NAVISP Element 2
Final Presentation
EL2-072 “DETECTRION”

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Agenda

- Short Saphyrion presentation
- Introduction to the project
- Rationale for the parallel filter architecture
- Demonstrator Design Verification and Validation
- Conclusions
- Next steps

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Who We Are

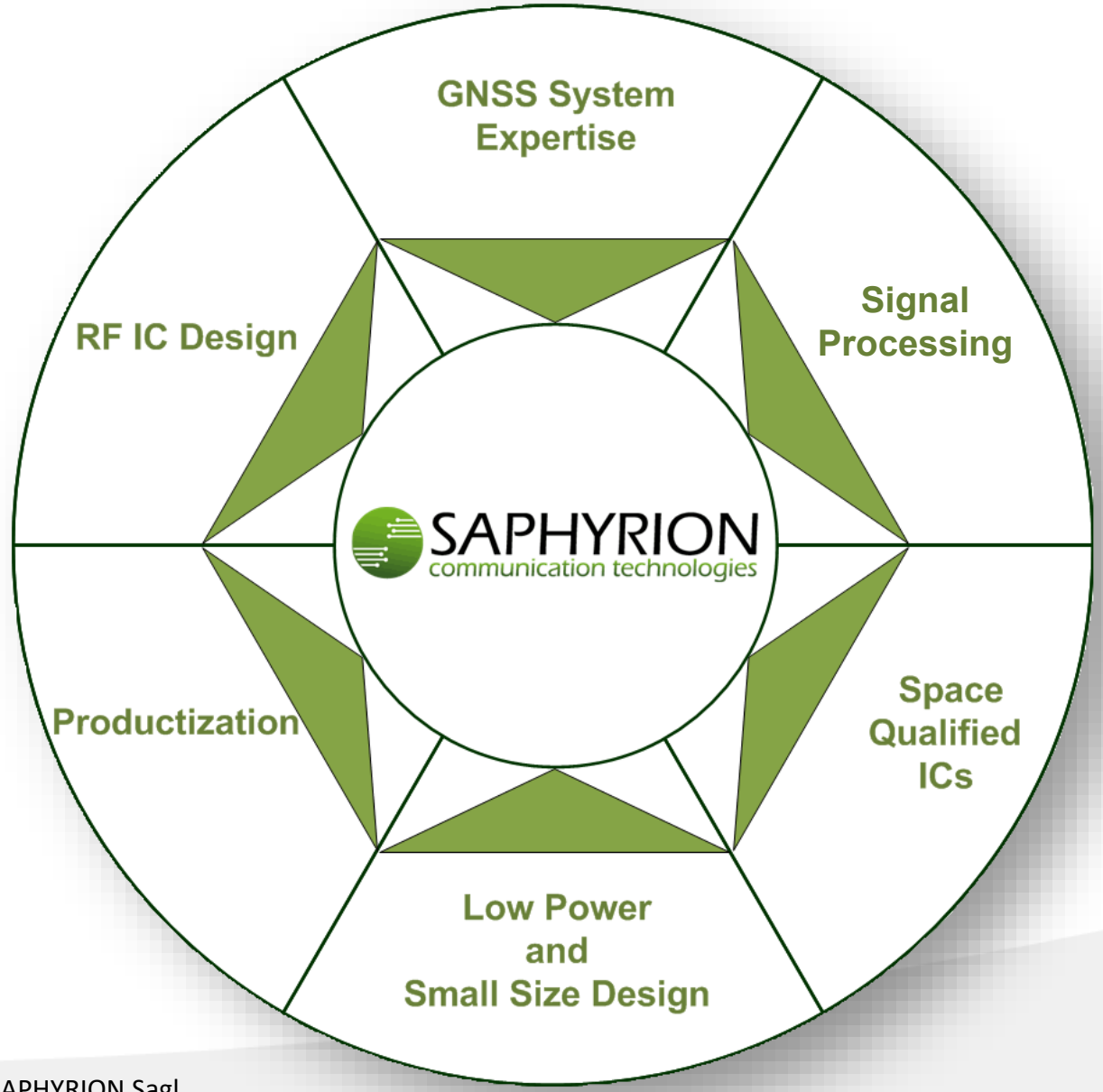
Who is Saphyrion

- Swiss privately owned company, located in Lugano (TI).
- European actor in space-qualified RF ASICs.
- Core team: skilled professionals from Swiss Federal Institutes of Technology (ETHZ, EPFL) and Swiss Universities of Applied Sciences.
- Engineering company, focused on semiconductors, board-level designs and software development.
- Fabless approach: all manufacturing is outsourced.

