Summary of EC Working Group:
Measurement of Cloud and Effects on Beam

J. Flanagan, Y. Suetsugu

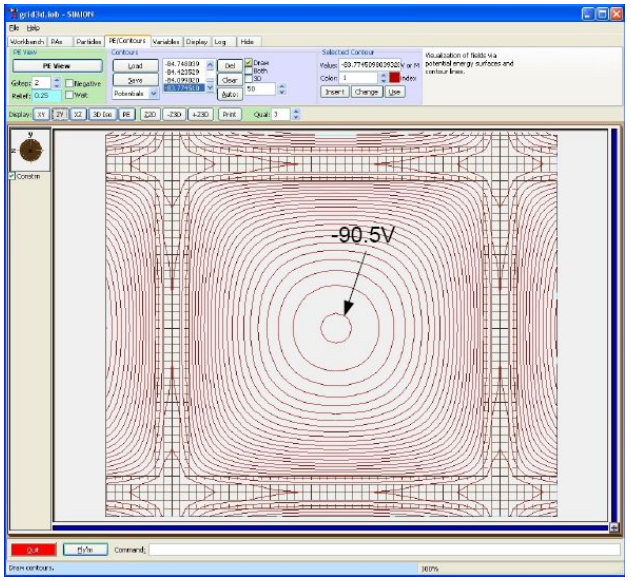
Talks

- 7 talks in the session

- Measurement of Cloud
  - RFA monitors: K. Kanazawa (KEK), R. Zwaska (Fermi Lab.) and S. Greenwald (Cornell)
  - Microwave transmission: S. De Santis (LBNL)
- Measurements of Effects on Beam
  - Incoherent emittance growth: K. Ohmi (KEK)
  - Coherent instability, Coded aperture x-ray monitor tests: J. Flanagan (KEK)
  - Tune shift: R. Holtzapple (Alfred Univ.)

Measurement_Zwaska_1

- RFA simulation using SIMION
  - High precision RFA (poor HPF characteristics)
  - Bessel Box design from ANL (behaves like BPF)
  - APS design (standard) (measured S/N in MI lower than in simulation: mesh non-ideal)
  - New proposed design (modified Bessel box with stop removed)
- Optimisation of physical parameters of RFA.
- Calculation of the attenuation factor for different slot geometries, mesh used for grids.
  - Achieved good HPF behavior, efficiency

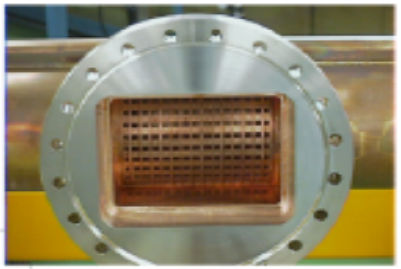


Measurement_Kanazawa_1

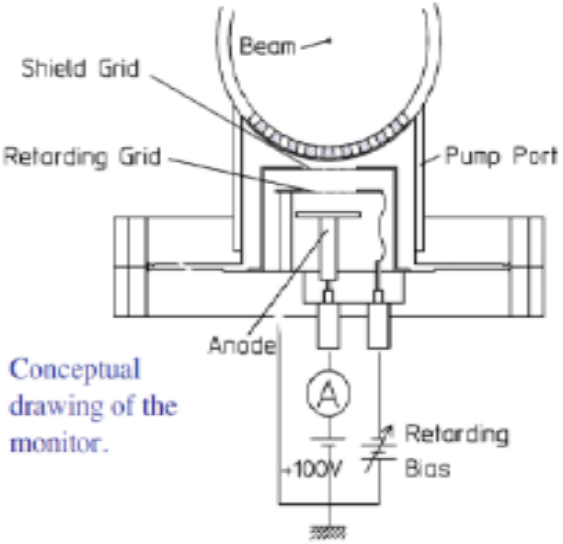
- RFA type electron detectors with Faraday cup or MCP or multi-strip anode are installed in KEKB LER.

Electron Monitors (1)

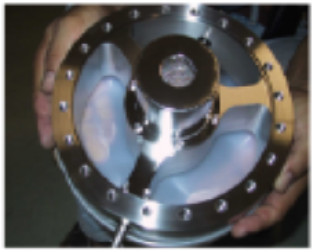
Retarding field analyzer type electron monitors are set at pump ports of KEKB LER.



