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An ADVA Optical Networking Company

Timing in the Pits

- GNSS in challenged locations

ITSF 2017

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Motivation & Background

- New technologies require higher accuracy time synchronization
  - eICIC, TDD, 5G, small-cell ...
- Synchronization service over network "coming" but…
  - Legacy networks
  - Technology diversity
  - Multi-vendor networks
  - Multi-operator networks
- GNSS needs to be widely deployed low in the network
  - Needs a viable solution for Urban canyon and Indoor deployment

What it takes to put a GPS antenna on the roof ?

- Permit for roof antenna (expense?)
- Cost of GNSS antenna kit
- Installation cable and lightning protector
- Cost of installation (technician)
- Cost of additional amplifiers if length >120m

Roof top antenna installation is very costly – can reach 1K-10K USD per site

What is the alternative?

- Integrated GNSS antenna with PTP grand master
- Standard Ethernet/IP connectivity
- Easy and cost effective installation - Indoor or simple outdoor locations
- No need to compensate for cable delay (two way time transfer)
- Fibre can be used for very long distances – better protection against lightning

OSA 5405- Outdoor

OSA 5405- Indoor

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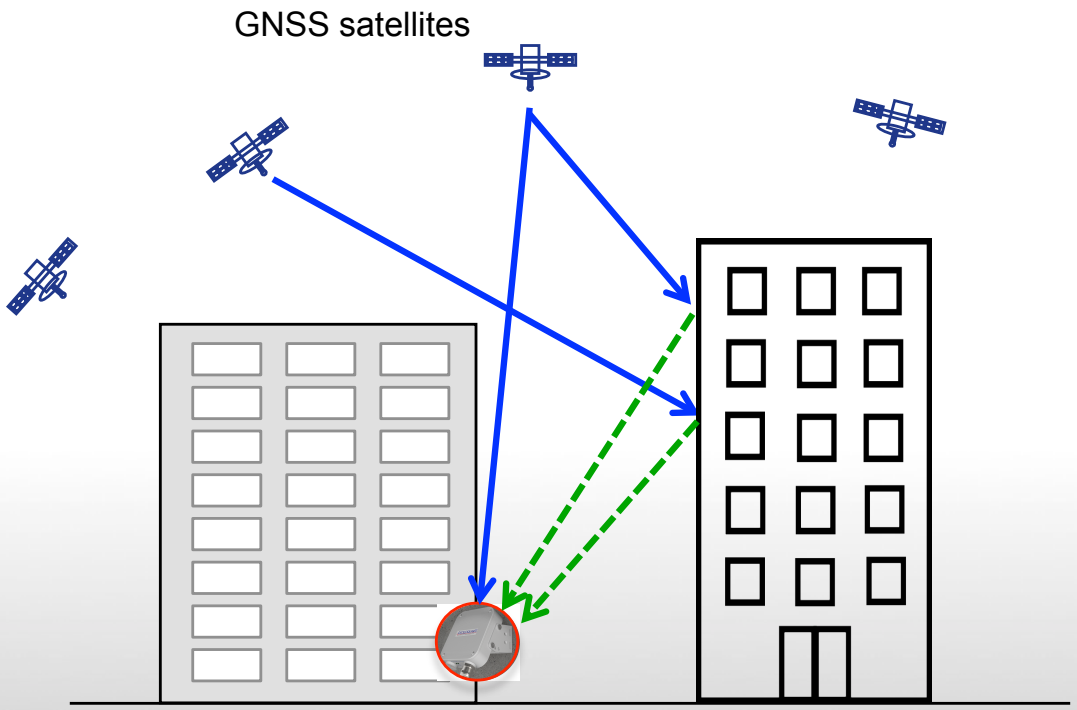
Urban canyon and Indoor Case...

- Roof installation not possible (cost, permit,...)
- Especially for small cell application
- No clear sky view – many multipath (reflected) signals
- Minimal total cost (in line with low cost of small cells)
- Backup via APTS (PTP and SyncE) avoiding single point of failure
- Part of overall sync solution

GNSS antenna in the urban canyon and indoor environment



- Reflections from neighboring buildings cause multipath.
- I.e. paths become longer and
- Few satellites with Line of sight to the antenna
- Algorithms


Antenna location

Direct signal

Reflected signal

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Urban Canyon GNSS Techniques.

- Choose location – indoor or outdoor?
- Fixed position – initially 4 satellites to determine position
- More satellites – Multiple concurrent GNSS constellations
- Known co-ordinates – I.e. Enter antenna position
- Good OCXO – for short term holdover
- Good GNSS Antenna (Dual Feed)

- GNSS chip vendors need to focus on Urban Canyon

(Still seem to be assuming Clear Sky View)

Urban Canyon - Needs optimized GNSS solution

Mounting Options for urban canyons
Location choice based on cost.