Target markets

- Navigation & telecommunication domains.
- Space market.
- High-end ground market.
- Combine development of own products with direct contract designs and research projects.

Core Competencies



Saphyrion's expertise:

Semiconductor Design Processes:

- SAPHYRION has developed, in 16 years of successful research, a set of techniques, both at design and layout level, able to provide radiation hardness to silicon IC products. The core team developed in more than two decades an unmatched expertise in design of :
  - ✓ rad-hard digital cell libraries
  - ✓ rad-hard I/O PADs
  - ✓ rad-hard analog/RF circuits (LNAs, VCOs, Mixers, filters, amplifiers, ….)
  - ✓ Digital rad-hard circuits (with TMR, hamming corrections, etc…)
- **Rad-hard design techniques are a core and demonstrated know-how of the company.**

GNSS instruments:

SAPHYRION has pioneered the development of GNSS instrumentation, leveraging its forefront activities in the field. The introduction of the GNSS record & playback unit GDARS (on the right) has enabled access to the most active laboratories working on GNSS interference detection and mitigation.

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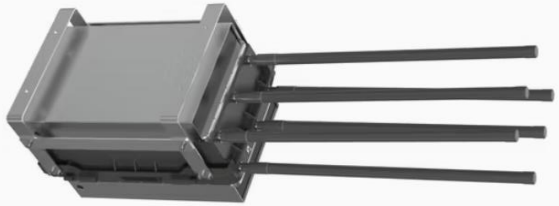
Why a low-cost, real-time spectrum analyzer like DETECTRION is needed?

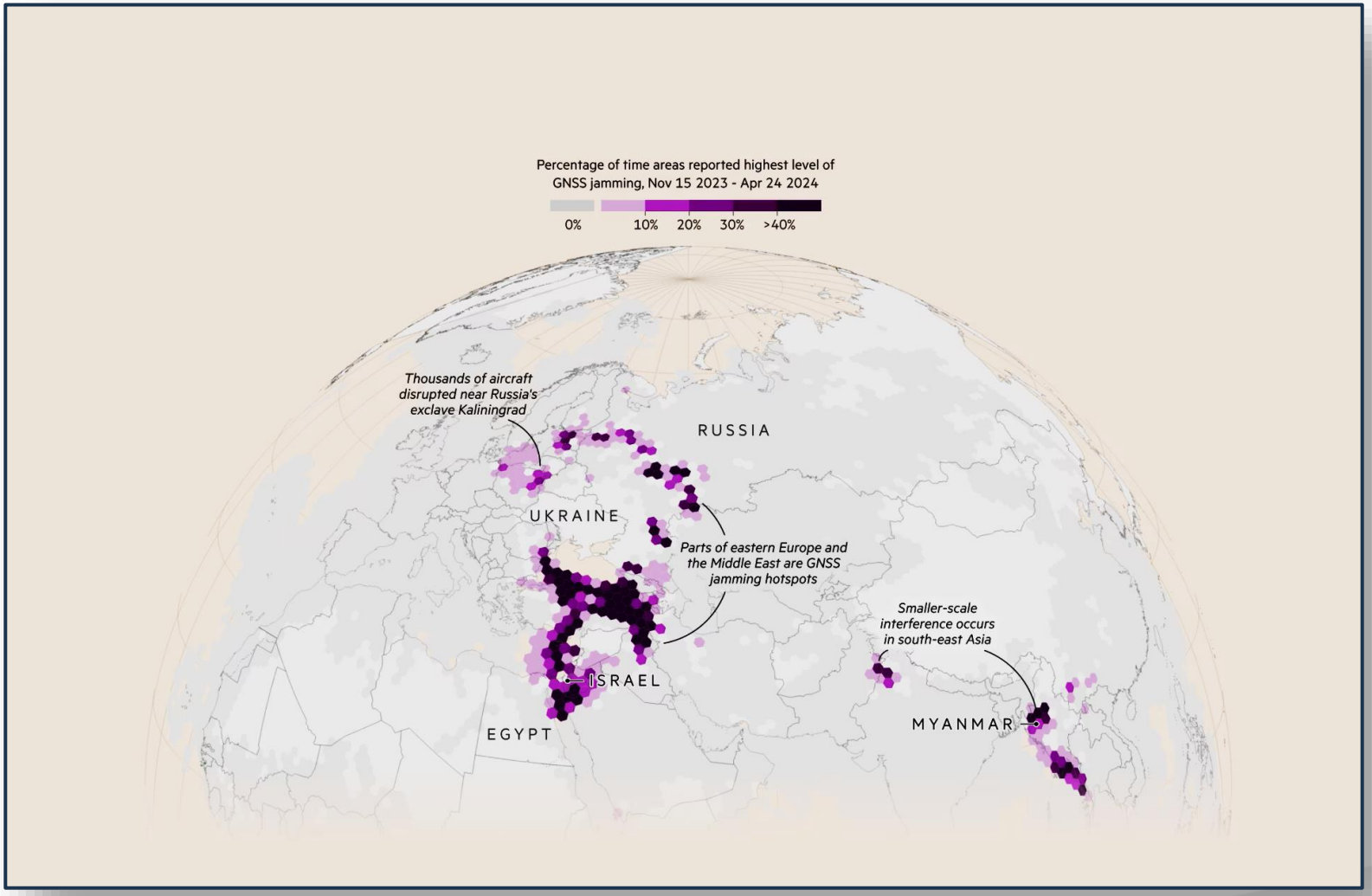
- **GNSS interference is rising**, but monitoring tools remain costly and limited in deployment, unlike the jamming devices (example below)



