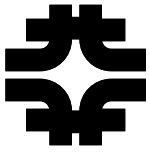


Fermilab

J. MacLachlan, BD/BP

Thursday 1 May 03

805 MHz μ-bunch in Booster

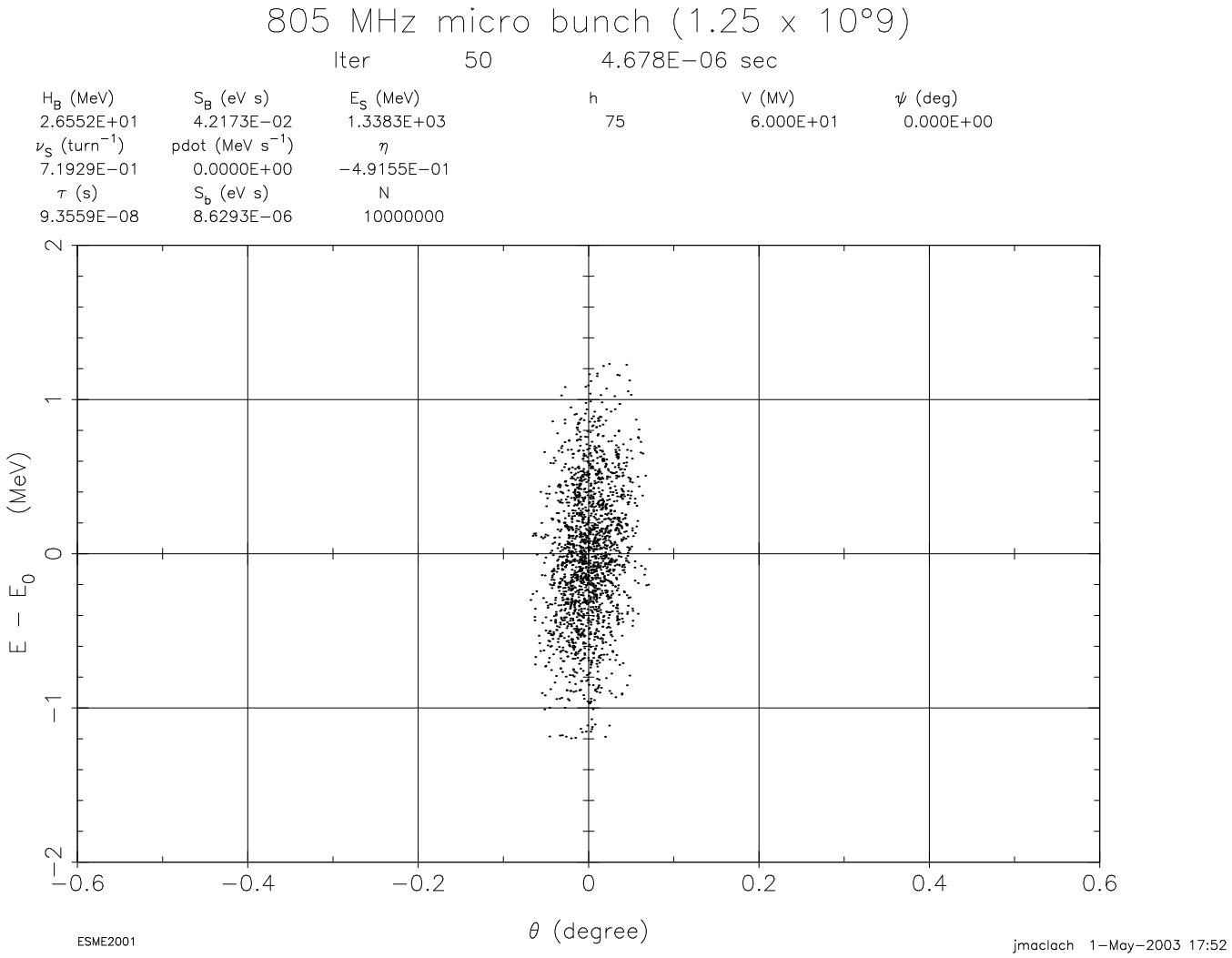
- Addressing only question of μ-bunch shape for one or two turns
- Complicated bunch shape argues for fine binning
- Statistics (granularity) a clear problem
- There is more than one source of granularity
  - macroparticle count
  - bin count
- Can use frequency or time domain calculation; techniques are complementary
  - time domain much faster
  - frequency domain gives simple digital filtering of high frequency component

