

## **23. Leibniz Conference 2018**

# **Localization Technology for IoT, Telematics and Industry 4.0**

November 22-23rd 2018, Lichtenwalde (Germany)

**PSFM - A Frequency Domain Narrow Band Approach for High SNR**

**Presenter: Yan Wu**



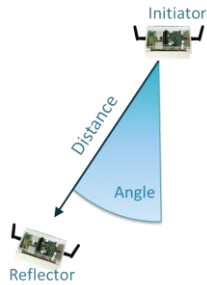
**LEIBNIZ-INSTITUT**  
für interdisziplinäre Studien e.V. (LIFIS)

1. Introduction to Metirionic
2. Introduction to PSFM
  - a. Primary and Secondary Radars
  - b. Pulse Modulated CW Signals forming Discrete Chirp Signals
  - c. Ranging Measurement -- Atomic Operation
  - d. Ranging Procedure – Illustrated
3. Long Range Experiments
  - a. SNR
  - b. Long Range Measurements up to 1km (Static)
  - c. Long Range Measurements up to 1km (Dynamic)
4. Summary

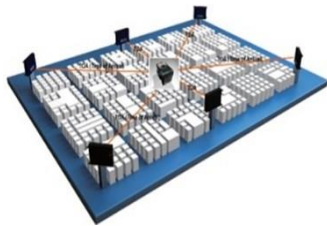
# Introduction to Metirionic



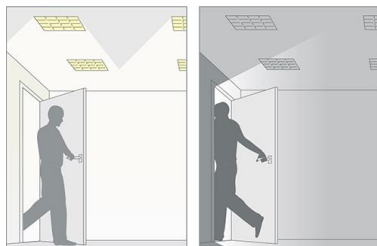
- Established in 2013
- Promote radar techniques with popular communication standards like IEEE 802.15.4 or Bluetooth



Point to Point – Position Finder  
(Distance and Angle)



Point to Multi-Point – RTLS  
(Multiple Distances and Angles  
with single measurement)

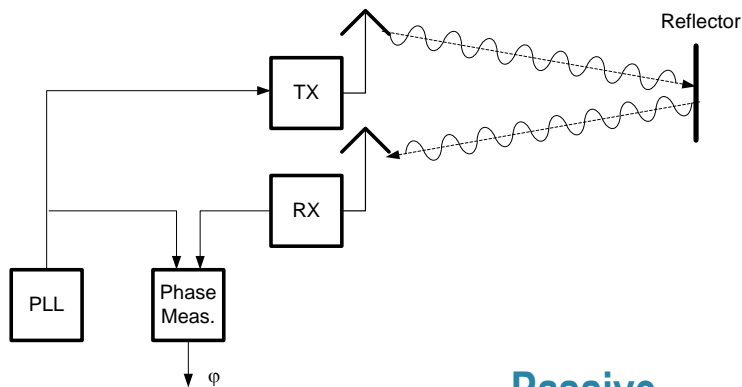


RADAR Applications  
(Presence and  
Motion Detection)

