

# Stacktail Momentum Cooling for Run IIb

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23-Sep-01

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- ✍ Range 50-60 mA/hour
- ✍ Accumulator for short term storage
  - ? ~15-30 minutes between transfers
- ✍ Recycler as storage ring
- ✍ Design ideas as they stand

# Stochastic Stacking

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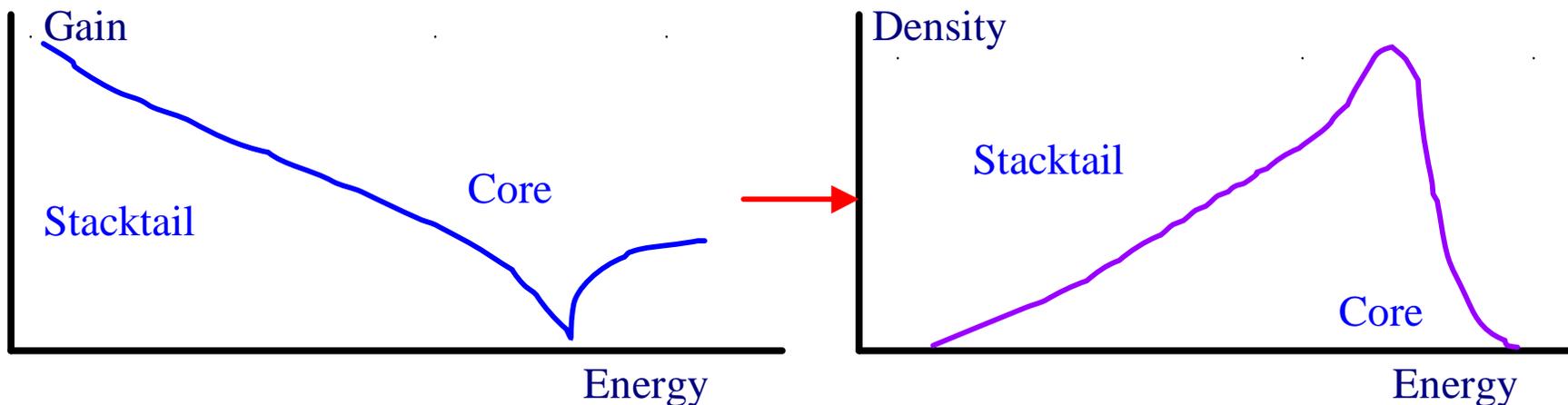
Simon van Der Meer solution:

? Constant Flux:  $\frac{??}{?t}$  ? constant

? Solution:  $\frac{??}{?E}$  ?  $\frac{?}{E_d}$ , where  $E_d$  characteristic of design ? = ?  $_0 \exp\left\{\frac{??E ? E_i ??}{?? E_d ??}\right\}$

? Exponential Density Distribution generated by Exponential Gain Distribution

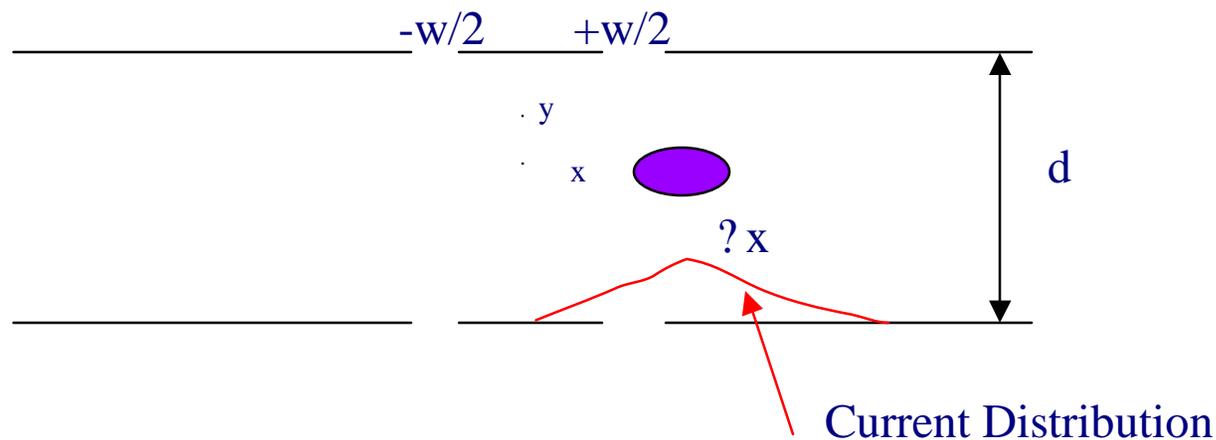
? Max Flux =  $(W^2|? |E_d)/(f_0p \ln(2))$