Indor - Window

Outdoor - Pole / Wall / Roof

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Indoor Small Cell Sync Requirements

- GM with integrated GNSS antenna
  - optional external antenna
- PTP capacity for building (~64)
- Cost effective and compact design
- Window installation
- Ethernet cabling:
  - Copper/POE
  - Fibre
- Multiple protection options:
  - Sync-E
  - PTP
  - APTS
- Support telecom profiles

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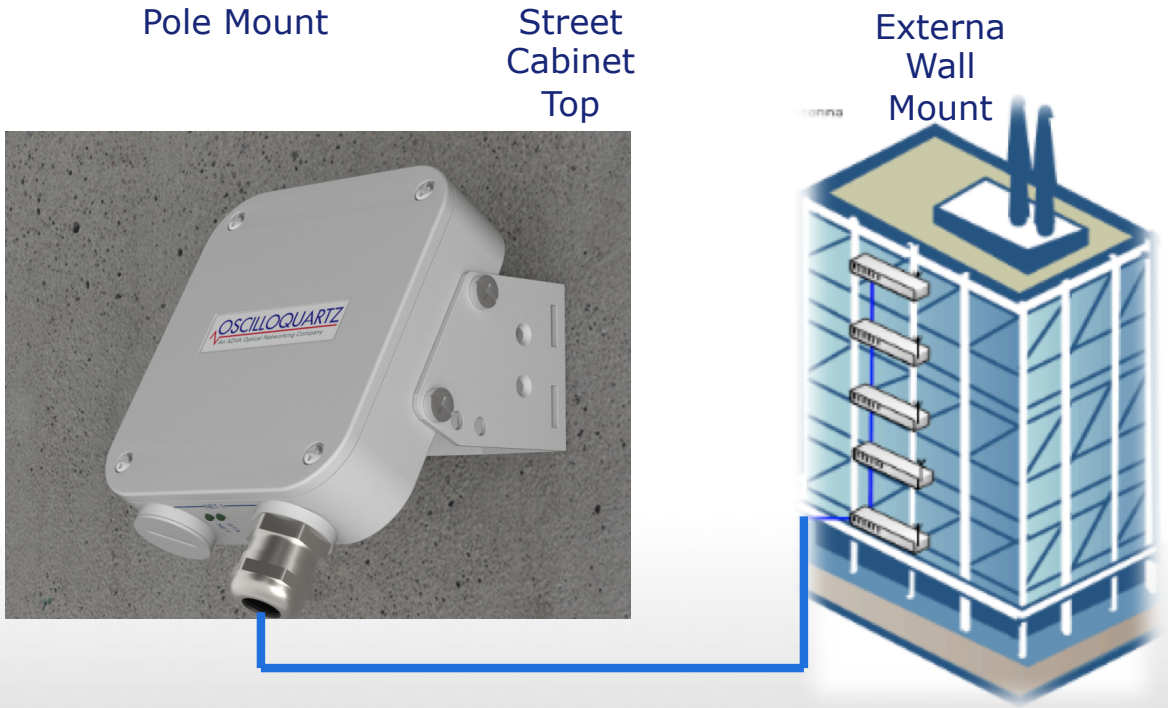
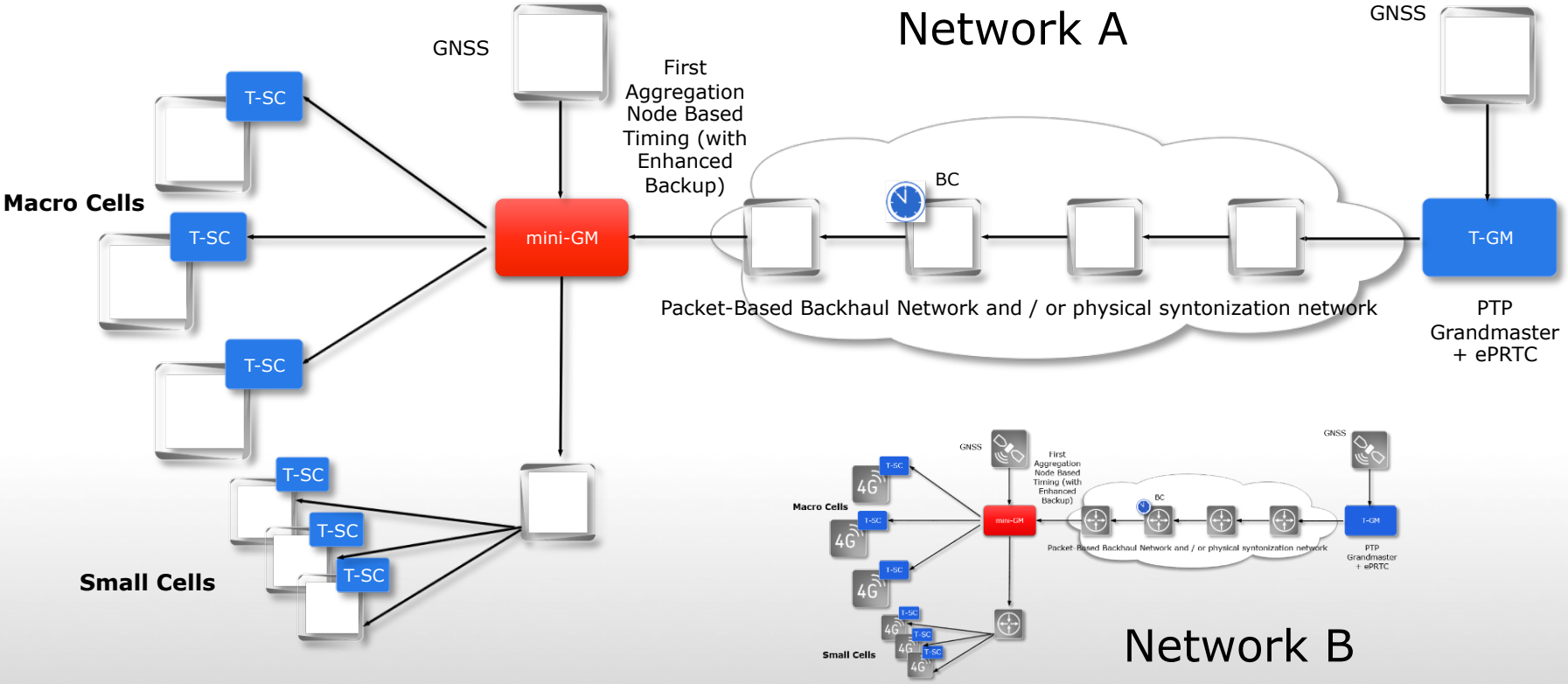
Outdoor Small Cell Sync Requirement