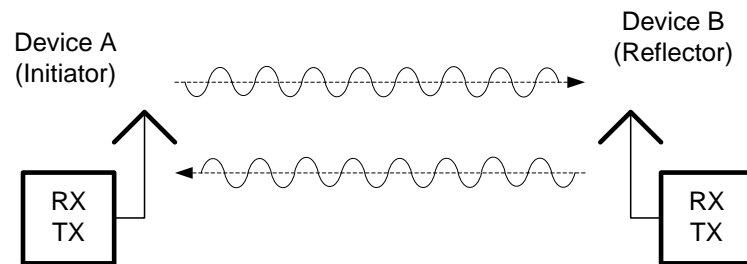


# Introduction to PSFM

## Primary and Secondary Radars (Passive and Active Reflectors)



Passive

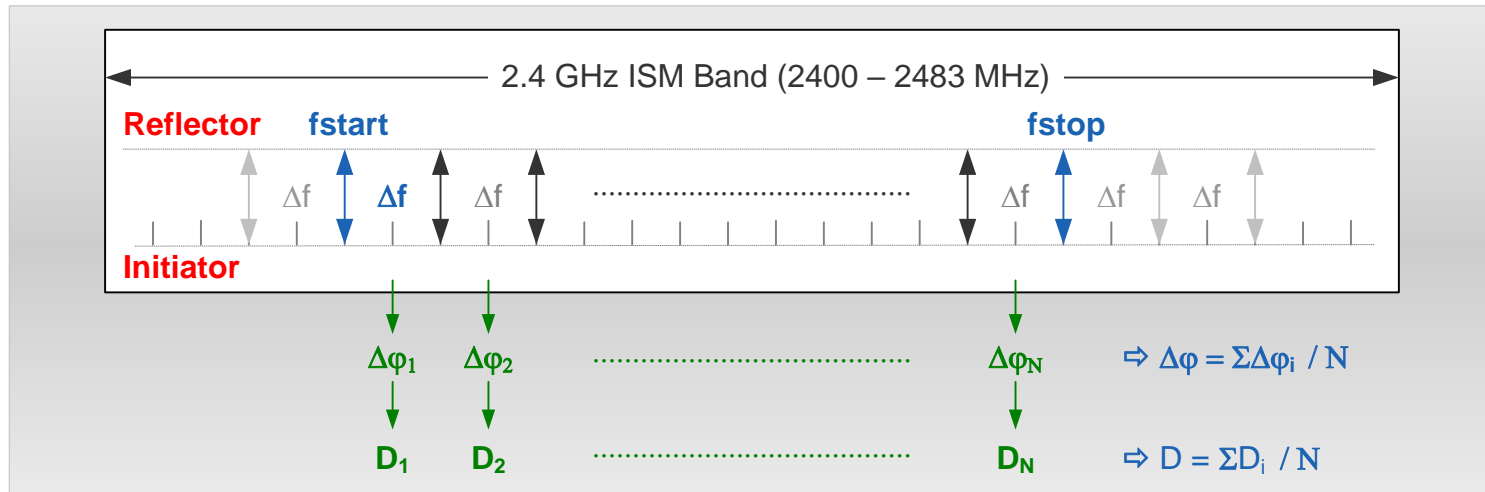


Active

- Active parts of radar transmits and receives at the same time
- Transmitted radar radio signals which are reflected by an object and reflected signals are received.

- Active Reflector Technology decouples TX and RX operation between initiator and reflector
- Reflector is actively engaged in measurement process