Using log scales on vertical axis

# Creating Exponential Gain Distribution

- Current intercepted by pickup



$$I = \frac{I_{beam}}{2} \frac{\tan^{-1} \left( \frac{\sinh \frac{w}{2d} x}{\cosh \frac{w}{2d} x} \right)}{\cosh \frac{w}{2d} x}$$

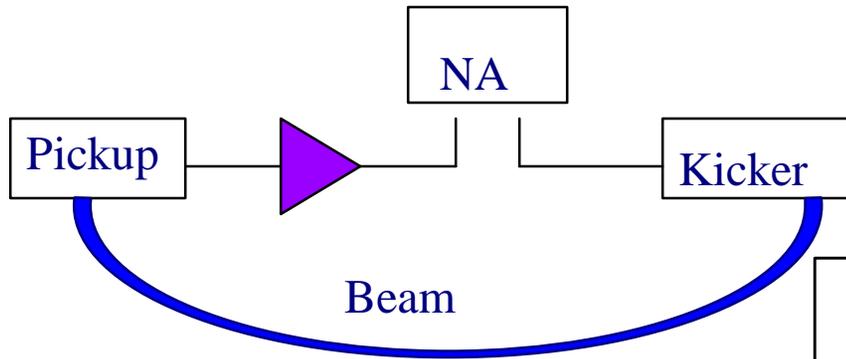
$$\approx \frac{I_{beam}}{2} \exp \left( -\frac{w}{d} |x| \right) \text{ for large } |x|$$

- Placement and aperture of pickups to give proper gain shape

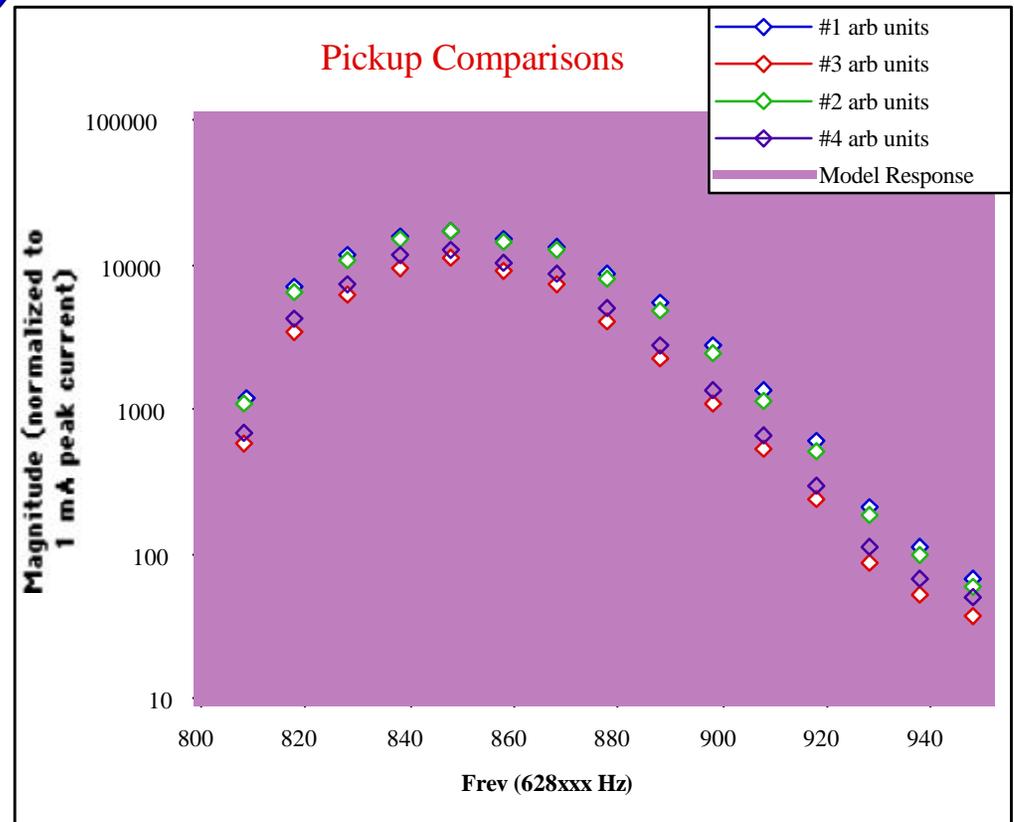
# Prototype measurements compared to predicted shape

