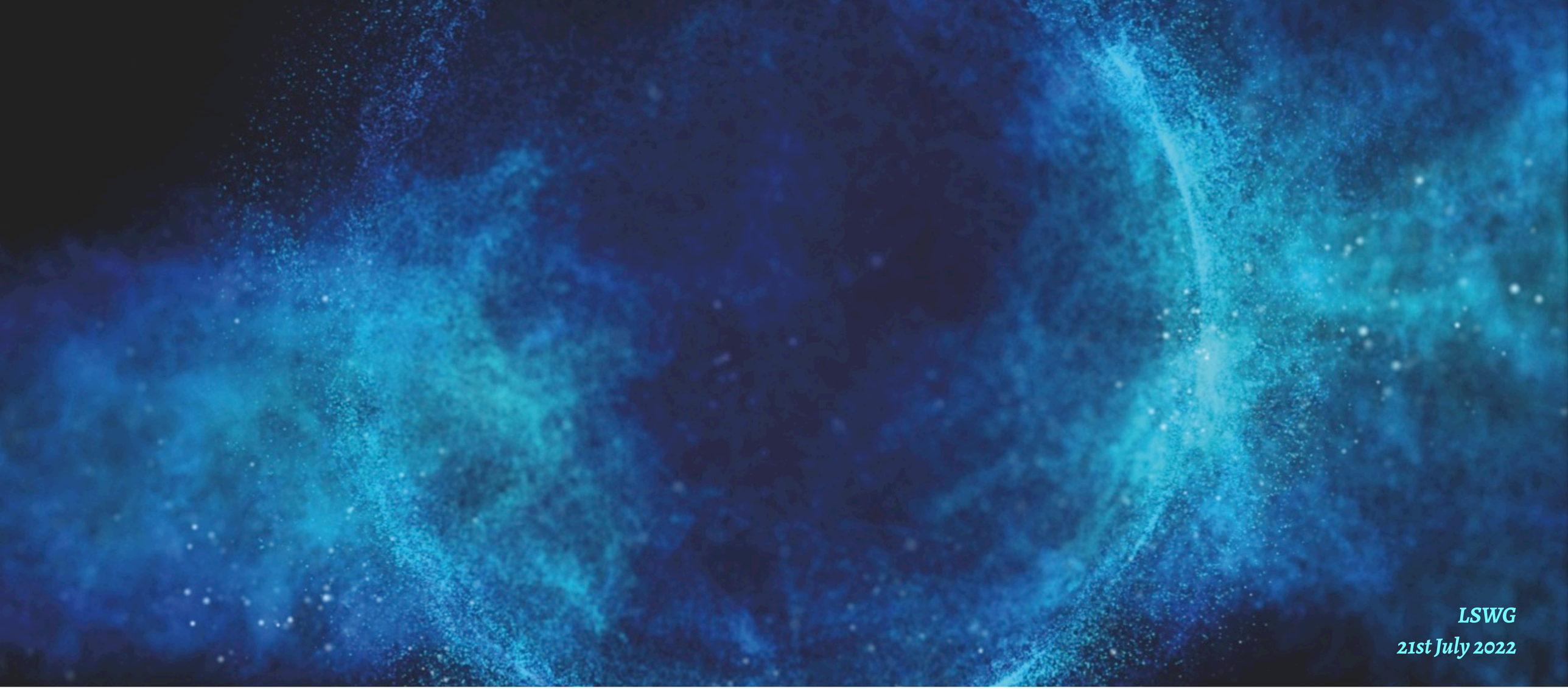

SUMMARY OF THE LHC RF FMD 2022
MD#6944 Voltage calibration

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SY-RF

Motivation and aim

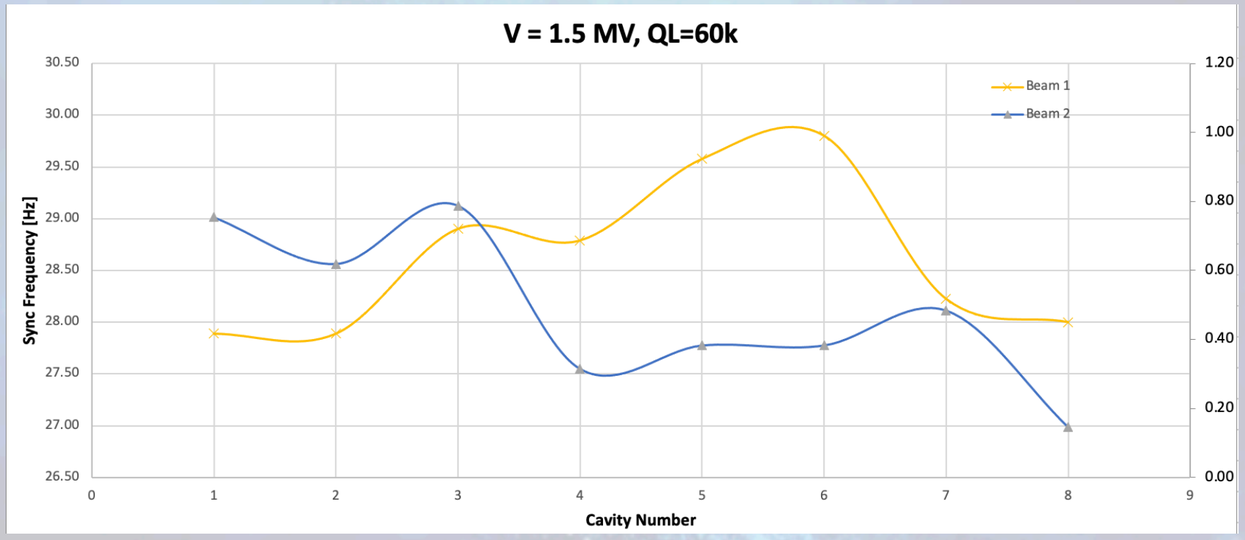
- **Motivation:**
  - To give precise estimates of RF power limitations at injection
    - Ideally, we should know precisely the RF power, but the measurement has intrinsically large errors
    - Another way to determine RF power is by knowing Q_L and voltage
      - Q_L is calibrated in open-loop response measurements
      - This MD was to calibrate the voltage with beam
- **Aim:**
  - Know the exact voltage seen by the beam
    - Feedback regulates antenna voltage to set point, but antenna voltage can have an error -> this is exactly what we try to calibrate in this MD

