

# Stack-tail Improvements: Present and Planned

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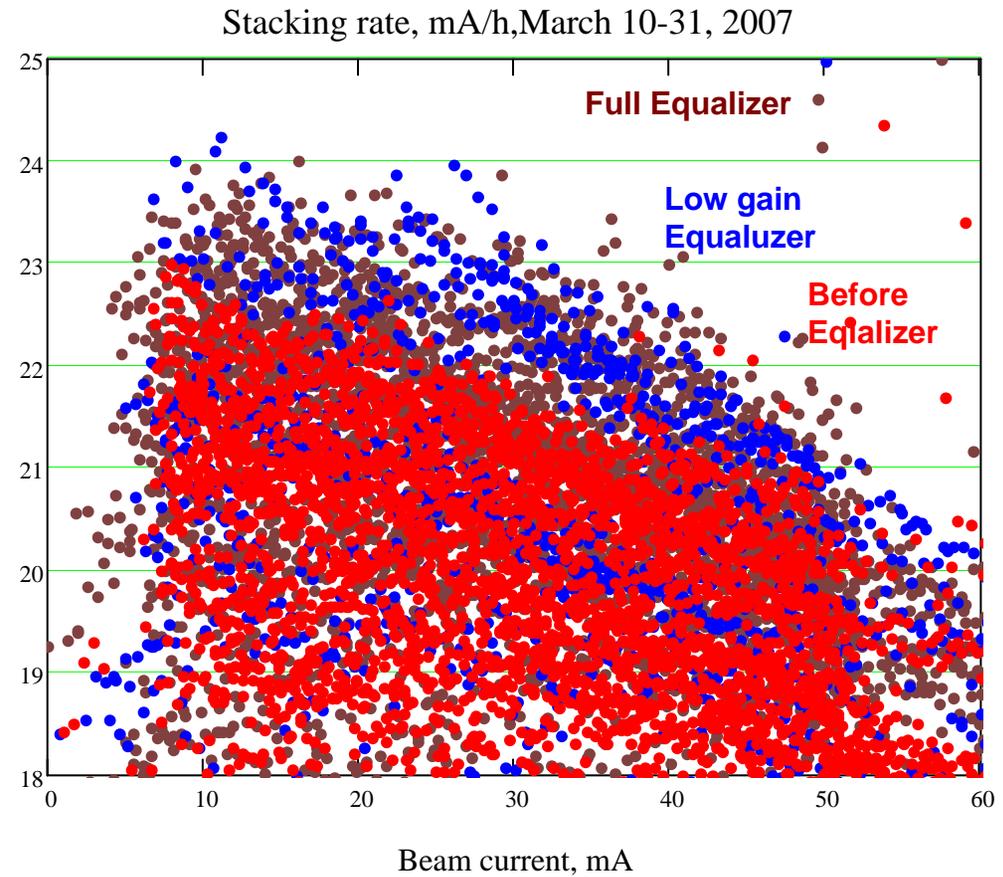
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All Experimenters' Meeting  
FNAL  
April 2, 2007

