HLS and WPS at SLAC

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- **WPS and HLS at the BABAR detector (decommissioned system)**
- **HLS in SPEAR3 (22 sensors)**
- **WPS and HLS in LCLS undulator hall (136 HLS and 99 WPS)**

WPS and HLS in BABAR (1)

- System contained 6 HLS sensors and ~6 WPS sensors from (~2002-2008) to monitor relative positions of magnets and detector
  - HLS
    - First generation BINP sensors,
    - serial data communication
    - Insufficient protection of sensor surface from water
  - Pipe:
    - 30 m pipes
    - 1 and 1 ½ inch copper pipes, copper works as a anti algae but copper oxidation flakes off
  - WPS
    - Inductive sensors (Wei Wang, Zack Wolf, LCLS-TN-05-27).

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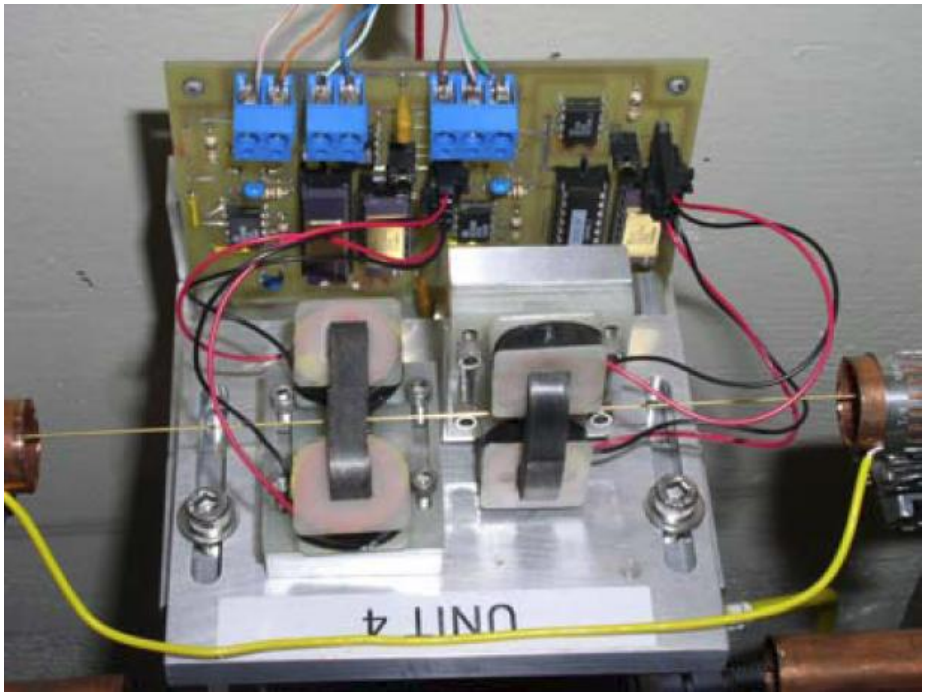
WPS and HLS in BABAR (2)

- WPS (Wei Wang, Zack Wolf, LCLS-TN-05-27).
  - Sensors contain magnetic sensors and an integrated lock-in amplifier.
  - 40 kHz Signal on copper beryllium wire
  - Vertical and horizontal pickup
  - DC signal analyzed at a data acquisition rack
  - Resolution <1 micrometer



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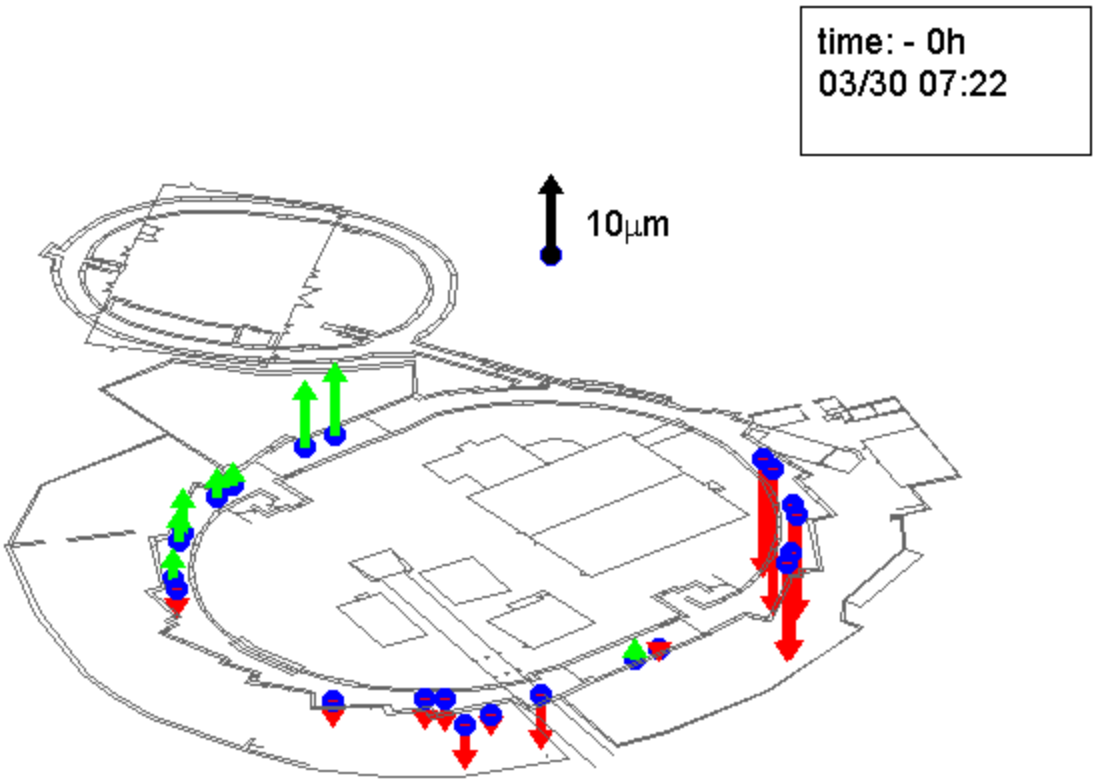
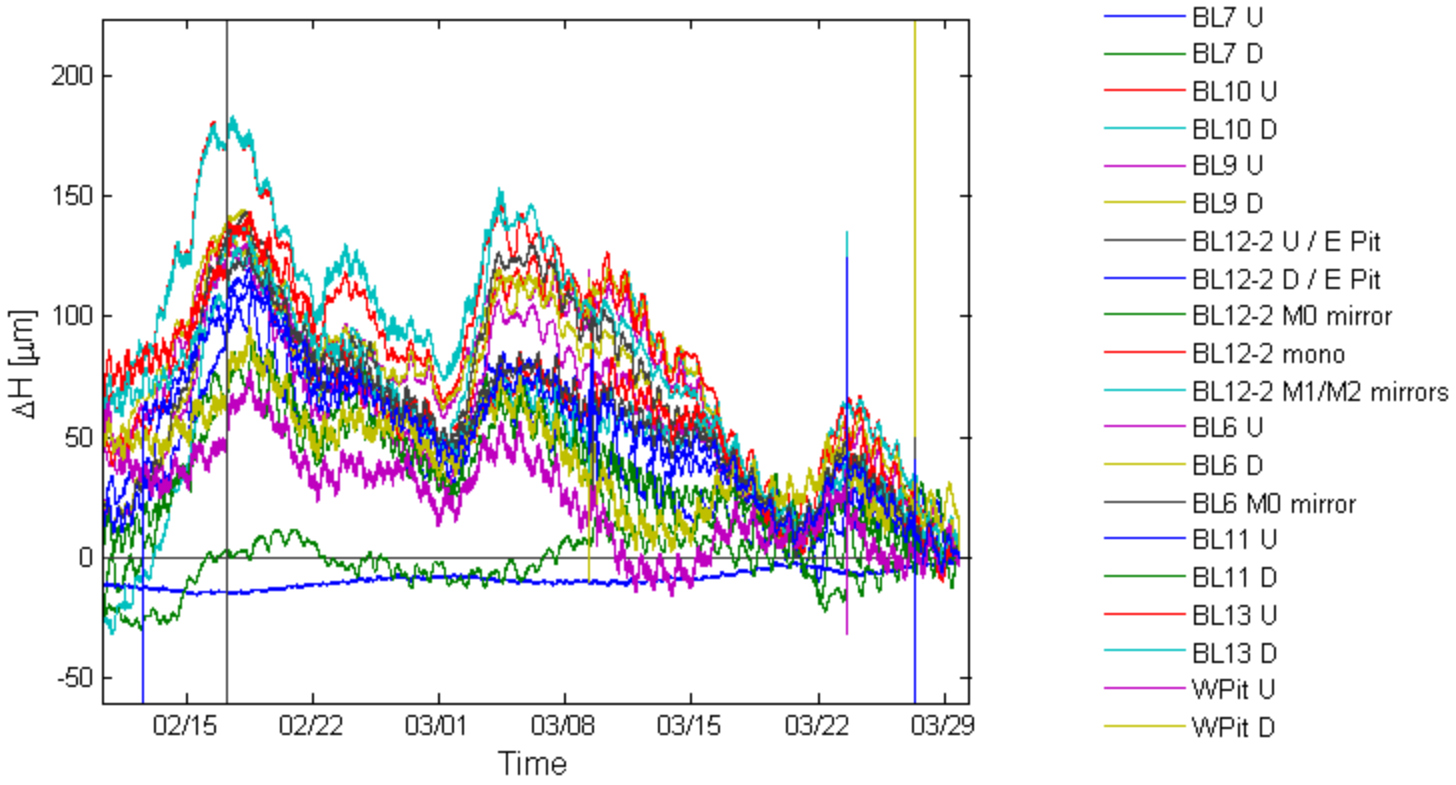
HLS in SPEAR3 (1)