Pump port of KEKB LER



Conceptual drawing of the monitor.



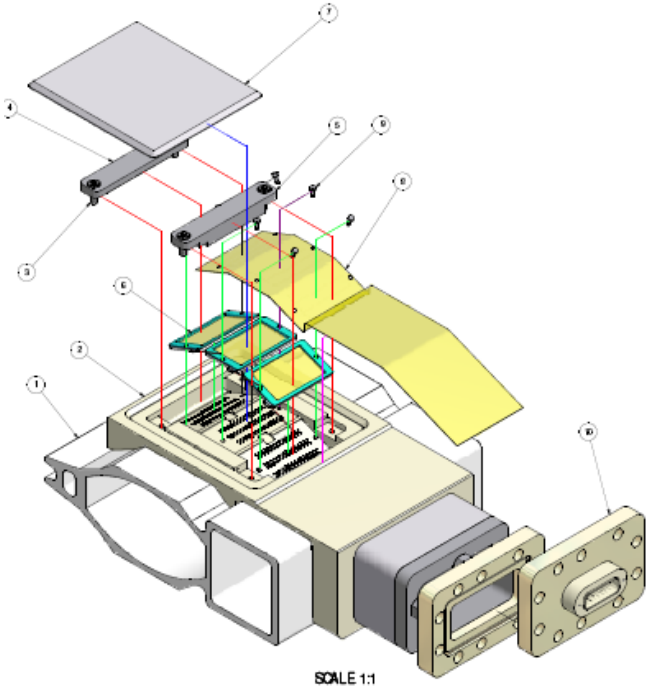
Electron Monitor (Modified Type)

Measurement_Kanazawa_2

- Most electrons that enter RFA have a low energy, below 20 eV.
- MCP measurement suggests long surviving electrons in duct.
- Antechamber reduces the electron cloud density but not completely.
- At the location where synchrotron light is negligible, the effect of coating was compared. TiN coating is more effective than NEG coating.
- By selecting high energy electrons that hit the chamber wall, the density of electron cloud near the circulating beam can be estimated.