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Place pickups in region with large Dispersion,  $\sigma_x \sim \sigma_E$



✍ Not quite as simple:

? -Real part of gain cools beam

? frequency depends on momentum

?  $f/f = -? ? p/p$  (higher  $f$  at lower  $p$ )

? Position depends on momentum

?  $x = D? p/p$

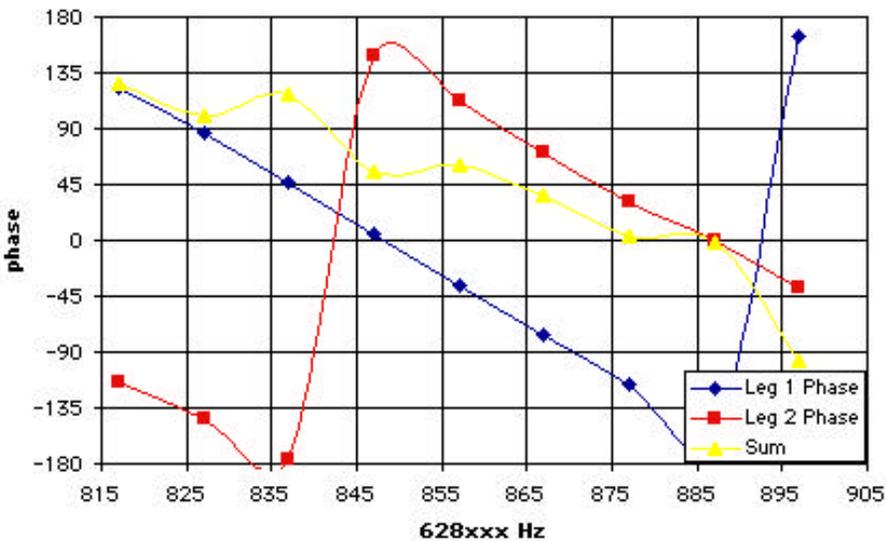
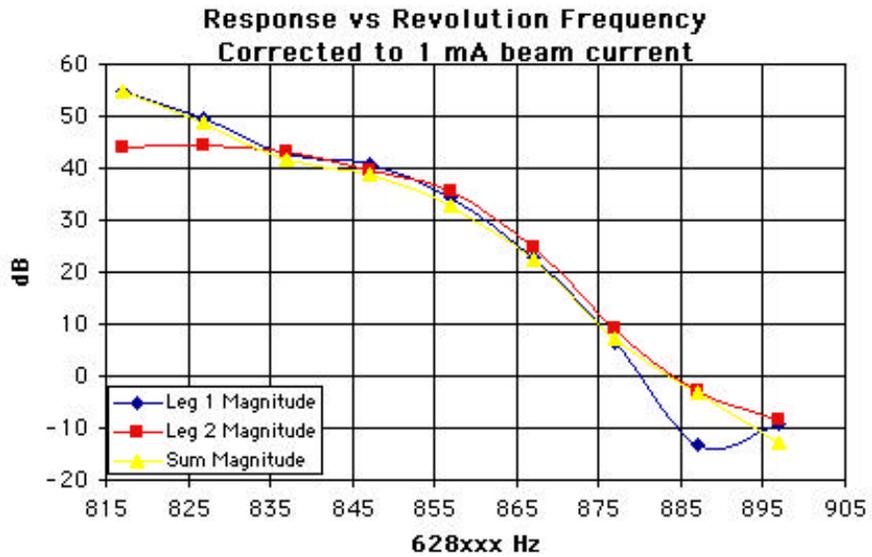
? Particles at different positions have different flight times