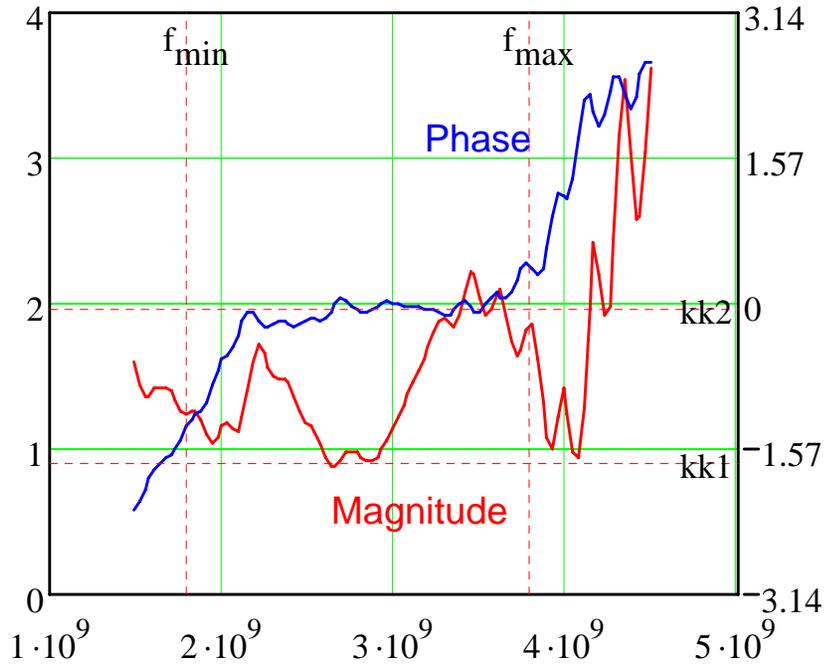
# Recent Work on Equalizer

- Beginning of January
  - ◆ Stack-tail model is built
  - ◆ Specifications for prototype equalizer are formulated
- January - February
  - ◆ Equalizer designed & built, D. Sun
- March 12, first attempt to install equalizer
  - ◆ Took too long time to install
  - ◆ Other problems (4-8 core cooling)
  - ◆ Acquired data
    - Next day data analysis - gain at high frequencies is too large !!!???
  - ◆ Withdrew Equalizer
- March 19, equalizer with reduced gain at high frequencies is installed
  - ◆ New massive measurements - learned how to do it correctly
  - ◆ Performance is close to expected one
  - ◆ Stacking record for one hour - 23.10 mA on 22-Mar-07 (+ ~0.5 mA/hour)
- March 22 final version of prototype equalizer is installed
  - ◆ 25-26 mA/hour expected - no further stacking rate improvement observed



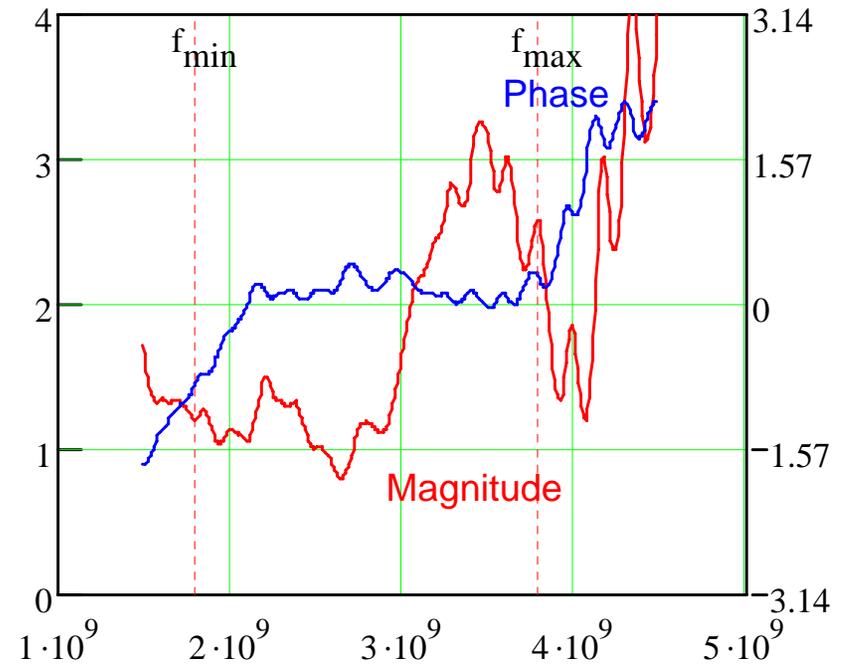
# What Equalizer does?

- It corrects phase and magnitude of the gain so that to achieve maximum bandwidth