Parameter Choices

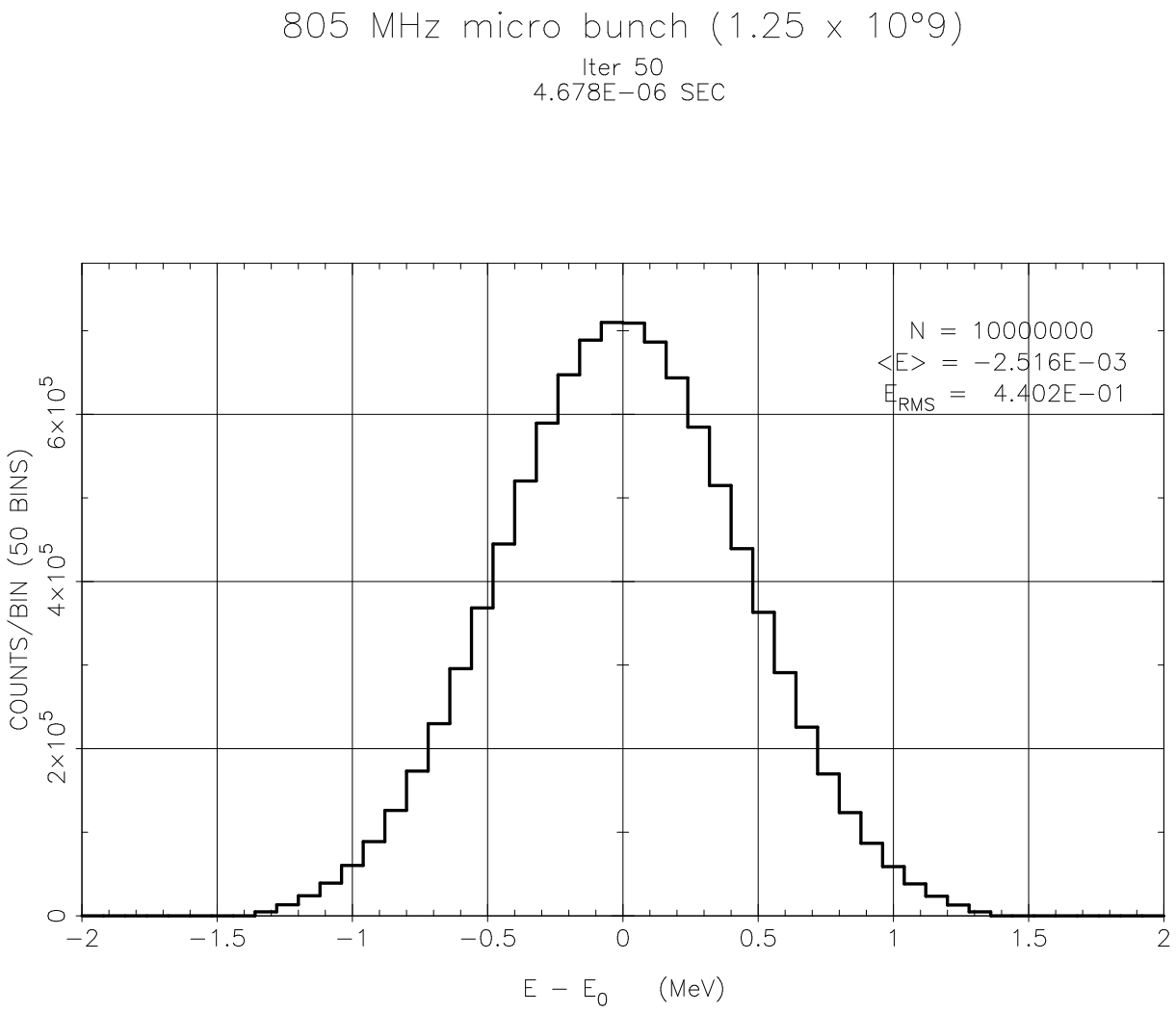
ε_ℓ (end linac)	$8.21 \cdot 10^{-5}$	eVs
ΔE (HW)	1.4	MeV
$\Delta\varphi$ at 805 MHz (HW)	9	deg.
number of protons	$1.25 \cdot 10^9$	
linac-debuncher separation	40.0	m
debuncher-booster separation	20.0	m

