Summary of the 1st PACMAN Workshop – WP4

Held on 02/02/2015

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

Subject: **PACMAN WP4**

1. Mrs. Silvia Zorzetti (CERN)

"Stretched wire techniques for a 15 GHz RF-BPM"

- Presentation about the CLIC beam position cavity
- The cavities BPM are diagnostic instrument for accelerator to determine the beam position. To center the beam inside the quadrupole measures are done with BPM cavity. The aim of PACMAN is to align the magnetic center of quadrupole and the electric center of BPM.
- In the cavity different modes are exited: monopole mode (11GHz TM010) and the dipole mode (15GHz TM110)
- The study of interest is the TM110 .
- With four slot-coupled waveguide is possible to discriminate modes: with the monopole mode any signal is pickup by the guide while with the dipole mode a signal is pickup.
- For the Slater theorem if on a stretched wire inside a cavity it is present a perturbation to the Eigen frequency this cause the excitation of the interest mode TM110 .With the displacement of wire it is possible to scan the area to find the minimum of the signal corresponding to the center (aligned position)
- The read signal has a quadratic dependence to the line displacement .The aim is to find the electric center and for this there are two technics:
- Signal excitation: more precise but are necessary more tools and the wire must be exited. Higher excitation around electrical center.

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no 606839

- Perturbation analysis: are easier fewer complexes to integrate inside the system. Lower sensitivity around the electrical center.

- Has been presented the actual test-bench and has been underline that for future implementation it is necessary to improve the actual test-bench and to develop a more complex system.
- The two stretch-wire methods introduced will be tested to find the most efficient method to implement.
- The first measurements expected in March

2. Dr. Dirk Lipka (DESY)

"Experience on design, prototyping and testing of the cavity BPM for the European-XFEL"

- Linear accelerator compress the beam very much so the energy is more concentrate .The European XFEL in building-up the most powerful laser with short wavelength. Desy has more repetition compared to other accelerator (Japanese) .The time between two bunch is 222ns. This means that the decay must be faster than 222ns.
- DESY is responsible for BPM mechatronics and PSI for the front end electronics and digitalization.
- There are two different time of CBPM one for undulator intersection and the other for the beam line position.
- Two simulations shows that the monopole mode and the dipole mode inside the CBPMs cavities.
- The mechanic characteristic of beam CBPMs cavities was introduced to underline that the RF – proprieties are linked to mechanical tolerances. Were also introduced the characteristic resonance frequency load and crosstalk important to reach a decay time of 6.7ns. About were shown the statistics characteristics on a production of 122 undulator cavity BPMs and on 30 BPM cavities.
- Has been introduced the electronic principle. The amplitude detection has a lower quality factor due to the high bunch repetitions (222ns).Has are used attenuators there is the problem that each attenuator has a di9fference that must be correct , otherwise there is the risk to introduce an error in phase.
- After the accelerating structure there are two FLASH .On FLASH1 is performed a beam based measurement: Are used all BPM except one under test and is predict the position of each bunch to this BPM .On FLASH2 CBPMs and two button BPMs are used to measure the difference between BPM under-test and the others. Building-up beamline of E-Xfel started in 2014 will end in 2016.

3. Dr. Nathan EDDY

"RF and digital signal processing of HOM and cavity BPM signals"

- The aim in RF measuament s from a beam is to measure both amplitude and phase so it is used the complex notation.
- As it is necessary a signal processing and the use of DAQS (analog digital convertion) the most important characteristics to take into account are : The drift that is undesired the accuracy (indicate by effective bits) performances flexibility and others.
- The problems that characterise a digital to analog conversion are:
- The aliasing (that can be a desired or un undesired effect), quantitation and sample clock jitter. All this effect can cause noise and a lost in the DAQ performances shown by the SNR signal to noise ratio .Explication of aliasing frequency effect and of the jitter.Esplication of the quadrature Down- conversion do to shift signal in frequency and send more signal togheter in quadrature after followed by a decimating low pass filter to demodulate the signal.
- Introduction on a single side –band signal Mixer used to supress one side band by shifting in frequency. Explication of HOM Downmix Electronics that use the structure previously introduce :SSB MIXER ADC RF AND IF.
    - Slides that shows the final HOM Multi-Channel Downmix Electronics and the labview interface developed for it. Dedicated multi-channel downmix electronics have been developed for the 3.9GHz module installed in FLASH and A three channel 15GHz prototype is almost complete.