? Cooling system delay constant

» **OUT OF PHASE WITH COOLING SYSTEM AS MOMENTUM CHANGES**

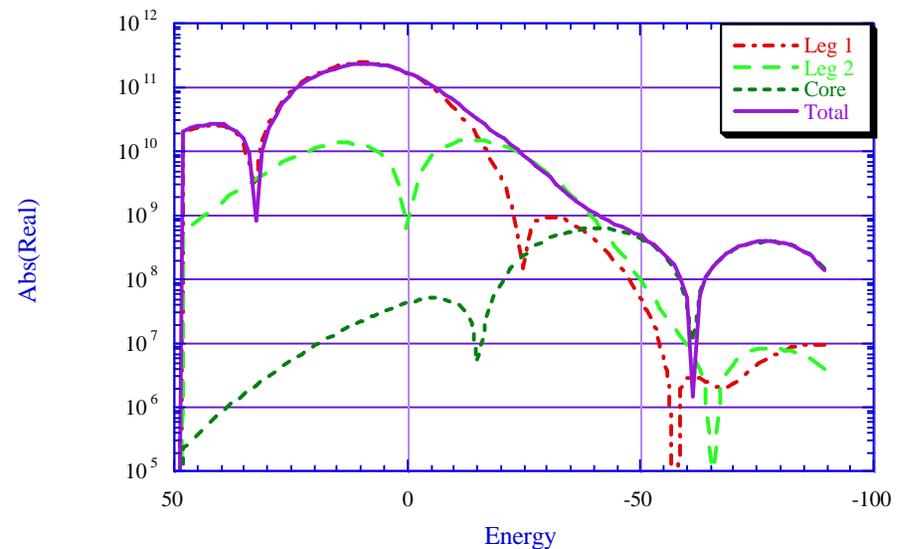
# Fine Tuning....

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Use two sets of pickups at different Energies to create exponential Distribution with desired phase Characteristics

Also have to match into core!



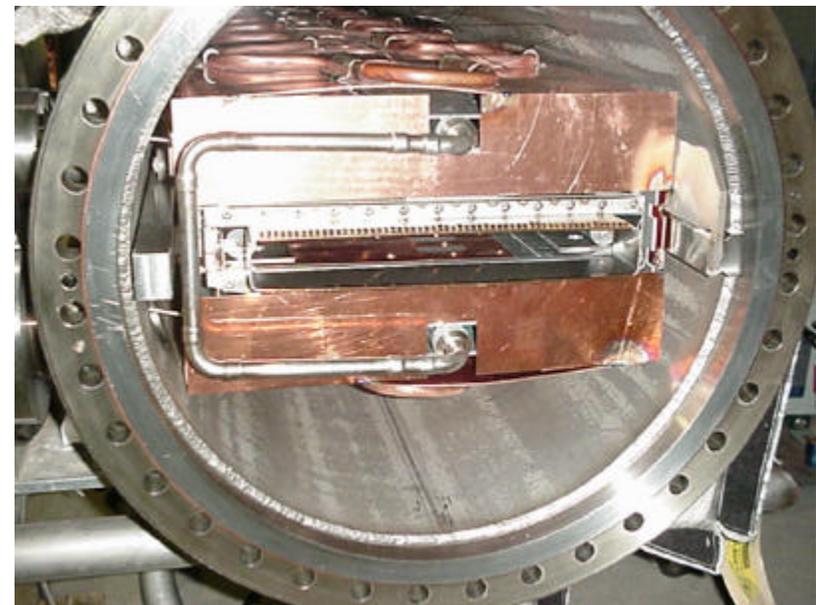
## Changes for Run IIb

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- ✍ Current stacktail:  $E_d \sim 6.3$  MeV (design goal was 10 MeV)
  - ? Max Flux  $\sim 30$  mA/hour
- ✍ As  $E_d \sim$  aperture (gain  $e^{-(p^2 x/d)}$ ), double aperture, double  $E_d$ !
- ✍ One Possibility:
  - ? Use same pickups, electronics, kickers, etc
  - ? Widen pickup aperture!
  - ? Minor rework of tank interiors
    - » Unless go to L He?
  - ? Need more TWTs!?!