- Features as Indoor plus…
- Options to be installed on:
  - external walls,
  - Pole / lamp post,
  - roof
- Rugged device
  - -40C to +65C
  - IP66 waterproof



Complementing Local GM with network backup



Testing in the pits – needs good UTC reference Sites in Espoo Finland

- VTT provides UTC MIKES
- Distance 876m
- Fibre (Telia) ~6km
- PTP White Rabbit
- Accuracy UTC ~5ns

Fibre link to Finnish Time keeper VTT MIKES

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Antenna/GM testing locations at VTT
#1 Indoor (glass bricks); #2 Outdoor (wall)

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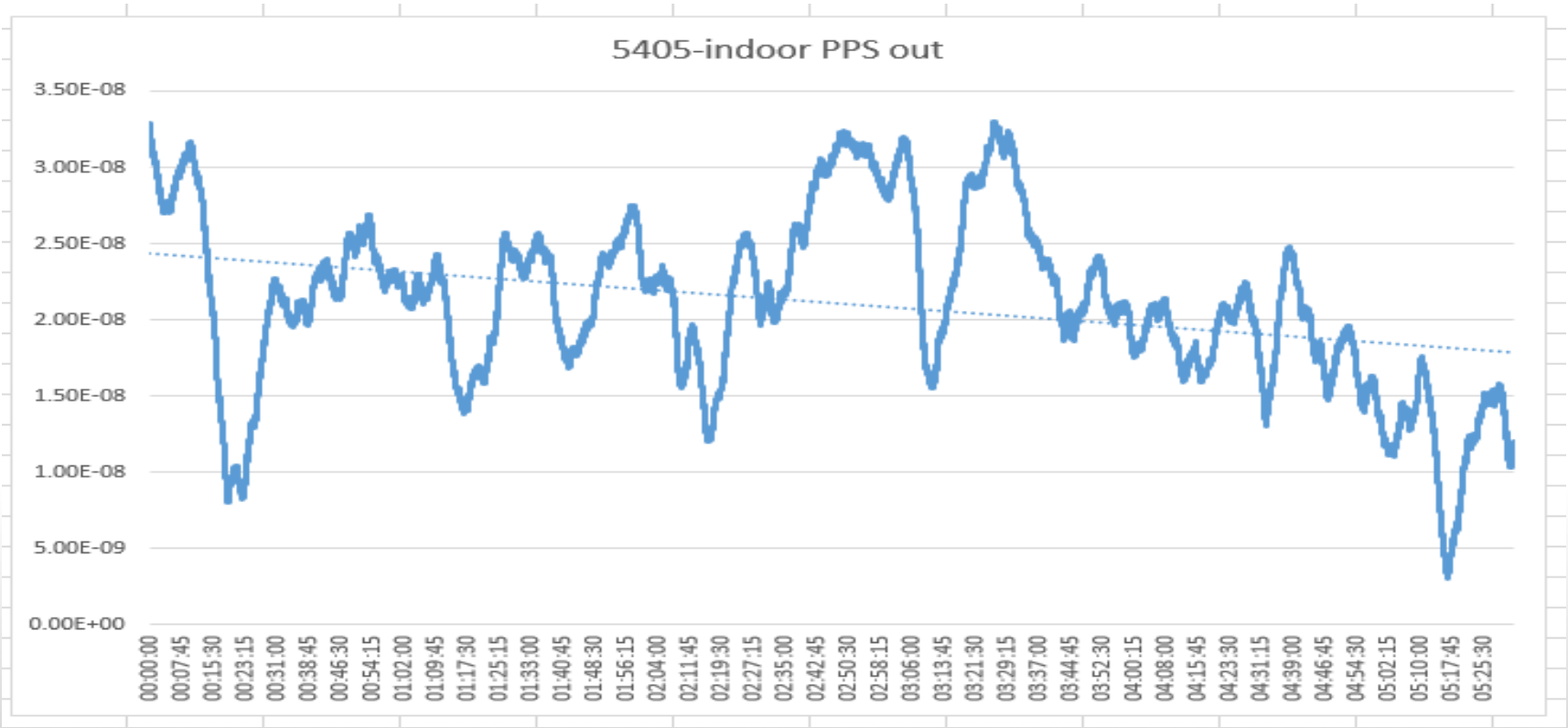
Measurement Result #1
Indoor (behind glass brick) at VTT (GPS + Glonass)