- System contains 22 HLS sensors (in various configurations since 2005)
  - Third generation BINP sensors,
    - TCP/IP
    - Power over Ethernet
    - Sensor calibration at SLAC
  - 300 m circumference
  - 2 inch PVC pipe throughout



HLS in SPEAR3 (2)

- Latest results



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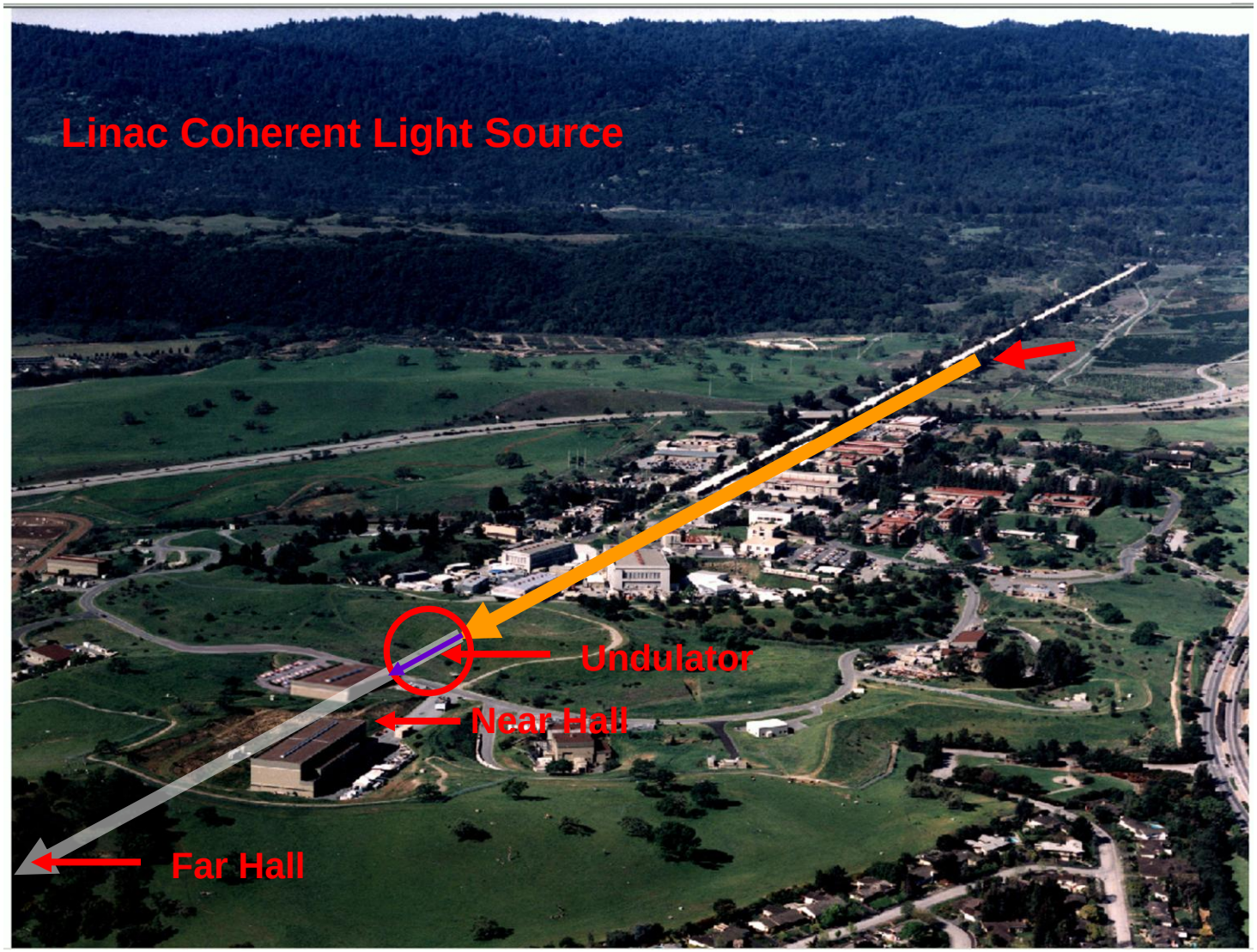
WPS and HLS in LCLS (1)