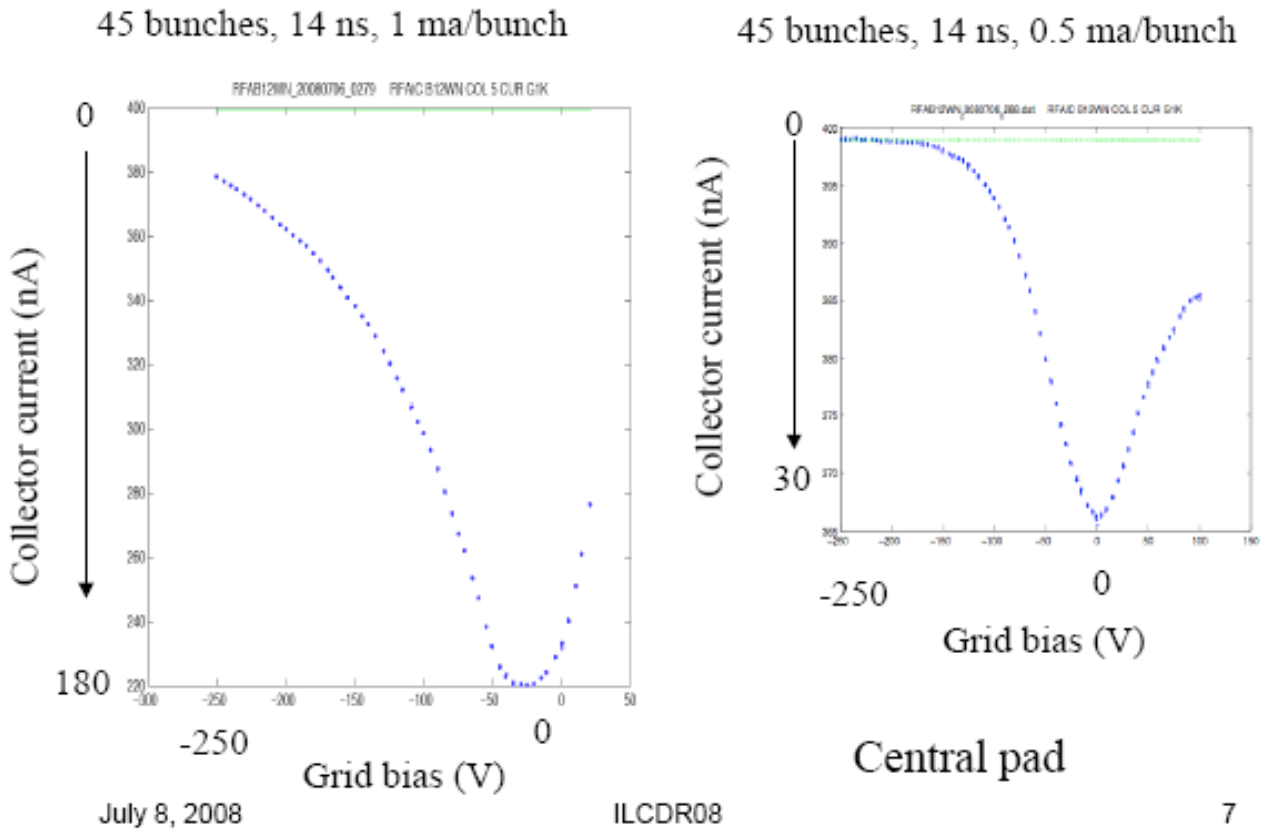
Measurement_Greenwald_1

- Comparison between Cornell-type thin RFA and APS-type
  - Almost consistent each other
- Effect of solenoid was clear
- Newly developed RFA for CESR-TA
  - Dipole Chamber RFA



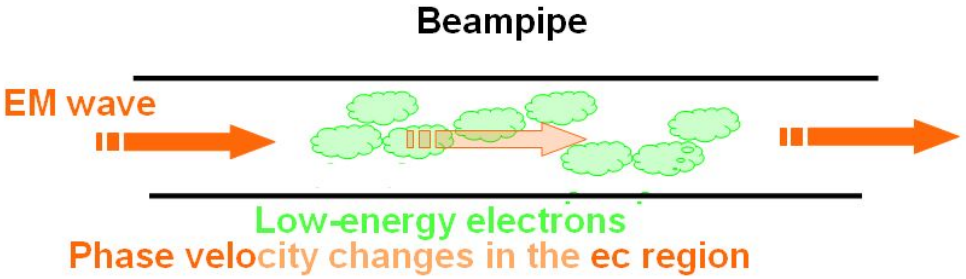
Measurement_Greenwald_1

- First results

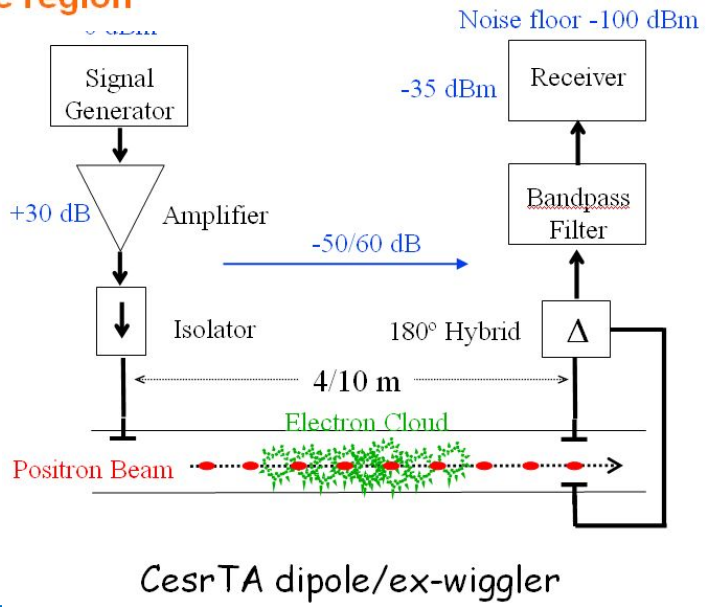


Measurement_Santis_1

- Electron density can be estimated by measureing the phase shift of transmitting microwave