Discussion

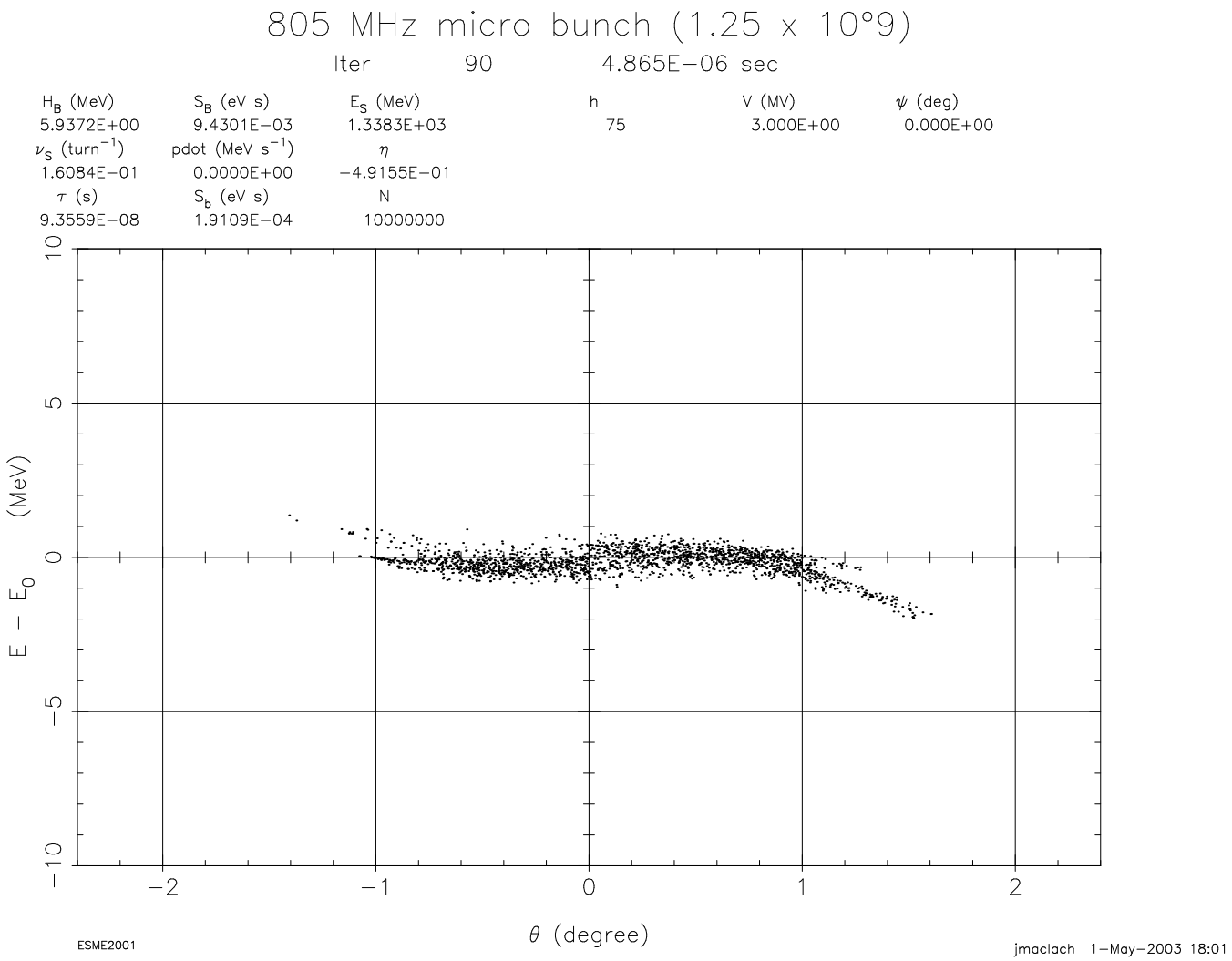
- linac-debuncher-booster sparations convenient, not precise
- bunch length at debuncher about $\pm 90^{\circ}$
- Booster first turn voltage at wrong azimuthal scale (program artifact, avoidable) Apparently no egregious bunch disruption.
- two turns with correct space charge voltage calculated to show beam charge effects in Booster
- collective voltage puts usfp in center of bunch
- following figures come from tracking of 10^7 macroparticles using 2000 bins for calculating the charge distributions



