



**Canova Tech**

*The Art of Silicon Sculpting*

**PIERGIORGIO BERUTO  
ANTONIO ORZELLI**

*IEEE802.3cg TF*

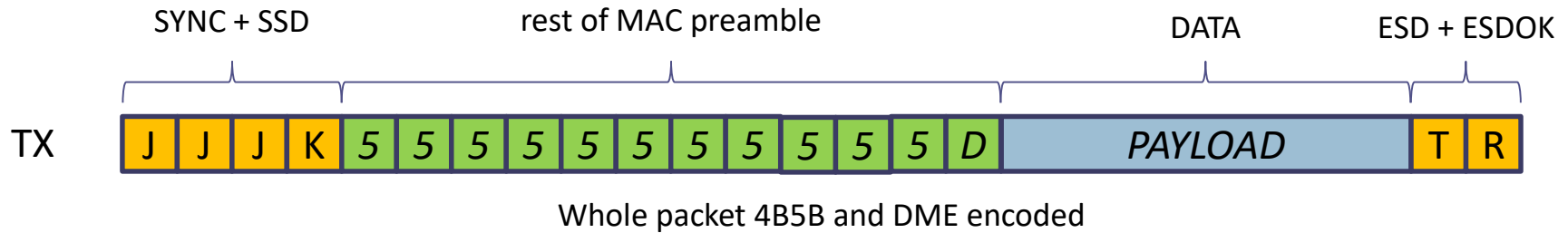
*TIS preamble*

*May 22<sup>th</sup>, 2018*

- Some concerns from Jay Cordaro & Mehmet Tazebay about 10BASE-T1S preamble and synchronization
  - [http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_8023cg\\_short\\_reach\\_new\\_preamble\\_proposal\\_1220.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_8023cg_short_reach_new_preamble_proposal_1220.pdf)
  - [http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_8023cg\\_01\\_0118\\_v2.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_8023cg_01_0118_v2.pdf)
  - [http://www.ieee802.org/3/cg/public/Jan2018/tazebay\\_3cg\\_01b\\_0118.pdf](http://www.ieee802.org/3/cg/public/Jan2018/tazebay_3cg_01b_0118.pdf)
  - [http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_3cg\\_06\\_0418.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_3cg_06_0418.pdf)
  - [http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_3cg\\_02\\_0509.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_3cg_02_0509.pdf)
- There's no general consensus in 802.3cg to redefine a preamble for the T1S PHY
  - No agreement on SNR benefits vs complexity (relative cost) for different implementation approaches that require different preamble properties
- This presentation suggests a compromise for T1S preamble that wouldn't preclude different implementations
  - Better synchronization performance, matching Cordaro's proposal (Golay sequence)
  - Still good for low complexity receivers and inline with currently specified architecture

# Main points of disagreement

- In [http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_3cg\\_05\\_0418.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_3cg_05_0418.pdf) an example of automotive BCI test has been presented
  - 500 mV p-p of differential noise proposed as target for automotive EMC
  - Differential noise measured **in presence of a resonance** effect (105 mV @16MHz)
  - Scaled to compensate for measured MC vs MC limit (8dB → 263 mV)
  - Scaled to increase BCI current from 200mA to **355mA** ( x1.77 → 465mV)
  - Add margin (500mV)
- **A preamble with better autocorrelation properties could help in resisting 500 mV of diff. noise**
- **However**
  - Different OEMs have different requirements, typically 200mA
    - See e.g. <http://www.ieee802.org/3/cg/email/msg00580.html>
    - Not clear how many would like to see the limit increased to 355mA
  - Resonance effects are usually solved otherwise (PCB, harness, cables, ...)
    - **CAN-FD / FlexRay would hardly work with such level of noise**
    - **Resonances could be much higher than 500mV anyway**
  - Not a requirement for industrial and backplane use cases
- **Having a PHY that can operate under extreme noise conditions could be a competitive advantage from a product and market perspective, but**
  - It should not be considered a mandatory target, 300 mV p-p sounds like a more reasonable objective
    - Cheaper implementations are not be precluded, exceeding the requirements is always permitted



- JJK sequence is good to achieve DME synchronization and alignment on 4B5B boundaries in low complexity receivers
  - Initial 0's are good to discriminate clock from data transitions
  - Starting J sequence can be “stretched” to accommodate PLCA COMMIT requests
- Different implementations could benefit from better autocorrelation properties of the preamble
  - See [http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_3cg\\_06\\_0418.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_3cg_06_0418.pdf) slides #9, 11

# Golay's sequence Ga32 proposal from Jay Cordaro

- From [http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_3cg\\_02\\_0509.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_3cg_02_0509.pdf)
- Proposed Golay sequence Ga32



- Better autocorrelation than JJK – from [http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_3cg\\_06\\_0418.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_3cg_06_0418.pdf)