## Changes for Run IIb

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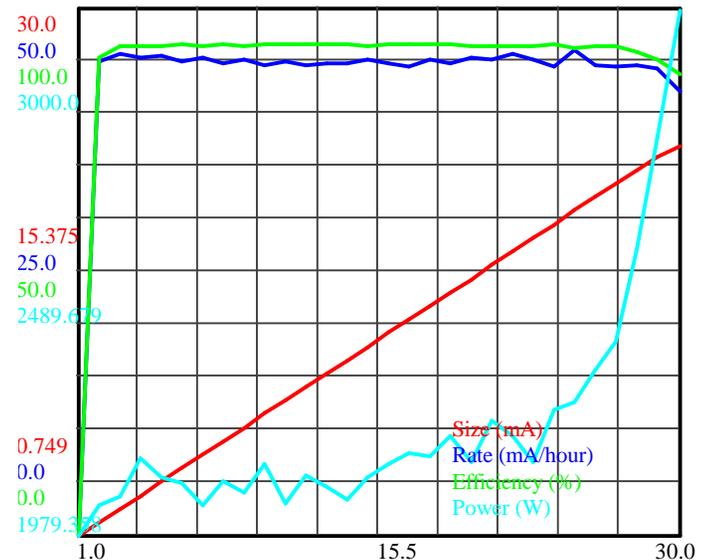
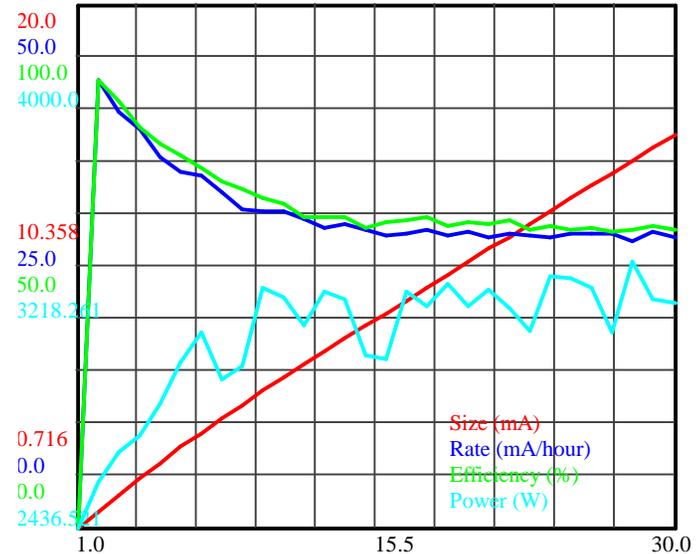
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- ✍ Increasing aperture decreases sensitivity
    - ? Increase stacktail electronic gain to move beam off injection orbit -- may be limiting more than gain slope
      - » 67% increase from current size in 40% decrease in response!
      - » More noise power in the system (1200 W stacktail)
      - » Raises the gain of the stacktail at the core
      - » Need to increase core gain to match at transition (by ~10 dB)
        - 200 W noise power!
  - ✍ Combination of effects makes it more difficult to have large stacks
    - ? Noise and Mixing terms blow the core up longitudinally as current increases
    - ? Will probably have transverse problems also

# Simulation Results

- ✎ With aperture of 3.3 cm
  - ? Input 50 mA/hour
    - » Power ~ 3-3.5 kW
    - » Stack rate ~ 30 mA/hour

- ✎ With aperture of 5.5 cm
  - ? Input 50 mA/hour
    - » Power ~ 2-2.5 kW
    - » Stack Rate ~45 mA/hour

