MAIN INJECTOR RF CYCLE AND Z/N LIMIT

King-Yuen Ng

Fermi National Accelerator Laboratory Batavia, IL 60510, U.S.A.*

From the two possible rf cycles of the Main Injector supplied by P. Martin, the bunch length and bunch height were computed. We also computed the Z/n stability limit for longitudinal microwave growth. The results are plotted in Figs. 1 to 9 for the first cycle and Figs. 10 to 18 for the second cycle.

In our computation, we assume that the bunch starts with an area of 0.25 eV-sec and remains constant until transition is reached. After that the bunch area increases to 0.5 eV-sec and stays constant. The bunch length is the total length or two times the half-length. The bunch height is the half-height expressed in $\Delta E/E$. These are calculated using approximate formulas for an accelerating bucket. The results are therefore only approximate.

For the computation of microwave threshold, we assume the bunch intensity to be $N = 5.1 \times 10^{10}$. The particle distribution inside the bunch is assumed gaussian with the bunch area $S = 6\pi\sigma_E\sigma_\tau$. Besides the region near transition, we notice that the Z/n threshold is lowest at the extraction end of the cycle. This is because the synchrotron frequency and $\Delta E/E$ are both small near extraction where the rf voltage has been reduced.

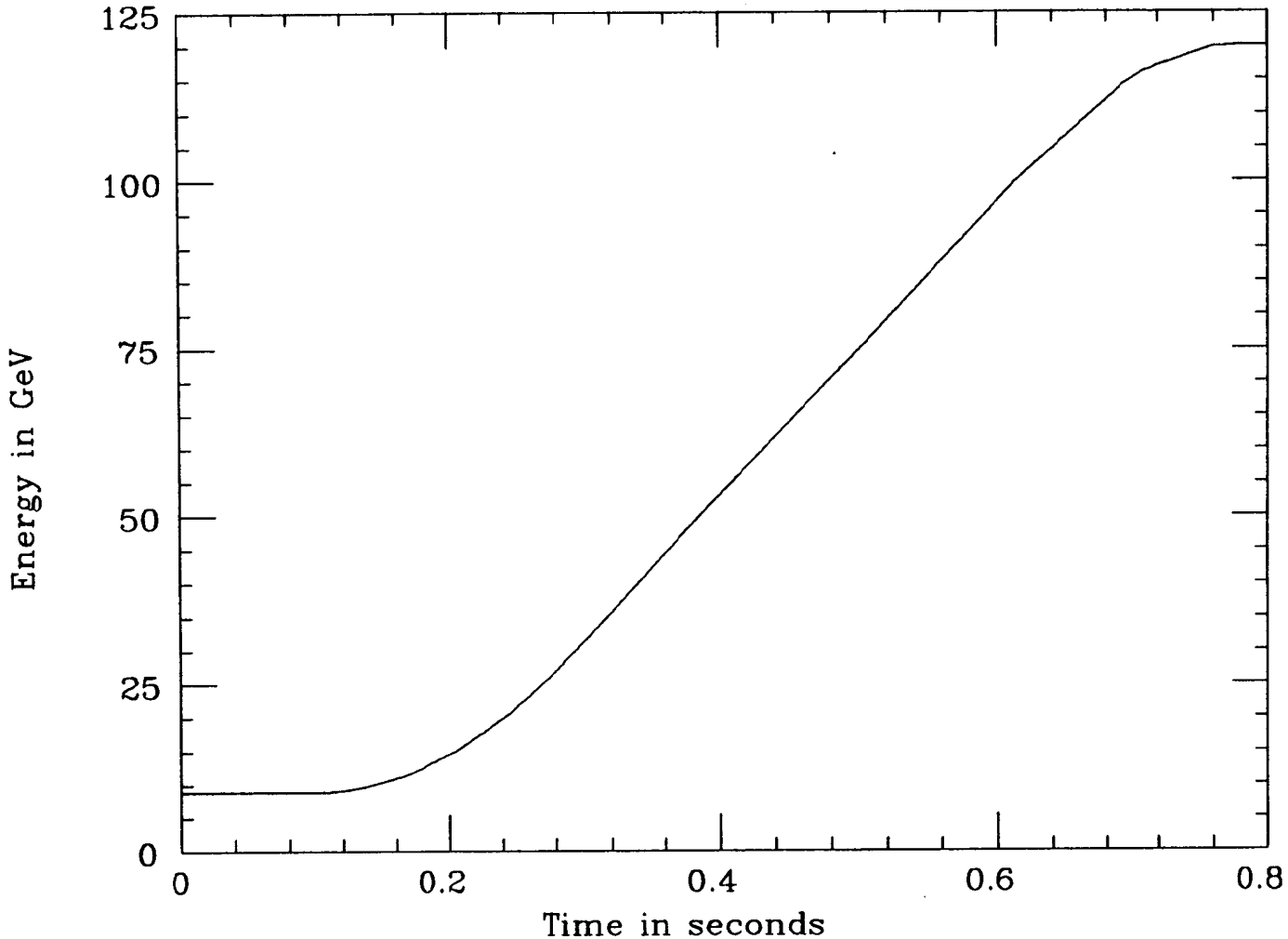


Fig. 1

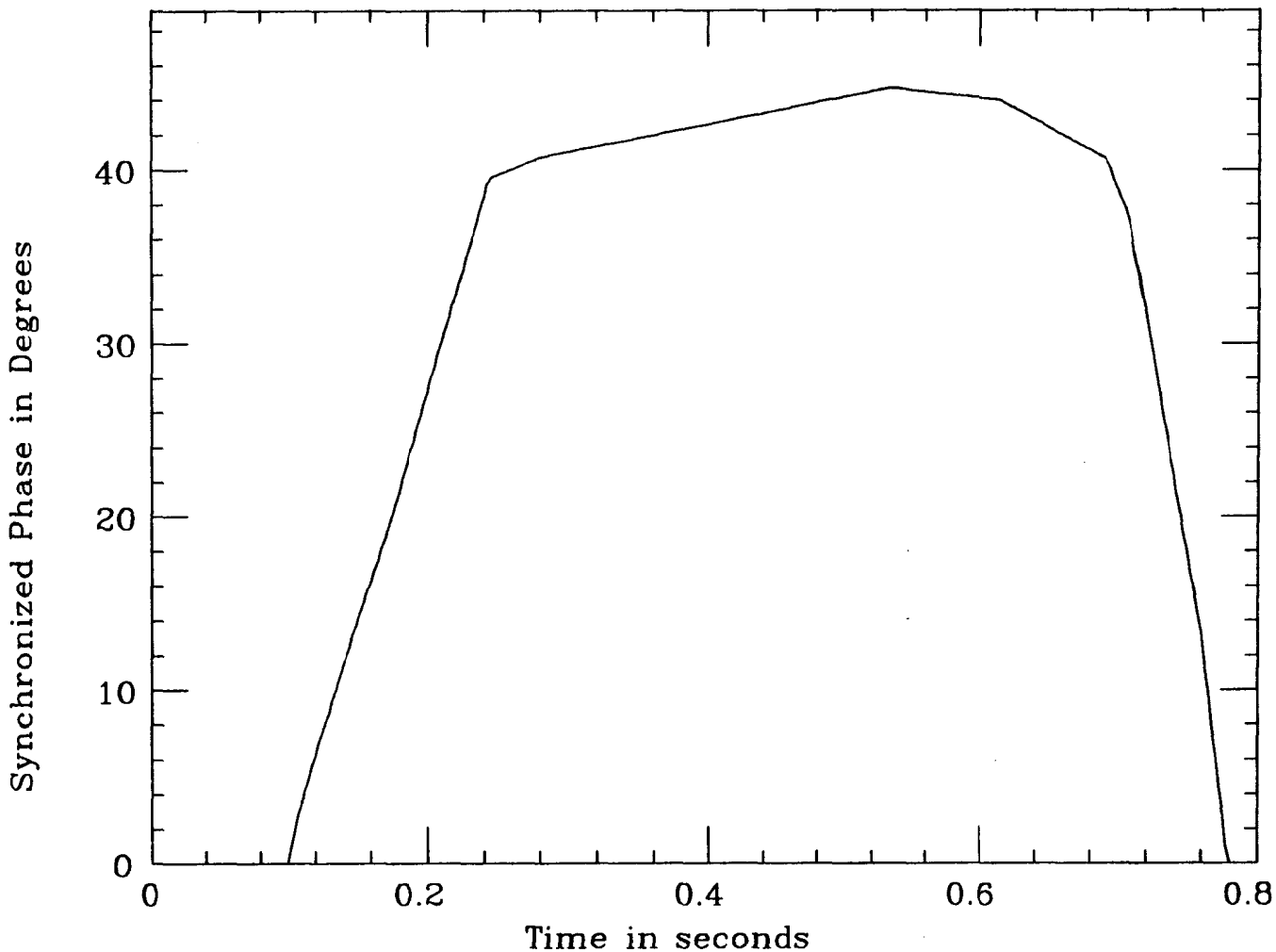

Synchronized Phase in Degrees
0
10
20
30
40
0
0.2
0.4
0.6
0.8
Time in seconds

Fig. 2

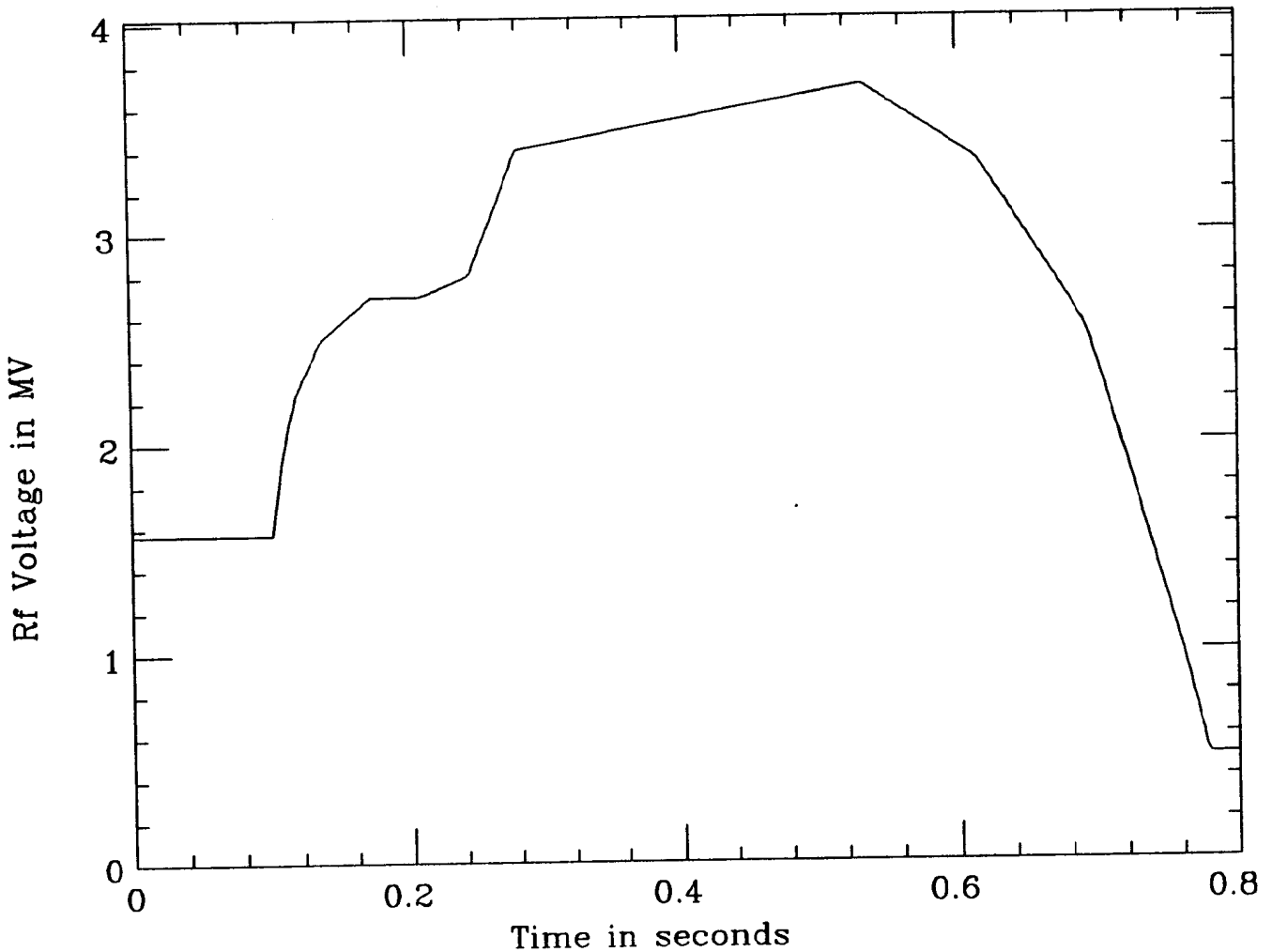


Fig. 3

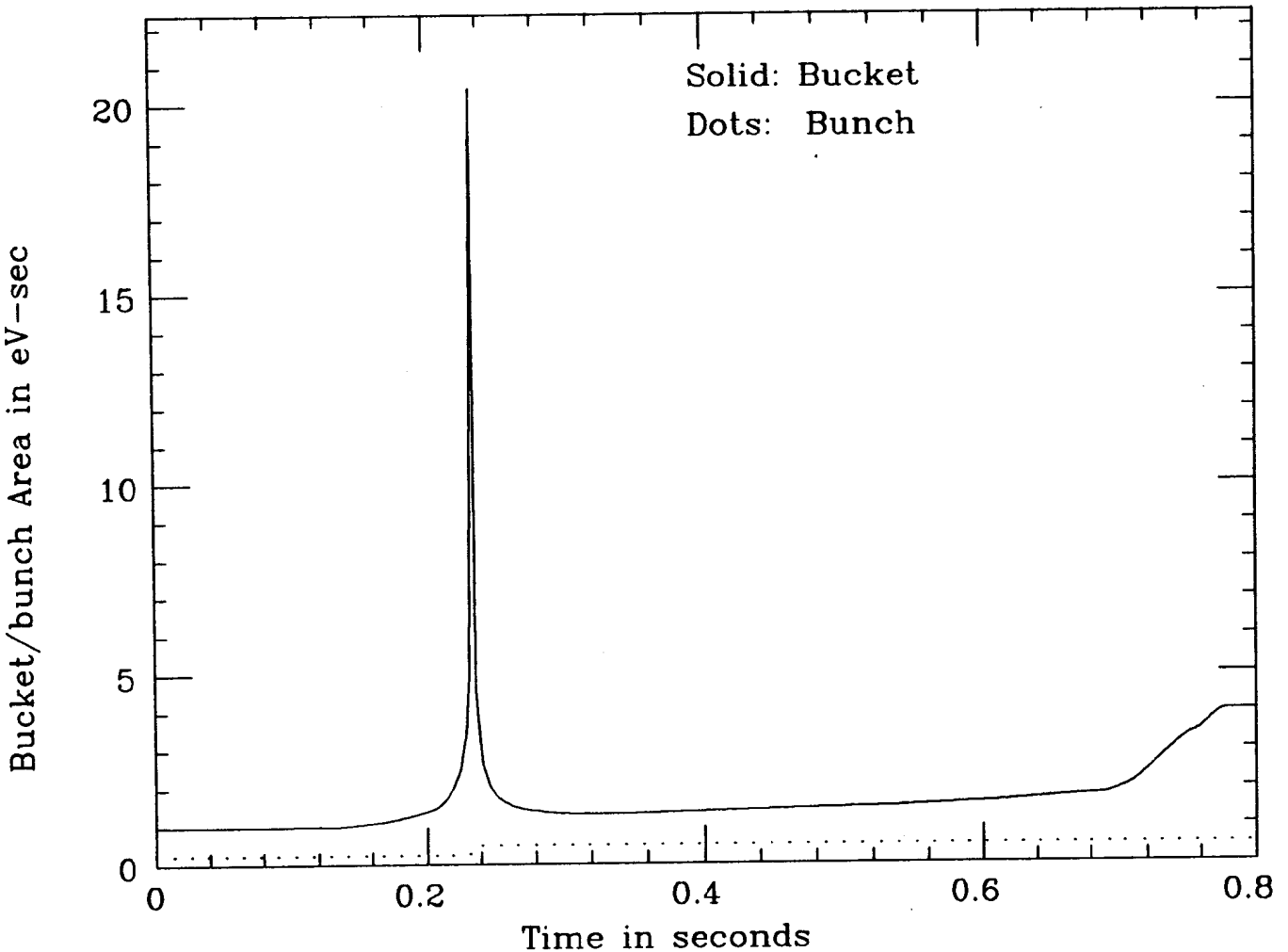

Solid: Bucket
Dots: Bunch
Bucket/bunch Area in eV-sec
0
5
10
15
20
0
0.2
0.4
0.6
0.8
Time in seconds