Normalized Autocorrelation Comparison 4B5B 'JJK' DME Modulated and GA32 Preamble

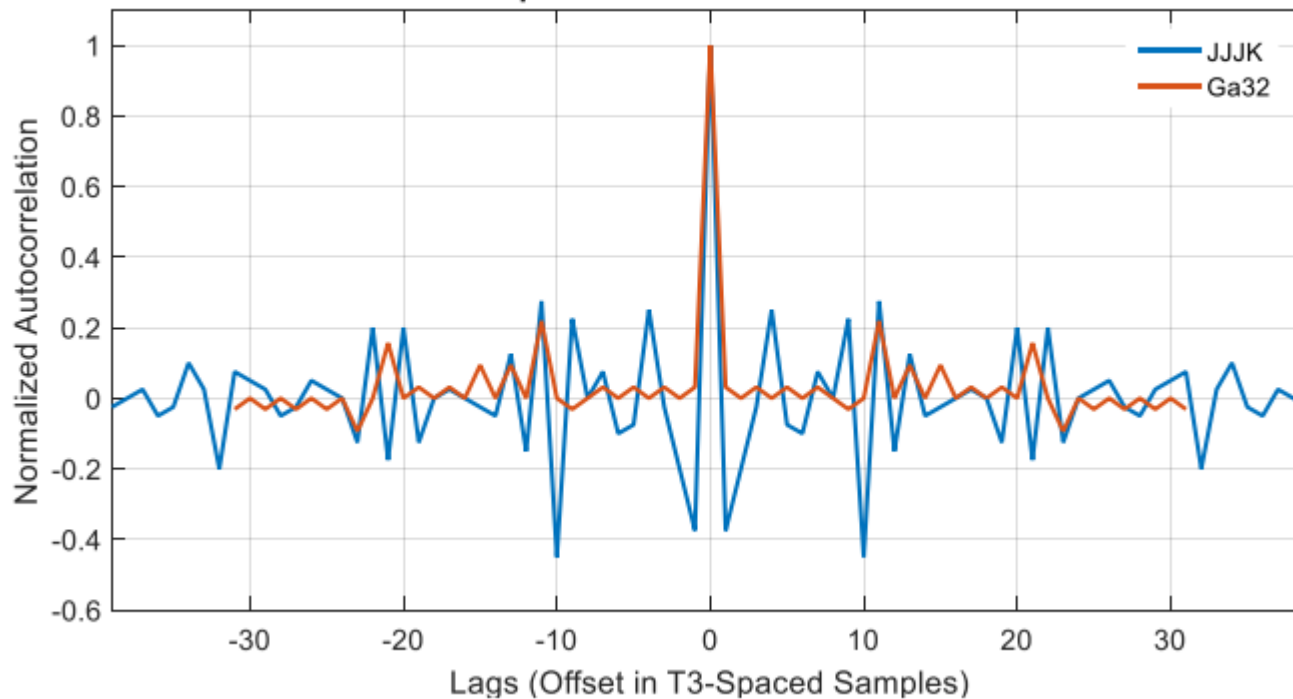


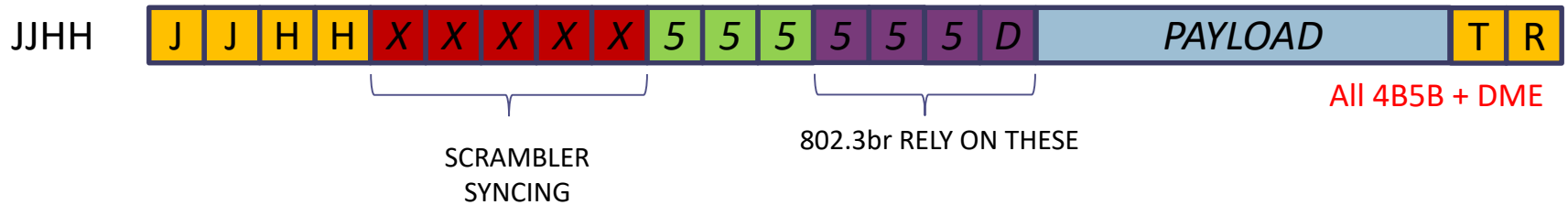
Figure from J. Cordaro's presentation slide #9

# Issues with Ga32 proposal

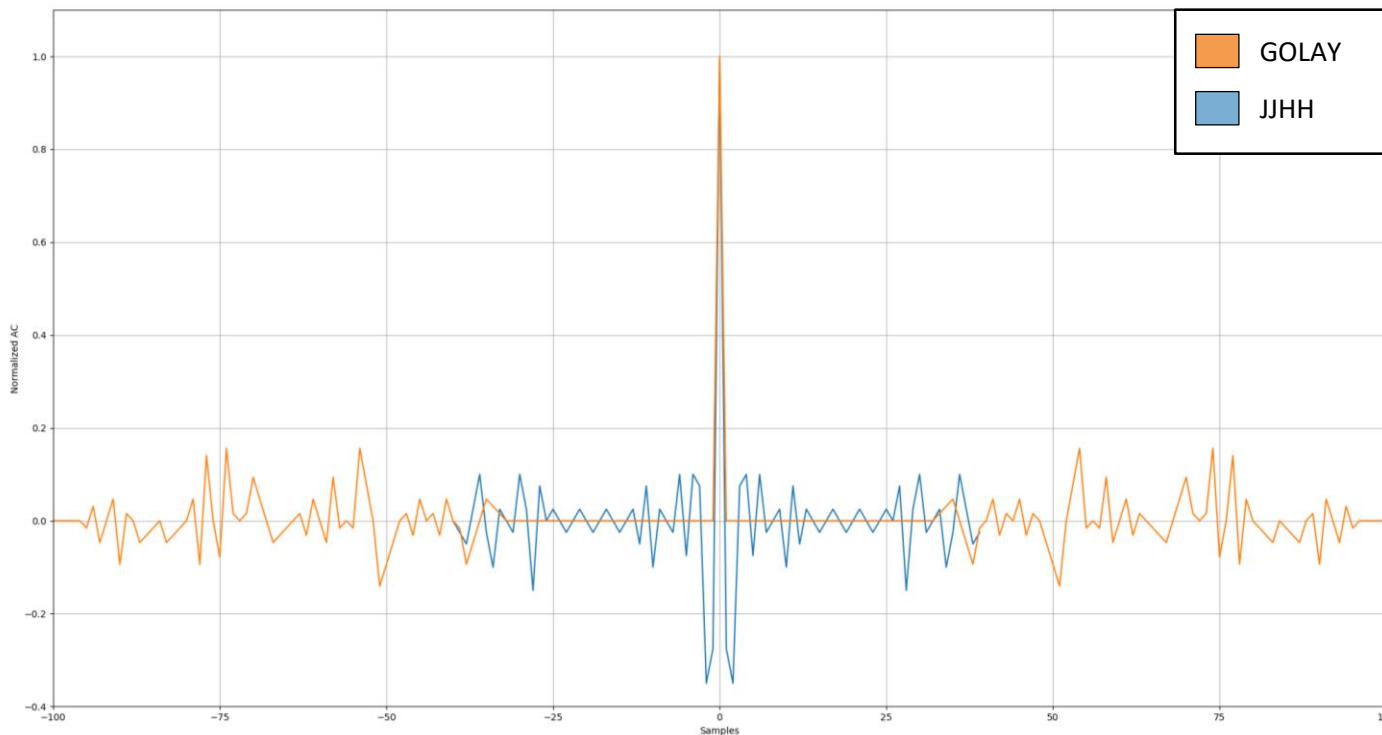
---

- not 4B5B, not DME (no clock transition each bit / 80ns)
  - Adds complexity to PCS, PMA
    - +5% chip area, +6% power
- Gives a real benefit only if multi-bit ADC and x-correlator is used along with matched filter
  - Even more complexity added
    - +55% chip area, +70% power
- Breaks PLCA commit request
  - COMMIT requires the PHY to assert carrierSense

