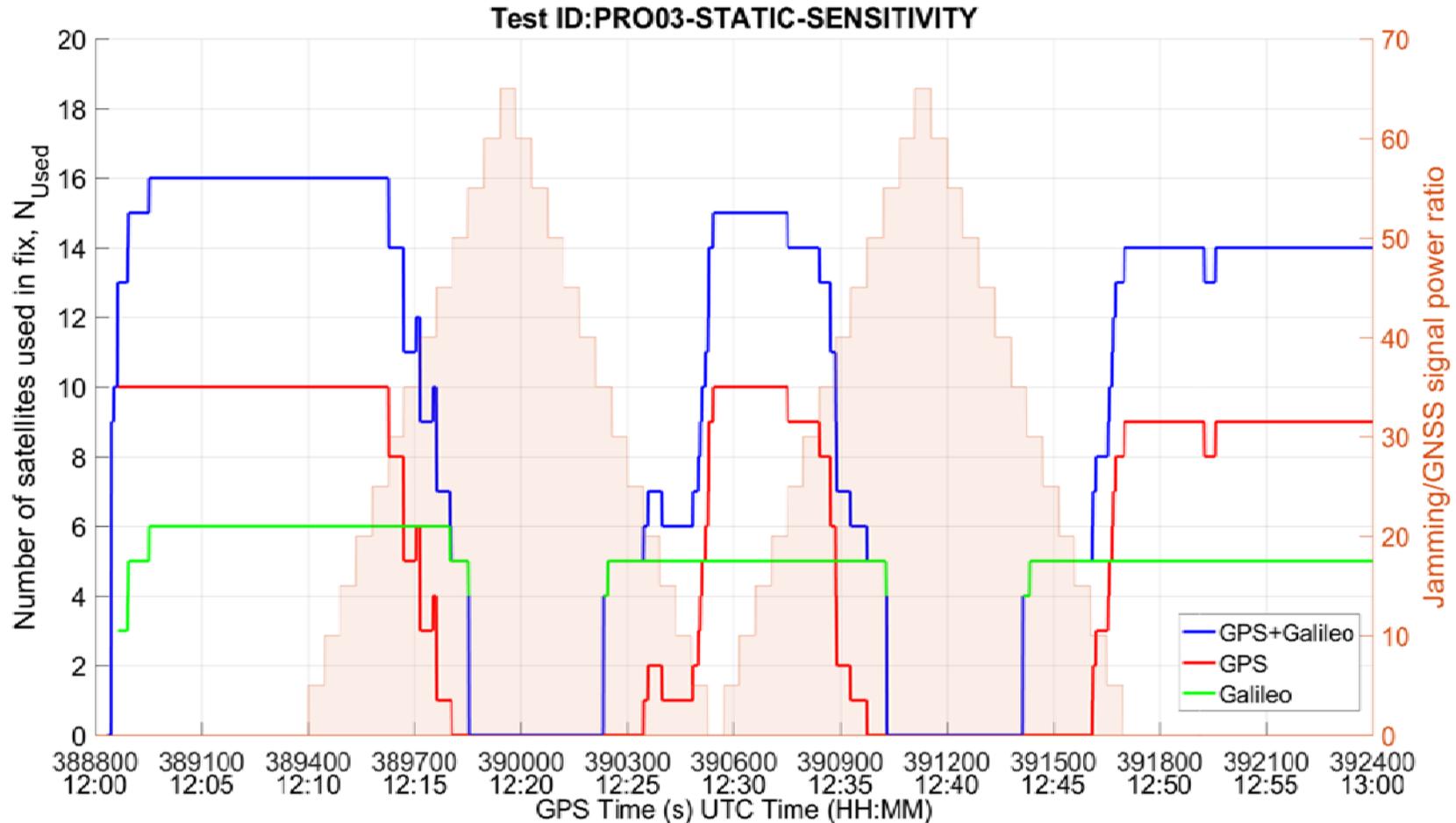


Ergeb.13: Einfluss von Jammer auf Empfänger (exemplarisch)