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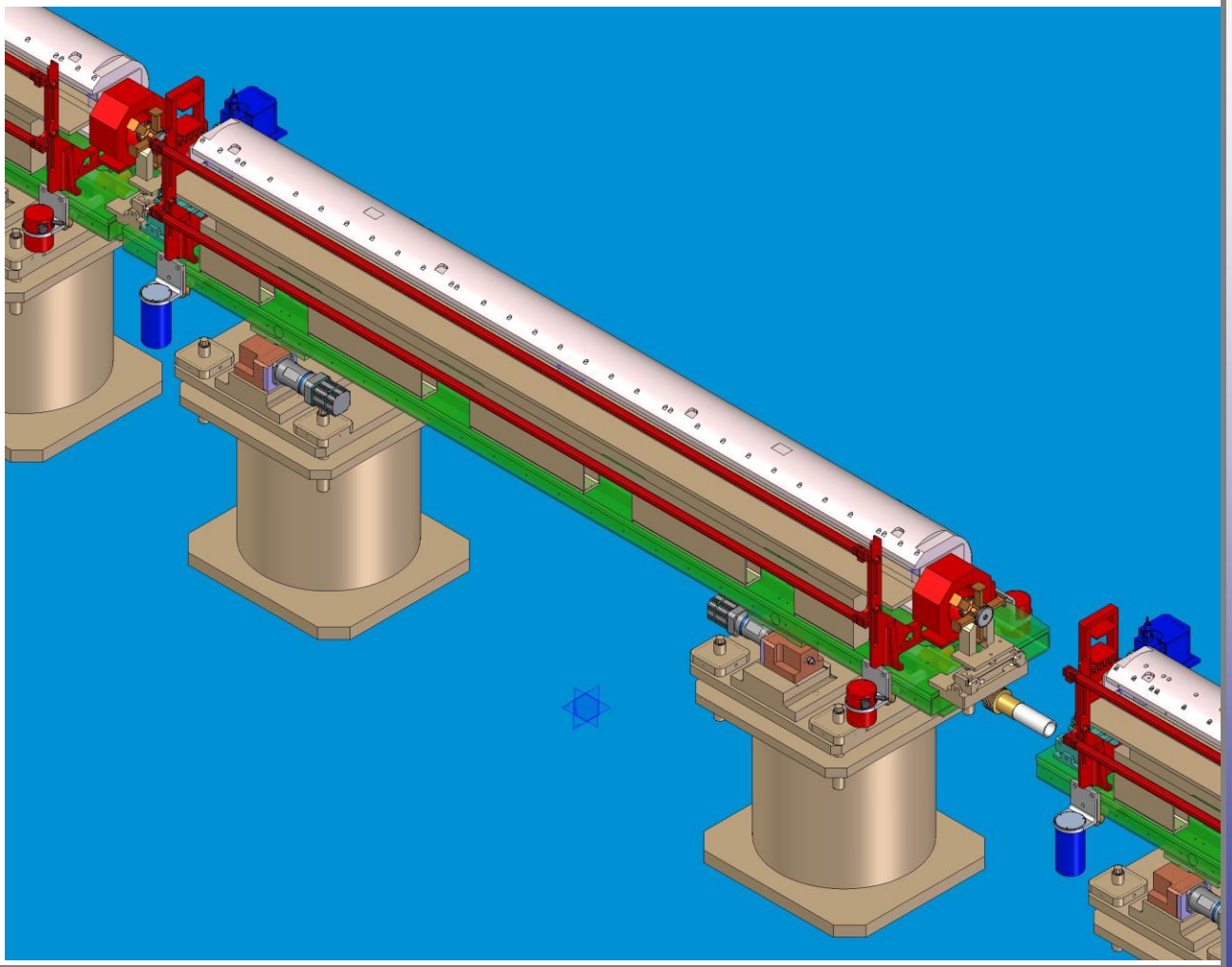
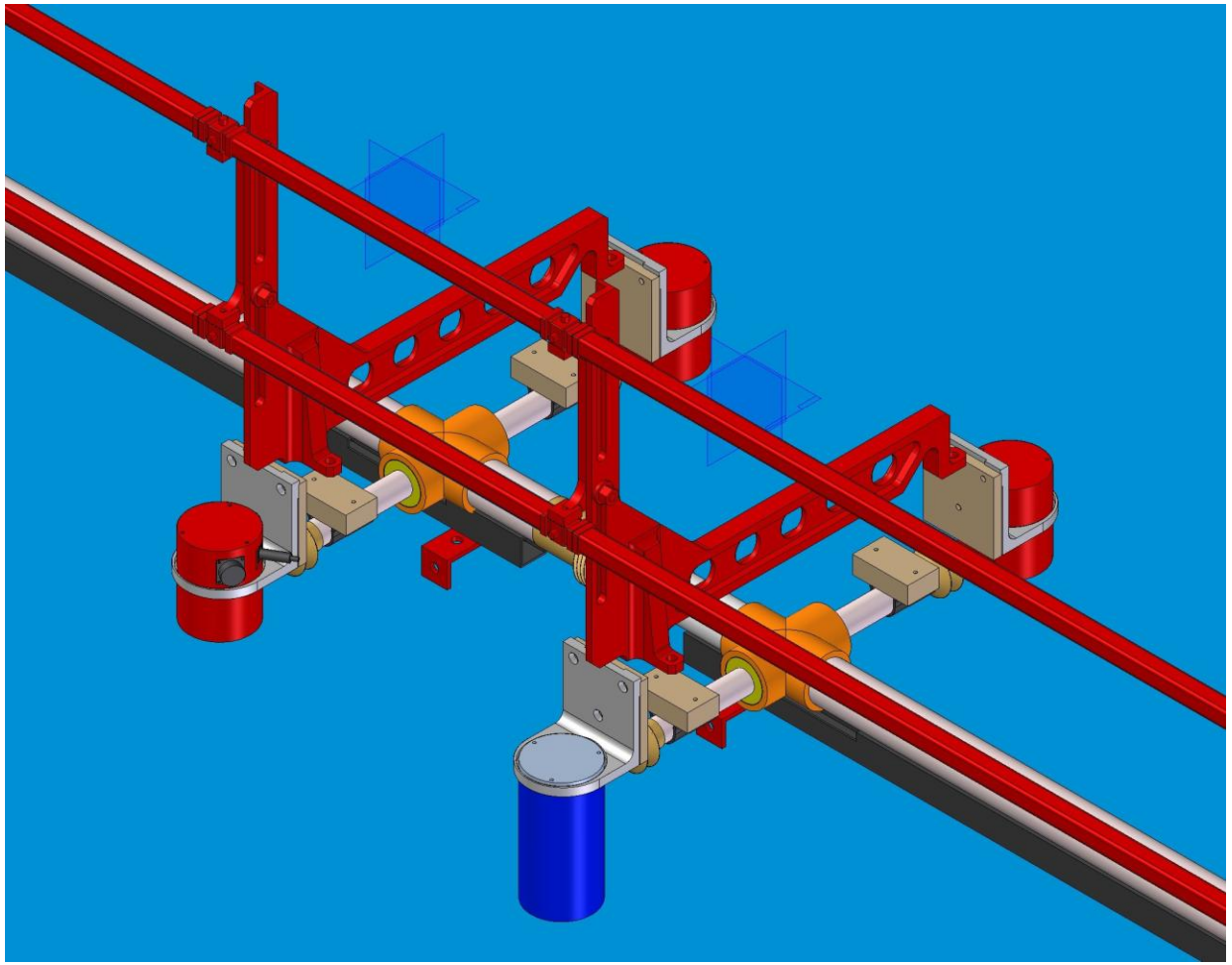
WPS and HLS in LCLS (2)

- Stable temperature
  - <0.5 degC
- Low Radiation
- Stability over 1 week period
- Relative motion over 140 m distance better than <2 μm



WPS and HLS in LCLS (3)

- HLS
  - 103 capacitive
  - 33 ultrasound
  - Refill station
- WPS
  - RF inductive



HLS in LCLS (1)

- 102 Capacitive sensors BINP
  - Precision < 1 μm
  - Instrument Drift ~1-2 μm / month
  - Accuracy < 0.1 % of full Scale
  - PoE Ethernet connection
  - Calibrated at SLAC
- 33 Ultrasound sensors
  - Precision < 0.1 μm
  - Instrument Drift potentially no drift
  - Accuracy < 0.1 % of full Scale
  - Transducer GE Inspection Technology
  - Electronic Box BINP
- Common
  - Moving Range ±2.5 mm
  - Availability: 10 minutes settling period after movement
- 2 inch CPVC pipe, half filled, 140 m long, 10 min damping time

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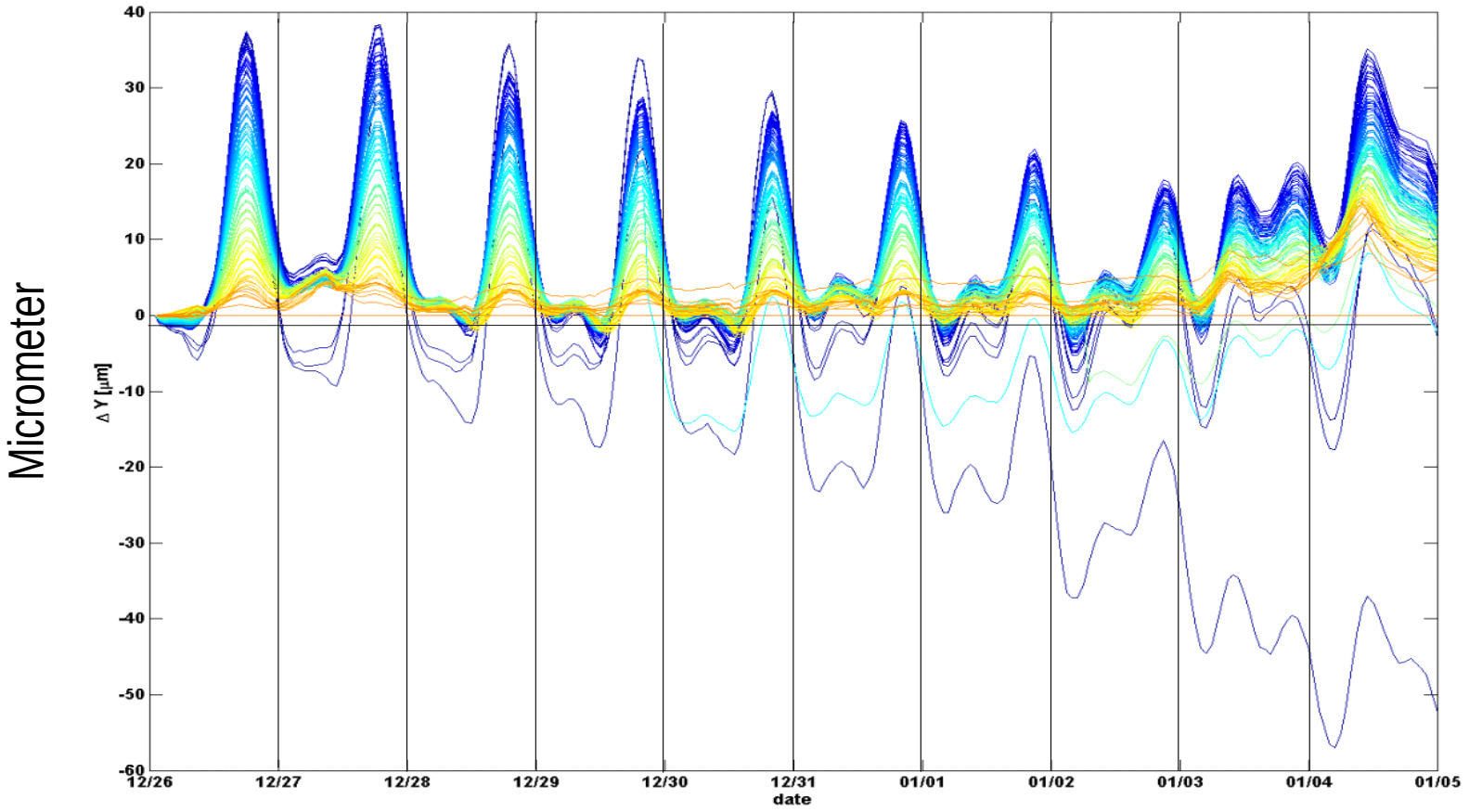
HLS in LCLS (2)