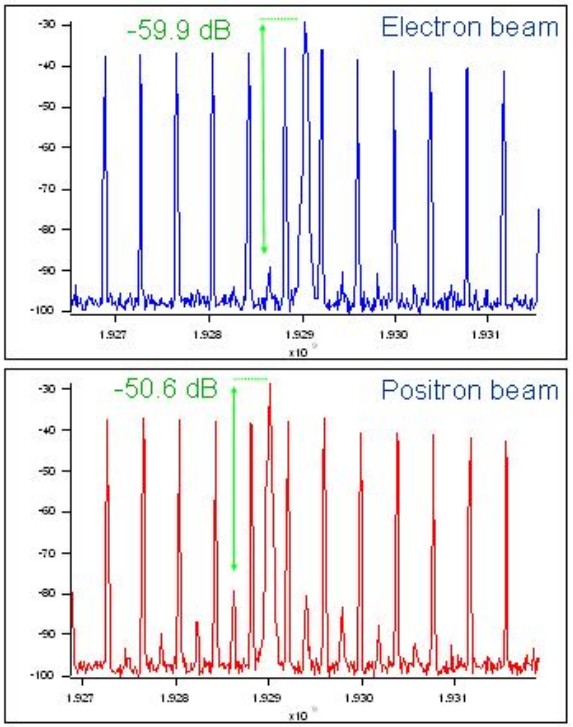


- Instruments were set up for CESR-TA, following PEP-II



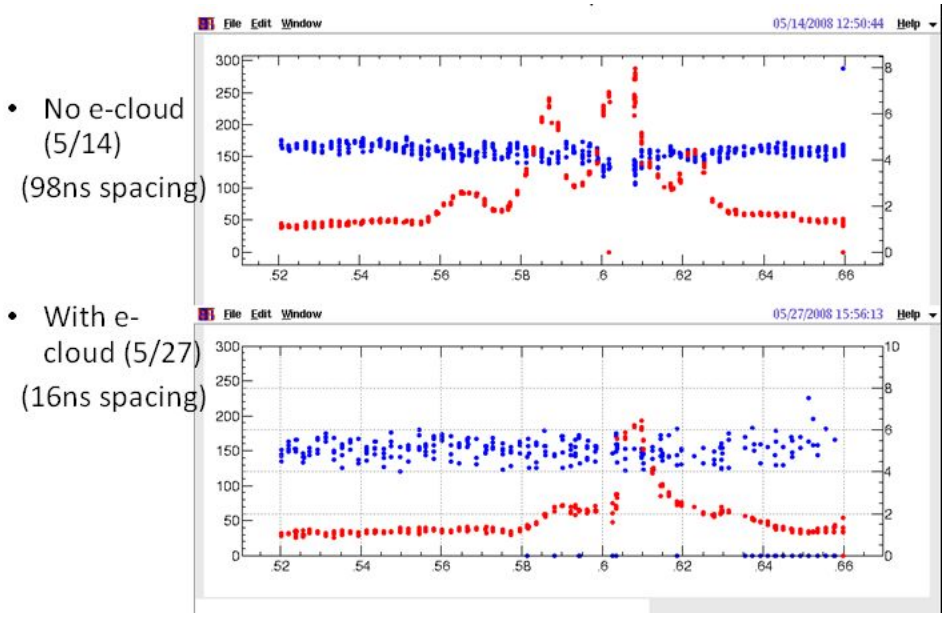
Measurement_Santis_1

- First data:
  - Positron and electron beam
  - Direction of the beam.
  - Dependence on gap length and beam/bunch current
  - Effects of vacuum chamber shapes
  - Dependence on beam energy
  - Cyclotron resonance