Example of all-GNSS bands, low-cost Chinese GNSS jammer (from the web)

- **Existing RTSA solutions** are expensive, bulky, and often unsuitable for field use.
- **Emerging applications (5G, satcom, megaconstellations)** need affordable, scalable spectrum surveillance.
- **Wider deployment** demands a rugged, modular, and cost-effective solution.
- (in the future) **Need for interference control in spaceborne GNSS** and other payloads

Geopolitical crisis ⇒ surge in GNSS disruptions



Direct correlation between military activity and unavailability of satellite positioning in 2023-2024

The DETECTRION Real-Time Spectrum Analyzer (RTSA) development: key modifications “on-the-fly”

Original design: in-band and out-of-band monitoring implemented in two different platforms with 50MHz bandwidth channels.

Technological breakthrough: introduction on SDR chips optimized for 5G

ADRV9009 SDR family phased-in

ANALOG DEVICES
AHEAD OF WHAT'S POSSIBLE™

Major project refurbishment approved by ESA, with the goal of having 200 MHz bandwidth channels, which allowed parallel filter architecture

Nearly complete redesign of the whole instrument to take benefit from the new hardware: intensive and challenging activity on signal processing and chip programming (even fixing AD bugs!)

Successful demonstration of DETECTRION proptotype to ESA

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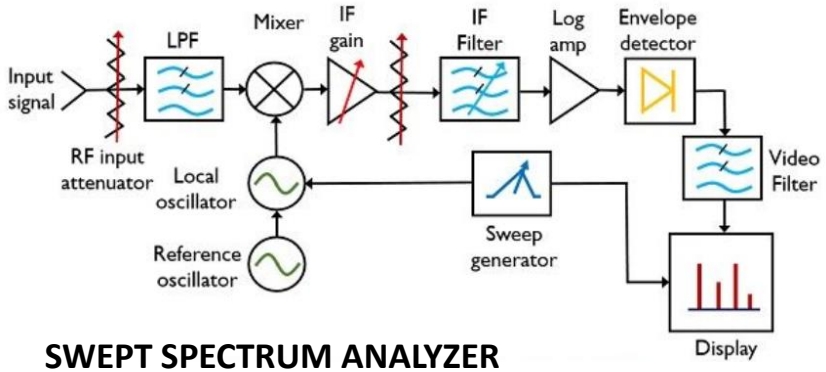
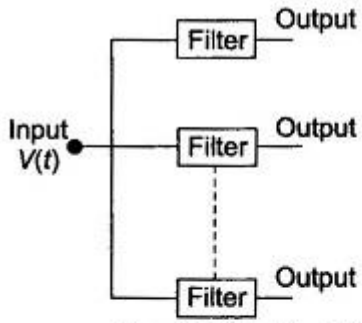
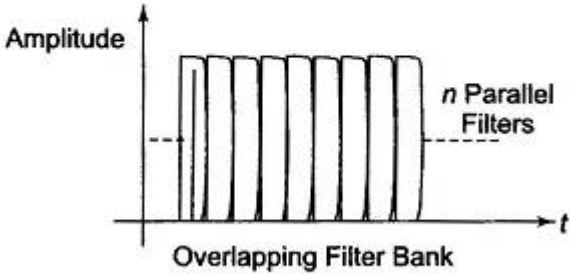
The three main types of RF Spectrum analyzers:



SWEPT SPECTRUM ANALYZER
Most common, but not real-time

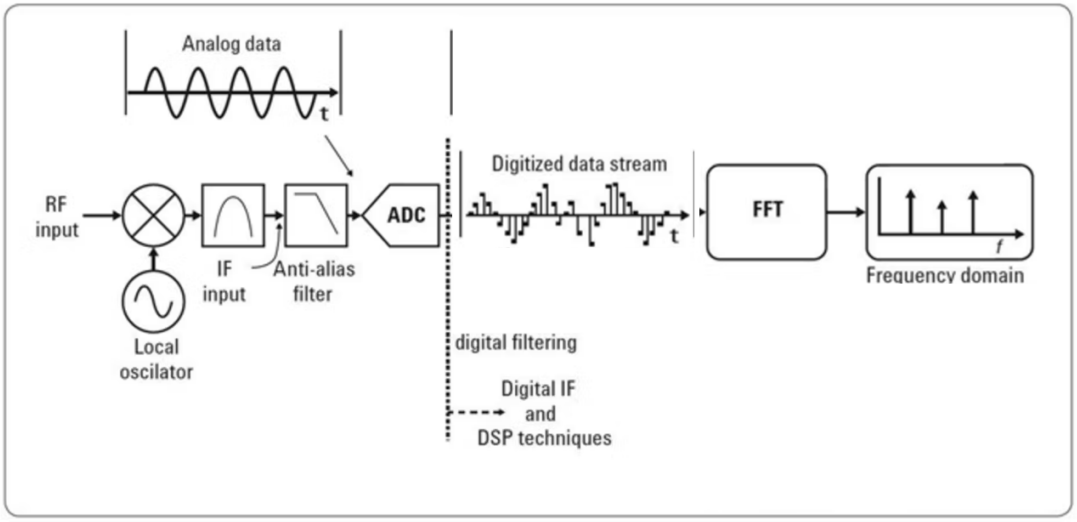


Parallel Filter Bank Analyzer



Overlapping Filter Bank

PARALLEL FILTER SPECTRUM ANALYZER
Realtime, straigtforward operation
Scarcely used in RF because large channel BWs were impossible to achieve so far.

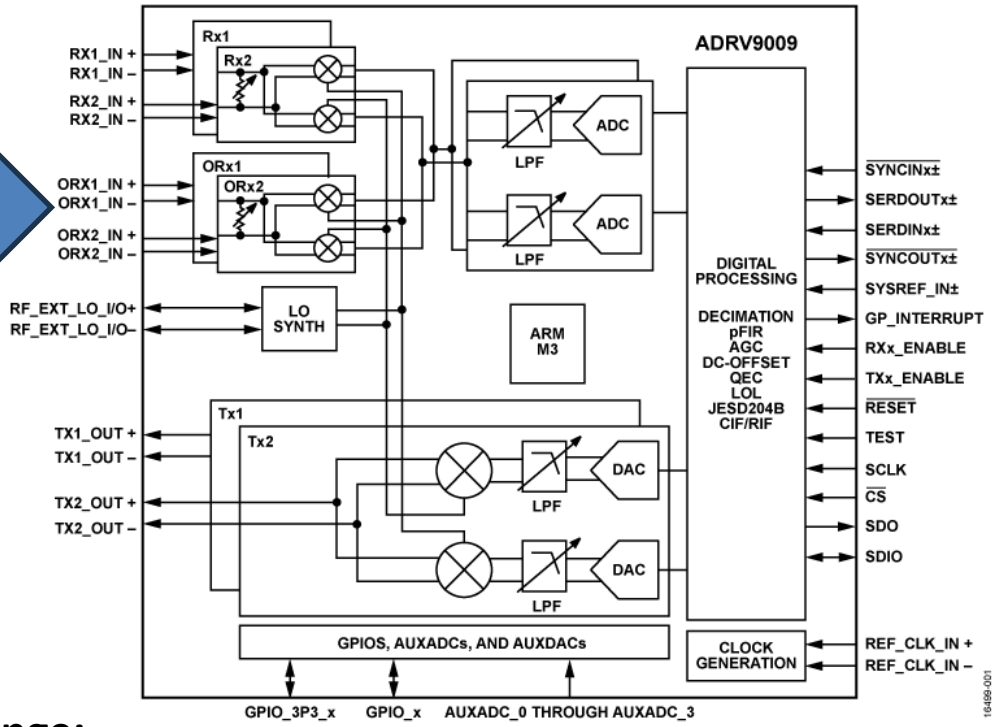


FFT spectrum analyzer
Nearly realtime operation –for large bandwidths and high frequencies, sophisticated ADC are required ⇒ high cost, limited quantization depth

ADRV9009: The game-changing innovation

Development of low-cost VLSI ICs for quickly expanding 5G applications and new design solutions allowed 200MHz BW channels, leading therefore to practical implementation of a RTSA based on parallel filter approach.