10 Days of Hydro Leveling System readouts - the tide effect -



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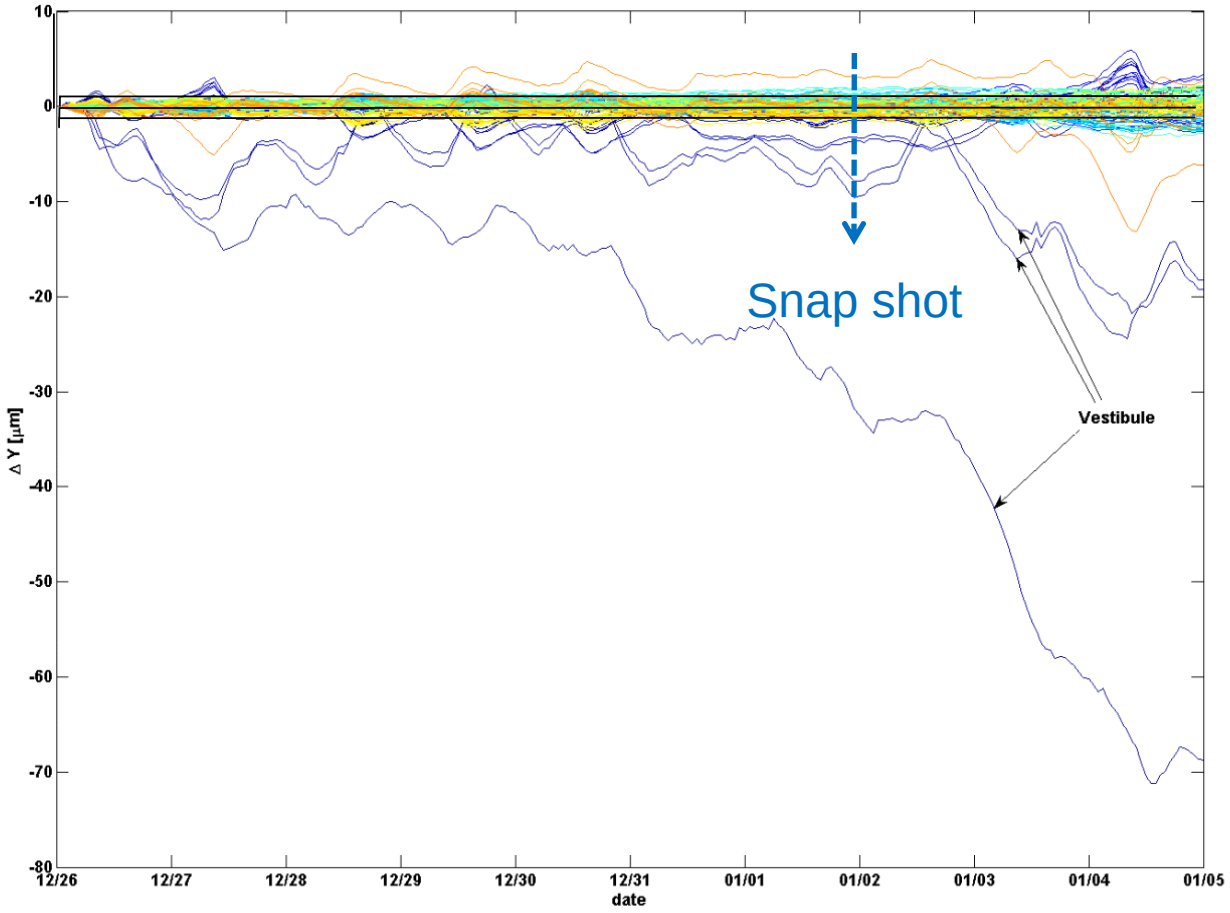
HLS in LCLS (3)

10 Days of vertical girder positions by HLS - tide effect eliminated -



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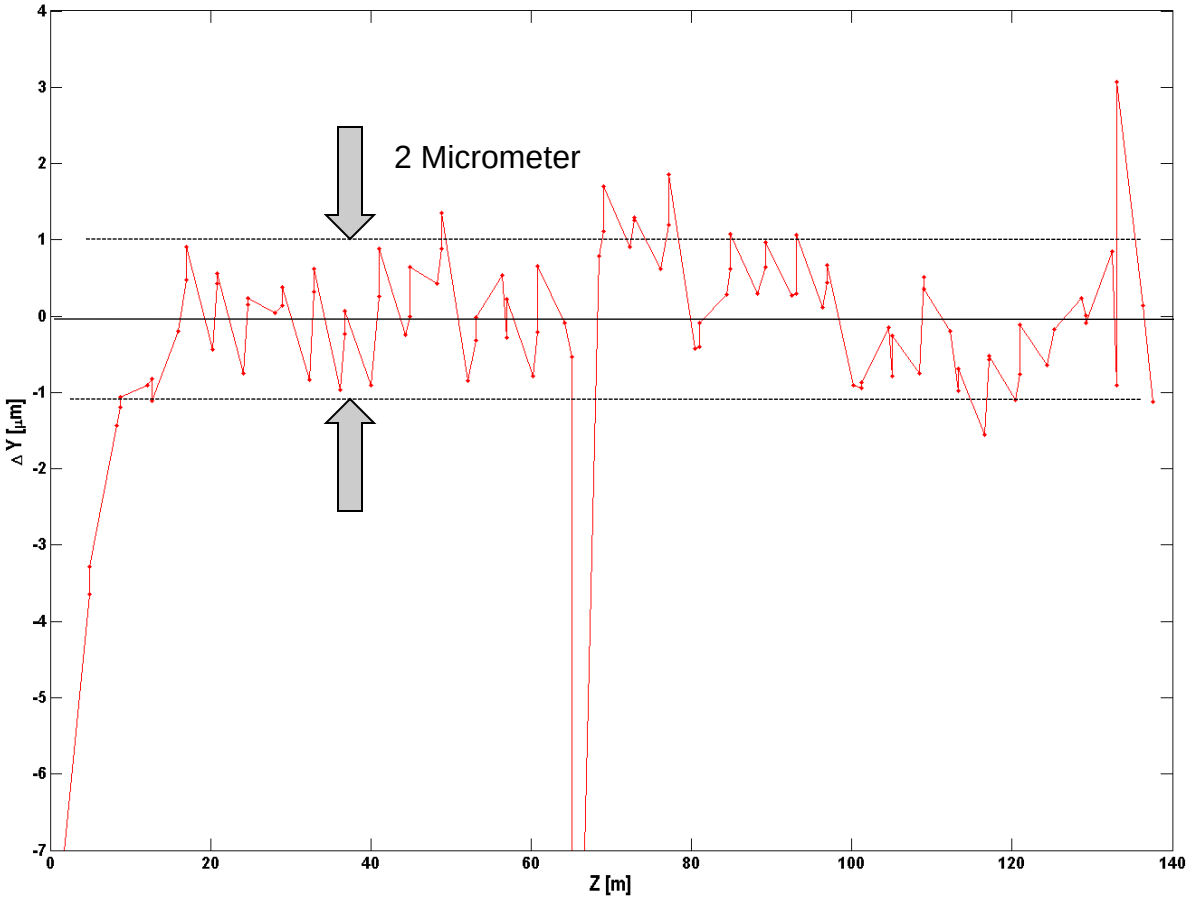
HLS in LCLS (4)