Fig. 4

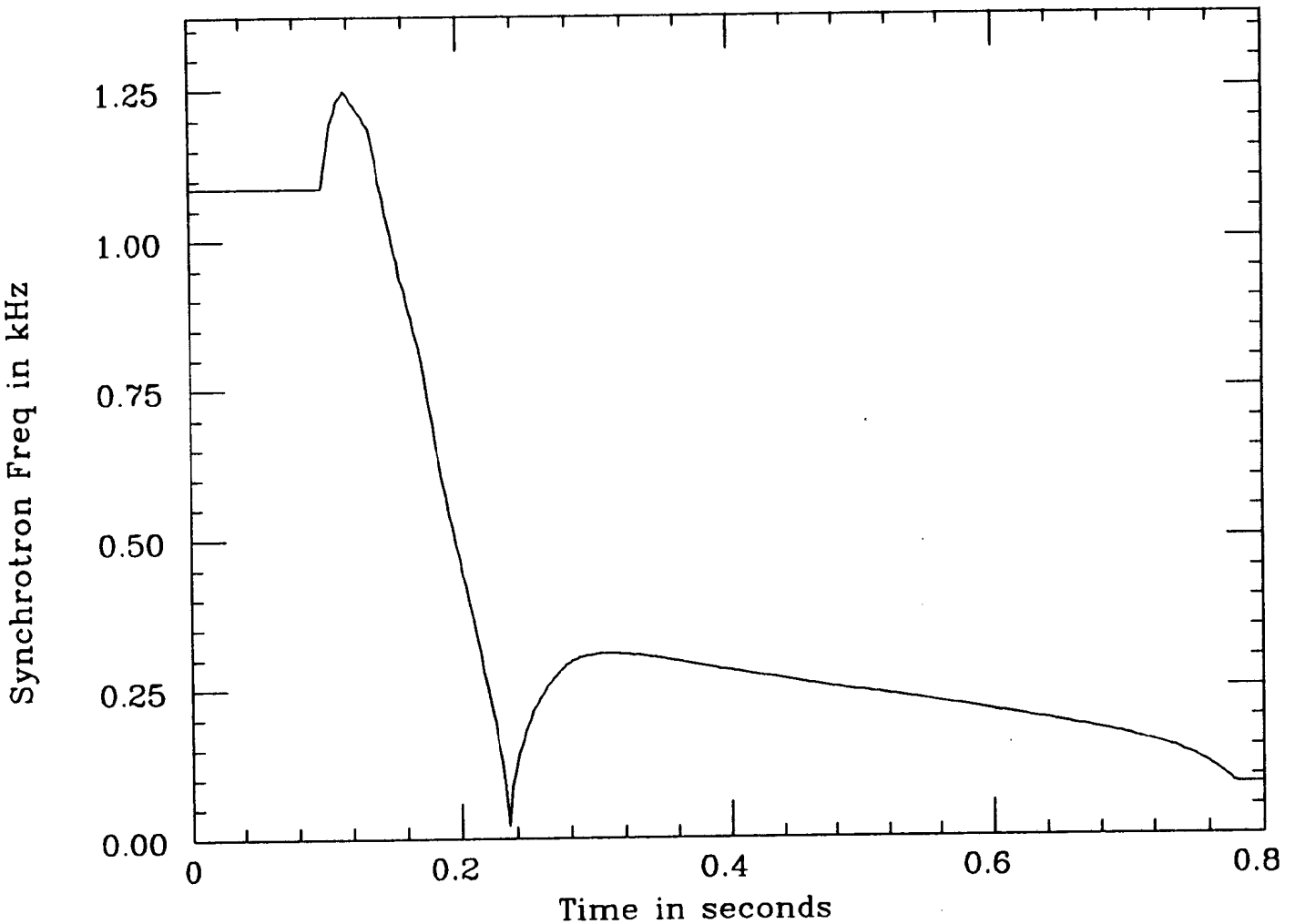

1.25
1.00
0.75
0.50
0.25
0.00
Synchrotron Freq in kHz
0
0.2
0.4
0.6
0.8
Time in seconds