# New preamble proposal (JJHH)



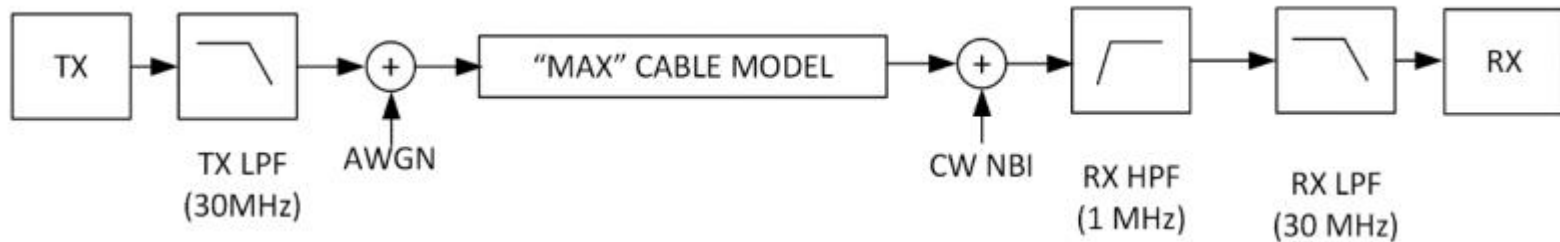
## Autocorrelation comparison Golay's vs JJHH



- Still 4B5B + DME
- Autocorrelation properties comparable to Golay's Ga32 sequence
- **What about noise?**

# Simulations test bench

- Replica of [http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_3cg\\_06\\_0418.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_3cg_06_0418.pdf) slide #10

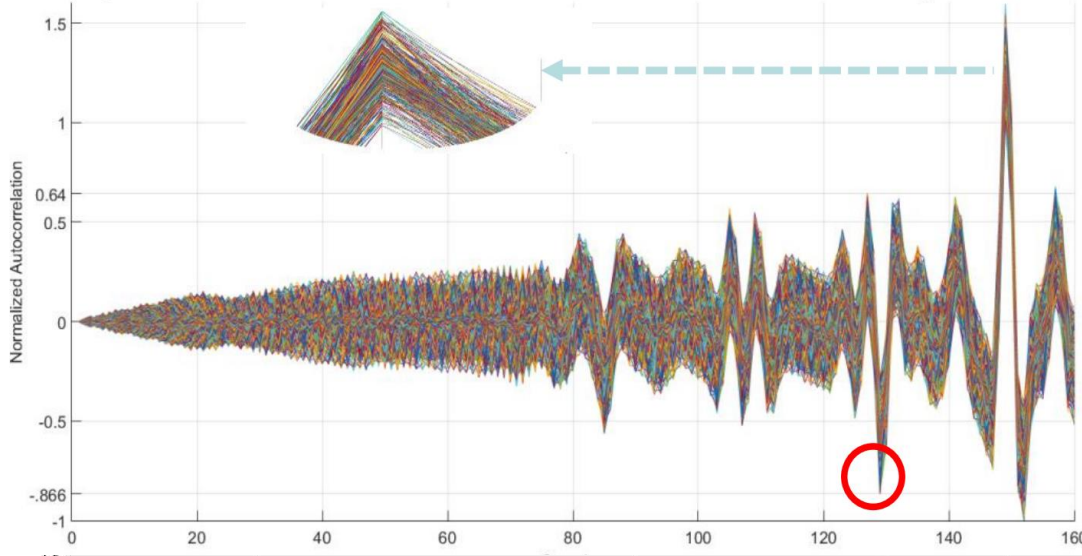


- TX: 1 Vp-p
- TX filtering: 2nd order Butterworth Low-Pass @30 MHz fc
- AWGN: -30dBc white noise added
- Cable model matching channel IL and RL
- CW: 500 mVp-p (0.178 Vrms) sweep from 1 MHz to 50 MHz
  - 500 KHz step,  $\pi/4$  phase step
- RX High-Pass filter 1<sup>st</sup> order @1 MHz fc
- RX Low-Pass filter 2<sup>nd</sup> order Butterworth @30 MHz fc
- Validated reproducing same results for JJK, Ga32 and full Golay's sequence (Ga32 + 32x0 + Gb32 + 16x0)



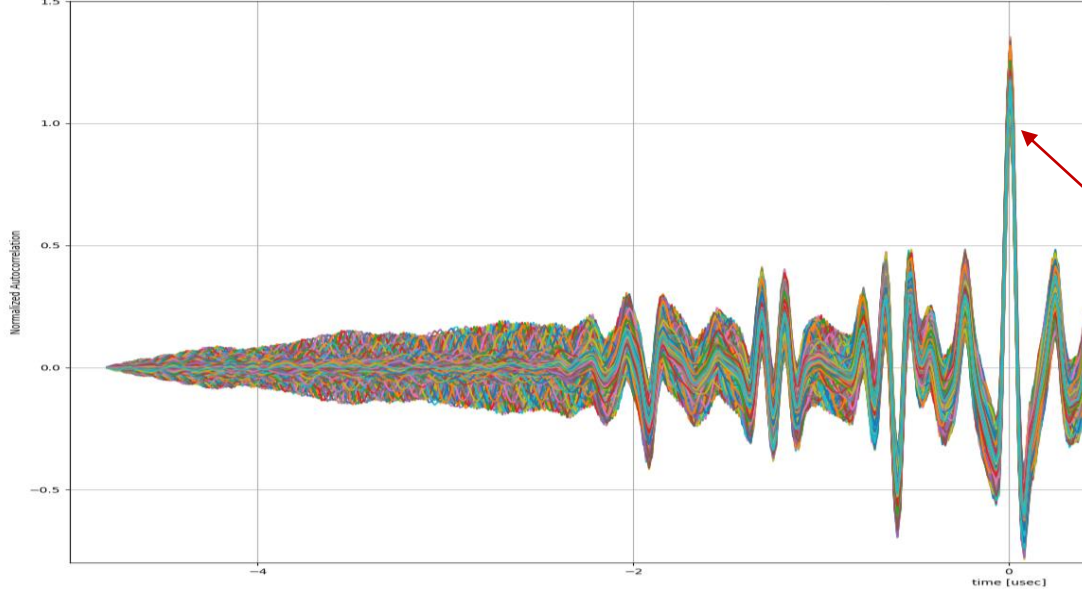
# Test bench validation (current preamble, JJK)

Aperiodic Autocorrelation JJK Preamble with CW Interference 1-30 MHz 9dB S/I Ratio, Multibit ADC



From Jay Cordaro's presentation:

[http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_3cg\\_06\\_0418.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_3cg_06_0418.pdf)  
slide #11