Snap shot: Vertical girder positions after 7 days of tracking with HLS



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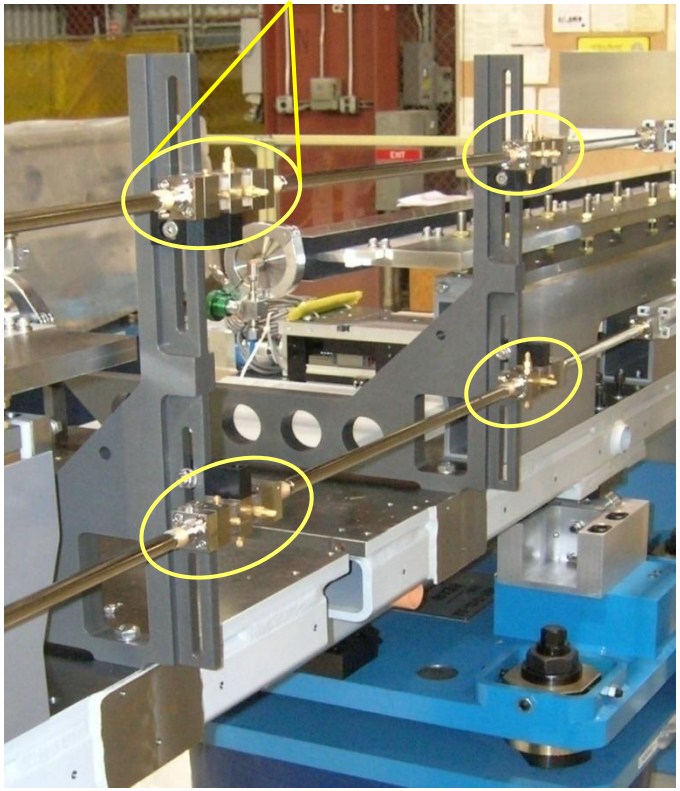
WPM in LCLS (1)

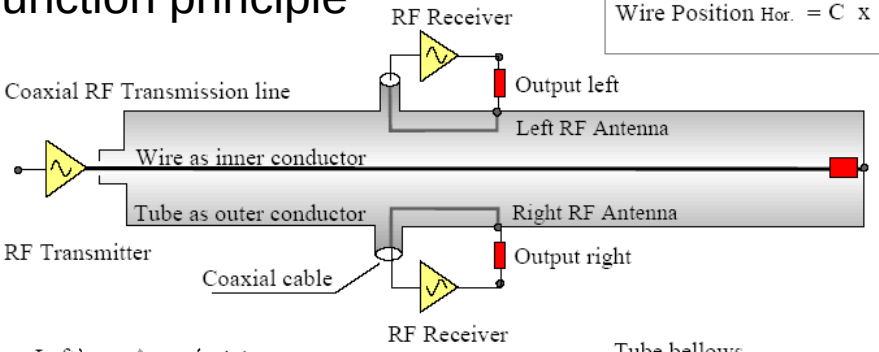
DESY development for the SLAC FFTB experiment (1991 – 1993)
Since 2002 adaptation for LCLS by Franz Peters

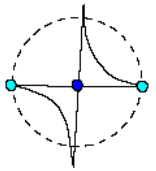
WPM at girder



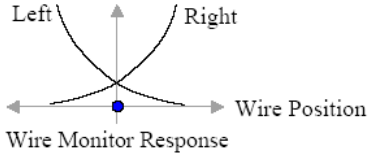
Function principle

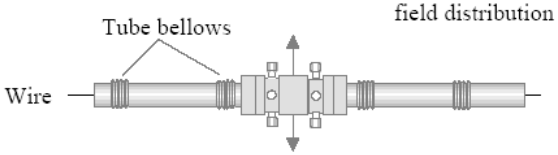
$$\text{Wire Position}_{\text{Hor.}} = C \times \frac{\text{ULeft} - \text{URight}}{\text{ULeft} + \text{URight}}$$



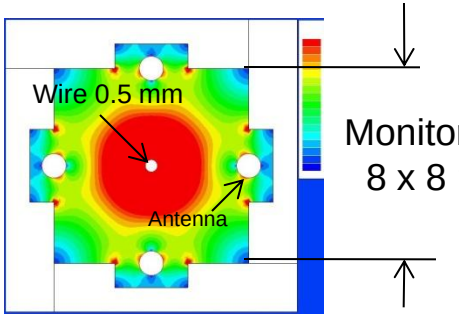


Transversal electromagnetic field distribution

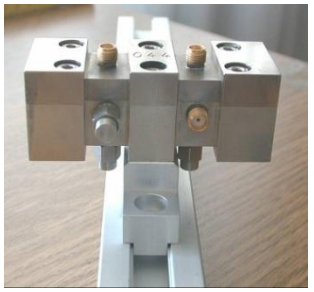




Tubes & position antennas moveable relative to the wire.



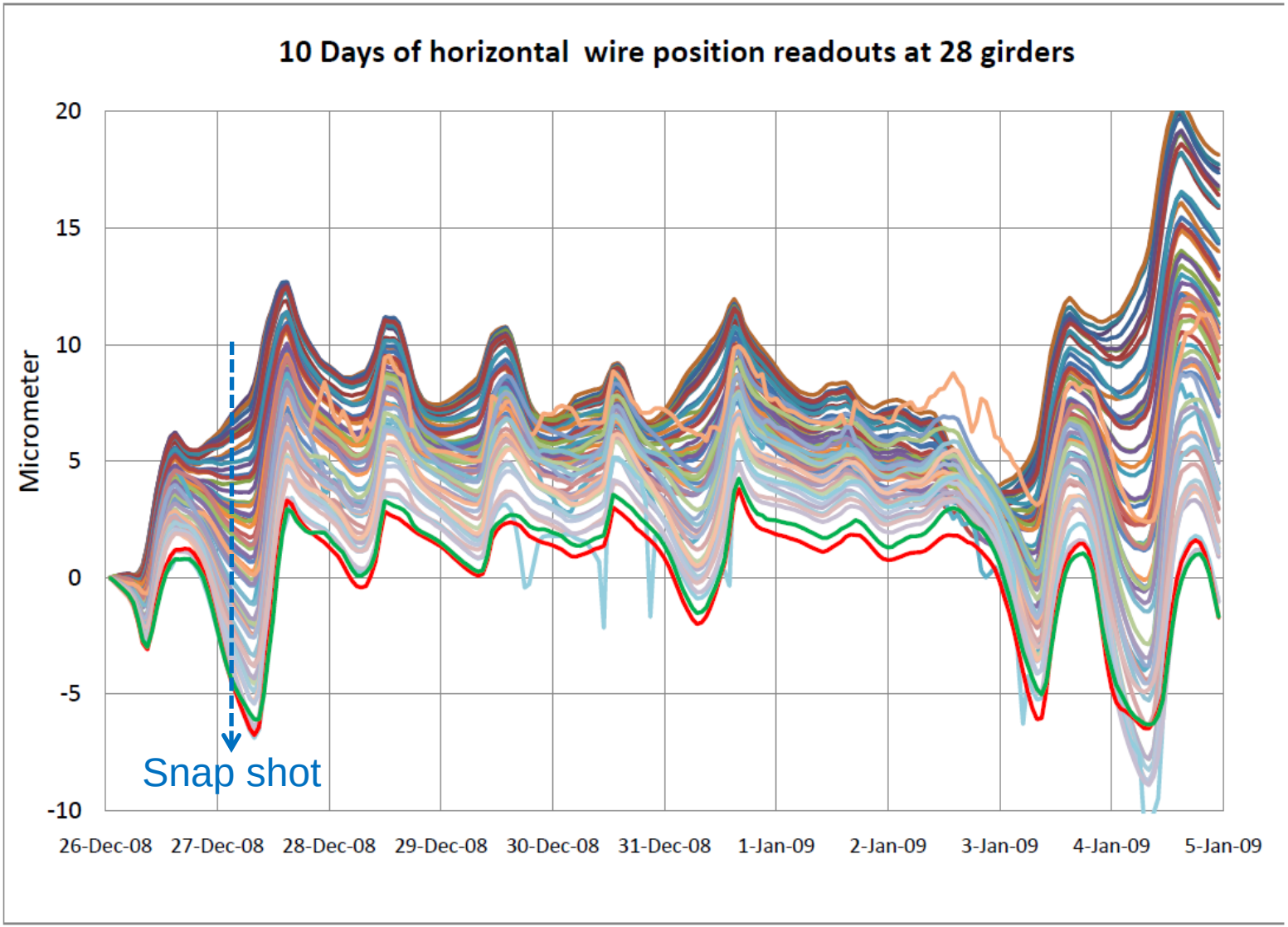
Monitor gap
8 x 8 mm



WPM in LCLS (2)