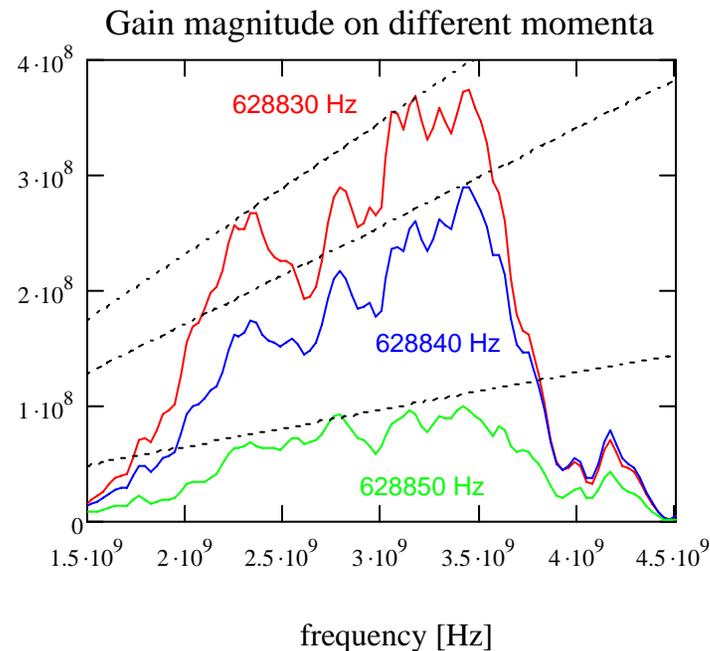
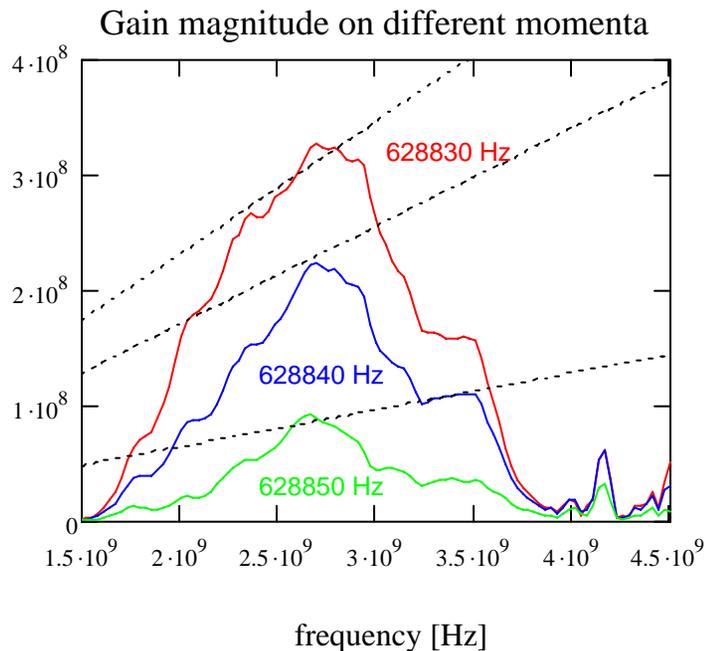
frequency [Hz]

*Equalizer with reduced gain at high frequency*

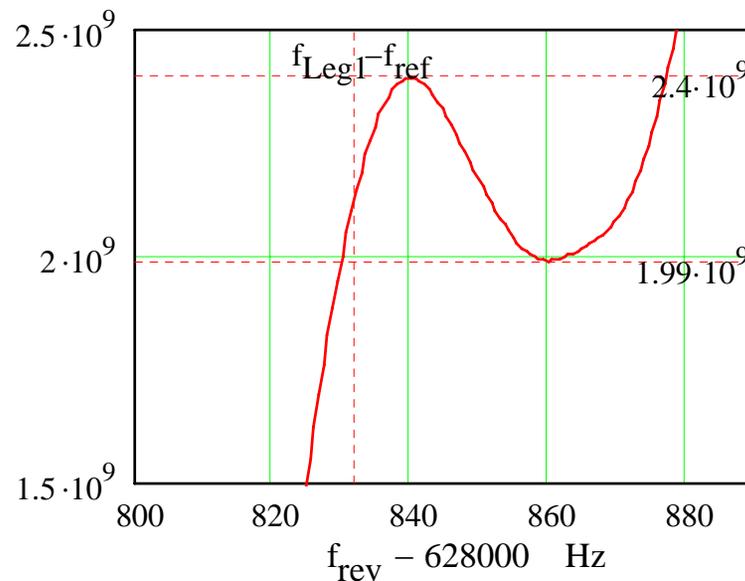
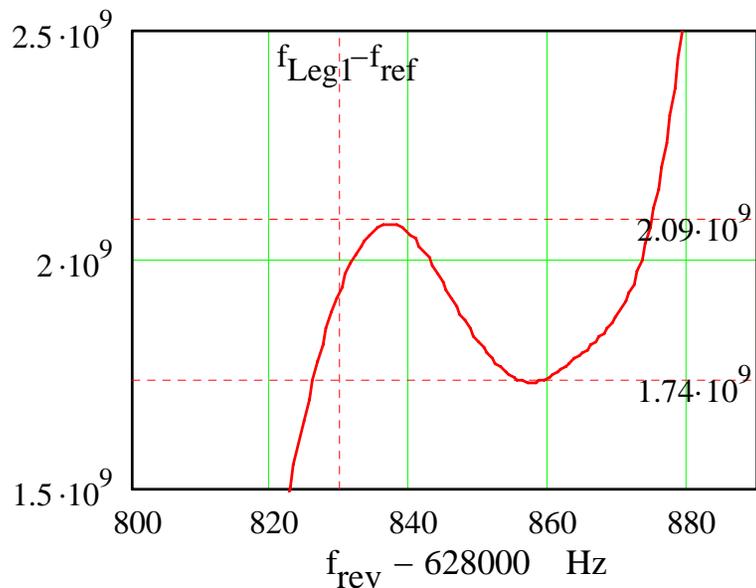