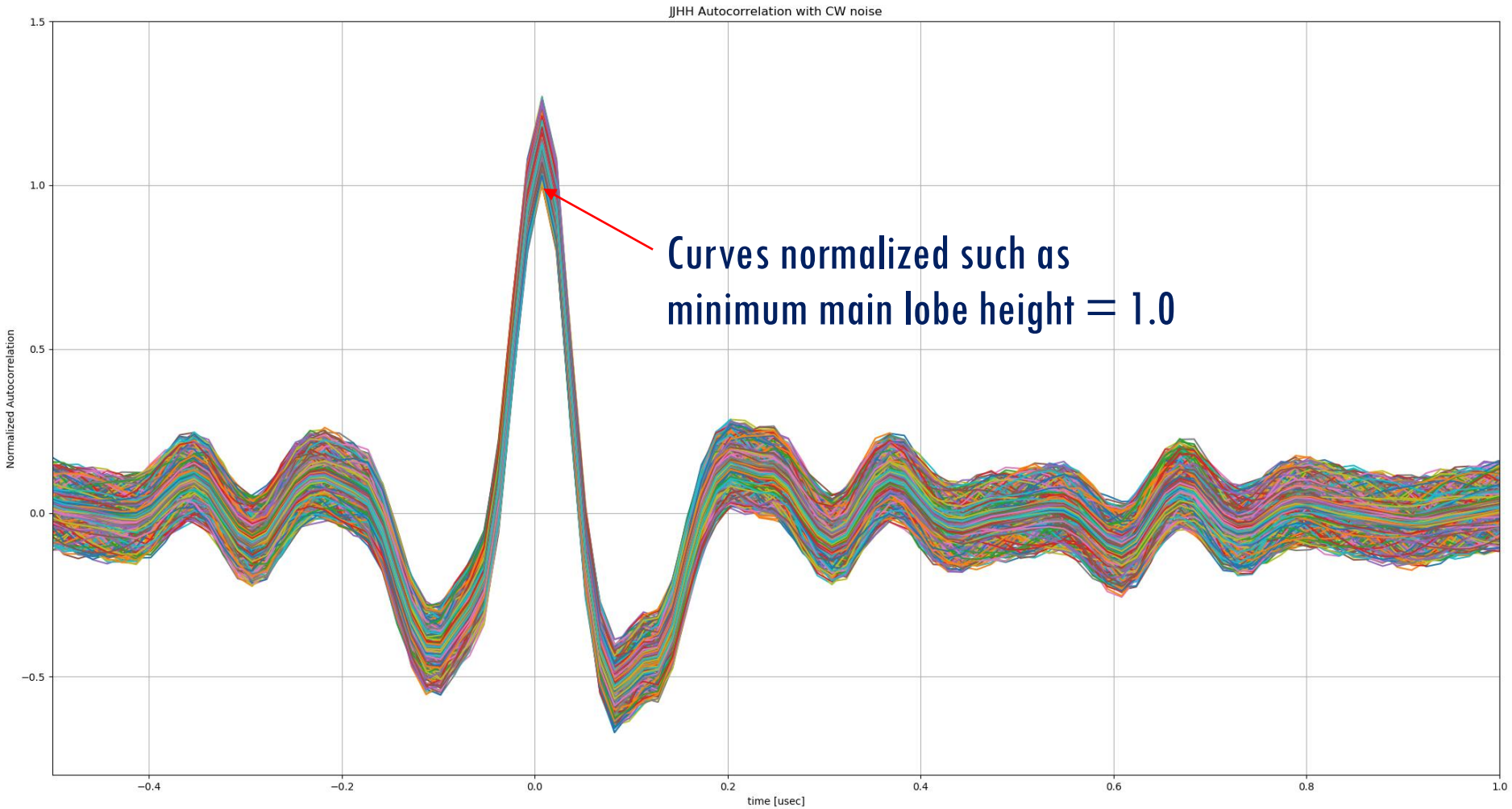


From CT replicated test-bench

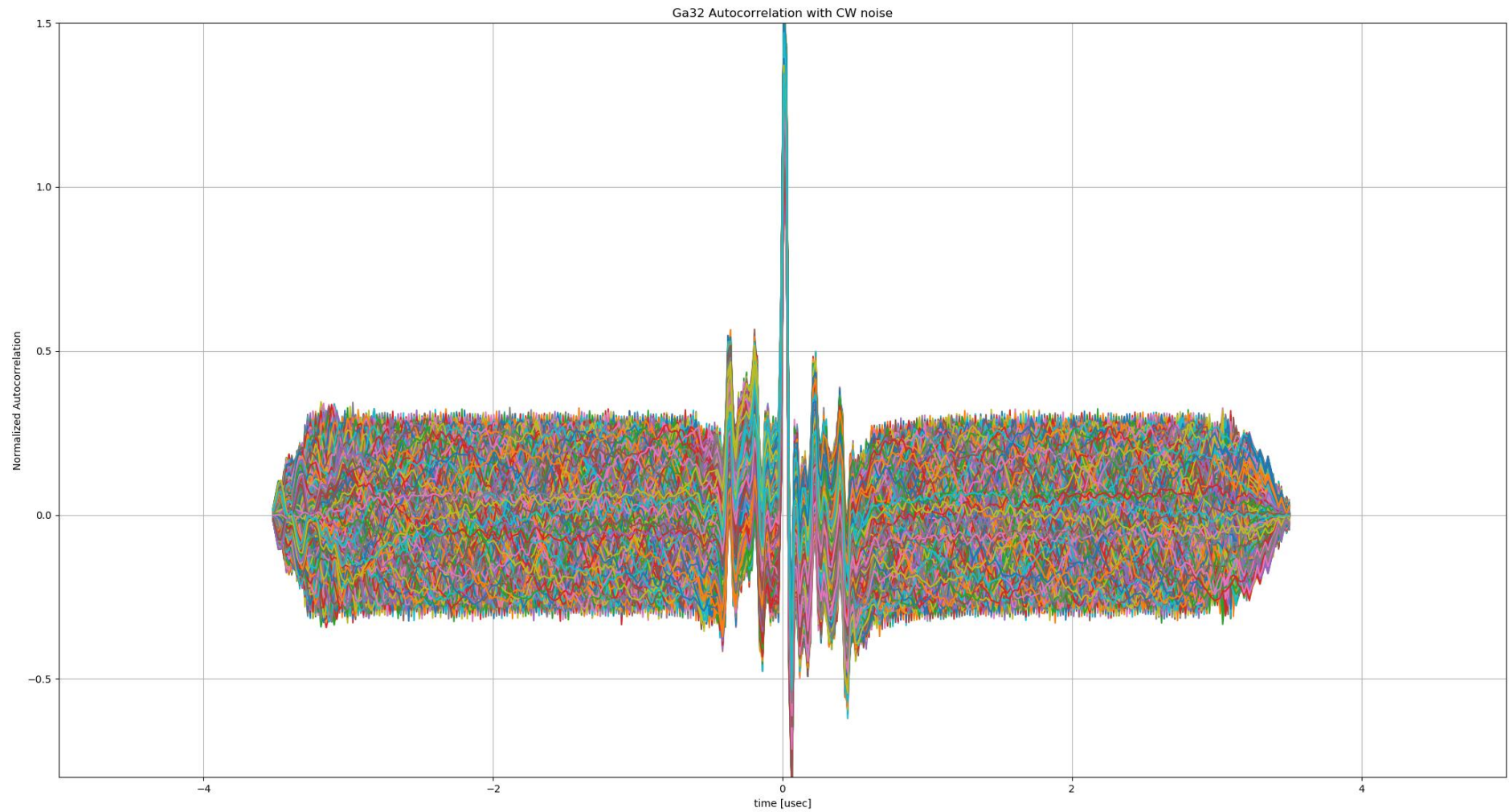
- Results are compatible

Curves normalized such as  
minimum main lobe height = 1.0

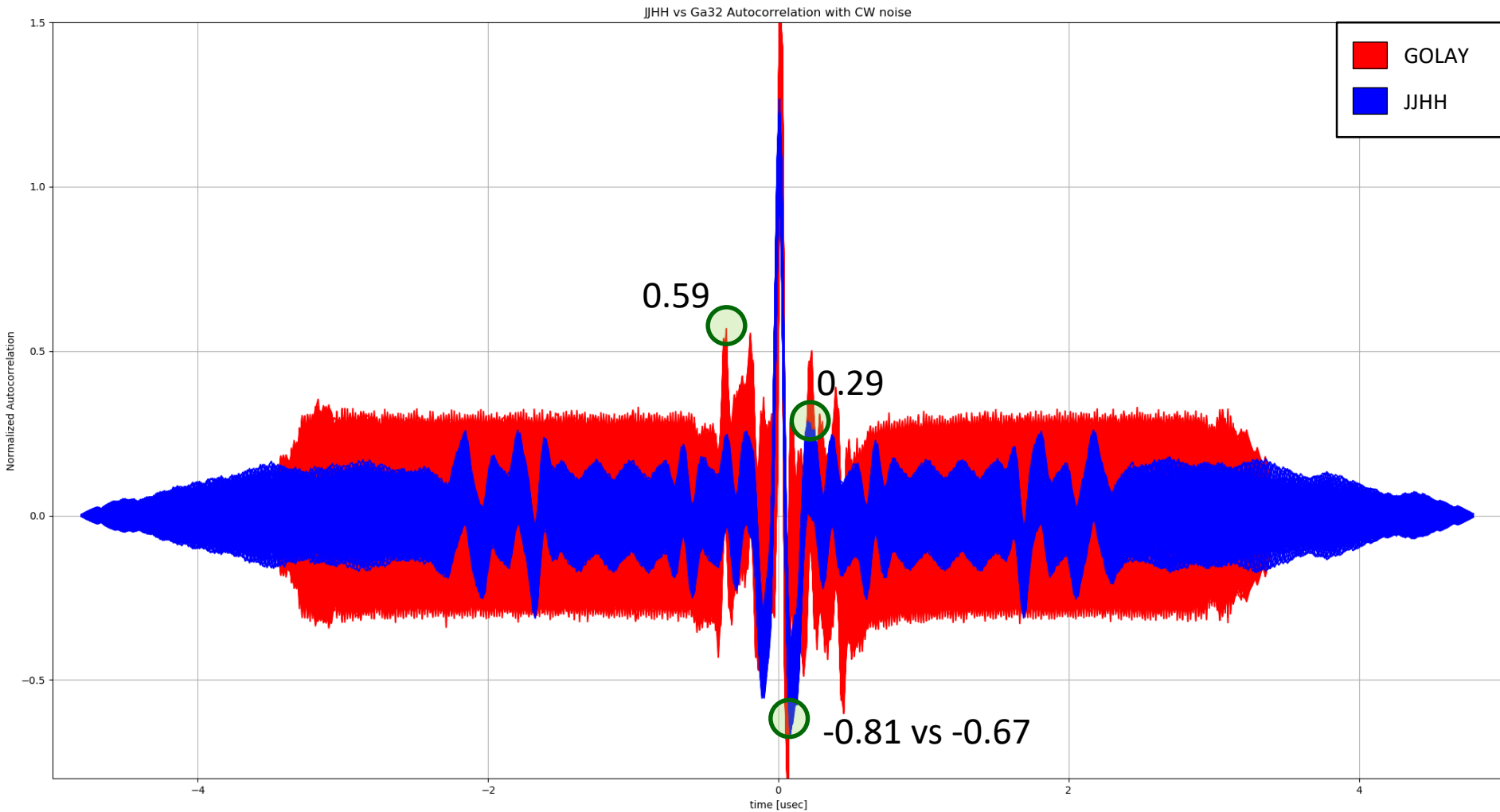
# JJHH Autocorrelation with CW noise



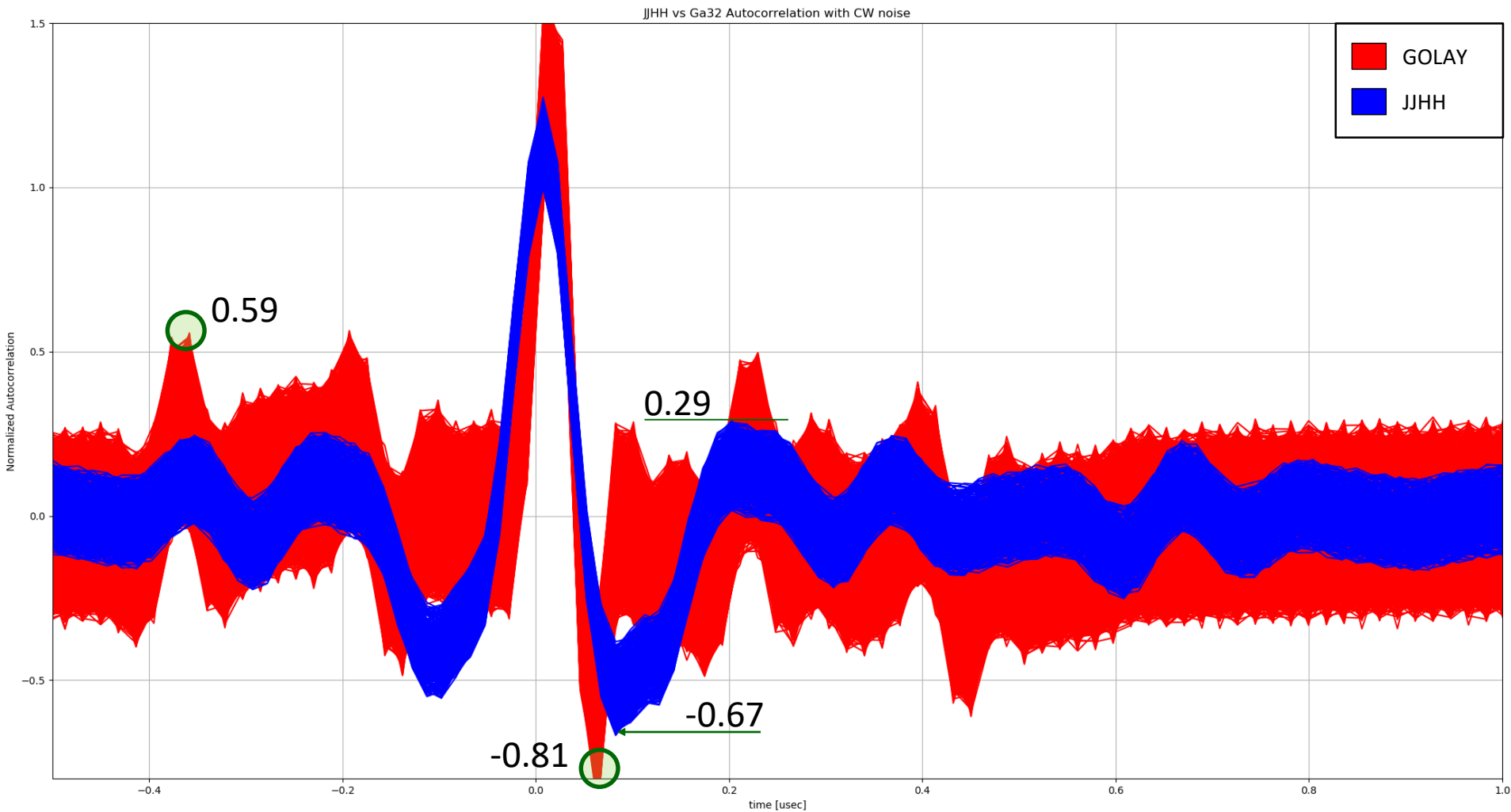
# Ga32 Autocorrelation with CW noise



# Ga32 vs JJHH Autocorrelation with CW noise



# Ga32 vs JJHH Autocorrelation with CW noise



- Ga32 sequence has a normalized sidelobe peaks height of  $+0.59$  and  $-0.81$ .
