X-Ray Monitor for SuperKEKB HER/LER to monitor vertical beam size bunch-by-bunch

- outline:
  - a (brief) history of the XRM
  - current status of the XRM
  - future prospects for the XRM

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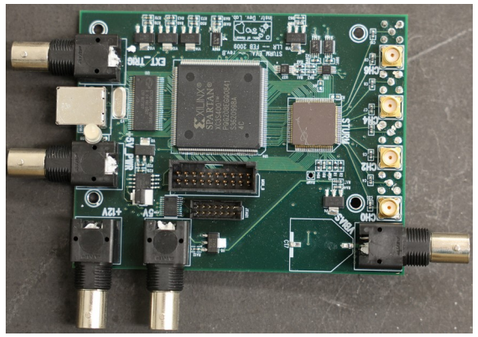
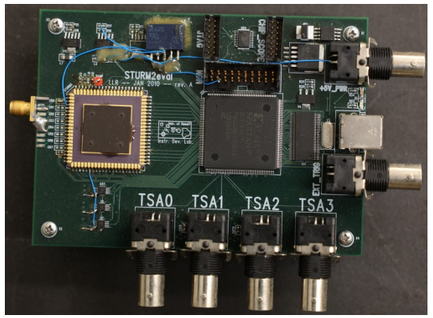
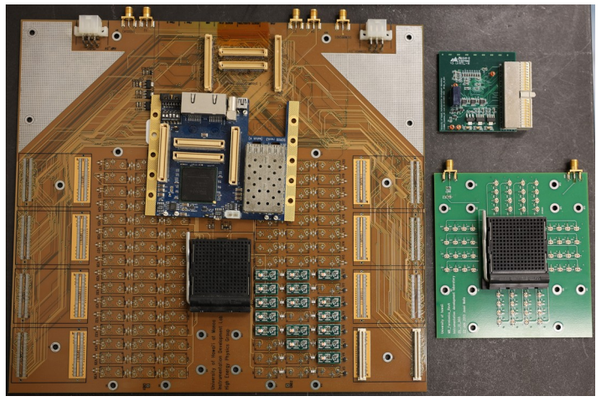
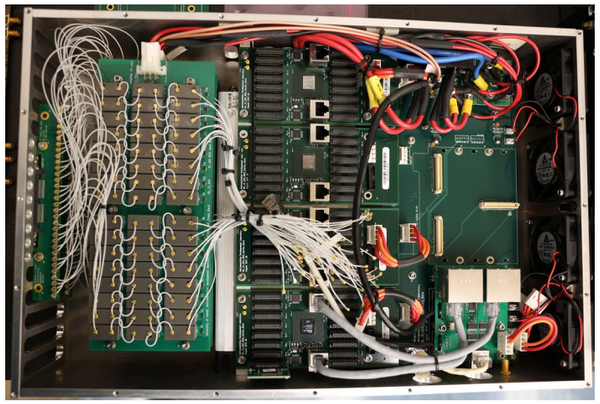
history of the XRM

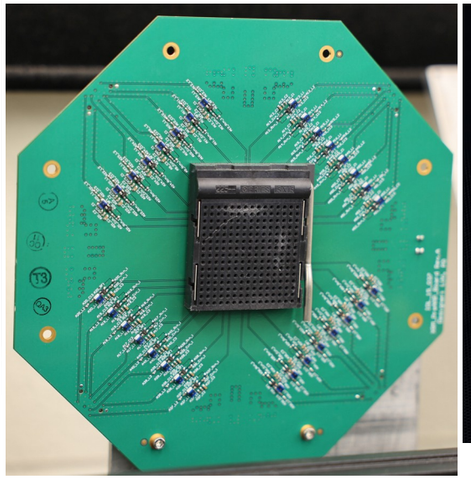
- 2009
  - InGaAs sensor (via Fermionics)
  - STURM2 asic (via MOSIS)
- 2010-2014
  - 2010 STURM2_eval PCB
  - 2012 STURM2 motherboard + 20dB amplifiers + PGA fermionics InGaAs assembly
  - 2014 IRSX variant
- 2015-2016
  - Belle 2 TOP boardstack + custom [0dB,20dB,40dB,60dB] amplifier assembly + InGaAs sensor/preamp board