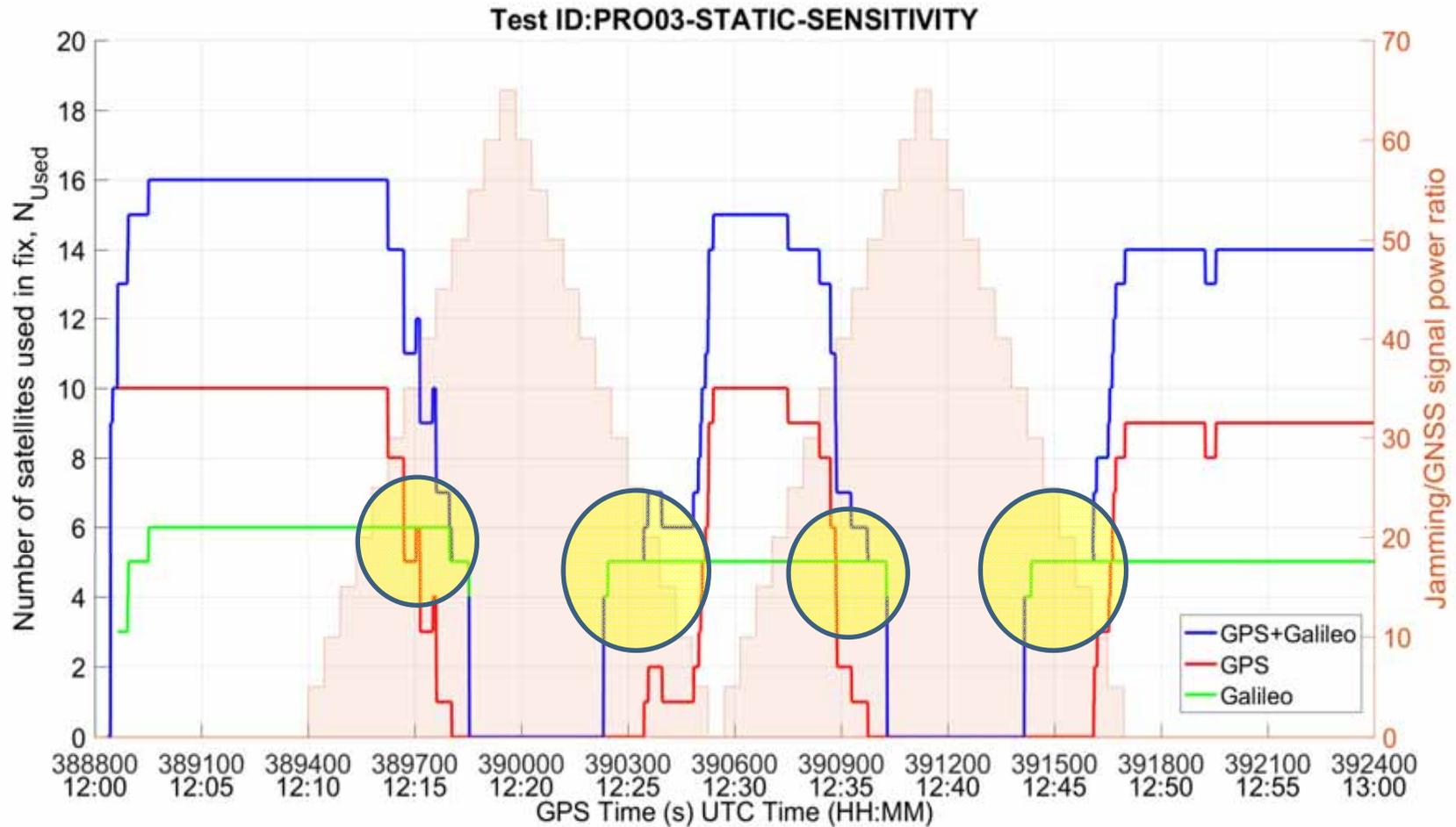
Abwägung zwischen Verfügbarkeit und Genauigkeit