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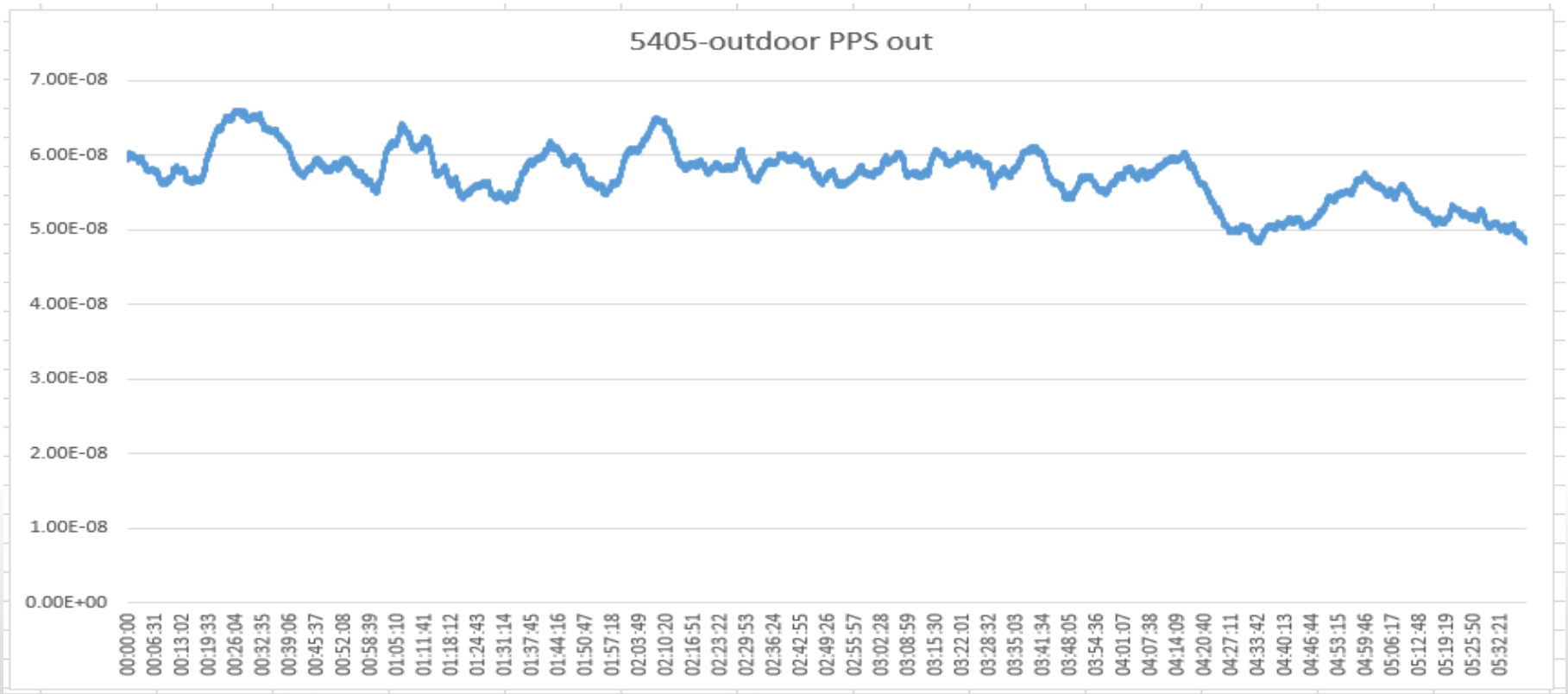
Measurement Result #2
Outdoor wall at VTT (GPS only)



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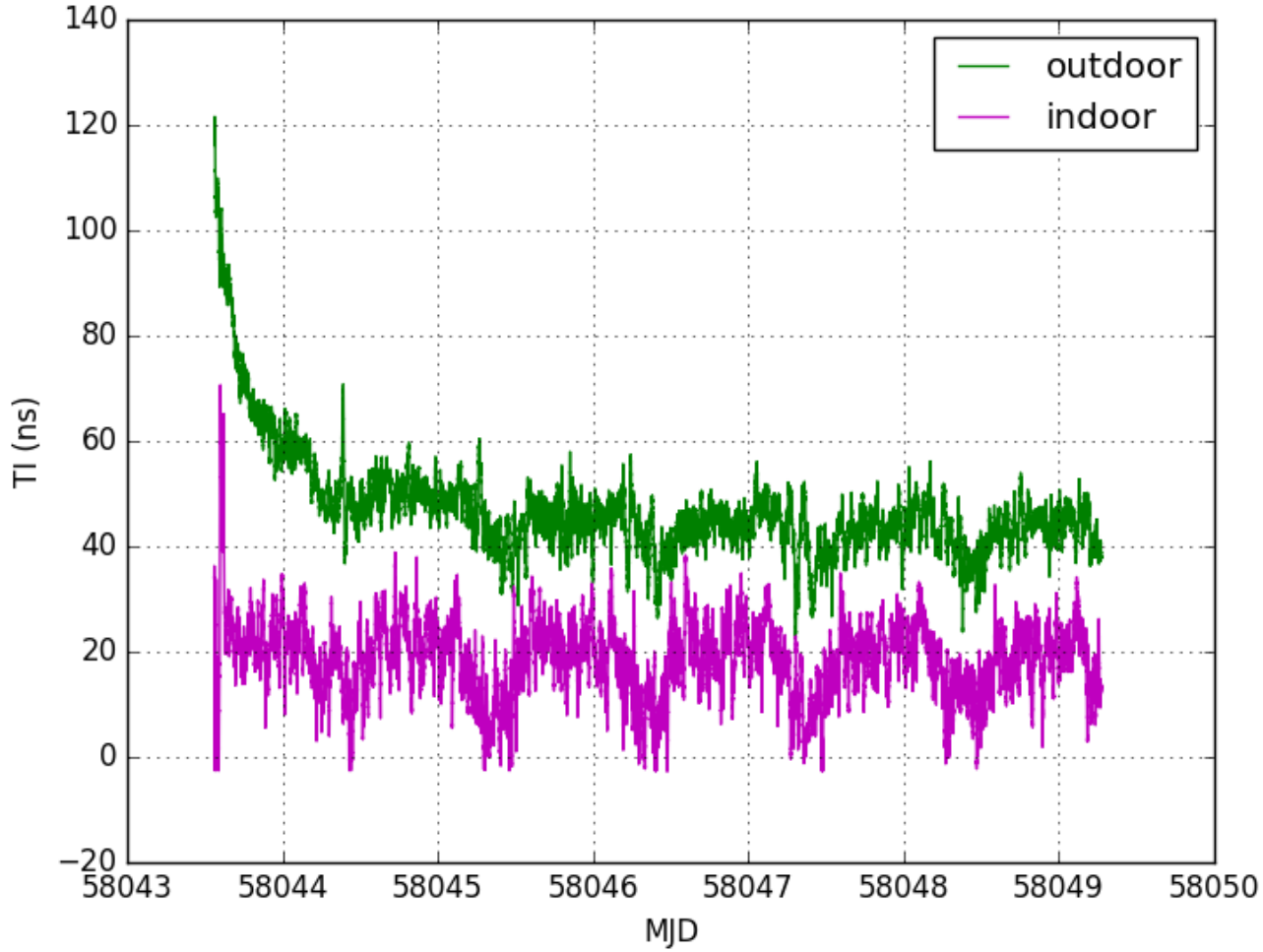
VTT measurement results – 1 week