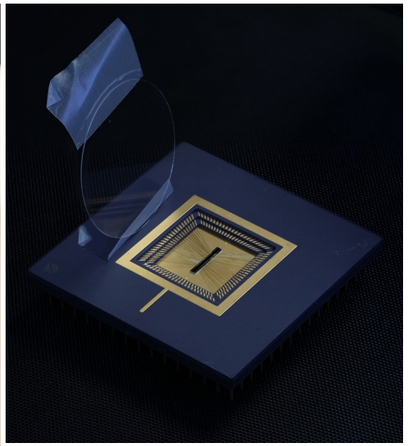


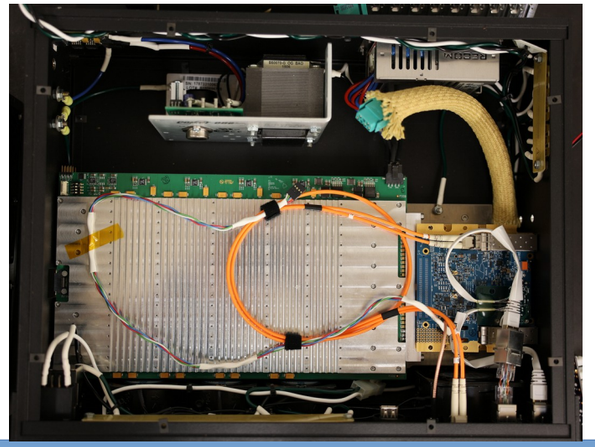


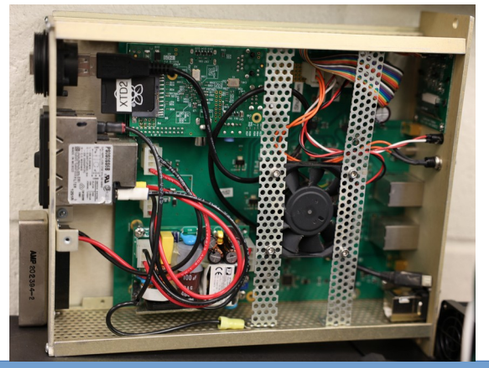






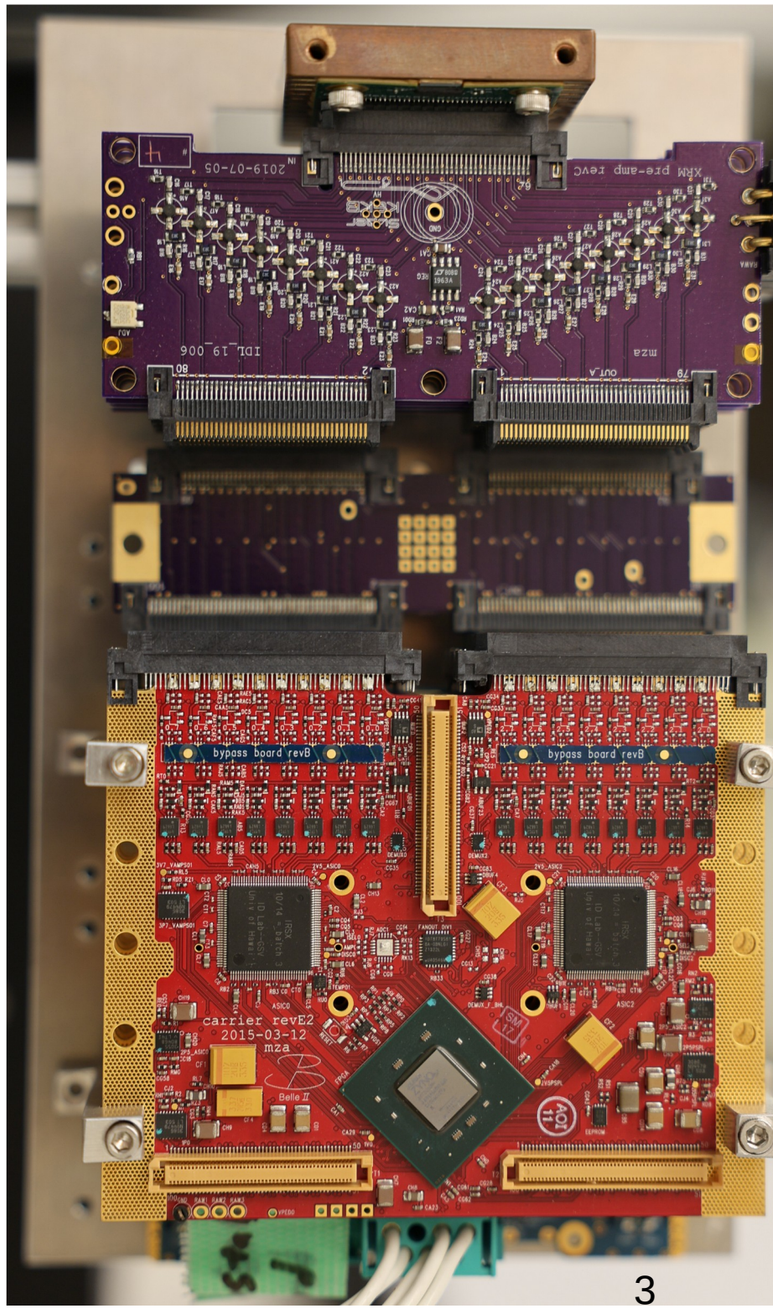






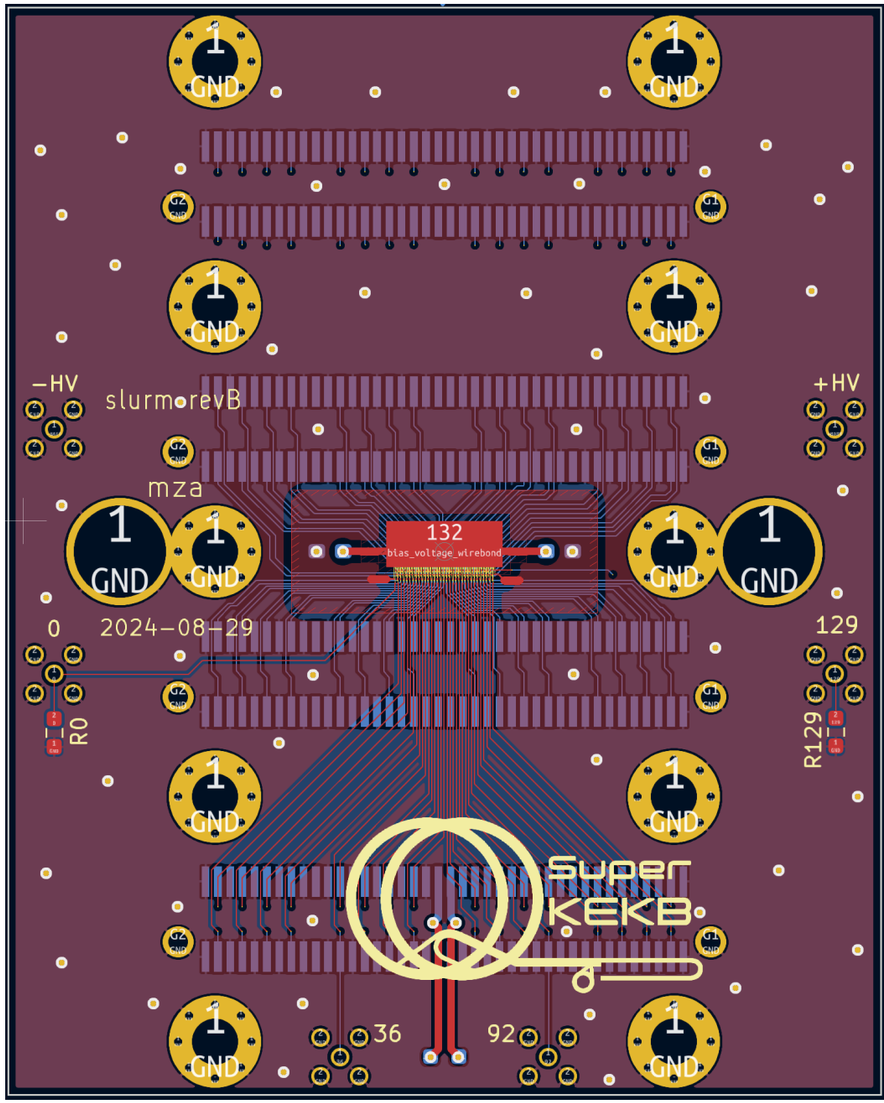
history of the XRM

- 2017-present “SiXRM”
  - Stanford NanoFab manufactured Si strip sensor for this project
  - 2017 Si sensor wirebonded on custom PCB
  - 2018 Si sensor characterized
  - 2019 Si sensor + preamp board + TOP boardstack deployed in HER
    - 64ch data collected 2019-11-15 through 2019-12-12
    - https://youtu.be/IVVIYGwrBqI [first light!; spans 1 day]
    - https://youtu.be/Op0LB1oA5y4 [reprocessed in 4k; spans 4 weeks]
  - 2020 carrier revF PCB fabricated+assembled
  - 2020 preamp revD fabricated+assembled (reduces/eliminates oscillation)
  - 2020 designed laser diode pulse board, controller and associated optics
    - to further development of amplifiers/firmware/readout software
  - 2020 all 3 sensors died?!?
  - 2022-2024 designed new sensor PCB (for Si or InGaAs sensor)