Measurement method

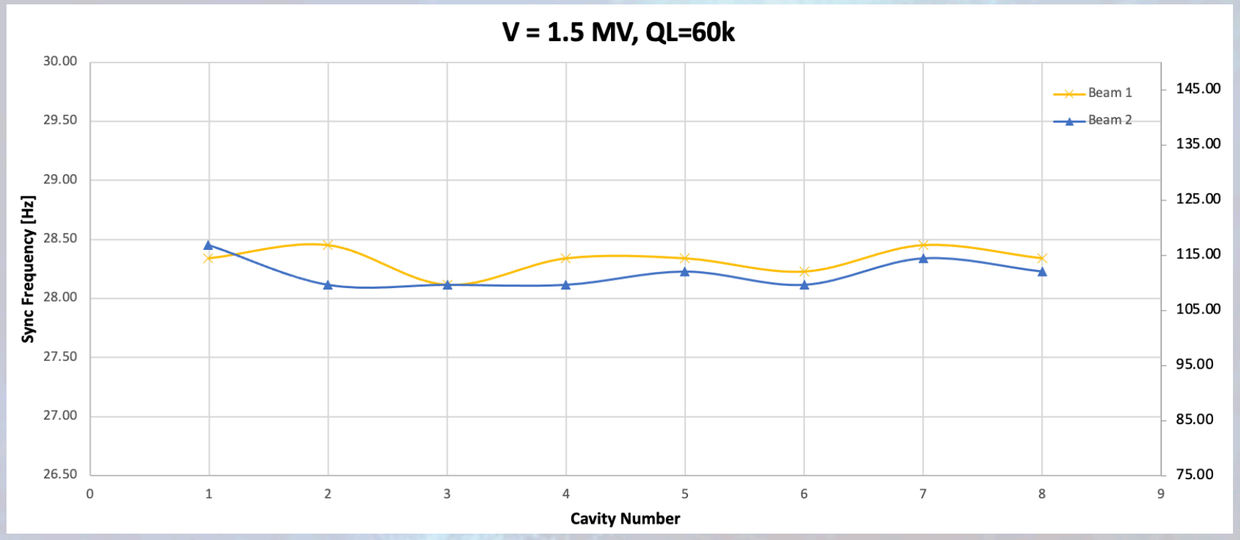
- **Determine voltage via synchrotron frequency measurement**
  - Injected small and nominal emittance pilots with phase loop open and observed oscillation frequency from high-resolution profiles
- **Voltage calibration in different settings**
  - Cavity-by-cavity: captured in a single cavity at a time
    - Measured at 0.5 MV/cavity, 1 MV/cavity, and 1.5 MV/cavity
    - Verified the reproducibility of results for 4/16 cavities
  - Corrected calibration errors via voltage partitioning
    - Verified that the voltage can indeed be corrected like this
  - Measured the overall calibration of the total voltage
    - With all cavities corrected, in the range of 4-12 MV

Overview of preliminary results

- Detailed analysis still to be performed
- Preliminary results show that there is indeed a small line-by-line error (about ±12-14% error in voltage), which is the same at different voltage levels and can thus be corrected
  - Shot-to-shot variation: 0.5 Hz, we can probably not do any better than this
  - In total voltage, observed a larger discrepancy at low than at high voltage, which could be a measurement artefact (t.b.c.)



Line-by-line synchrotron frequency, operational voltage



Line-by-line synchrotron frequency, "calibrated" voltage

Outlook

- **A detailed analysis is yet to be performed**
  - We need to understand also the behaviour observed with the total voltage
- **If preliminary observations are confirmed, we have to decide whether or not to implement the correction of voltage calibration errors operationally**
  - Promising: cavity-by-cavity results show small voltage dependence and results are very reproducible
- **The results of the MD will also help us to determine calibration errors of the RF power**
  - A first analysis shows some outliers among the 16 lines -> to be investigated in future MDs

Thanks for your attention!