Fig. 5

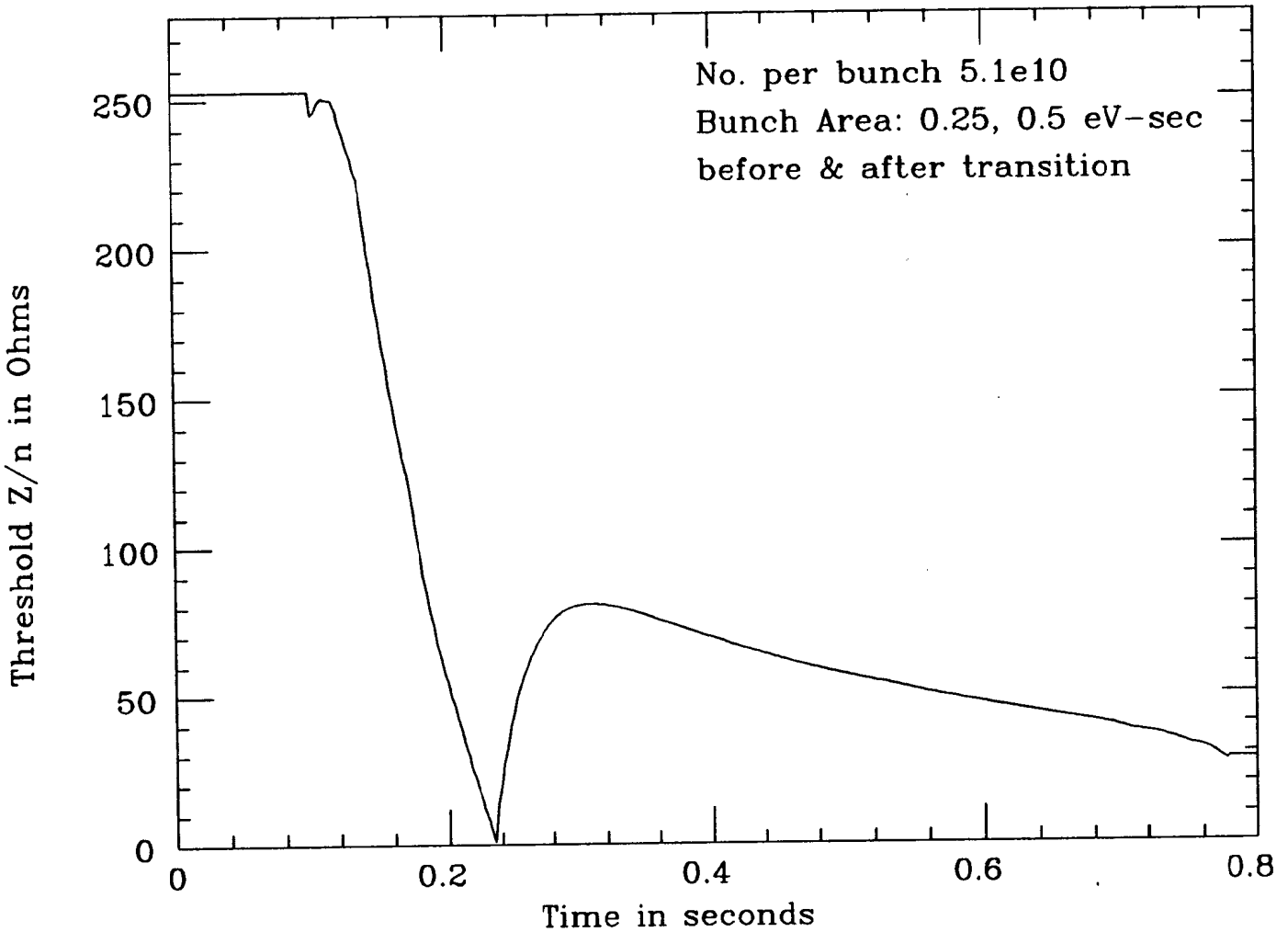

No. per bunch 5.1e10
Bunch Area: 0.25, 0.5 eV-sec
before & after transition
Threshold Z/n in Ohms
250
200
150
100
50
0
0
0.2
0.4
0.6
0.8
Time in seconds