- 140 RF sensors
  - Resolution < 100 nm in X & Y Direction
  - Instrument Drift < 100 nm per day
  - Moving Range ±1.5 mm in X & Y Direction
  - Accuracy 0.1 % of full Scale
  - Availability Permanent, no Interrupts
- Wire
  - 140 m gold plated stainless steel wire
  - 140 mm wire sag (30kg tension)
  - Transverse harmonic frequency of the 138 m wire 1.36 Hz (0.73 sec)
  - Wire oscillation, due to surrounding vibrations up to ~ 10 Micrometer
  - High resolution needs averaging about 5 to 10 periods 7.3 Sec / Monitor

WPM in LCLS (3)



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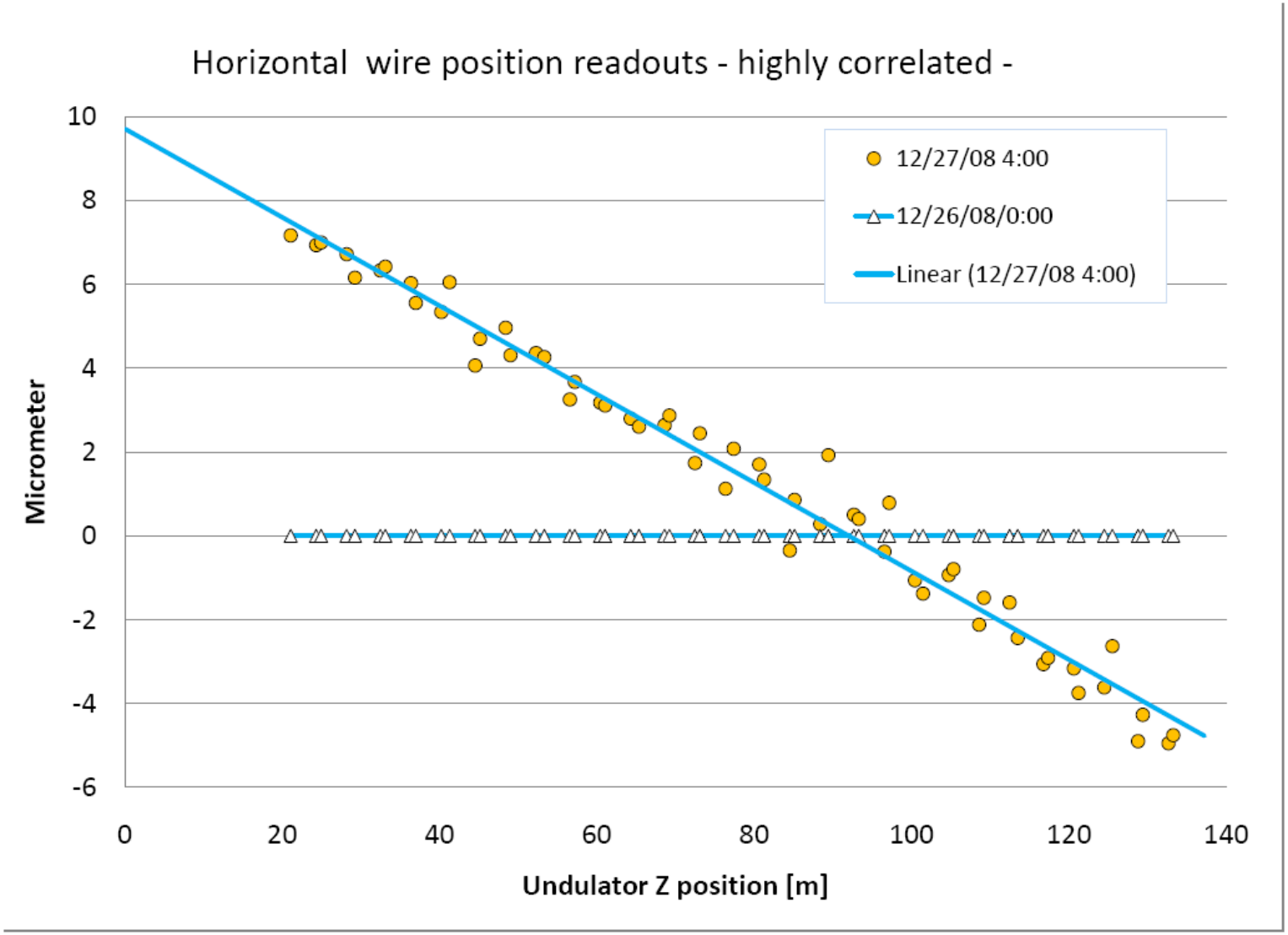
WPM in LCLS (4)



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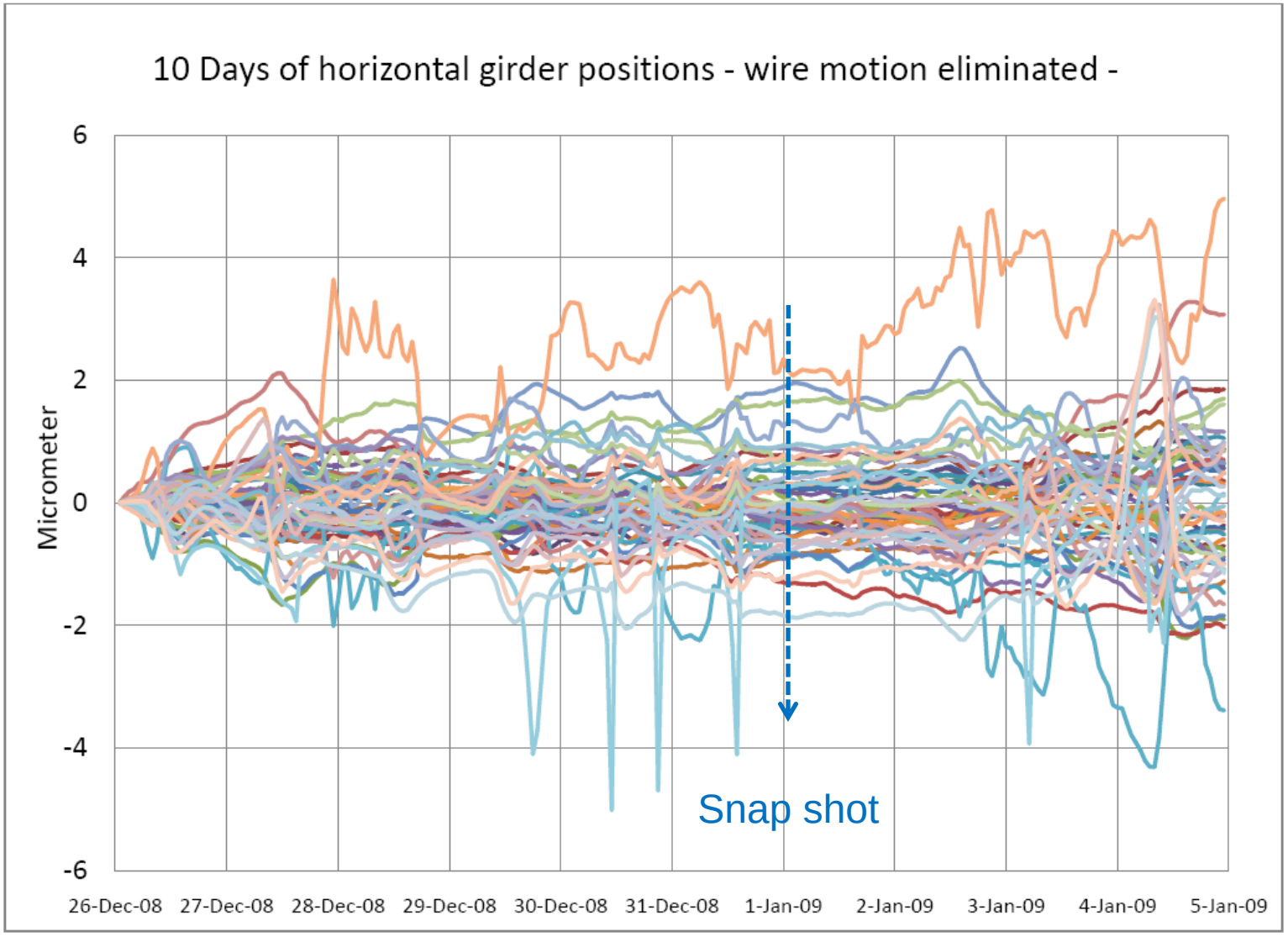
WPM in LCLS (5)