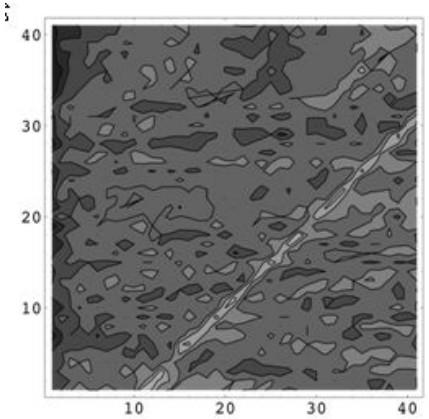
Effects on Beam_Ohmi_1

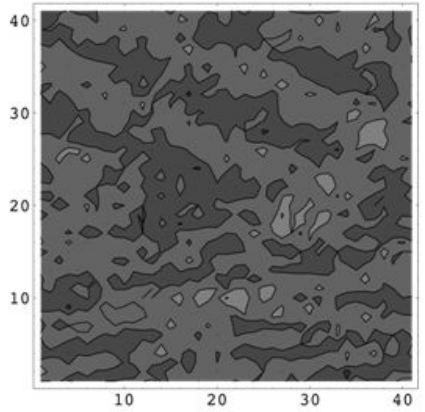
- Incoherent emittance growth
- KEK: Beam size was measured for changing fill pattern, which means changing electron density.
- Electron cloud weakened chromatic synchro-beta resonance, rather than causing emittance growth far from resonance.



Effects on Beam_Ohmi_1

- CESR-TA:Emittance growth was measured under the presence of electron cloud.





- Clear emittance growth related to resonances was not seen, even very high current 7mA/bunchx10bunch, 14ns.
- The resonance line nx-ny-2ns=n is weakened, similar to KEKB.

Effects on Beam_Flanagan_1

- Vertical synchro-betatron sidebands found at KEKB LER, which are associated with electron-cloud induced beam blow-up.
- Signal has since been reproduced in simulation, supporting interpretation of it being a signature of head-tail instability.
- Measurement of how coherent instability threshold scales is critical to design of future machines.
- This should be possible at CesrTA

  ==>This should be done at CesrTA

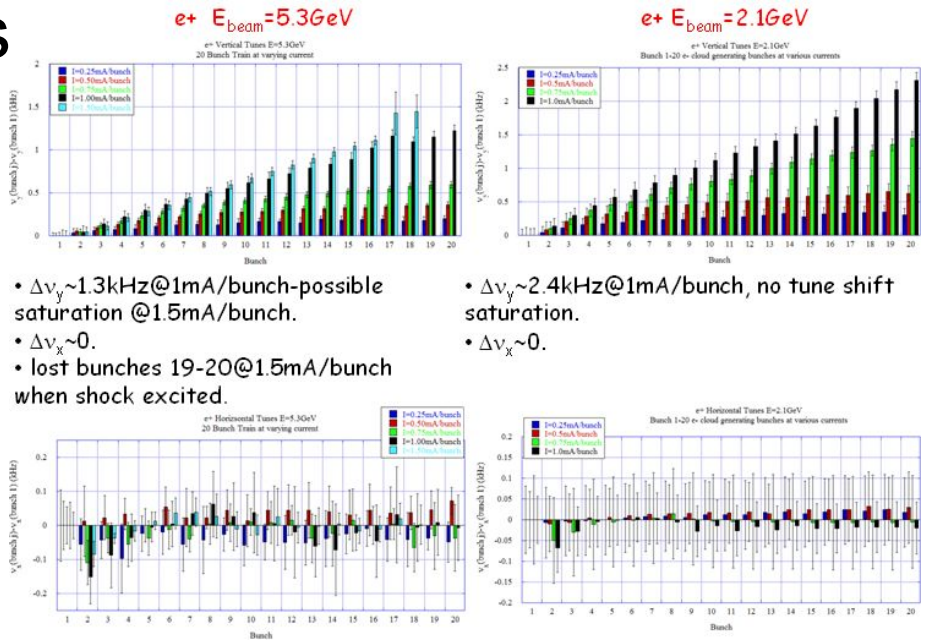
Measurement_Flanagan_2

- X-ray monitor to measure beam size with high resolution.
- To maximize bandwidth and minimize beam current dependence we are investigating the use of coded aperture imaging techniques which could be useful for general beam profile diagnostics at CesrTA, SuperKEKB, and elsewhere.
- Measurements made at 2.1 GeV at CHESS B line show clear difference between “thin” and “fat” beams.
- Beams looks much larger than expected, with both Coded Aperture and 40 um slit (thin=220-240 um, fat=290 um), but in crude agreement with Mike Billing’s estimate of beam size from previous day's orbit data (200 um).
- Current beamline has complicated background structure (Be striations? possible scattering?) -- will be examining this afternoon. October beamline is hoped much cleaner.