# Pulse Modulated CW Signals forming Discrete Chirp Signals



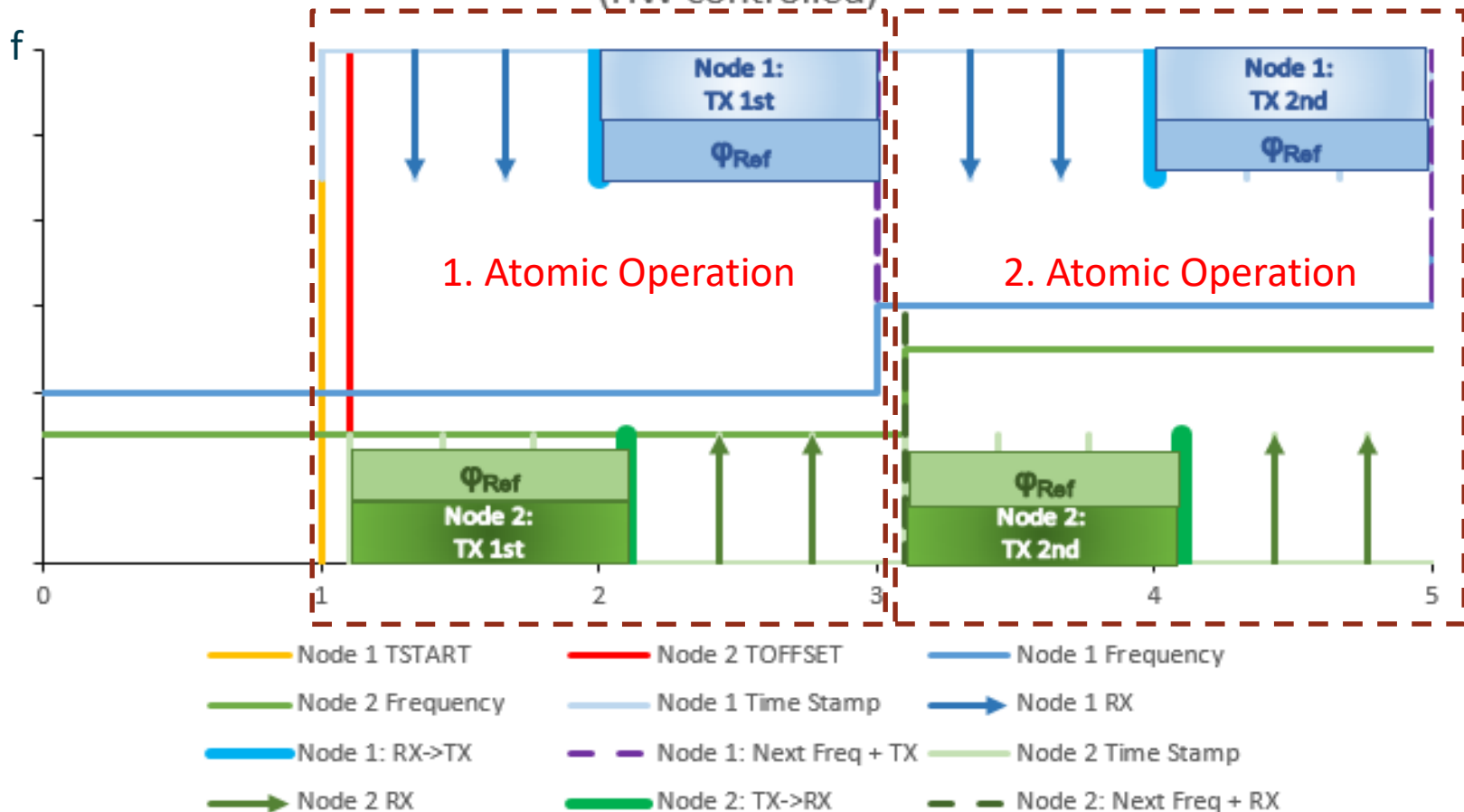
$$d = (0.5 *)c * t_g = (0.5 *)c * \frac{\Delta\phi}{\Delta\omega} = (0.5 *)c * \frac{1}{\Delta f}$$

- Initiator and Reflector exchange discrete chirp signals by consecutively transmitting CW signals of increasing frequency stepping through the band of interest (Ping-Pong)