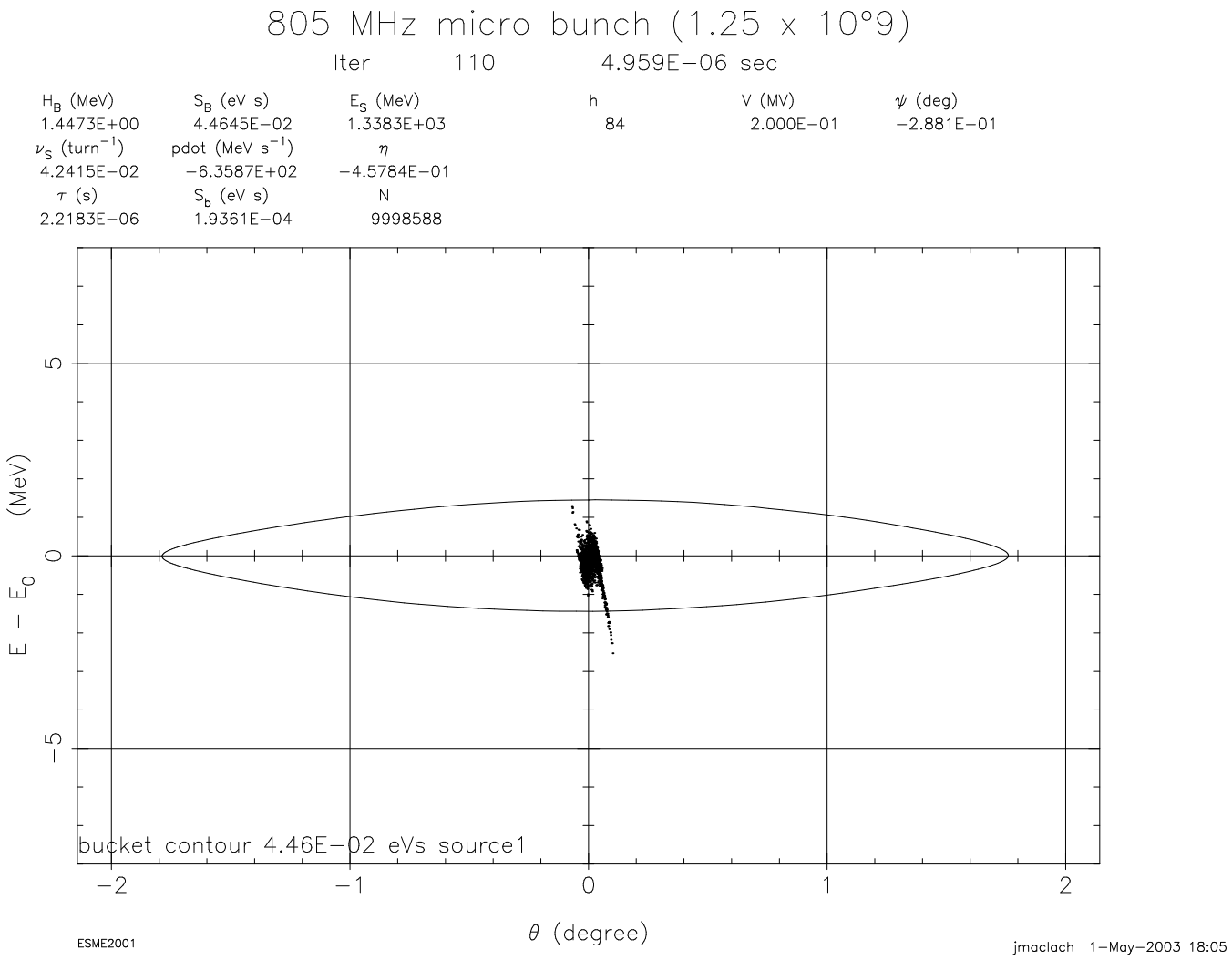
Longitudinal phase space plot of nominal bunch at end of 400 MeV linac, the starting distribution for results following The phase axis spans 45° of 805 MHz phase; energy axis is in MeV.