- JJHH has a normalized sidelobe peaks height of  $+0.29$  and  $-0.67$
- JJHH (5B and DME encoded) exhibits even better autocorrelation properties than Ga32 Golay's sequence for preamble detection in 10BASE-TIS with multi-bit ADC and CW noise
- What about PLCA BEACON?

- PLCA BEACON is different from the packet preamble in the following sense:
  - There is no data after the BEACON signaling
    - No need for very precise synchronization: the PHY needs to reliably detect the **end** of a BEACON (TO\_TIMER is synchronized on the end of a BEACON)
  - BEACON can be reliably detected by synchronizing on the four autocorrelation peaks within the ‘NNNN’ sequence
    - Important thing is not to confuse a JJHH for a NNNN sequence

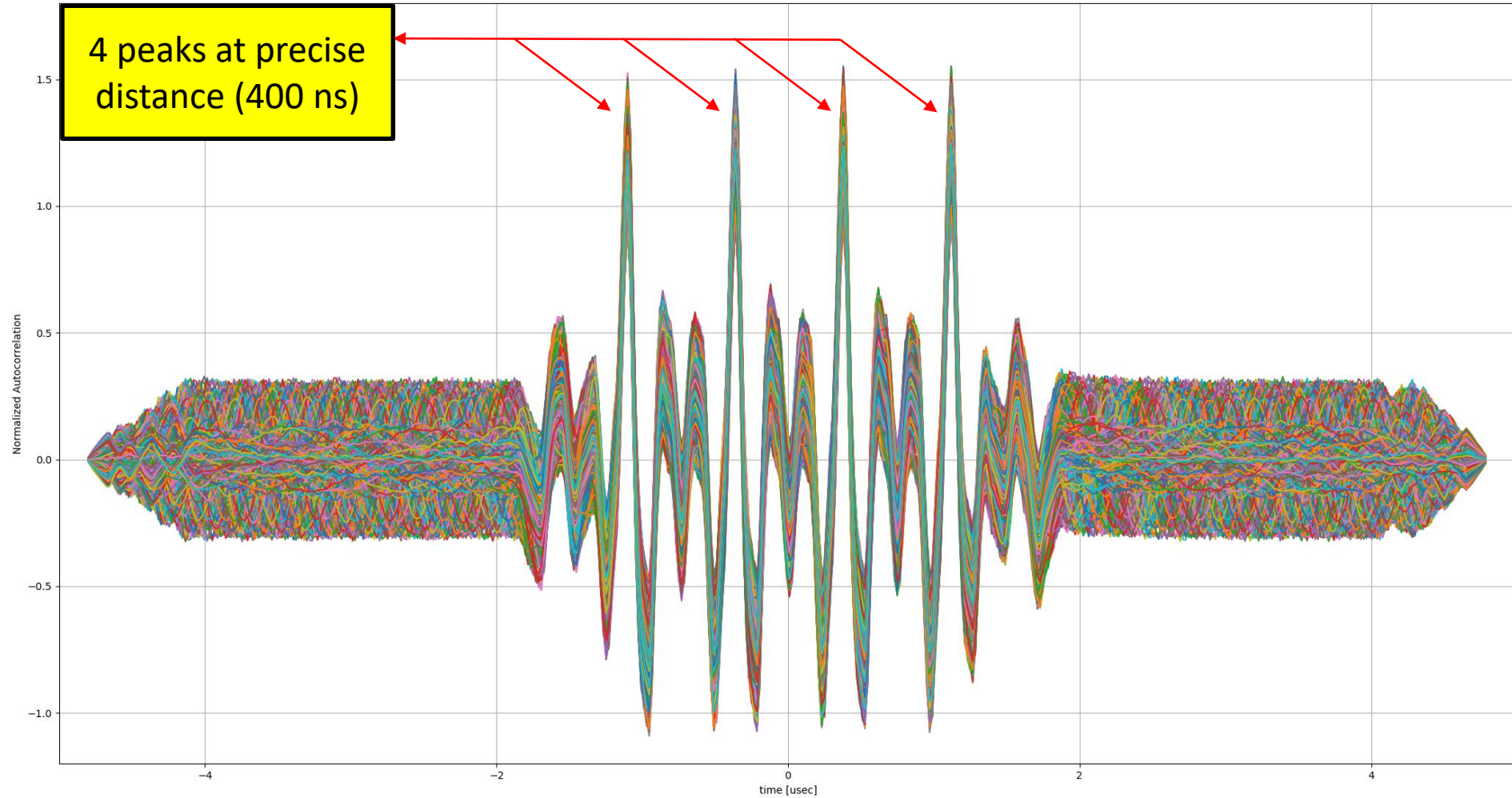


# Correlation of 'N' within 'NNNN' with CW noise

TX: NNNN

NNNN vs N Autocorrelation with CW noise

4 peaks at precise distance (400 ns)