frequency [Hz]

*Present equalizer*

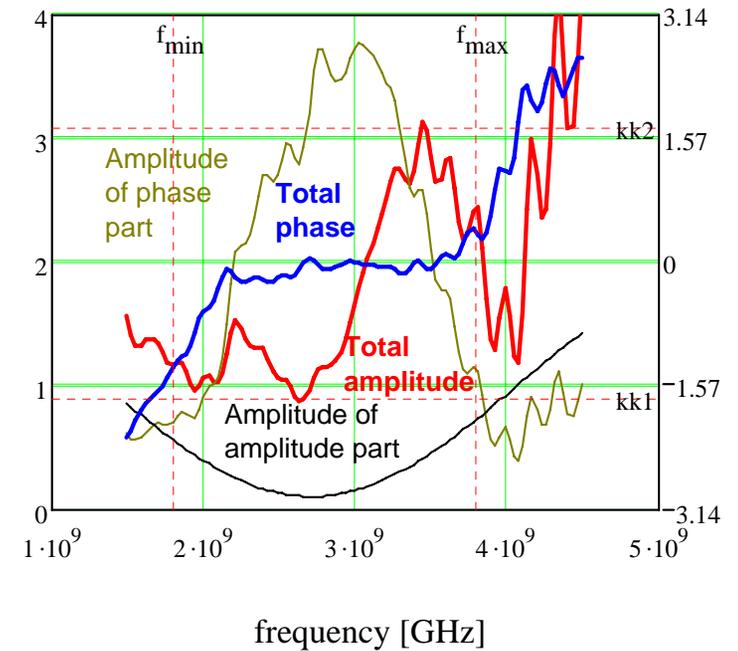
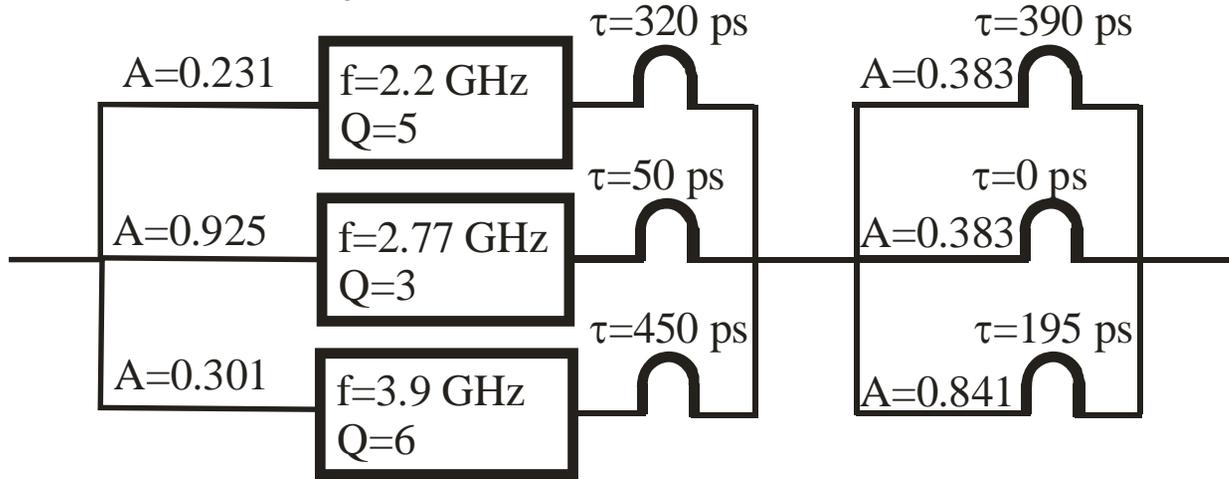