2x 200 MHz BW
75-6000 MHz
input channels



Ultrafast
digital
streams of
BB data

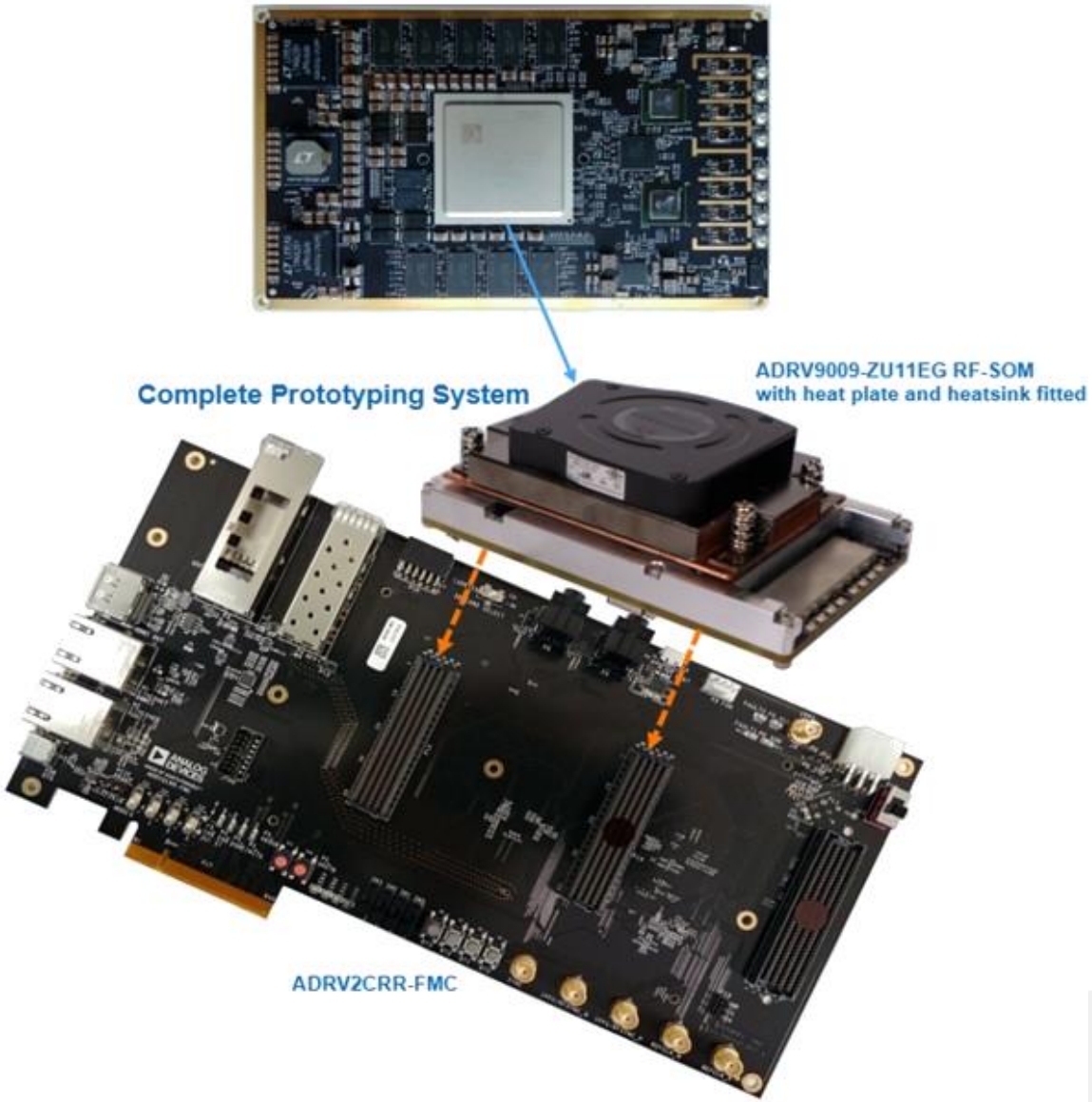
The DETECTRION challenge:

To use an IC designed for a totally different purpose (5G) as a building block for a high-performance RTSA useful not only for GNSS but also in other frequency bands (up to Ka)