Effects on Beam_Holtzapple_1

- Tune shift measurement using witness bunch
- Use long trains e+/e- bunches to generate a electron cloud density.

  Place witness bunches at varying times after the generating train and measure the coherent tune shift of the witness bunch.



Effects on Beam_Holtzapple_1

- For e+ generating trains:
  - vertical tune shift along generating train is positive and is larger at lower energy. Vertical tune shift saturation has not been observed.
  - horizontal tune shift is small
- For e- generating trains:
  - vertical tune shift along generating train is negative and its magnitude is smaller than for e+ trains. No significant difference in vertical tune shift between low and high energy trains at low bunch current.
  - horizontal tune shift is small
- The decay time for the tune shift is approximately 200ns or longer.

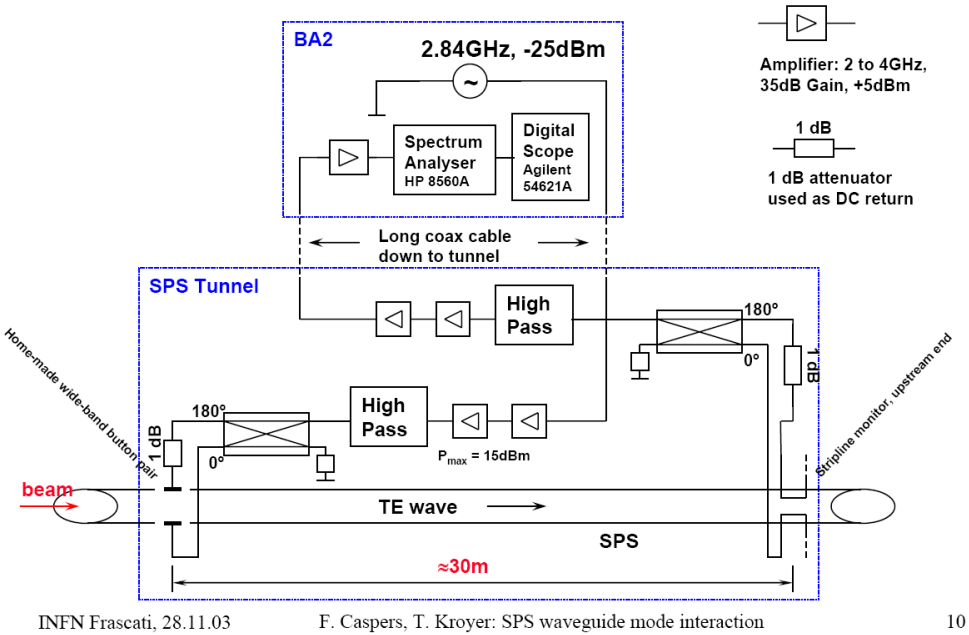
Measurement_Caspers_1

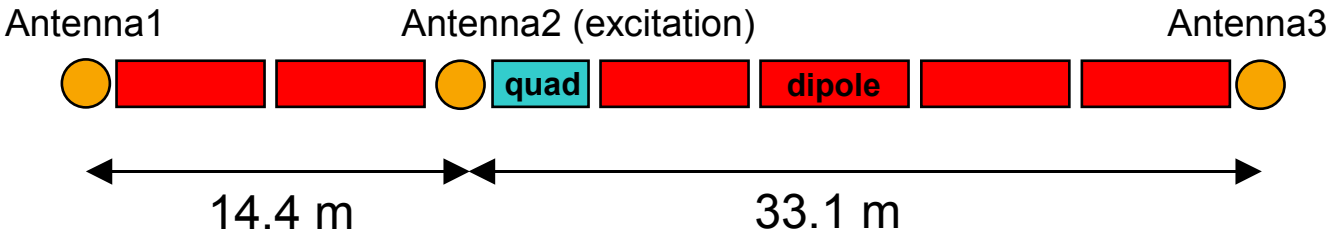
- TE wave transmission measurements made to measure cloud density at SPS