*Dependence of stack-tail gain on frequency before and after installation of the equalizer*



*Dependence of effective bandwidth before and after installation of the equalizer (~15% growth)*

# How the equalizer is built



## Equalizer specifications

- Phase part corrects phase
- Amplitude part corrects amplitude so that to get the total amplitude as desired

$$K_i(\omega) = \frac{A_i}{1 + iQ_i \frac{\omega^2 - \omega_i^2}{\omega\omega_i}}, \quad i = 1, 2, 3$$

$$K_A(\omega) = 1 + 0.91 \cos(\omega\tau), \quad \tau = 195 \text{ ps}$$

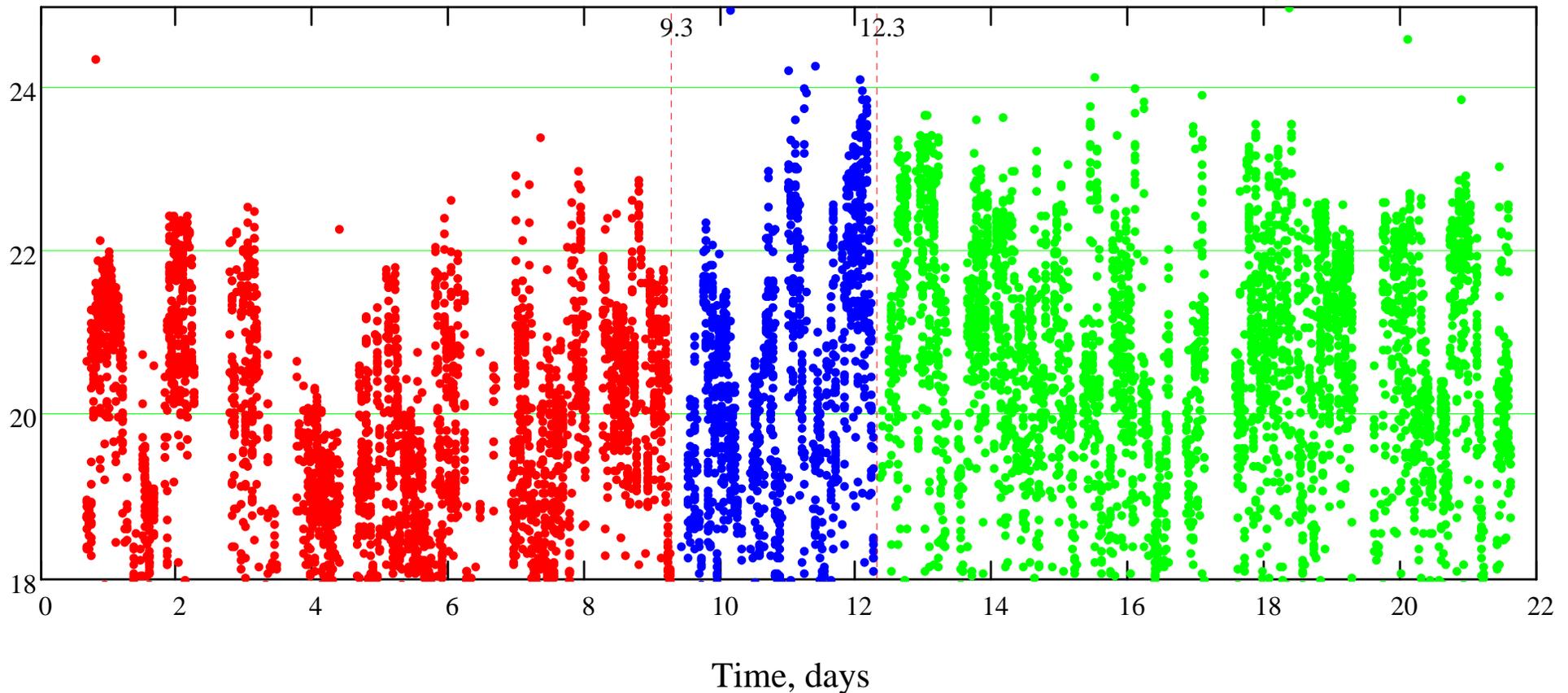
$$K_{tot}(\omega) = K_A(\omega)(K_1(\omega) + K_2(\omega) + K_3(\omega))$$