# Ranging Measurement -- Atomic Operation



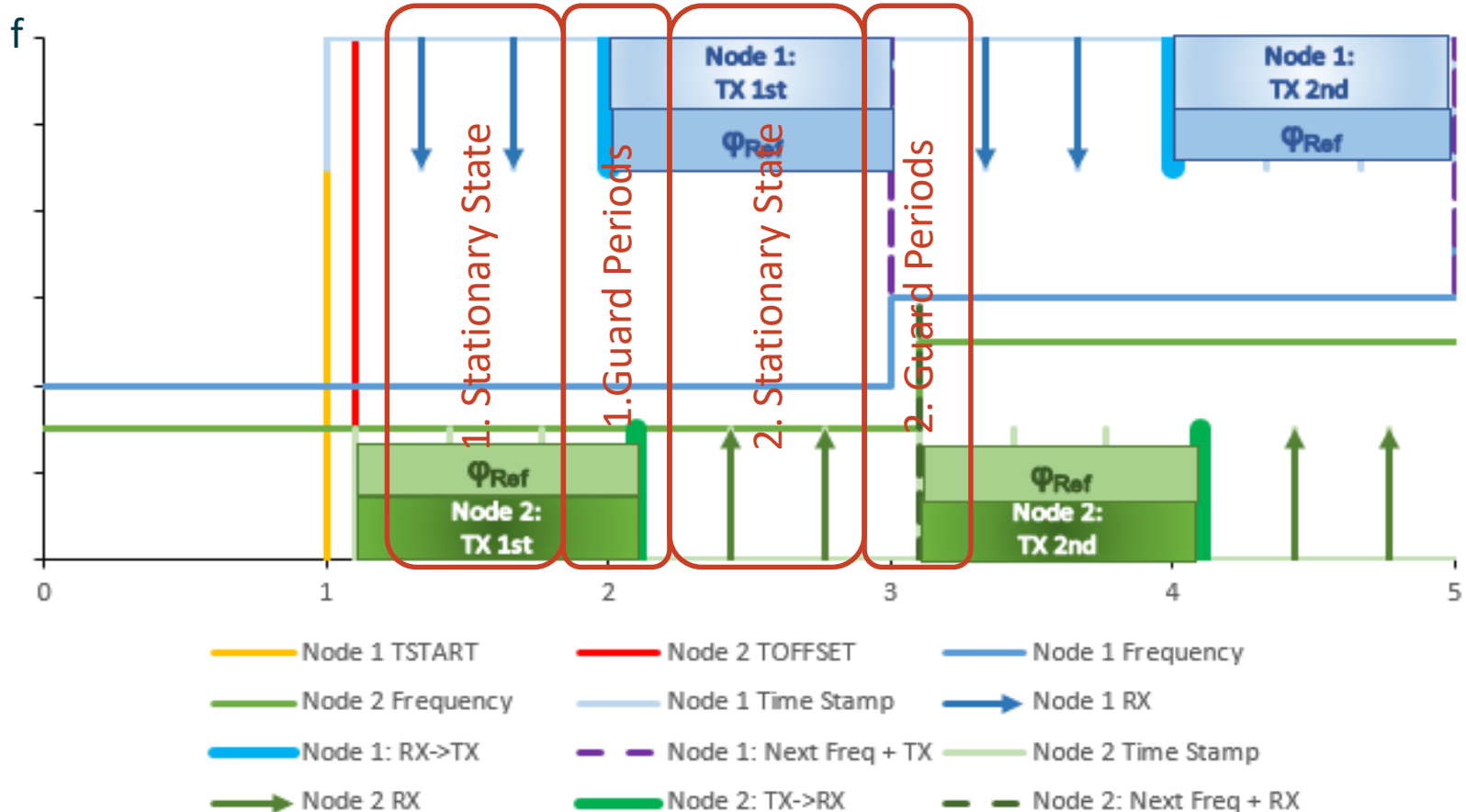
Measurement Scheme with fixed Timed Channel Switch  
(HW controlled)



# Ranging Measurement -- Atomic Operation



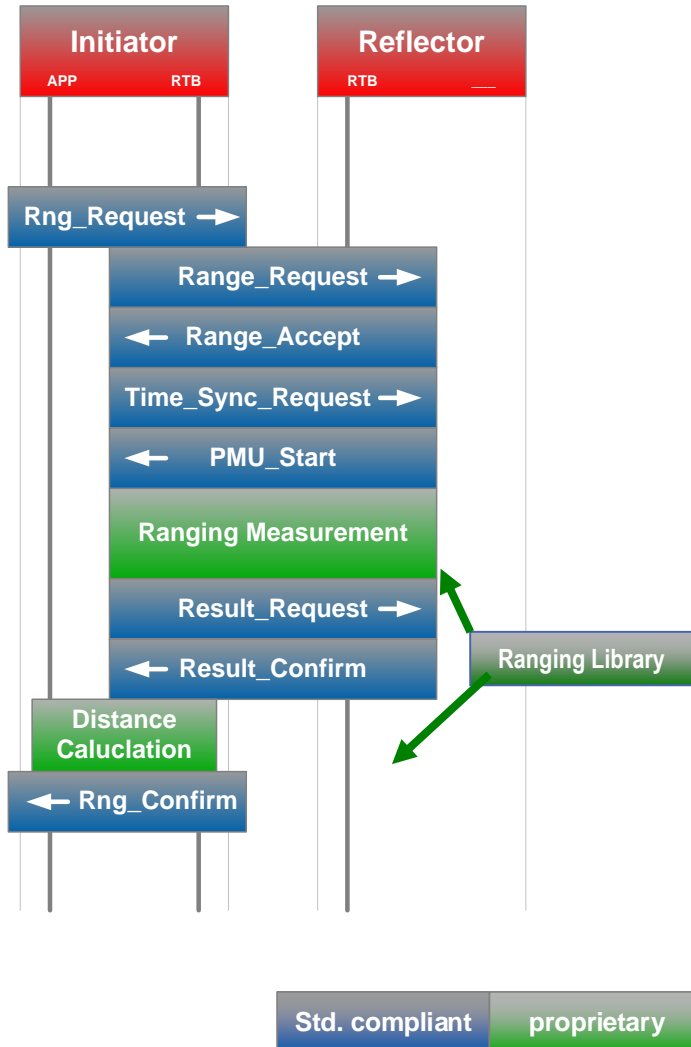
Measurement Scheme with fixed Timed Channel Switch  
(HW controlled)