ADRV9009 – Key characteristics

- *Dual transmitters*
- Dual receivers
- *Dual input shared observation receiver*
- Maximum receiver bandwidth: 200 MHz
- *Maximum tunable transmitter synthesis bandwidth:450 MHz*
  Maximum observation receiver bandwidth: 450 MHz
- Fully integrated fractional-N RF synthesizers
- Fully integrated clock synthesizer
- Multichip phase synchronization for RF LO and baseband clocks
- JESD204B datapath interface
- Tuning range (center frequency): 75 MHz to 6000 MHz

ADRV9009 – Prototypization platform



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Design challenges and problems overcome in DETECTRION:

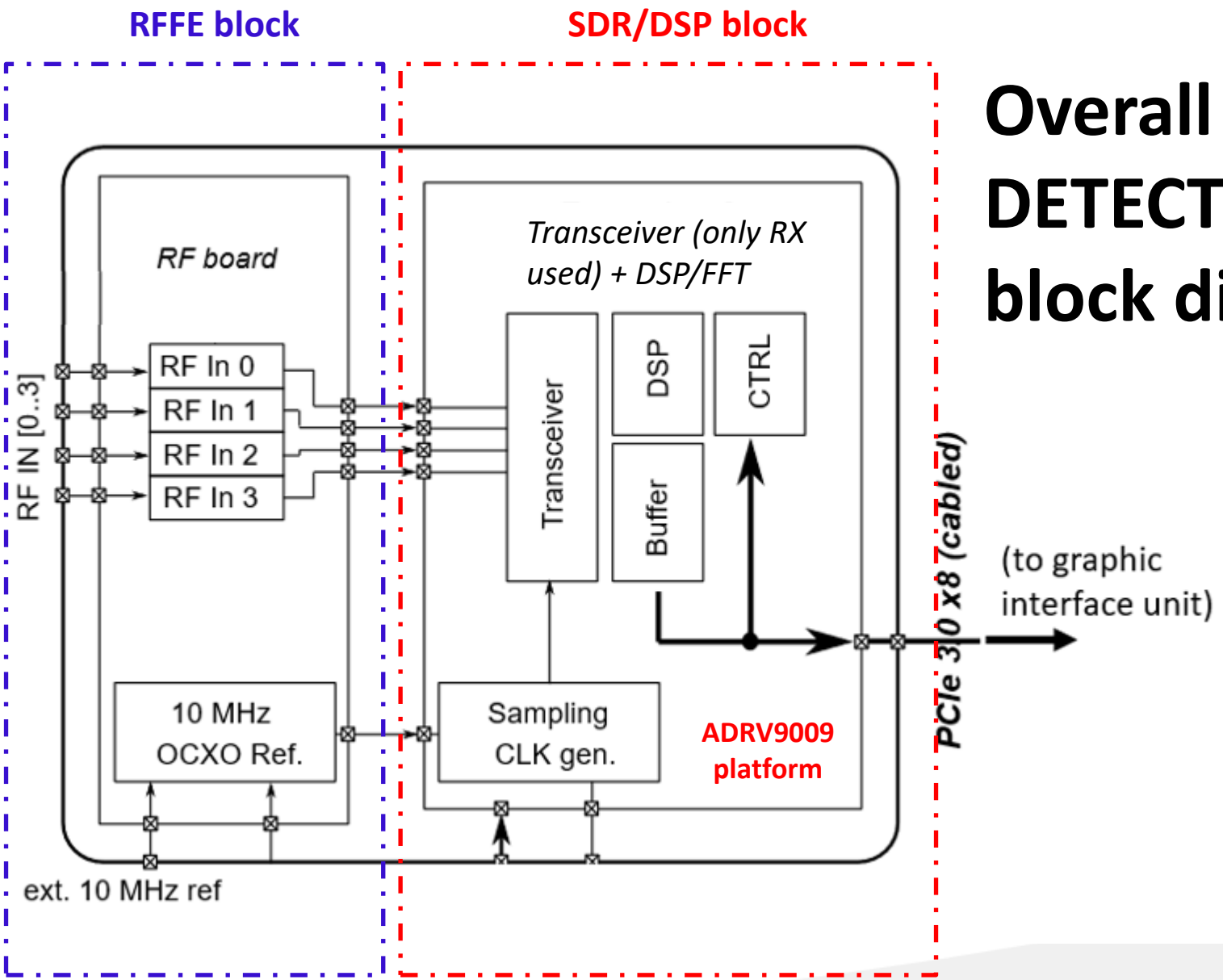
Problem: ADRV9009 input levels are rather high because of the main intended use in 5G signal processing.