Equalizer on March 6, 2007 (no amplifier yet)

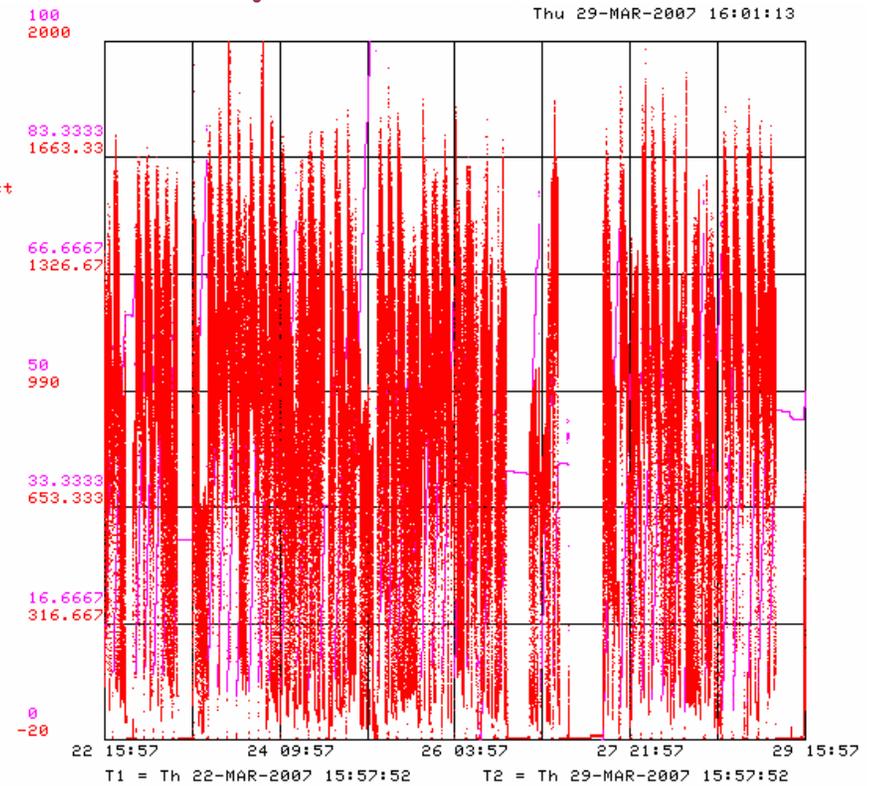
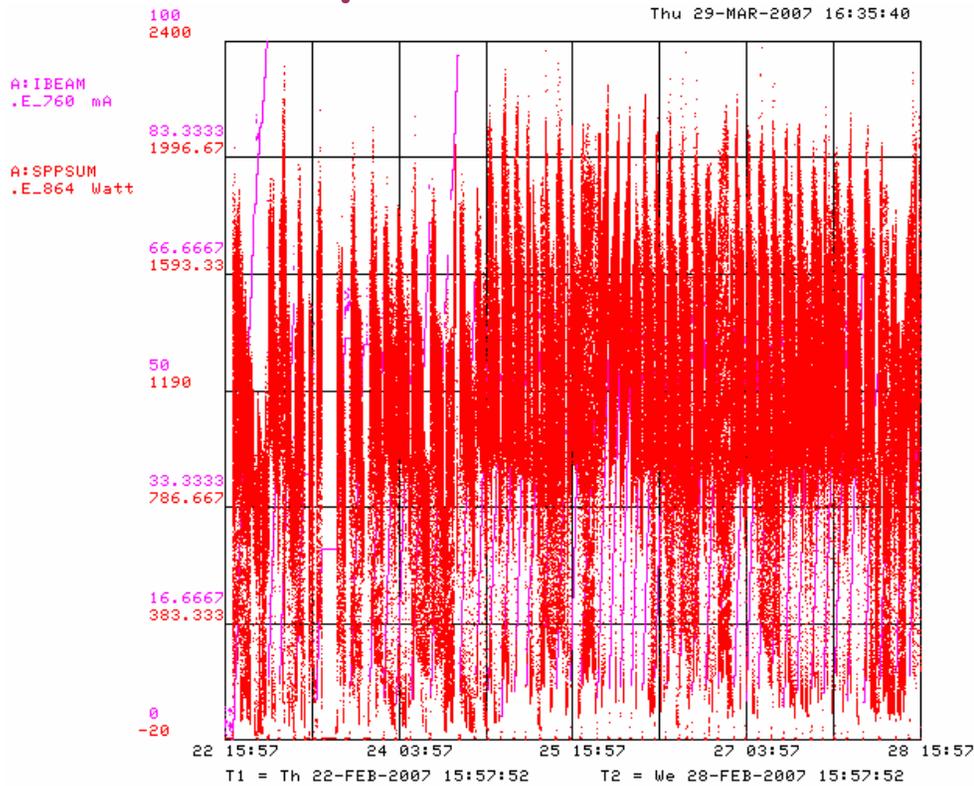
# Stack-tail performance with and without equalizer