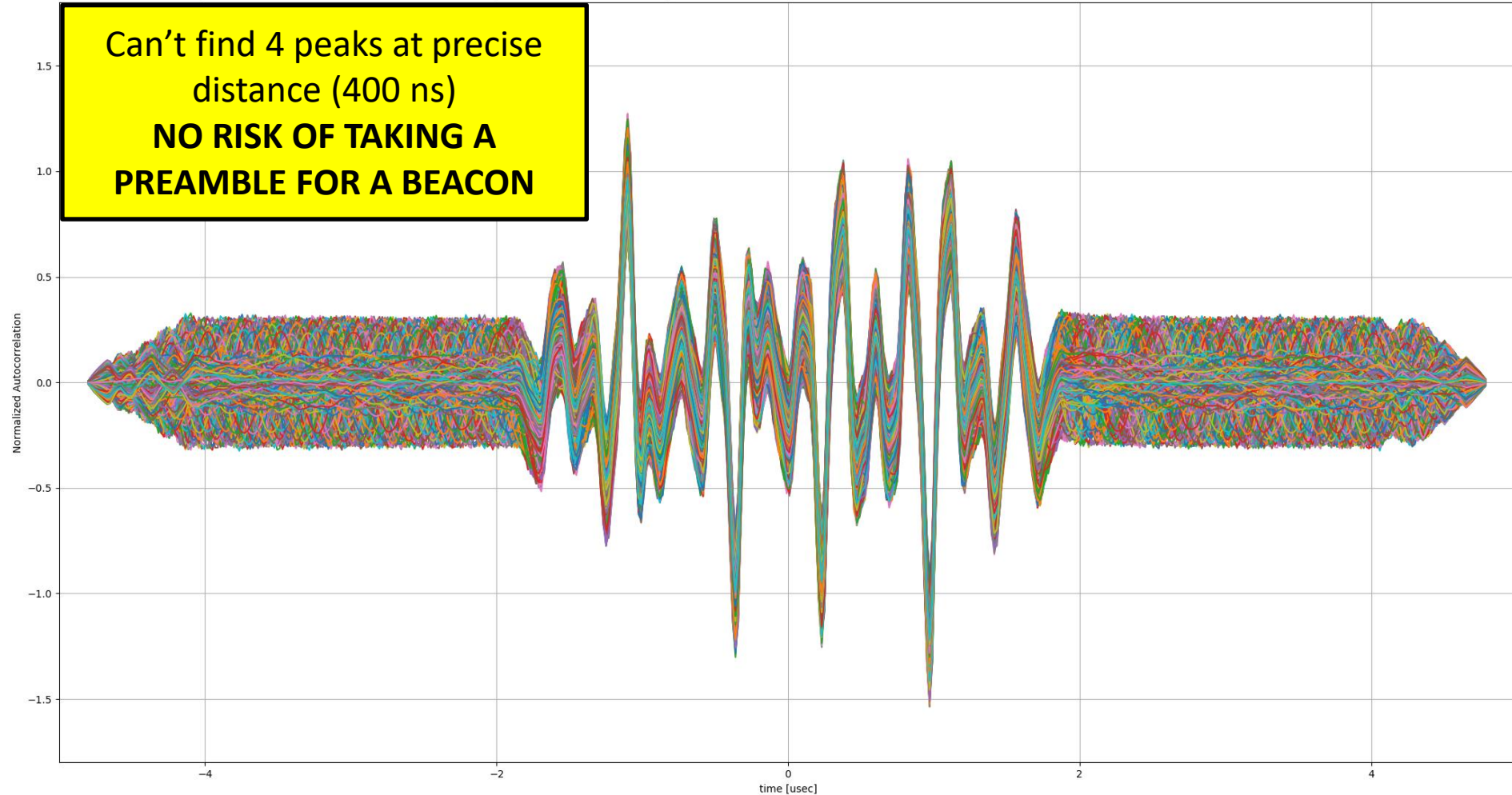


# Correlation of 'N' within 'JJHH' with CW noise

TX: JJHH

JJHH vs N Autocorrelation with CW noise

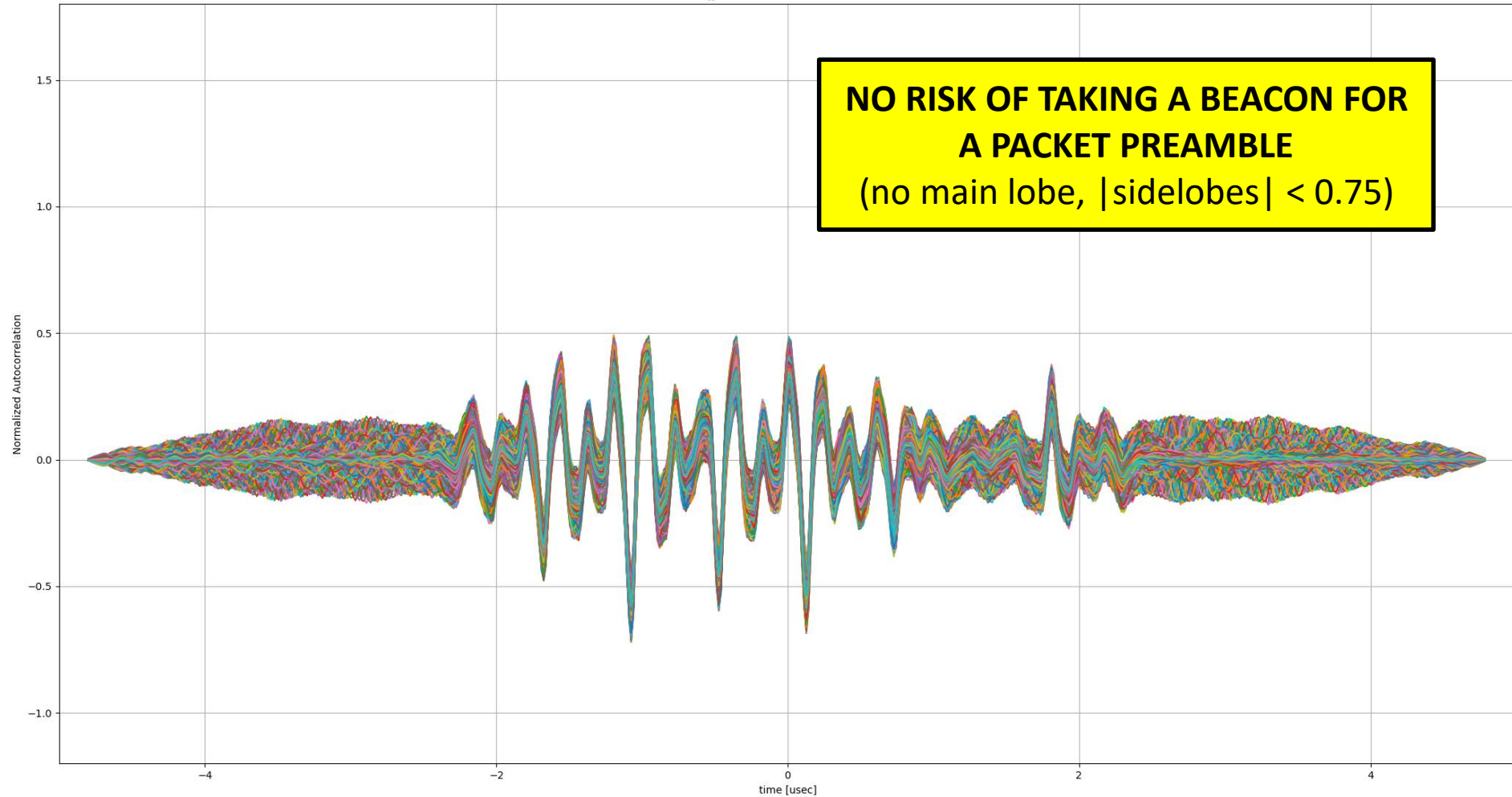
Can't find 4 peaks at precise distance (400 ns)  
**NO RISK OF TAKING A PREAMBLE FOR A BEACON**