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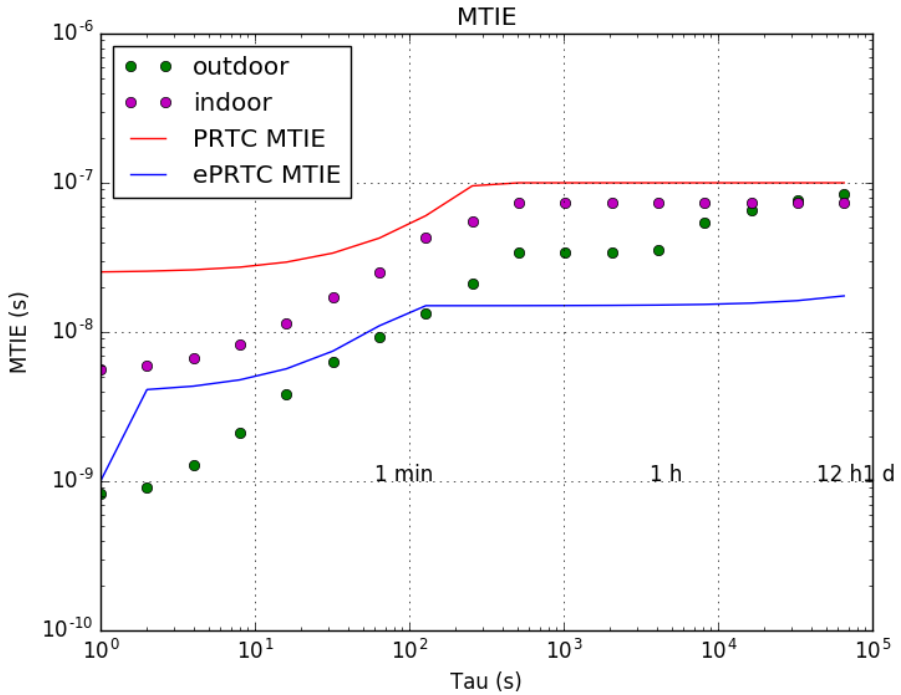
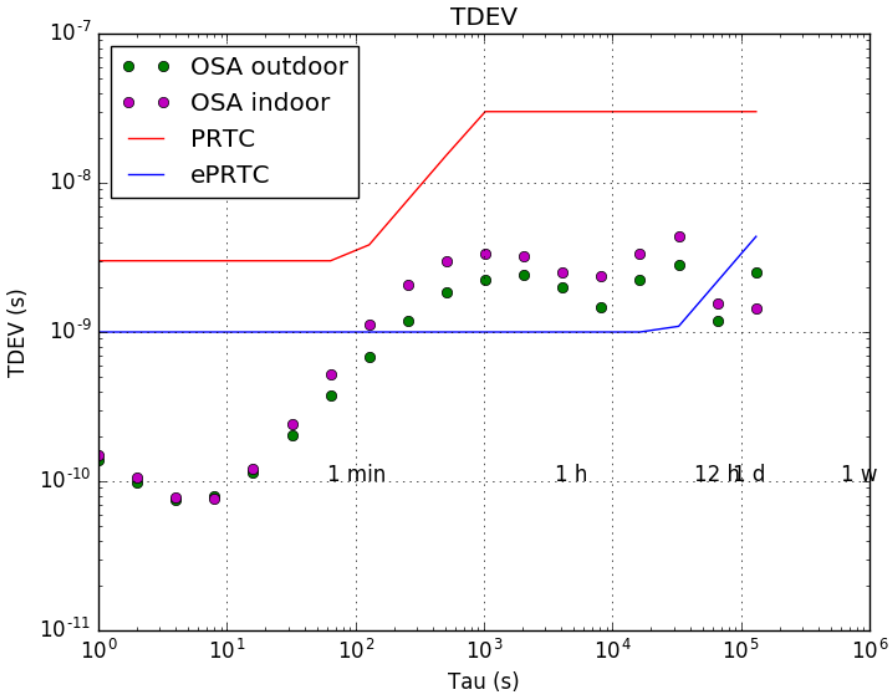
VTT measurement results – 1 week
MTIE / TDEV