The energy projection of the linac bunch, truncated gaussian extending $\pm$ 1.4 MeV. The extremes of the phase projection (also gaussian) are $\pm 9^\circ$ of 805 MHz phase.

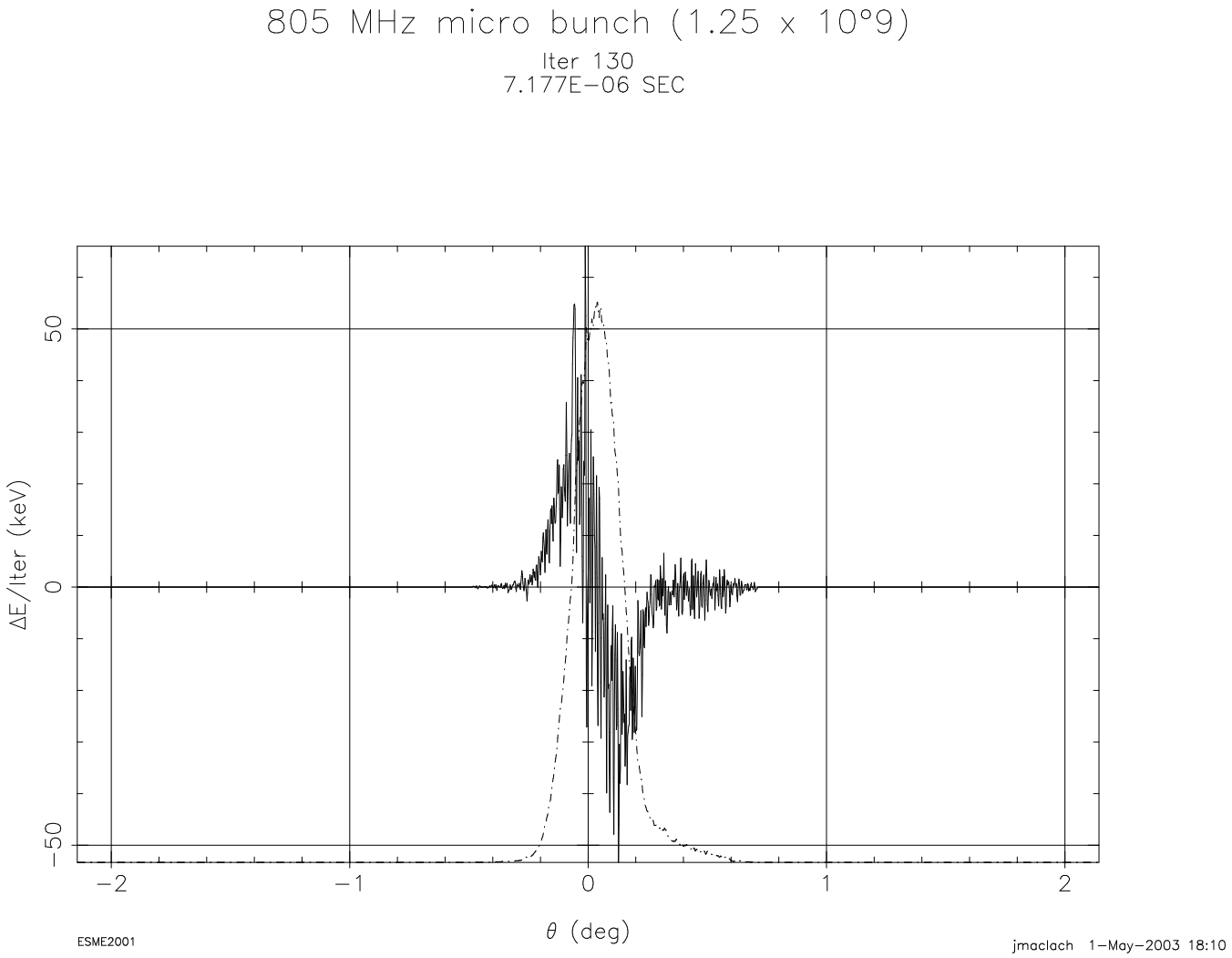


Linac bunch after debunching at 805 MHz 40 m downstream of the linac

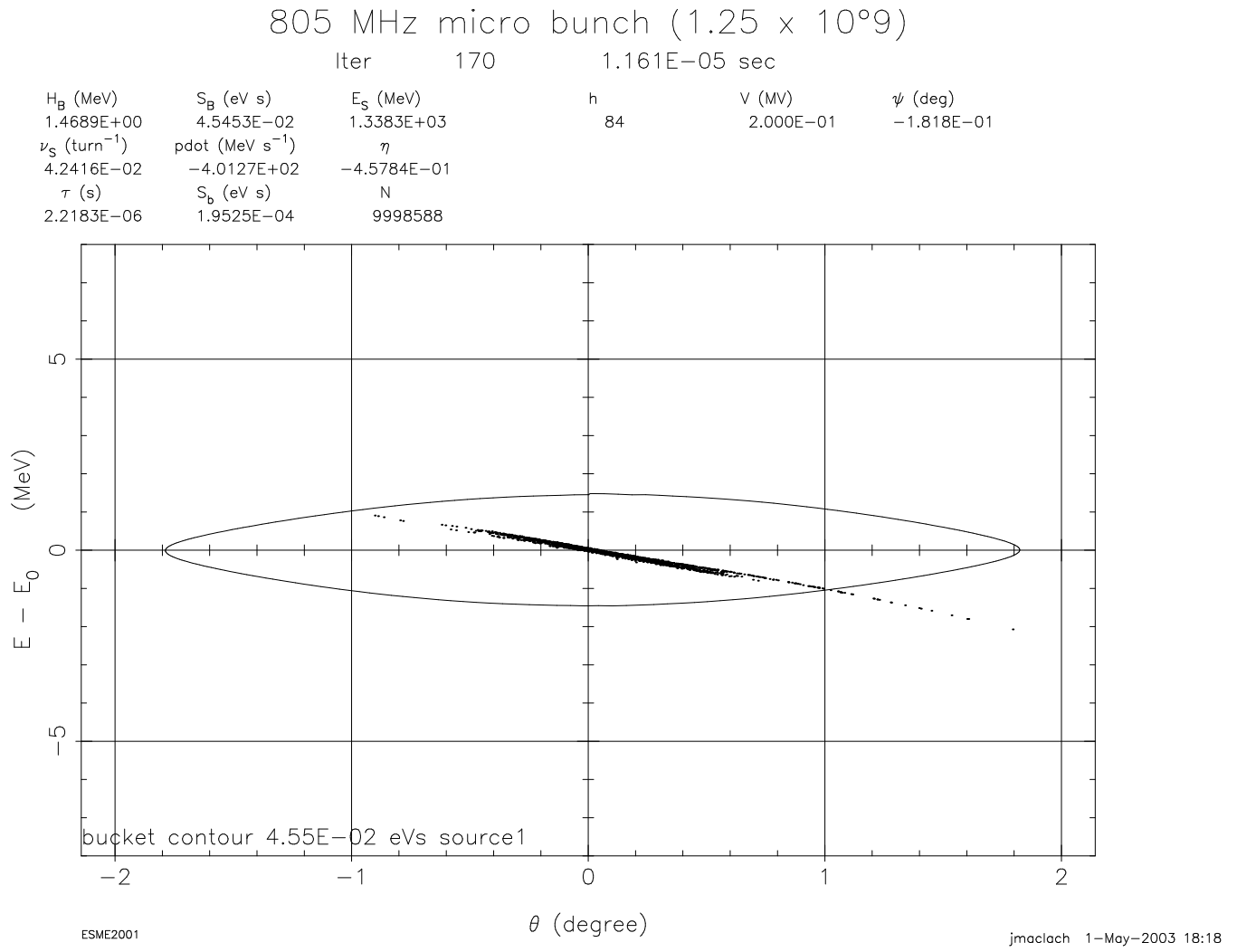


μ-bunch in booster after 20 m drift from debuncher

The phase axis is now in degrees of



The perfectly conducting wall voltage expressed as the energy loss or gain for 1/20 of a booster turn. Thus the voltage values are 20 times the values on the ΔE/iter axis.



The μ-bunch after 3 turns in the booster without additional beam injection

Results

- μ-bunch maintains integrity
- voltage developed by one μ-bunch $\sim$ peak rf voltage at injection
- fast increase in rf necessary to stay ahead of growth arising from collective voltage (little to do with “adiabatic capture”)
- present result unlikely to effect conclusions drawn from existing (PWL) multi-turn injection calculations with lower statistics