# Ranging Procedure – Illustrated



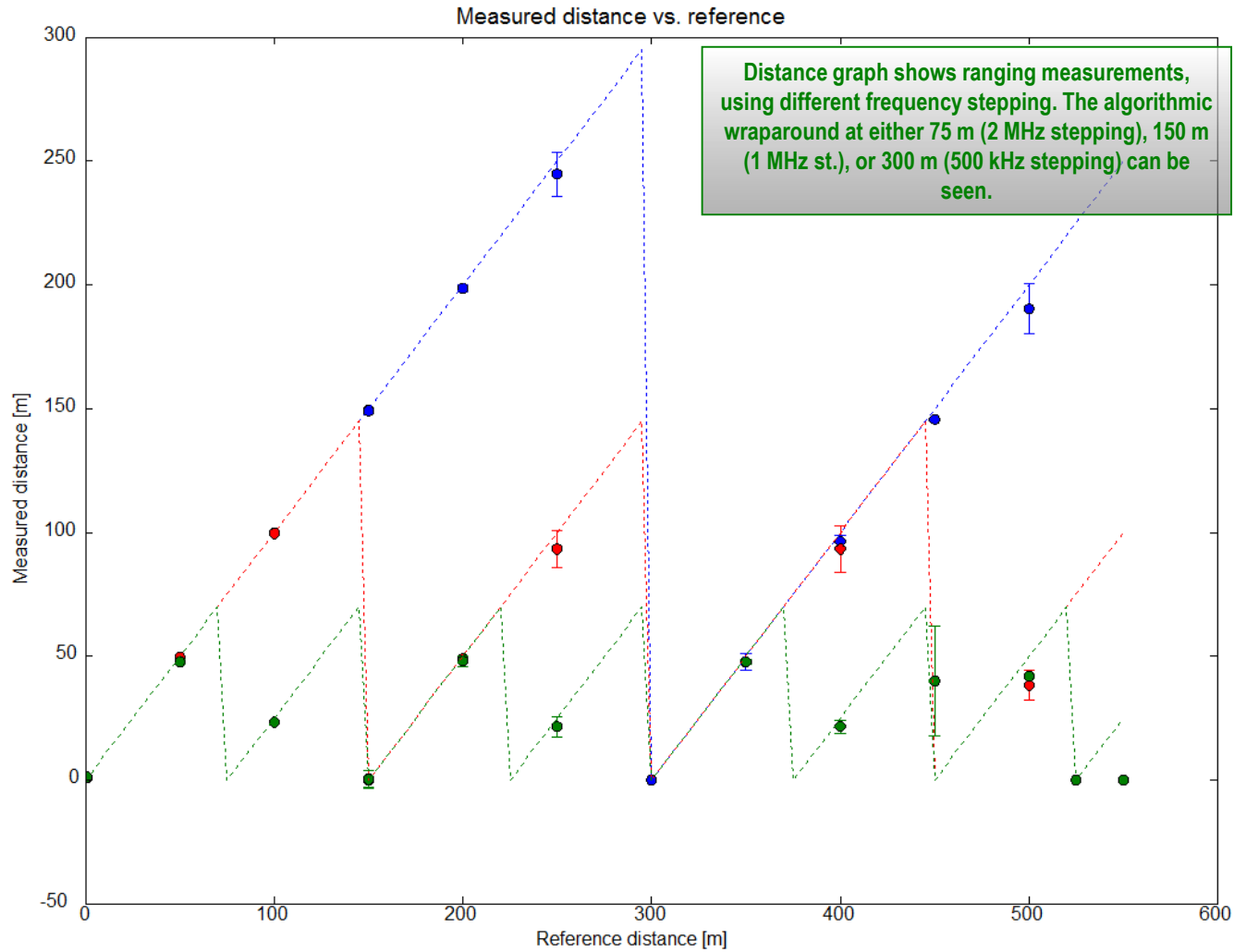
## RTB – Ranging Procedure



- Signaling between *Initiator* and *Reflector* using communication frames
  - synchronization
  - channel allocation
  - data transfer
- No reception of communication frames during range measurements