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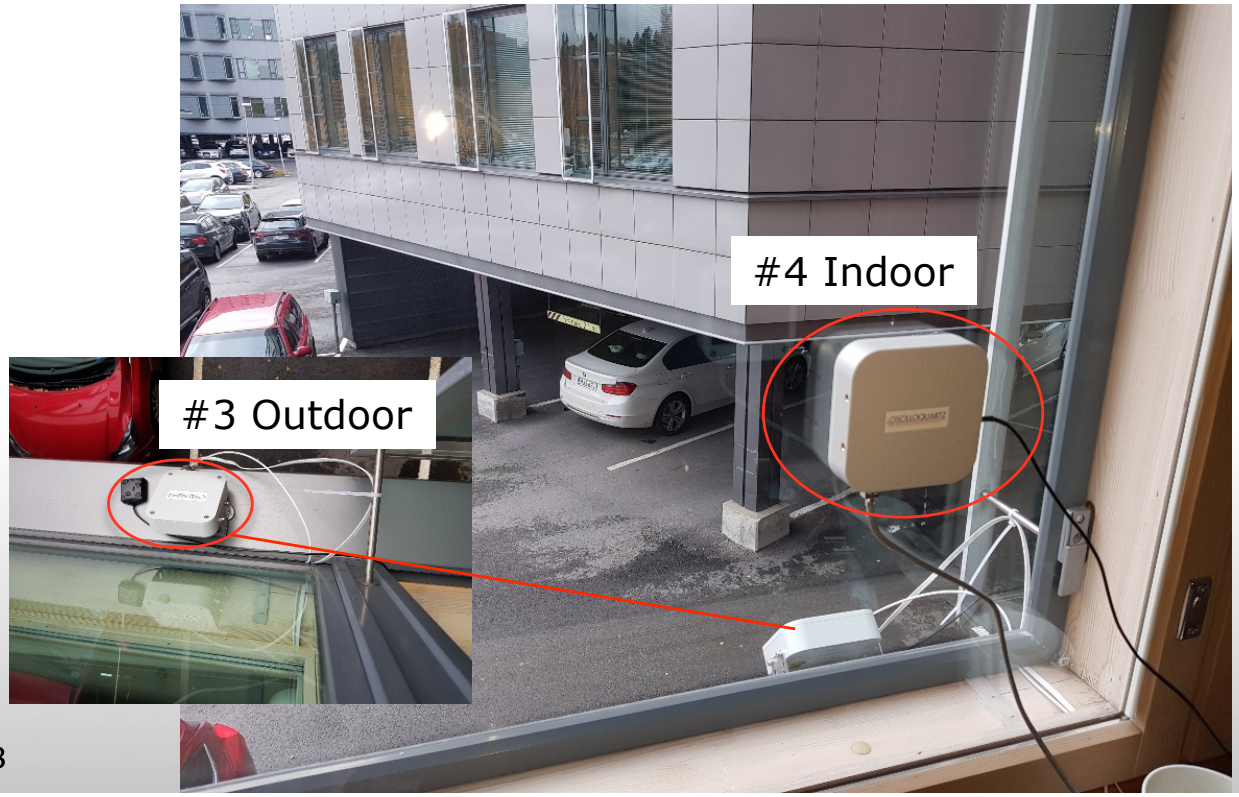
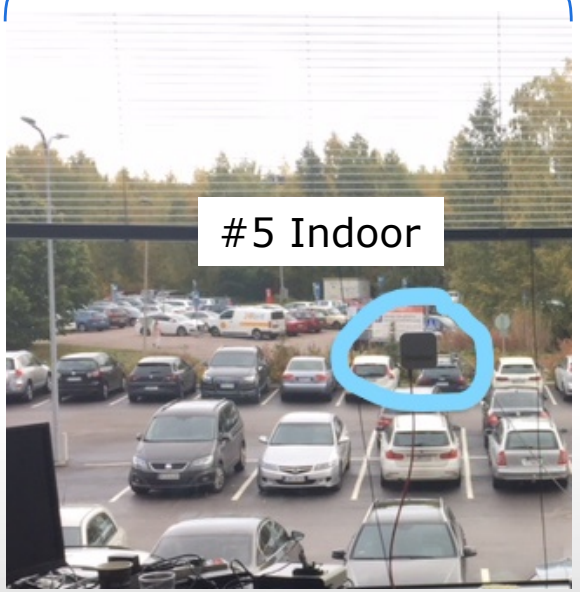
Oscilloquartz office testing

East – Aluminium panels producing extreme multipath (reflections)