current status of the XRM

- need to wirebond more Si sensors (with 64 or 128 strips connected)
  - only 6 unbonded Si sensors remain
  - one Si strip sensor was recently wirebonded (with 42 strips connected)
    - can be used for bench tests or at KEK in beam
- have new PCB design ready; waiting for feedback from wirebond vendors to see if they are willing+able
- should also try bonding InGaAs sensors to new PCB
  - have 3, but Fermionics is willing to manufacture more for us
- need to modify asic control/readout firmware to be able to acquire data every beam orbit (currently requires 33us)



future prospects of the XRM

- need to find another sensor:
  - need a continuous supply of sensors
  - needs to be practicably wirebondable
  - needs to have a 50um-100um pitch
  - needs to absorb significant soft x-rays
  - needs to respond quickly to stimuli (~2ns)

backup

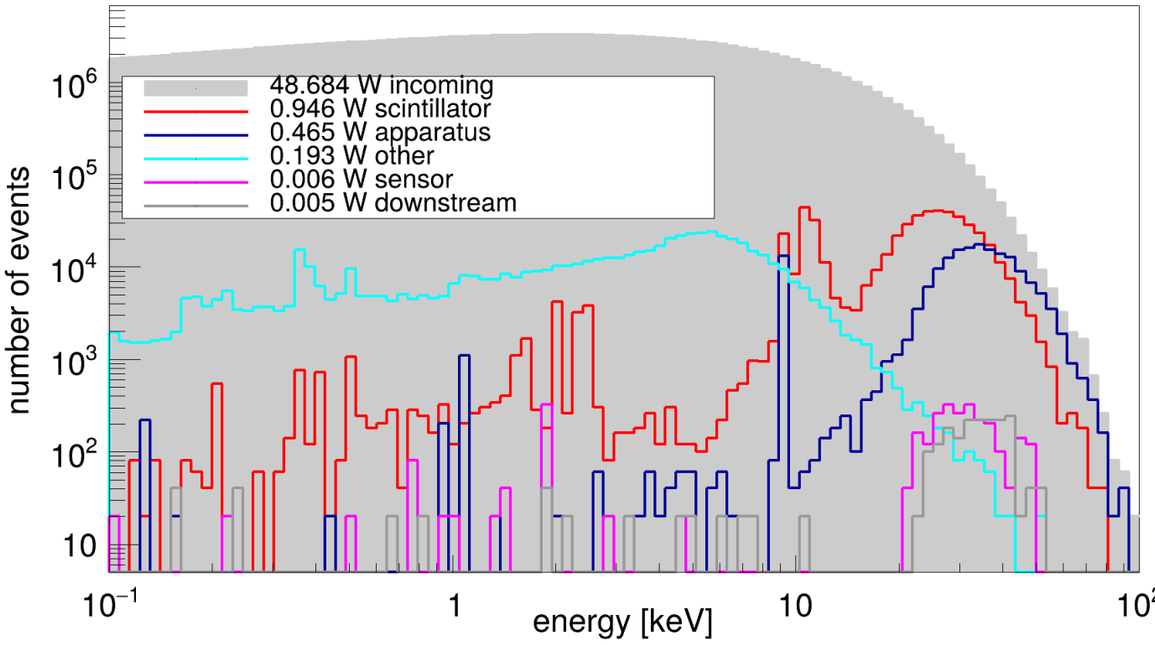
backup

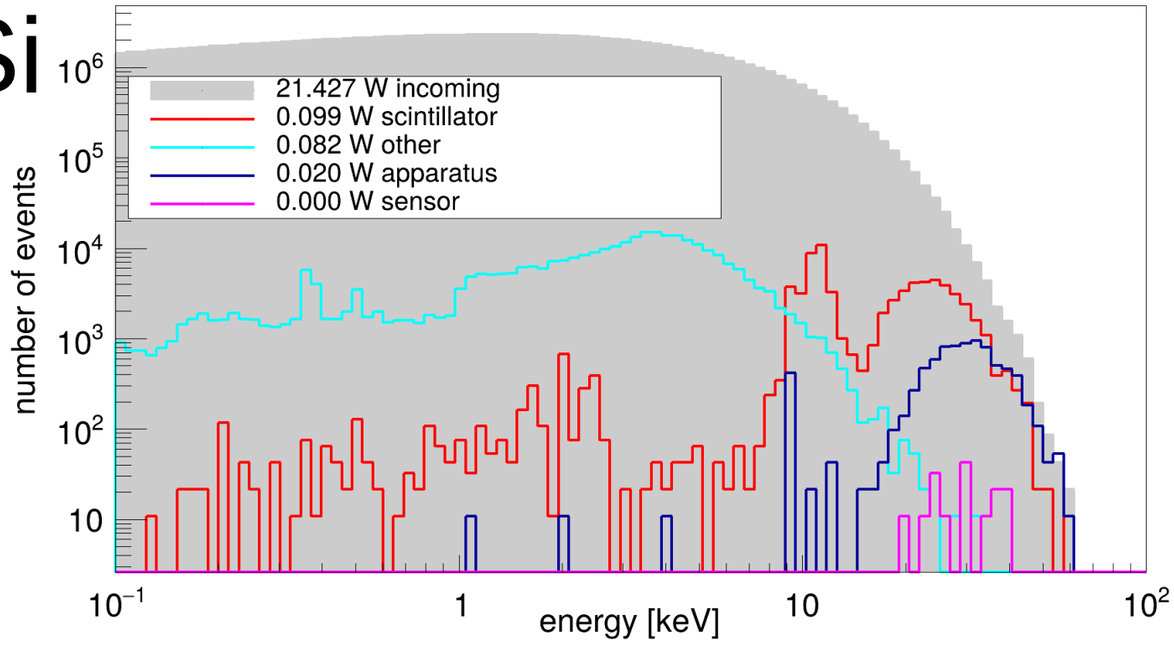
- 2024-08-07.XRM-status.pdf [shows Si sensor variants and new PCB design]
- 2022-08-09.state-of-the-SuperKEKB-SiXRM.pdf [slide version of 2021 poster]
- 2021-04-22.XRM.US-JAPAN-symposium-poster.pdf [geant4, mechanical, XRM boardstack, Si sensor, control/timing data acquisition, laser/bench testing, 2019c run results, new preamp board]
- 2019-04-15.XRM.US-JAPAN-symposium-poster.pdf [shows motivation, geant4, Si sensor, laser/bench testing, mechanical, IRSX, TOP boardstack, amplifier PCB, readout/acquisition]