# Long Range Experiments



# Long Range Experiments -- SNR



Parameters:

BW	80MHz
Step Size	250kHz
IF	250kHz
IF BW	160kHz
Modulation	MR-OQPSK-1000
Tx PWR	20dBm
NF	4dB
Ranging SNR [Avg.]	6dB

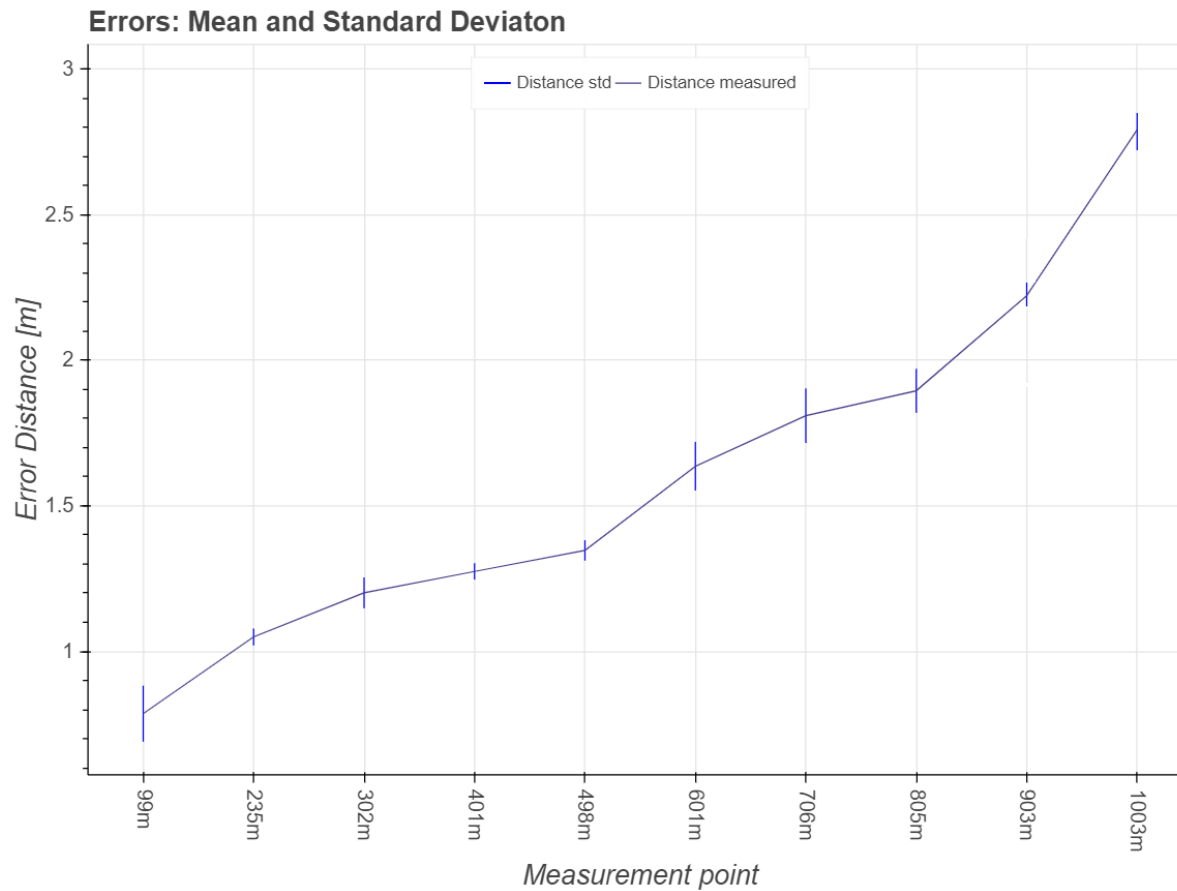
	DATA	Ranging
Rx Sensitivity	-116dBm	-113dBm
Tx PWR	20dBm	20dBm
Link Budget	136dB	133dB