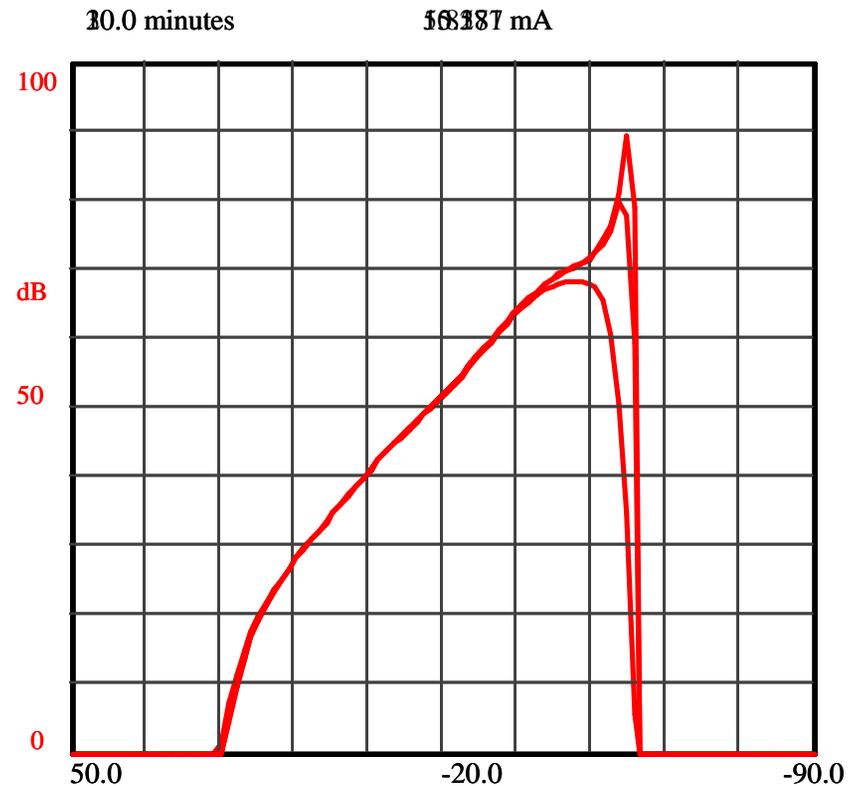


# Core Development Run II Stacktail

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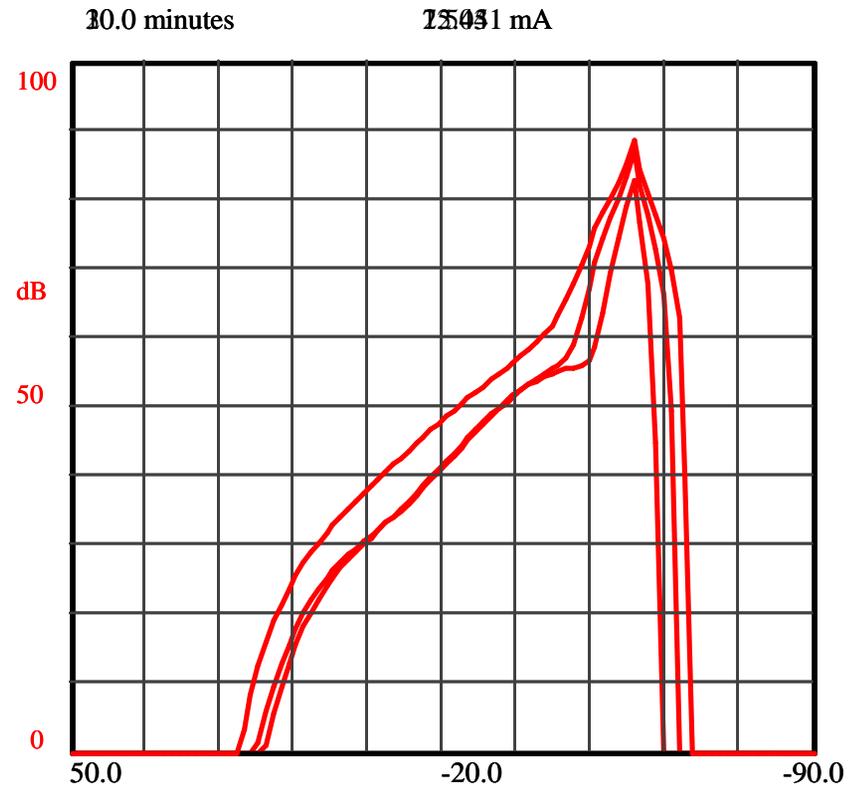
- ✍ @ 10, 20, 30 minutes
- ✍ Do not have a well defined core until after 20 minutes
  - ? Significant beam in stacktail!
- ✍ Wait for beam to cool in before transfer?