HER

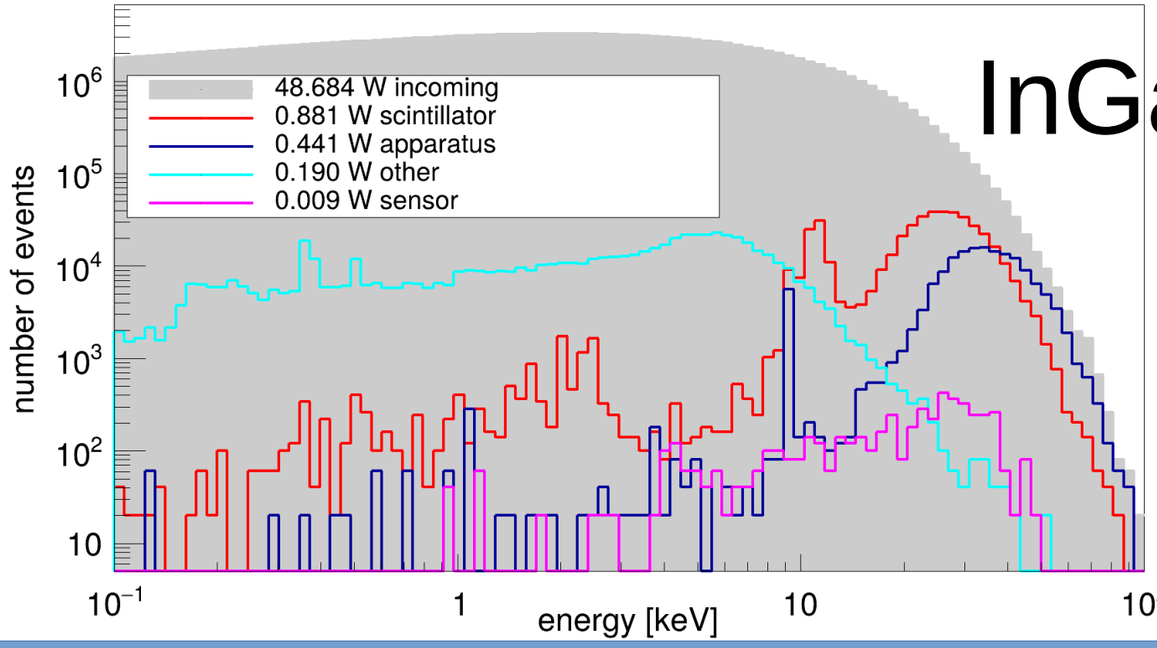
LER

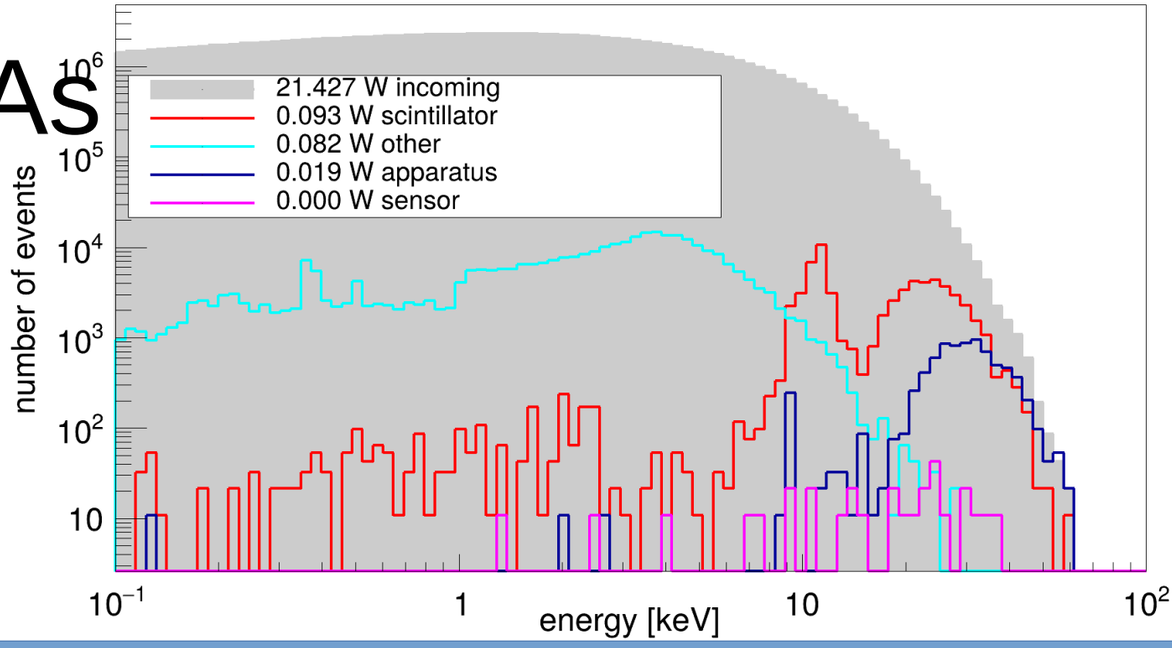
Si

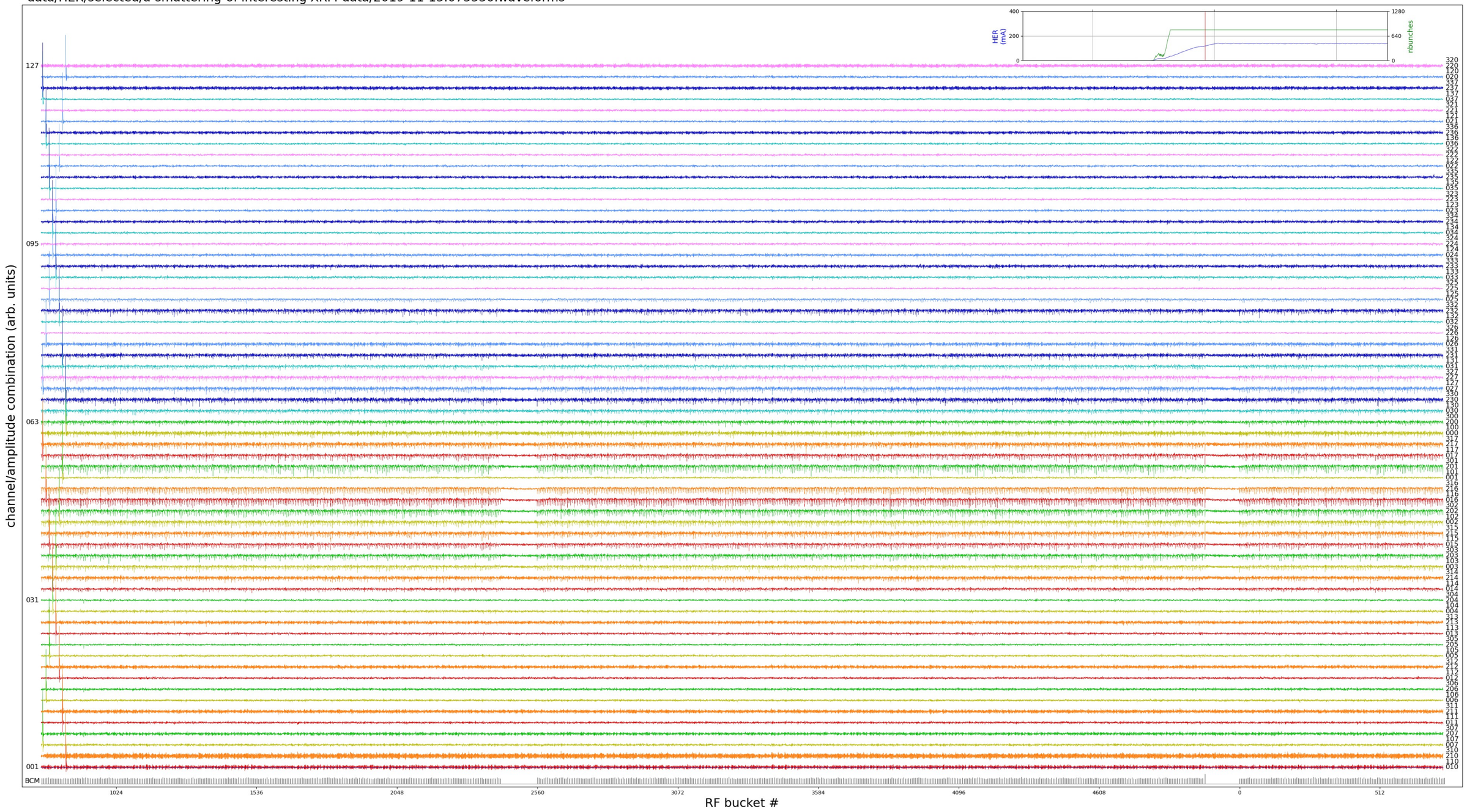