# Long Range Measurements up to 1km (Static)

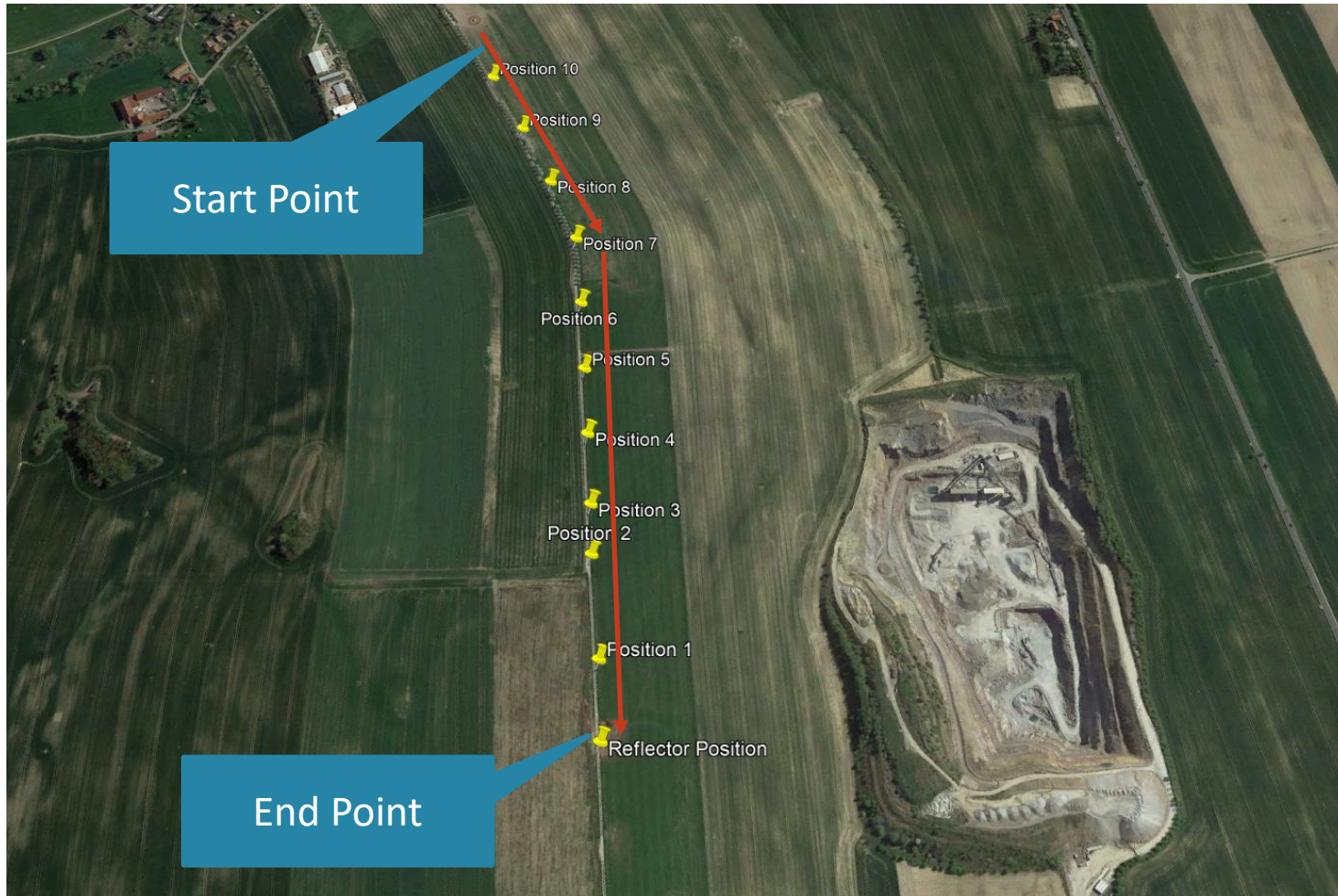


Positions	Distance from Refl. to Pos.
Position 1	100m
Position 2	235m
Position 3	300m
Position 4	400m
Position 5	500m
Position 6	600m
Position 7	705m
Position 8	805m
Position 9	900m
Position 10	1000m