# Core growth Upgraded Stacktail

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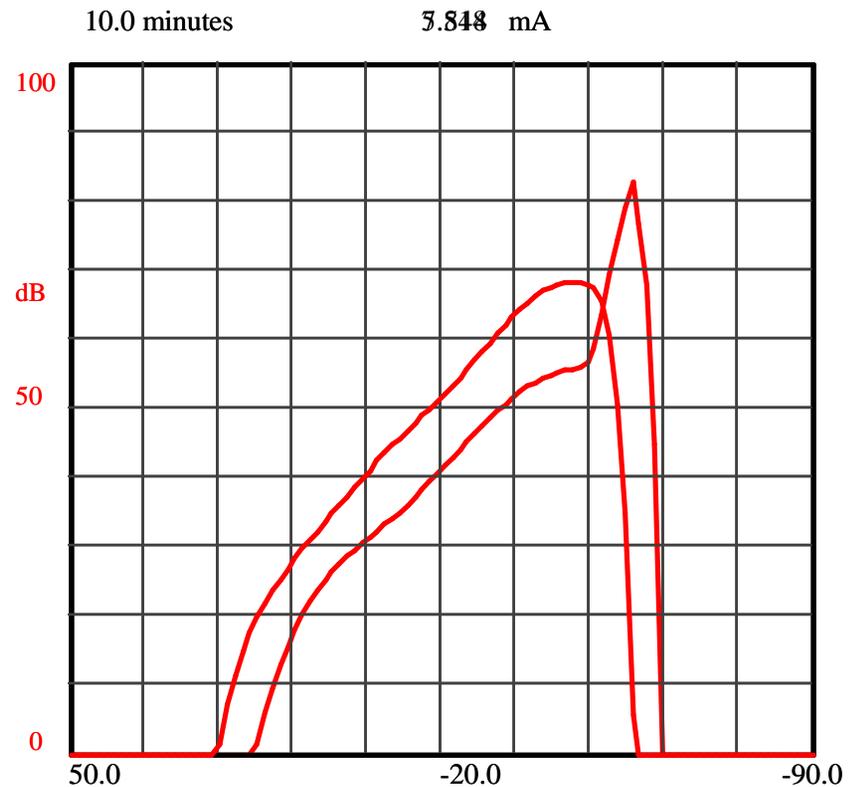
- ✍ @ 10, 20, 30 minutes
- ✍ After ~15 minutes, core system unable to contain beam!
- ✍ Large increase in system power and core blows up longitudinally
- ✍ Want to transfer before this happens -- every 10 minutes?



# Comparing Density Distributions

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- ✍ Upgraded Stacktail  
moves beam to core  
faster
- ✍ Ratio of beam in core to  
beam in stacktail is  
higher



## Where does this go from here?

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- ✍ Open up aperture further:
    - ? Other effects keep from attaining goals
  - ✍ Liquid Helium pickups:
    - ? Drop noise power by factor of 4-5
  - ✍ Still need lots of gain to move beam past dropoff
    - ? Function of momentum width coming in  
thinner beam = less gain
  - ✍ Core performance will probably limit size in Accumulator

## Conclusions

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- ✍ Can design stacktail to accumulate  $>40$  mA/hour
    - ? Pickup aperture modification
    - ? Liquid Helium pickups
    - ? TWTs? May be limiting question
  
  - ✍ Changes necessitate more power, which causes core blowup
    - ? Dependent upon incoming beam -- coupled to Debuncher performance
    - ? Need to transfer regularly (~15 minutes)