North



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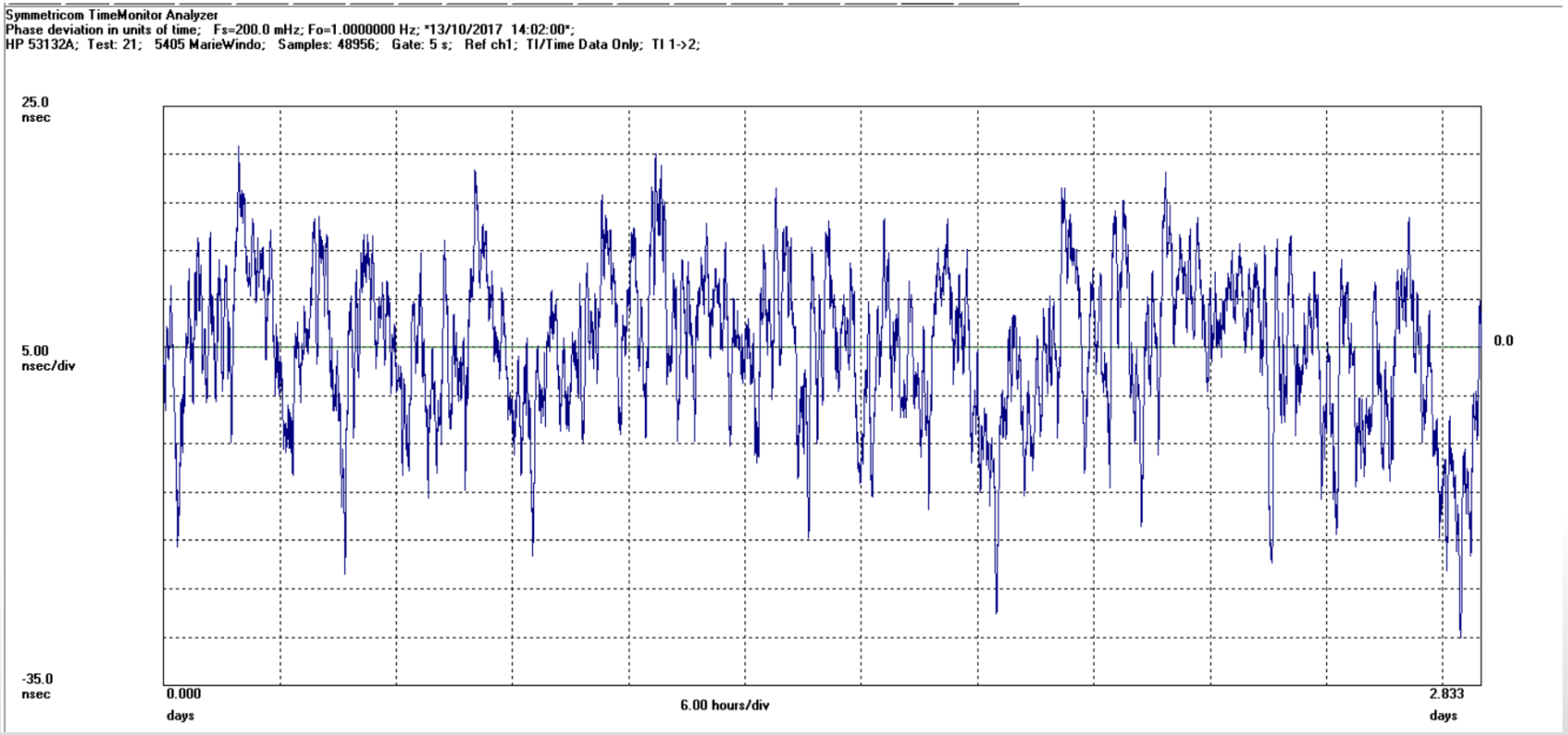
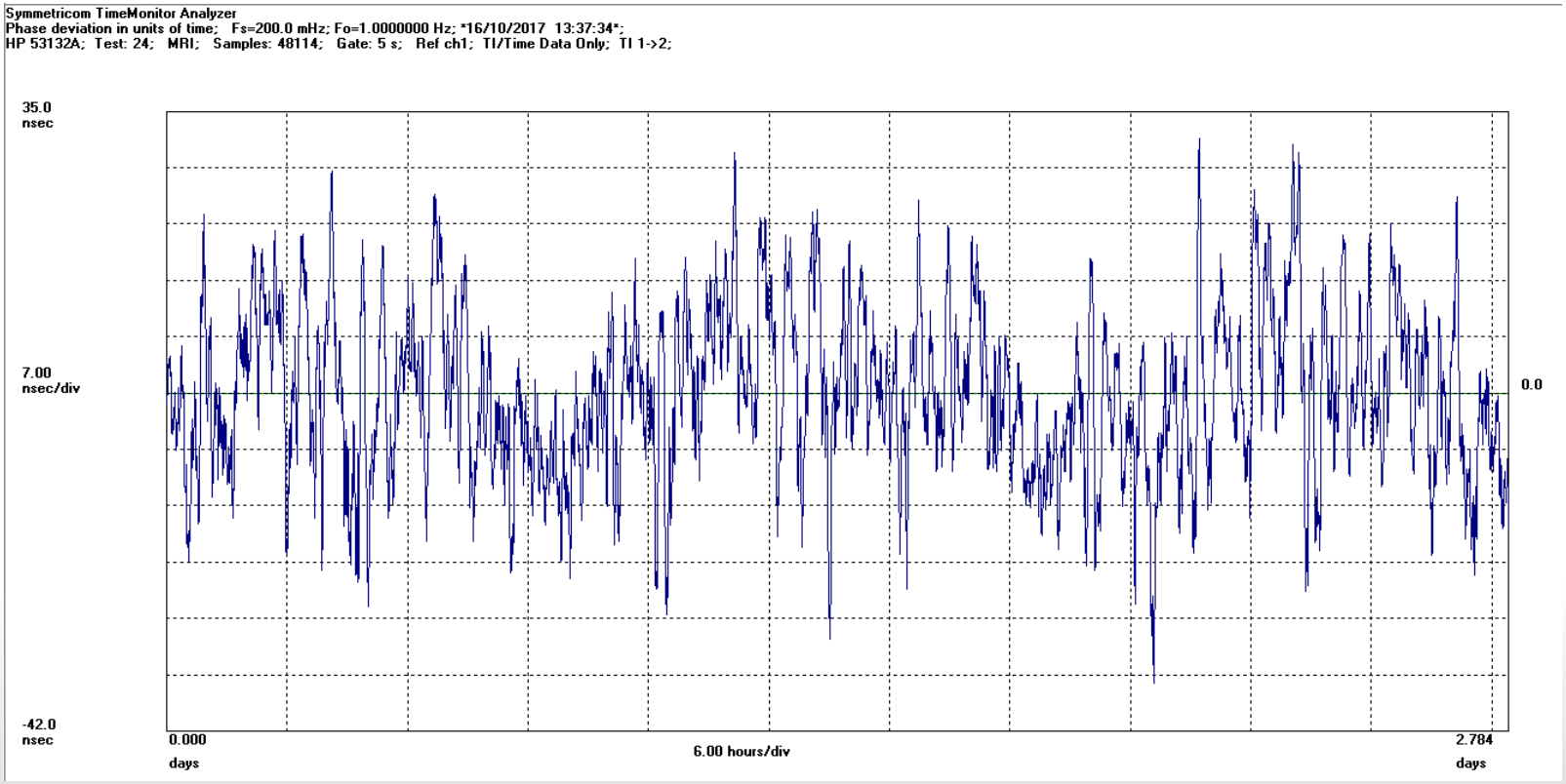
Measurement Result
#3 Outdoor