InGaAs



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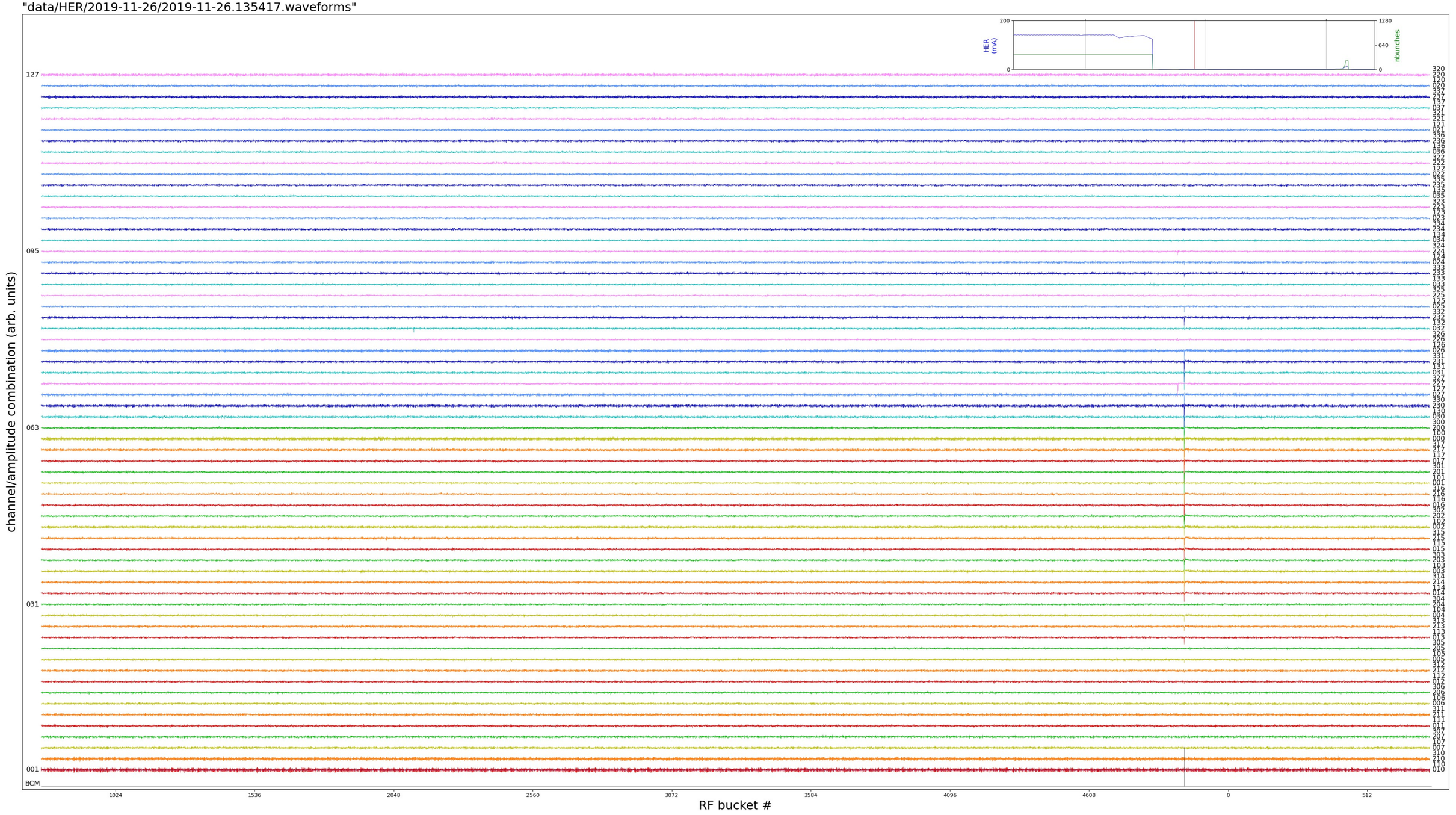
HER (mA)
nbunches
channel/amplitude combination (arb. units)