# Long Range Measurements up to 1km (Static)



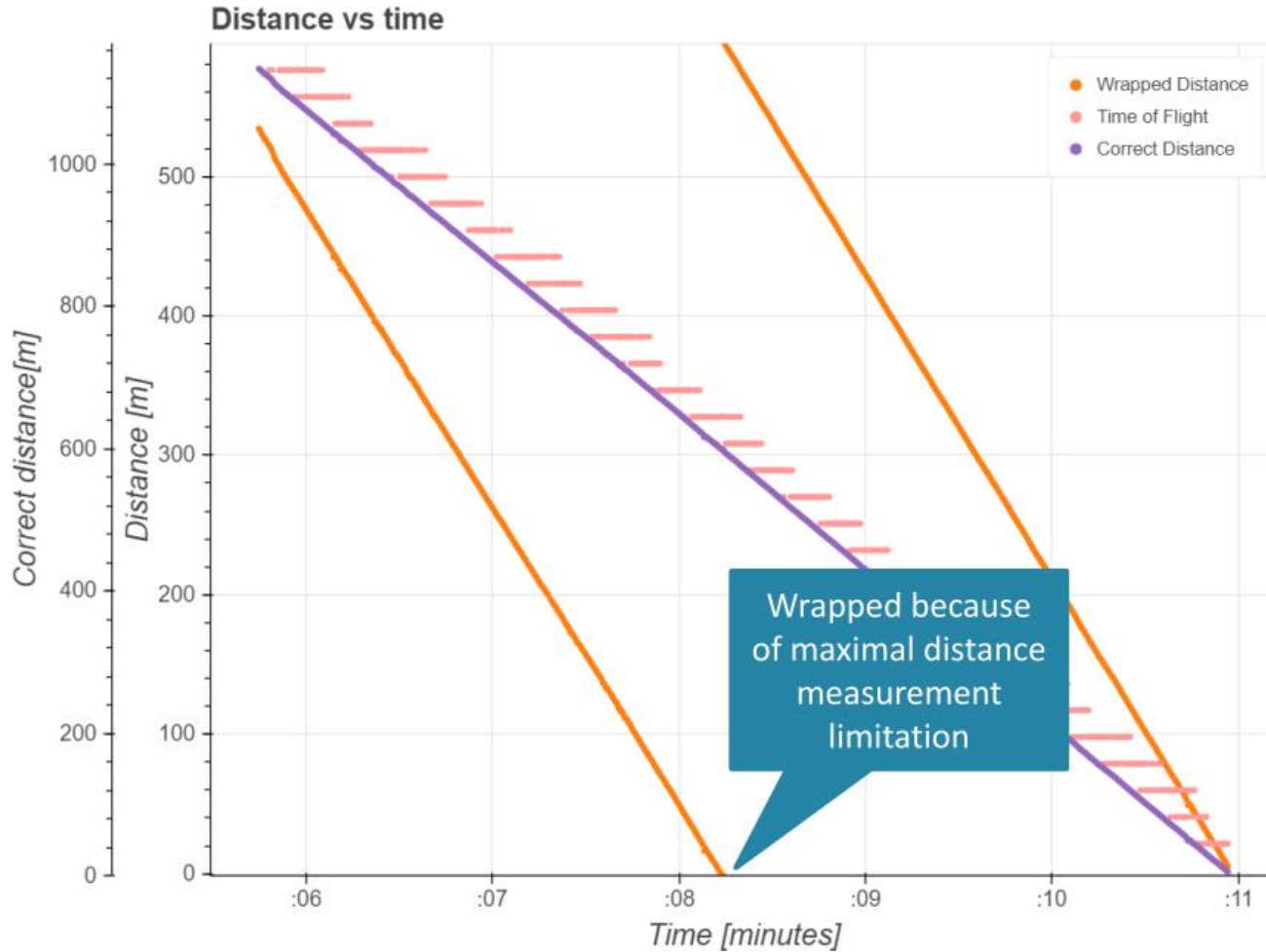
# Long Range Measurements up to 1km (Dynamic)



Start Point

End Point

# Long Range Measurements up to 1km (Dynamic)



- a. Introduce PSFM
- b. Discussion about Procedure of Distance Measurement
  - Discrete Chirp Signals
  - Atomic Operation
  - Ranging Procedure
- c. Long Range Experiments
  - SNR
  - Static and Dynamic

# We know the distance !

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