Measurement Result
#4 Indoor



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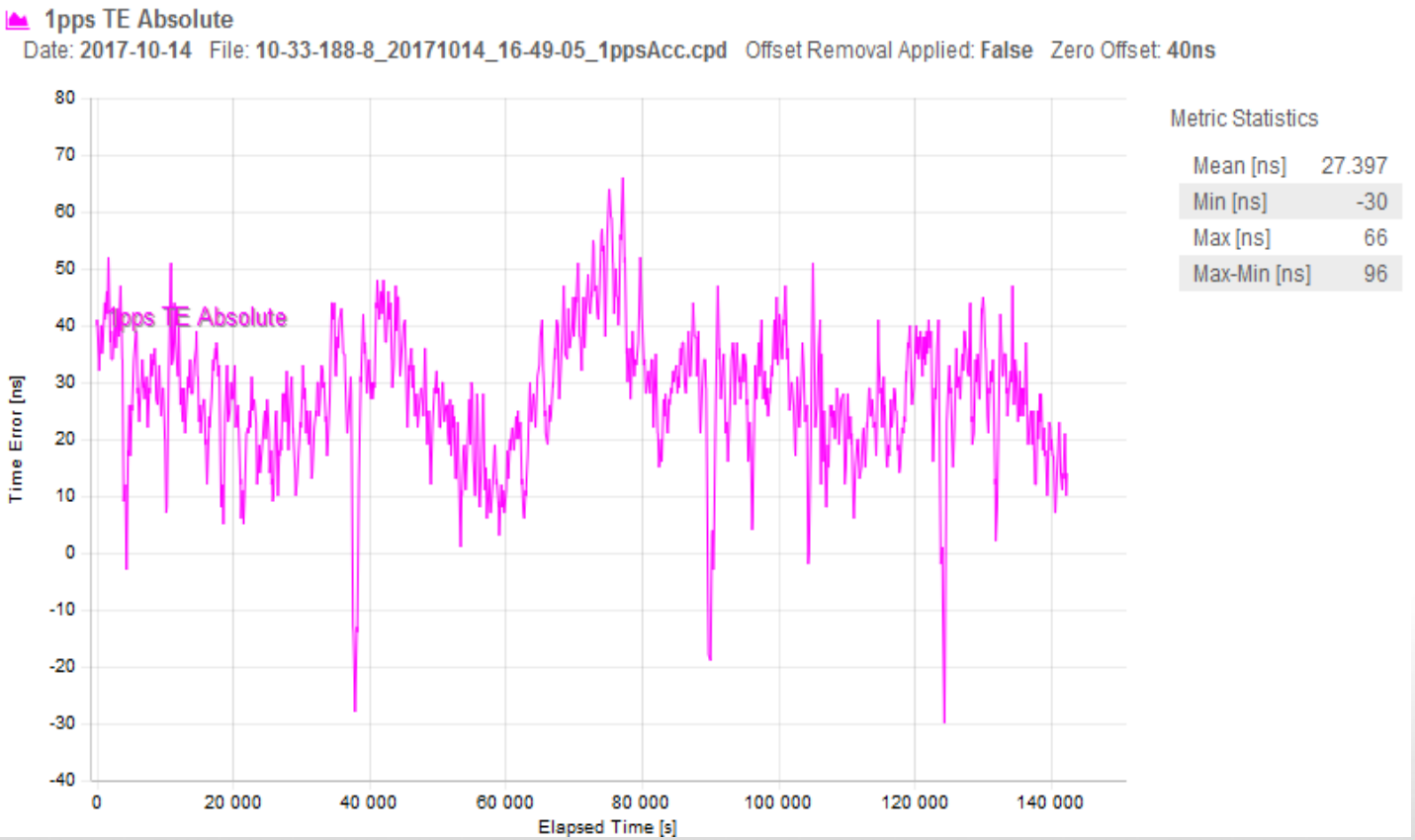
Measurement Result
#5 Indoor (GPS + Glonass)



Metric Statistics

Mean [ns]	27.397
Min [ns]	-30
Max [ns]	66
Max-Min [ns]	96

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All GNSS Antennas are not created equal. Time accuracy

Location	Time Accuracy GM + Internal Antenna (Dual-Feed)	Time Accuracy GM + External Antenna (RHCP Patch)
#3 Outdoor	51ns	66ns
#4 Indoor	70ns	98ns
#5 Indoor	96ns	132ns

For the same location...

- Dual-feed antenna (e.g. OSA5405) improves result
- I.e. Better multi-path rejection = Better time accuracy

Conclusions

- Strong motivation for breaking GNSS ”Sky-View” model
  - PRTC (100ns UTC) achievable Indoors and in deep Urban Canyons
- Improved flexibility and lower cost:
  - Ethernet cabling e.g. direct to small-cell switch
  - Fibre provides greater reach
- Urban Canyon / indoor requires optimization of GNSS:
  - Antenna optimization - helps
  - Backup from core - helps
  - GNSS chip vendors have some work to do

Selecting the right wave improves packet clock performance

Thank You

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