Principle idea:
"When electromagnetic waves are transmitted through a not too dense plasma, they experience a phase shift and possibly a small attenuation"

- Setup similar to 2004 measurements

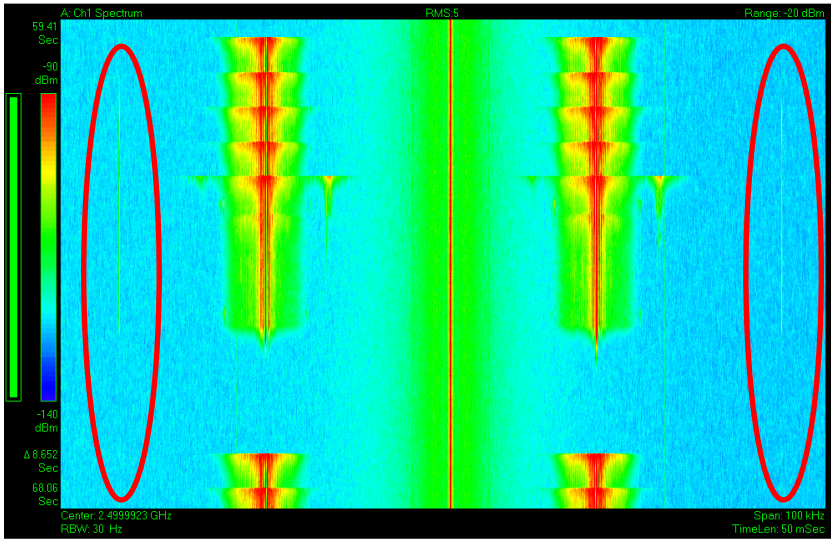
Measurement set-up





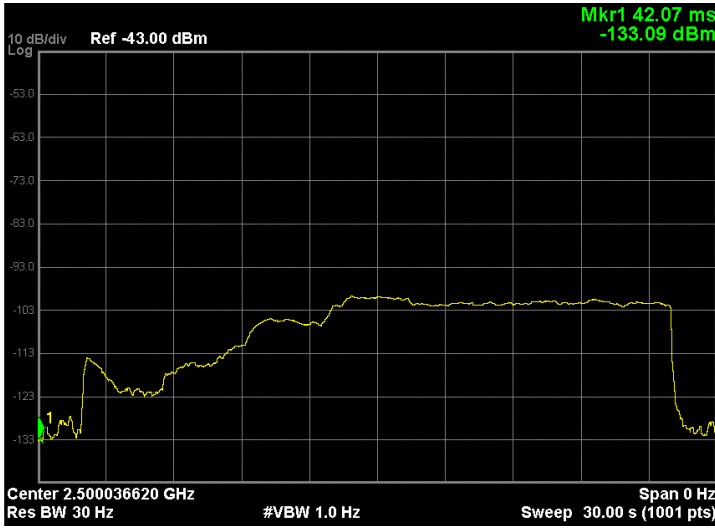
Measurement_Caspers_1

•Frontend filters reduced previously seen seen intermodulation problem. Phase demodulation function strongly recommended for the elimination of residual AM contamination.



•**First electron cloud transmission experiments performed during the 2008 SPS scrubbing run in June have shown very promising results in BA5.** The presence of electron clouds was identified simultaneously with button pickups.

•Microwave transmission over a full LHC arc at cryogenic temperature has been already successfully demonstrated around 7 GHz. **The technique discussed here can be directly applied for integral electron cloud diagnostics over a full arc in the LHC**.



Intensity of the modulation sideband vs time in logarithmic scale

Proposal for CESR-TA program

- Measurement of cloud
  - Thin RFA is prepared for wiggler section
  - Microwave transmitting method with better hardware
  - How about in Q-magnet or in solenoid field?
- Measurement of effect on beam
  - Tune shift measurement
  - Measurement of coherent instabilities
  - Measurement of incoherent emittance growth
  - Development of technique for X-ray beam size monitor
- Provide valuable data for verification of simulation codes.