Solution: Each channel was provided with a highly optimized radiofrequency frontend, where a first down-conversion (two, if needed for >6000 MHz bands)

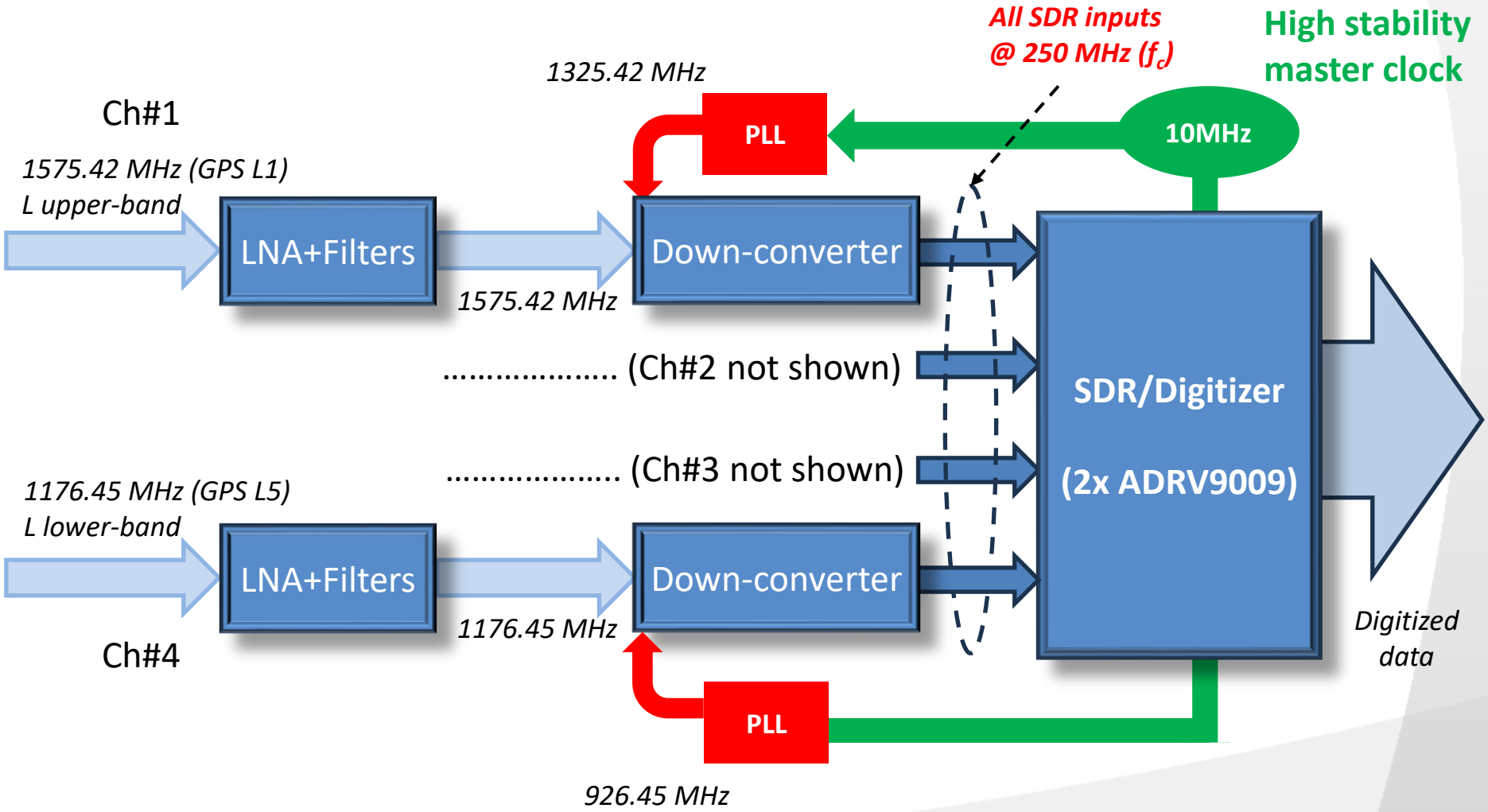
Problem: ADRV9009 contains two SDR with programmable down-conversion, but just one local oscillator for both channels, i.e. the channels are not fully independent

Solution: The local oscillator frequency choice was moved to the radiofrequency frontend section. All the channels entering ADRV9009 are down-converted to a band having 250 MHz as center frequency.