Stacking rate, mA/hour, March 10-31, 2007

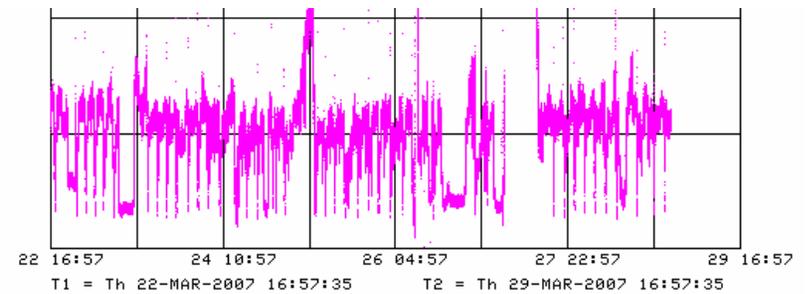
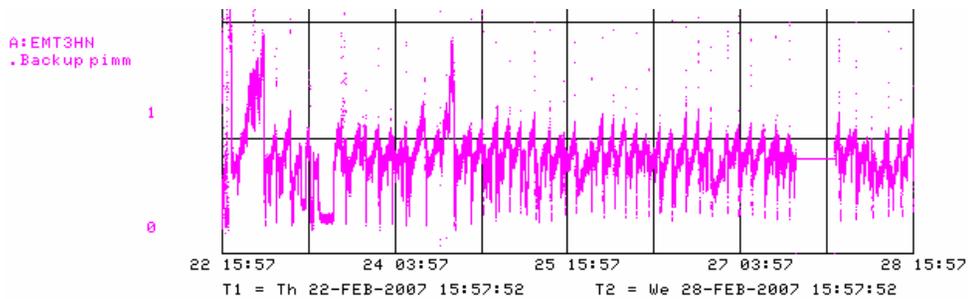


- Open loop measurements carried out after installation of equalizer proved that the stack-tail is phased correctly
- It is also verified by reduction of total stack-tail power by ~20%
  - ◆ Presently we cannot keep the same power as before because heating of core longitudinally and transversely

# Stack-tail performance with and without equalizer (continue)



*Total stack tail power*



*Horizontal emittance*

*Feb. 22-28*

*March 22-28*

# Plans

## ■ April 3

- ◆ Moving tanks where legs 2 and 3 are located by ~6 mm radially out
- ◆ Using leg 3 should help to achieve better phasing across the stack-tail

## ■ Next 2-3 weeks

- ◆ New optics in Accumulator
  - Additional shunts are already installed
  - Increased slip factor by 18% - should produce proportional increase effect on the stacking rate

## ■ Second half of May

- ◆ Final equalizer will replace the present prototype equalizer

## ■ Better understanding of beam heating will determine the final value of stacking rate

- ◆ Improvement from present 24 mA/hour to 30 mA/hour (+25%) still looks tough but achievable
  - Certainly more difficult than it looked 1 month ago

## ■ 20% increase during last half year was achieved