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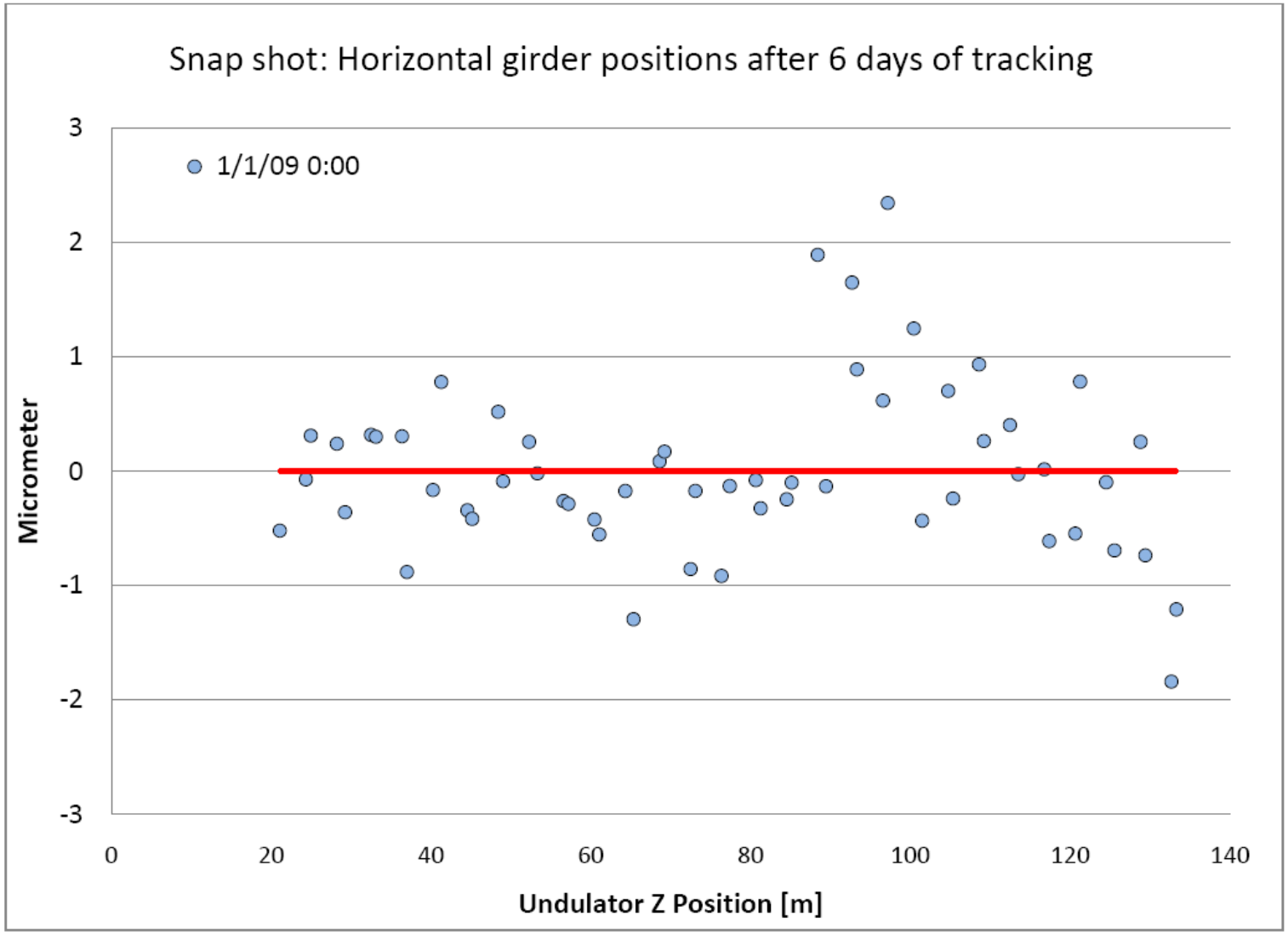
WPM in LCLS (6)



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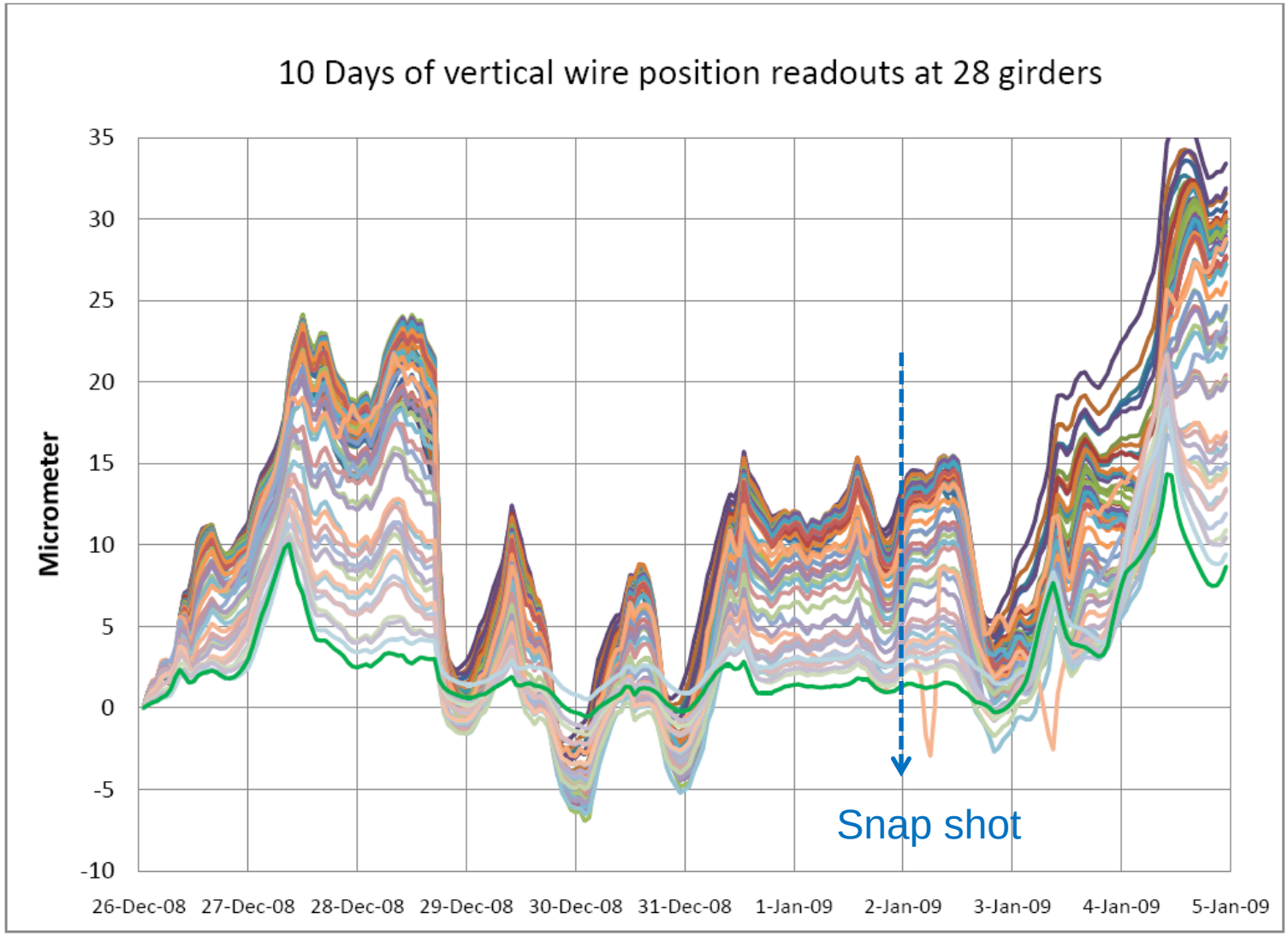
WPM in LCLS (7)