# Correlation of 'JJHH' within 'NNNN' with CW noise

TX: NNNN

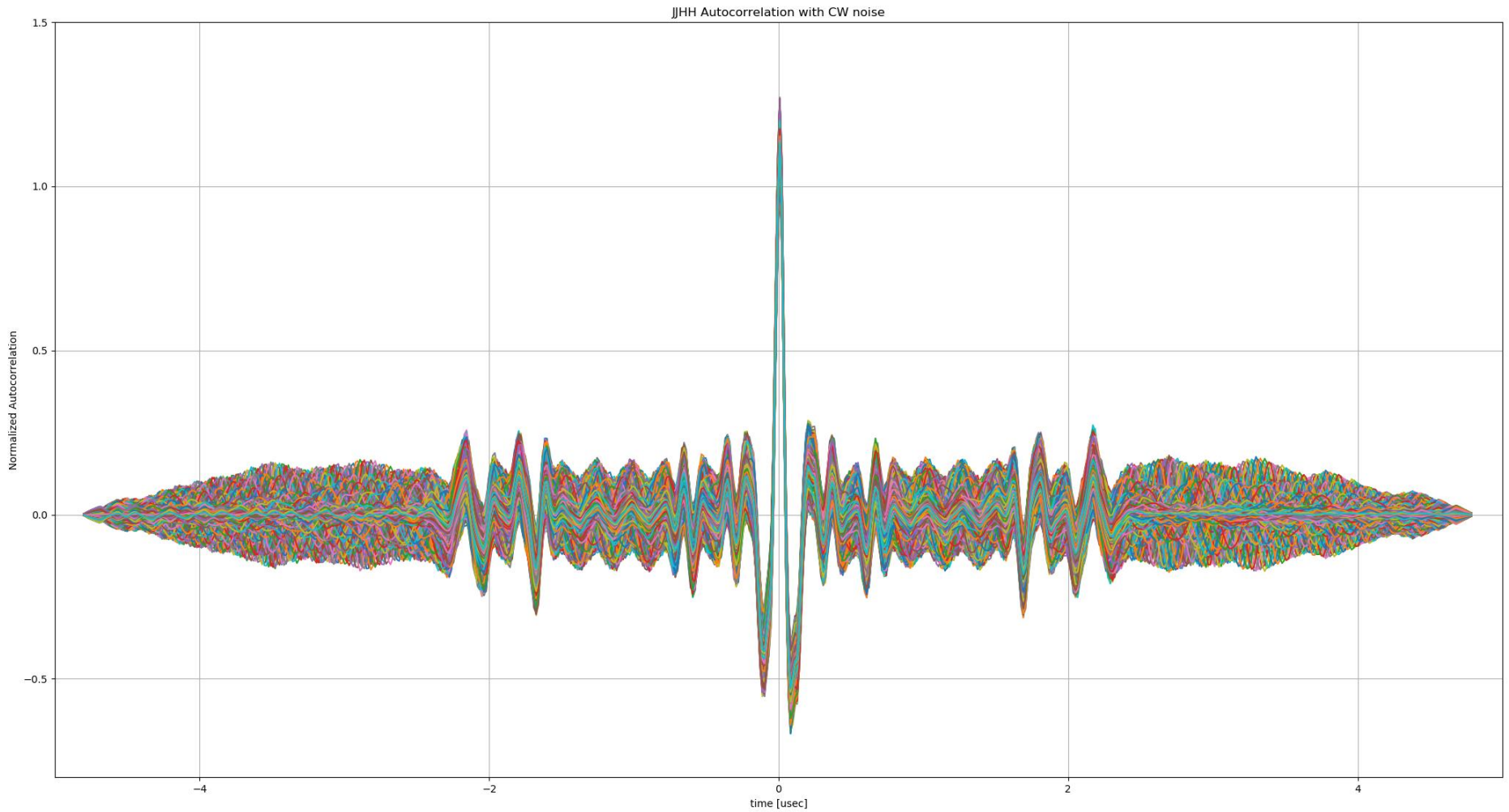
NNNN vs JJHH Autocorrelation with CW noise



- JJHH 5B sequence (DME encoded) shows autocorrelation properties matching those of the Golay's sequence Ga32 proposed by Jay Cordaro in [http://www.ieee802.org/3/cg/public/adhoc/cordaro\\_3cg\\_06\\_0418.pdf](http://www.ieee802.org/3/cg/public/adhoc/cordaro_3cg_06_0418.pdf) for 10BASE-T1S preamble
  - Still 4B5B and DME encoded (preserves current architecture)
    - Does not add complexity to the currently defined PHY
    - Keeps compatibility with PLCA support definition in c147
      - does not break PLCA commit
- PLCA BEACON is not a concern
  - 'NNNN' sequence is detectable and can't be confused with proposed JJHH preamble
- Harness defect detection, if needed, is not precluded by proposed preamble
- JJHH proposal requires only minimal changes to c147 to be adopted
- Implementations with different performance/complexity trade-offs are not precluded

**Thank You !**

# JJHH Autocorrelation with CW noise



# NNNN vs JJHH crosscorrelation w/o noise

