Measurement uncertainty in the RF system control of a particle accelerator

POSTER

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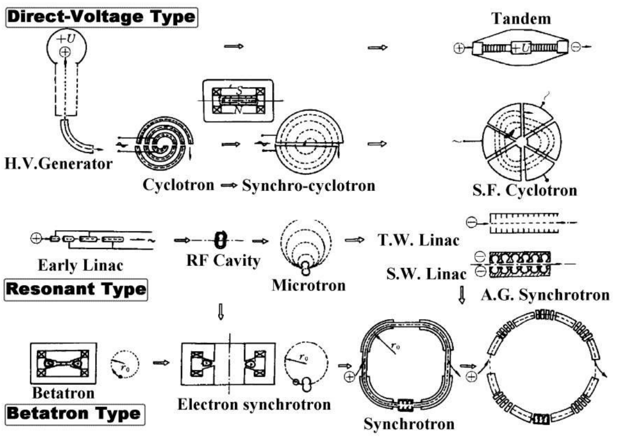
Abstract

When talking about microwave/RF power systems in particle accelerators, we typically take consideration on key parameters such as amplitude, phase, and frequency stability, whether given by a custom LLRF system or standard measurement instrument. When measuring some specific microwave/RF parameters of the system, such as system stability, the loaded Q value of the cavity and some active and passive microwave devices, LLRF can act as a online measurement tool/instrument equipped with procedures introduced those measurement uncertainties. This will show the discrete characteristics and possible true values of these results, thereby improving the recognition of our measurement methods and results and enhancing the credibility of the data.

RF system in particle accelerators

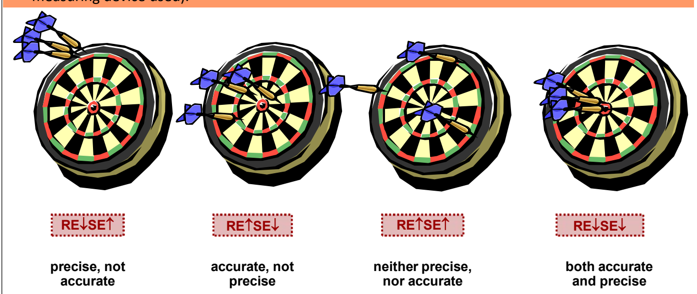


RF Measurement involved in Accelerator RF system control

Measurement Uncertainty

Accuracy is the closeness of agreement between a measured value and a true or accepted value

Precision is the degree of exactness (or refinement) of a measurement (results from limitations of measuring device used).



RE: • Random errors can be reduced by averaging.
• A precise experiment has small random error.

SE: • Systematic errors are usually difficult to detect.
• Systematic errors can be detected using different methods of measurement

For some important parameters or functional measurements, we need uncertainty, not the simple results of self-tests

- Amplitude/Phase/Frequency Measurement Uncertainties
- Mismatch Uncertainties
- Measurement Uncertainties as RF Power Meter
- Uncertainty of VNA Measurement of Absolute Power
- Measurement Uncertainty as Spectrum Analyzer
- Measurement Uncertainties as a VNA
- Noise/jitters Measurement Uncertainties
- …

What Low Level RF can do for us ?

Is that possible to automatedly do the Calculation Of Measurement Uncertainty within LLRF?

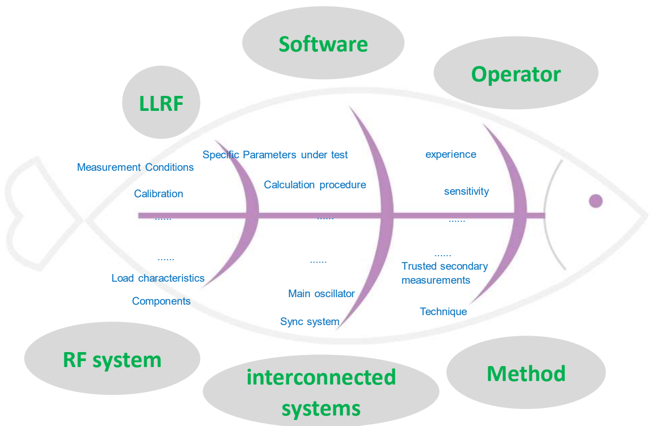
1. With LLRF the user configures and give the Measurement Details :
   - Specific statistics used
   - Confidence / Coverage
   - Number of measurements
   - Accuracy of the standard

2. In the cal. or test procedure you also specify test parameters:
   - Test point
   - UUT resolution

3. In the test process, LLRF provides the uncertainty details (Repeatability Uncertainty; Calibrator Uncertainty; Resolution Uncertainty; Calculated Total Uncertainty)

4. Details are permanently stored in the data base. They accessible for reports & future analysis.

Trustworthy results with Uncertainty Factors



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