4. Mrs. Natalia Galindo Munoz (CERN)

"EM field alignment of the CLIC accelerating structure with help of WFM signals"

- The accelerating structure to be used in CLIC has been described. It consists of 24 coupled cells where the mode TM010 at 12 GHz is excited to accelerate the particle beam, 2 coupling cells for input and output power, damping waveguides with RF absorbers of high order modes and 4 wake field monitors to detect the misalignment of the structure with respect to the beam.
- The concepts of pre-alignment with respect to external fiducials and beam-based alignment have been presented. These steps are crucial for limiting the emittance growth, which imposes tight manufacturing tolerances for the components of the structure.
- The accelerating structure has to be fiducialized within 7 µm with respect to its electromagnetic center and the wake field monitors have to provide an accuracy of 3.5 µm. Two methods are being investigated to achieve these goals. One consists in using a stretched wire as an excitation and is suitable to prove the required accuracy for the

wake field monitor. The second one uses the wire as a perturbation and is suitable for the fiducialization.

- A schematic of the test bench has been showed. This will be the same bench used for the BPM.
- Simulations concerning the second method have been presented. The scattering parameters have been studied as a function of the excitation frequency for different models of the structure. The results confirm that the wire creates a large enough perturbation to be sensed by the detecting devices.
- Discussion
    - Even though in principle also a dielectric wire is suitable, a conducting wire (copper) will be used as the same wire is to be used also for magnetic measurement of the main beam quad.

5. Dr. Andrea Mostacci (Sapienza University of Rome e INFN-Roma I (IT))

"Stretched wire measurements and impedance matching"

- The theoretical basics of the use of a stretched wire to measure RF properties and the issues arising from the presence of transmission lines with different characteristic impedance have been presented.
- Both simulations and experiments in the EPA machine have shown the effectiveness of a stretched wire in simulating the beam when a pulse in sent into the wire itself.
- The problem of impedance mismatching has been introduced. Here matching sections are required to change impedance to the value required in the measured line in order to minimize reflections.
- One diagnostic technique for impedance mismatching, the Time Domain Reflectometry, where impedance mismatches are separated in time, has been described.
- Resistive matching networks allow the desired impedance matching to be obtained. The working principle of this technique has been described and illustrative examples have been shown.
- If the working frequency is such that the parasitic effects in the resistors become dominant, then solutions based on tapers con be adopted. However, tapers can generate string reflections at low frequency. This drawback can be overcome by using the technique of time domain filtering.
- Discussion
    - As far as the measurement system is calibrated, the type of connection to the analyzer (differential or single ended) should not affect the accuracy in measuring the impedance of a line.
    - If possible the measurement setup can be also vertical, in order to improve mechanical stability and avoid wire sagitta.
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6. Dr. Reidar Lunde Lillestol (CERN/Uni. Oslo)

"Wake field monitors conception, installation and measurements in the CTF3 TBM and TBTS"

- Transverse wakes generated by beam offset in the accelerating structures can kick the beam, determining emittance growth. Wake field monitors can detect this misalignment with the aim of minimizing the offset.
- The structure of the CLIC Test Facility 3 has been described, with the-two beam test stand, now replaced by the two-beam module, where 4 accelerating structures are located and two wake field monitors for each structure.
- Measurement of wake fields performed on the two-beam test stand and first results on the two-beam module have been presented. In the first case, the wake field monitor gave a good resolution and revealed a horizontal misalignment of the structure. In the second case a background signal is present in the measurement, which is hard to compensate as it is different between the data sets.
- A new solution based on Electro-Optical Modulators for the front end of the wake field monitor will be probably tested in this year on the two-beam module.
- Discussion
    - The measurement on the two-beam module at 24 GHz presented a quite huge amount of noise. This depends on the working frequency, in fact such a noise was not found at 18 GHz.

Reported by G. Severino and D. Caiazza