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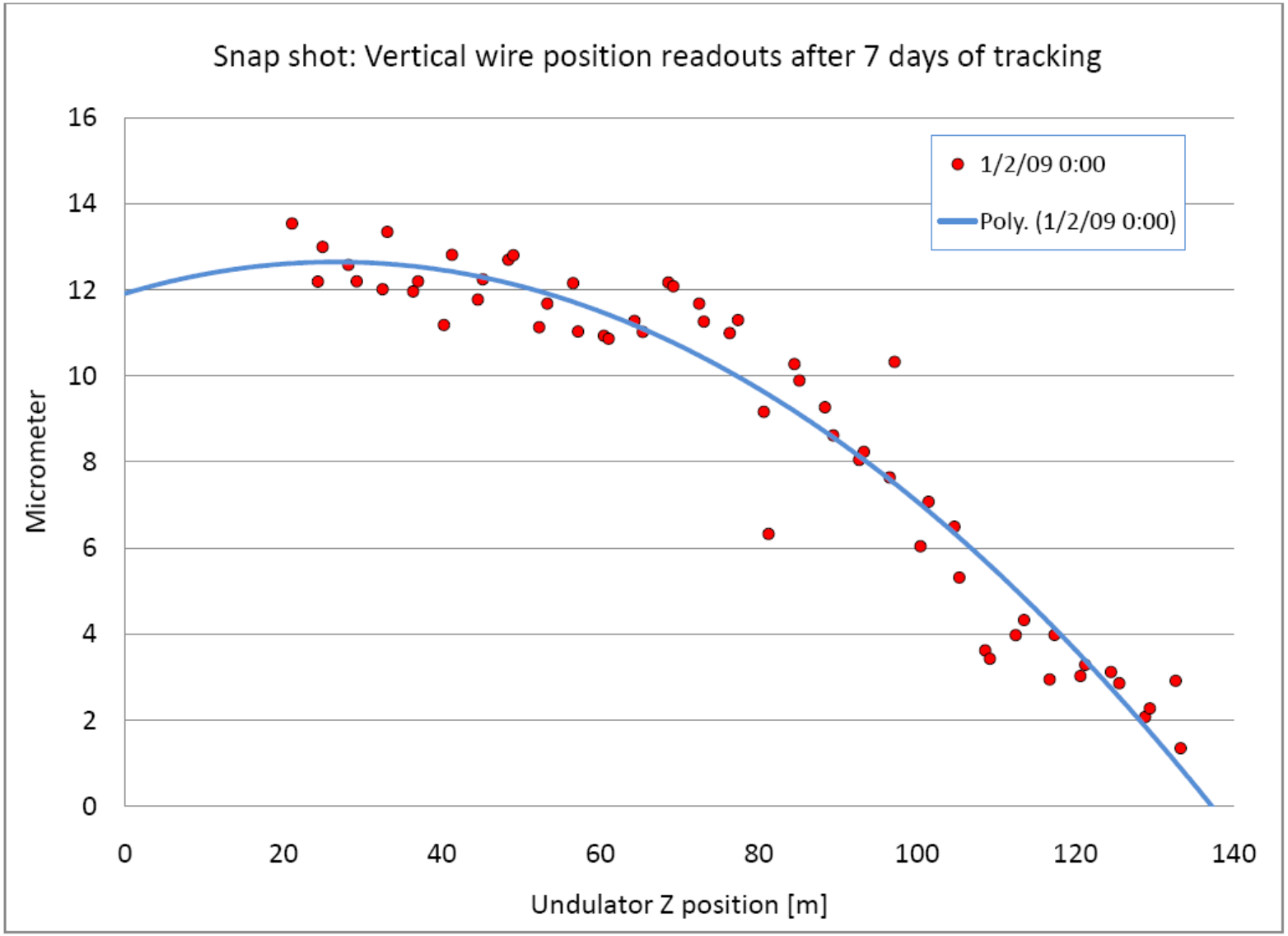
WPM in LCLS (8)



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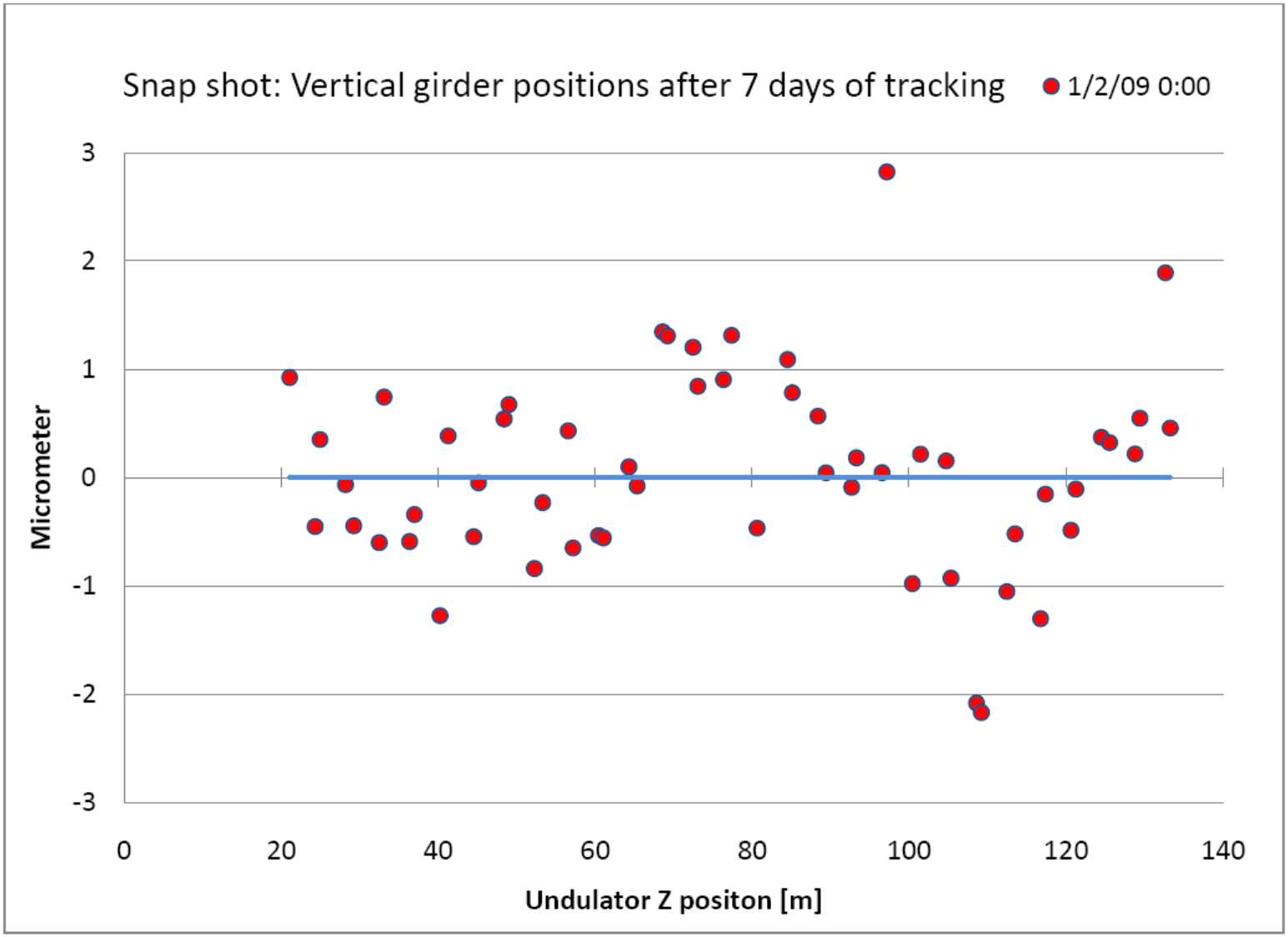
WPM in LCLS (9)



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Summary

- HLS:
  - Third generation capacitive sensors (BINP):
    - Electronics in sensor head
    - Reliable
    - Drift < 2 μm / week
  - Ultrasound sensors (BINP)
    - Electronics not at the sensor
    - Not as reliable (5 out of 33 transducer needed to be replaced so far)
    - In theory no drift
- WPM
  - Inductive System (Wei, Wolf)
    - Electronics next to pick up
  - RF inductive system
    - Very low drift < 1 μm / week
    - No electronics at the sensor itself
    - Max length of 200 m

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