RUT Professional Grade Receiver



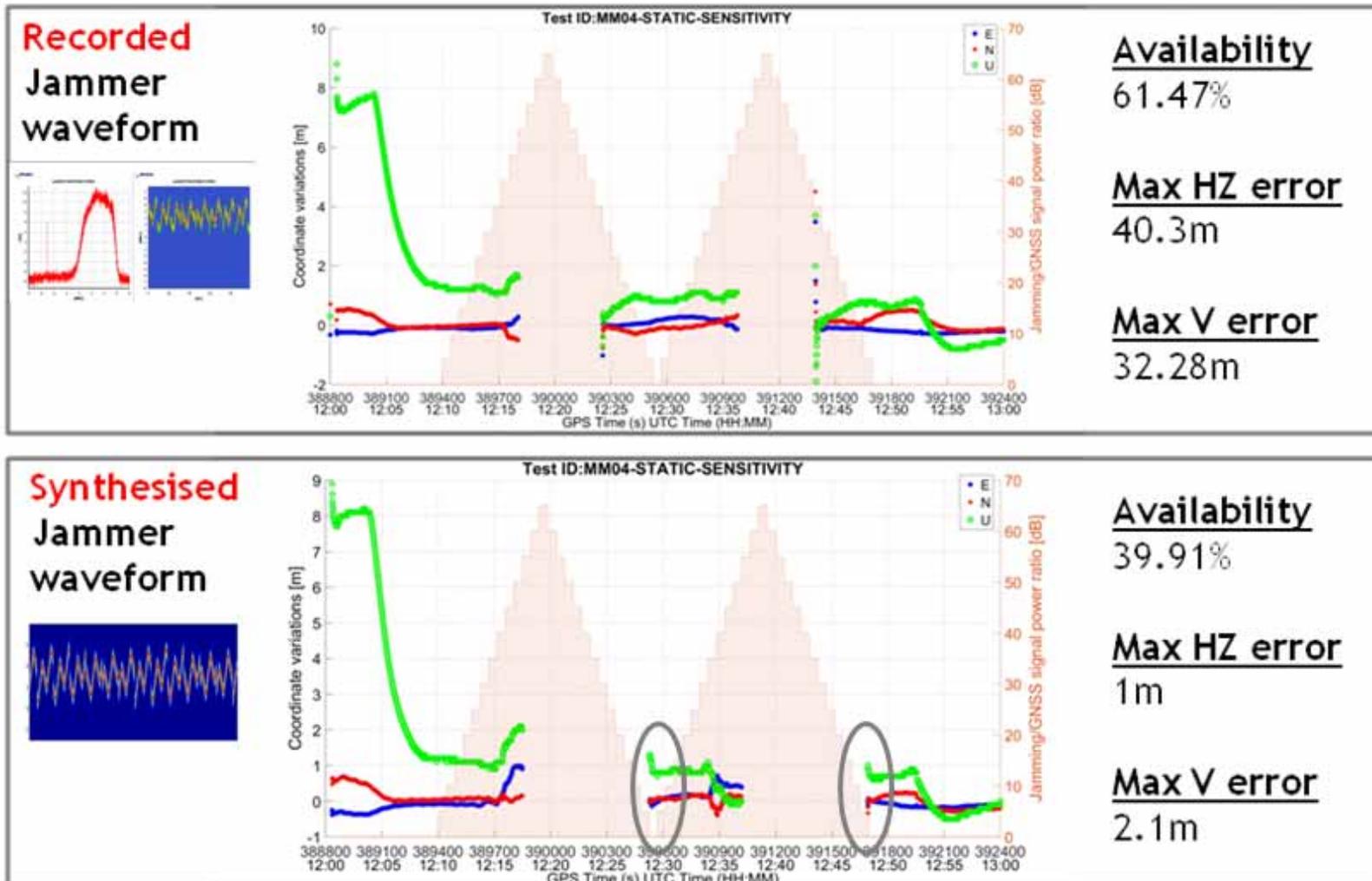
Ergeb.13: Einfluss von Jammer auf Empfänger (exemplarisch)

RUT Professional Grade Receiver



Ergeb.14: Vergleich von aufgezeichneten und synthetischen Wellenformen

STRIKE3



Das synthetische Replikat hat eine stärkere Auswirkung

Realität heute



Inside GNSS October 31, 2018:

Criminal Investigation Underway in GPS Jamming Incident That Crashed Drones, Caused HK\$1M in Damage

„More than 40 drones performing in a professionally organized light show fell from the sky in Hong Kong Saturday after the GPS signal they were using was jammed. The incident, which caused some HK\$1 million in damage (U.S. \$127,500), is now under criminal investigation.

.....

The drones were lost during a show Saturday, October 27, 2018. Shows already had been done Thursday and Friday.”



Weiterführende Informationen und Dokumente zum STRIKE3-Projekt:

➤ www.gnss-strike3.eu

- DRAFT Standard for GNSS threat reporting and analysis
- DRAFT Standard for assessing the performance of GNSS receivers under threat
 - Both basis for further standardisation work groups
- **NEW: STRIKE3 Forum:** bietet eine Diskussionsplattform für die GNSS Community
- STRIKE3 Abschlussbericht verfügbar in Q1-2019

Vielen Dank für Ihre Aufmerksamkeit!

Dipl.-Ing. Martin Pölöskey

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