RF bucket #
BCM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channel/amplitude combination (arb. units)
RF bucket #
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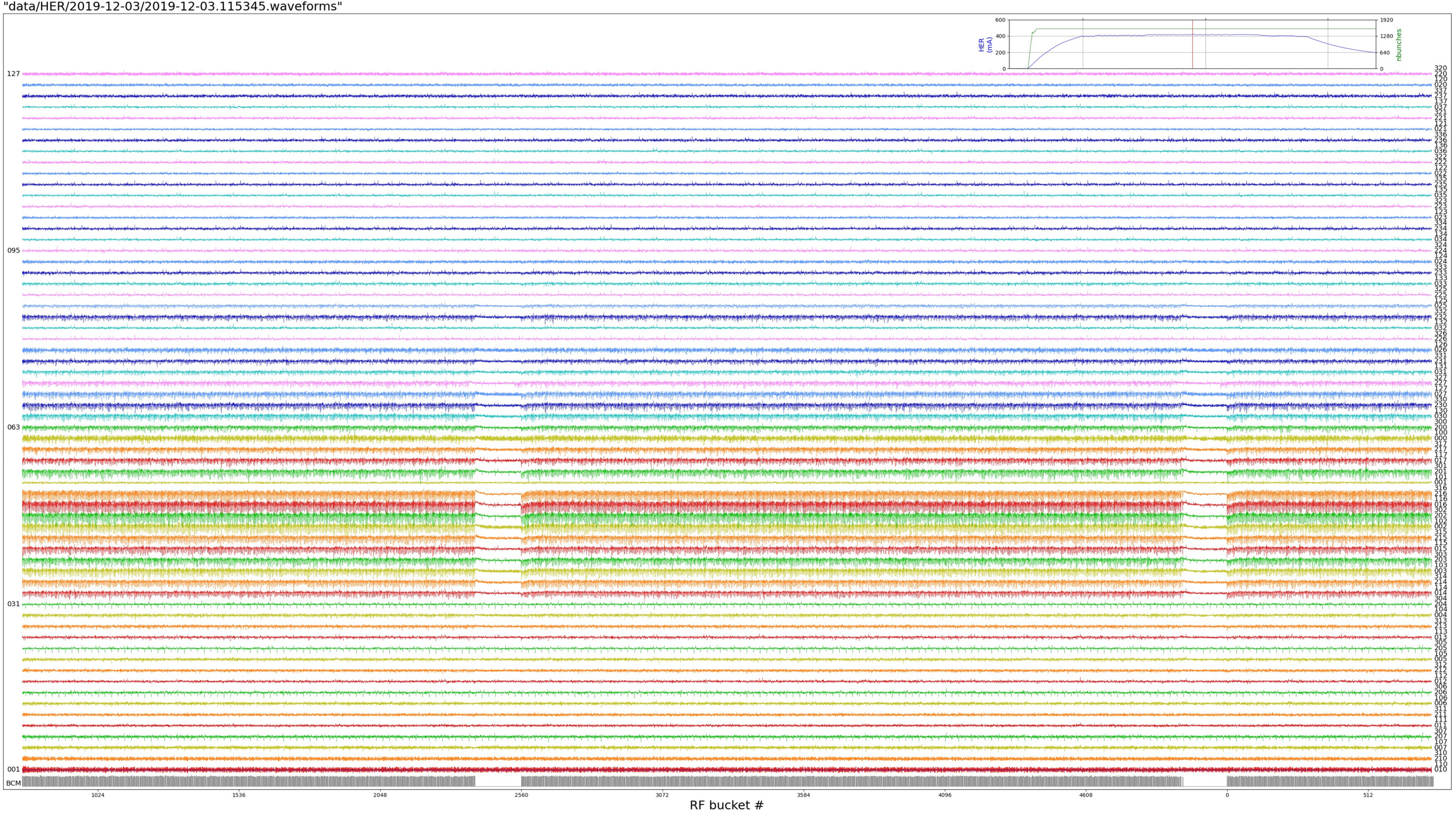
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