



Summary of the 1st PACMAN Workshop – WP2

Held on 04/02/2015

Agenda: <https://indico.cern.ch/event/332431/>

Subject: PACMAN WP2

1. Dr. Martin Albrecht (PTB)

“The activities and the equipment available in the magnetic measurement working group at PTB”

- Presentation about the magnetic measurements carried out from the magnetic measurements group at PTB, with some details about measurements with coils and calibration for coils
- Questions and discussion after the presentation:
 - Uncertainty of the dissemination of the unit Tesla, anticipated as 10^{-4}
 - Calibration done with magnets are fast and useful for the production, but the best and most precise calibration is with coils, which are more stable
 - There are standards for the gradients measurements, for some applications two coils may be used
 - Discussion about the magnetic shielding

2. Mr. Alexander Temnykh (Cornell University)

“Theory and applications of the vibrating stretched wire technique for high-precision quadrupole alignment”

- Theory of the vibrating wire for magnetic field measurements





- Introduction to Domenico Caiazza's talk, about the measurements on a small aperture quadrupole
- Discussion and questions after the presentation:
 - Is there a valuable difference in moving the wire or the magnet? It depends from the application and the setup available. For moving the magnet precise translation stage which can support an heavy load are required, this is why often moving the wire is easier
 - How good the tension has to be controlled? The resonant frequency depends also from the temperature, if the wire is closed in a tube it may be more stable
 - What is the quality factor of the resonant frequencies? It is around 100-200, but is it not a critical point for this application, even if from this parameter some important information may be deducted, such as temperature change and tension.

3. Domenico Caiazza (CERN)

"Stretched wire systems for the magnetic measurement of small-aperture magnets"

- Presentation about magnetic measurements using vibrating wire techniques, in the frame of the PACMAN project.
 - Here the challenge part comes from the small aperture diameter of the magnet, which is 8 mm.
- Introduction to magnetic field quality measurements, talk from Giordana Severino.
- He presented two methods that help to determine the magnetic center of the magnet: stretch wire and vibrating wire.
 - With the first method the idea is to displace the wire inside the magnet until finding that the magnetic field is zero.
 - With the vibrating wire method he will use two modes in order to determine the center of the wire and the tilt of the magnet.
- Experimental setup, with some measurements using both methods.
- He found solutions in order to compensate the background field that is not detectable by the stretched wire technique.
- He has already measured the magnetic axes of the quadrupole and fiducialize it. His results were presented at IPAC.
- He also was able to measure the amplitude of the oscillation of the wire with respect to the frequency and the vibrations that are described in an ellipse.
- Discussion and questions after the presentation:
 - Discussion about the background field compensation
 - About the PACMAN application, is it possible to make magnetic axis measurements with a lower current? Yes, it is possible, at the moment; the measurements are already done with a lower current, with respect to the CLIC magnet.



4. Dr. Walter Bich (INRIM)

“A review of the state of the art, present norms and future trends in the field of the measurement uncertainty estimation”

- Presentation about the uncertainty of measurement uncertainty and standard measurement uncertainty.
- He mentioned all the existing and future documents that describe the uncertainty of the measurement and there is one for each application.
- These documents don't explain how to evaluate the uncertainty but how to use it, the probability density function for the measurand,, decision rules and risks.
- Dr. Walter described the GUM method.
 - This method does not consider a few cases.
 - But there are remedies such as the Monte Carlo method explained in Supplements.
 - The GUM and its supplements are inconsistent and the GUM is ambiguous due to the definition of uncertainty in the GUM.
 - Anyways, the idea of making the GUM and its supplements as much consistent as possible is a purpose.

5. Giordana Severino (CERN)

“PCB technology for small diameter field probes.”

- She will use rotating coils in order to measure the field quality and magnetic magnet axis of accelerating magnets for CLIC in which the aperture diameter is 8mm.
- The field quality consists on measuring multipoles coefficients.
- She explained the advantages and disadvantages of using multi-wire coil and PCB coil.
- The key point is that the measurement of the multipoles depends on the geometry of the coil.
- The calibration of the coil is very important in order to calculate the coefficients of sensitivity, which are necessary to compute the field harmonics.
- She wants to use an in-situ calibration to calculate both rotation radius and area of PCB coil.
- She explained that the in-situ calibration uses the DFT coefficients of measured flux in order to set the radius of the coil. The in-situ calibration is done with a quadrupole of reference and she simulated with Roxie the effect of higher order harmonics on the classical formula of in-situ calibration for a not reference magnet.
- The next step is to make measurements in the laboratory to verify with the real magnet the effect of higher harmonics.
- She explained how to find magnetic axis of magnet, mechanic axis of magnet and rotation axis of the rotating coil.
- She presented the differences between using a polygonal and a cylindrical reference magnet for the calculation of magnetic and mechanic axis.



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- She also has to evaluate the sag of the coil underlining the difference between the effect of sag and a coil deformation on measurements.
 - This problem can be corrected easily for the harmonic calculation but not for the axis measurement.
 - Finally, she exposed which are the future studies that need to be done.

Reported by N. Galindo and S. Zorzetti