Overall DETECTRION block diagram



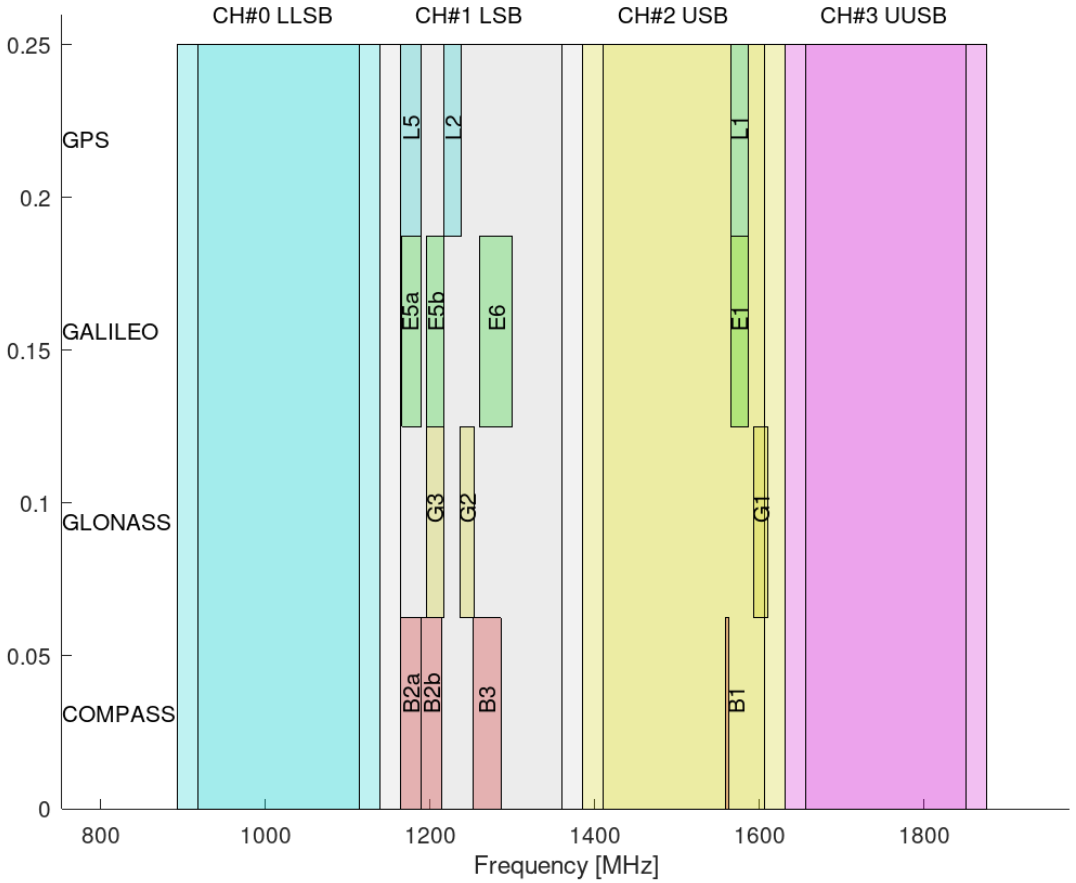
A closer look to the Radiofrequency Front-End (RFFE) design philosophy:
(only two channels shown for clarity; input central frequencies selected for illustration only)



Validation of the design and final tests

The DETECTRION prototype has undergone exhaustive tests to demonstrate the real time operation of the architecture. In the following slide, a QAM128 signal whose central frequency slides over 800MHz is correctly detected and shown, confirming the capability of the instrument to monitor in parallel different bands, also widely spaced apart.

Allocation of DETECTRION four channels in the final validation test



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The DETECTRION project has achieved:

- Successful «off-label» exploitation and reuse of SDR 5G chipsets as building blocks of a RTSA in the microwave bands
- Demonstration of a parallel-filted RTSA architecture allowing a viable approach to the implementation of GNSS interference monitoring
- Operation not limited to GNSS and neighboring bands: DETECTRION can effectively operate as an interference sensor in mobile networks
- SW/FW recofigurability, to easily transform the DETECTRION platform into a 4-channel receiver (up to band Ka)

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DETECTRION PROJECT: Exploitation strategy

- Proposal of a new, low-cost instrument for spatially-resolved GNSS monitoring
- DETECTRION customization for interference monitoring in other bands
- Development of a compact version for use in space payloads (bands TBD with potential users)
- IPR licensing (DSP and data filtering in high speed FPGAs)

made in switzerland

Think INNOVATION !

Contact

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