Fig. 6

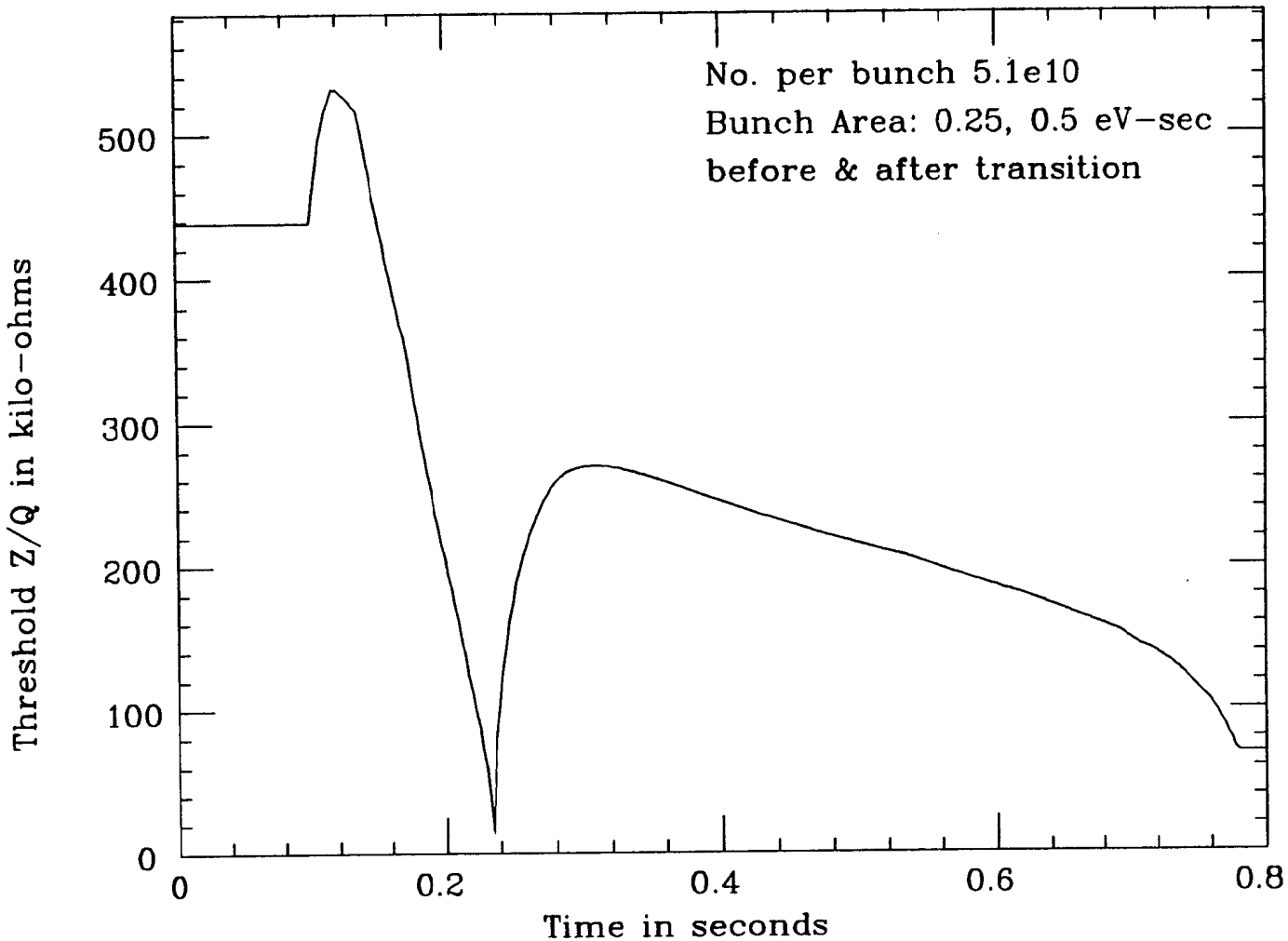

No. per bunch 5.1e10
Bunch Area: 0.25, 0.5 eV-sec
before & after transition
Threshold Z/Q in kilo-ohms
500
400
300
200
100
0
0
0.2
0.4
0.6
0.8
Time in seconds

Fig. 7

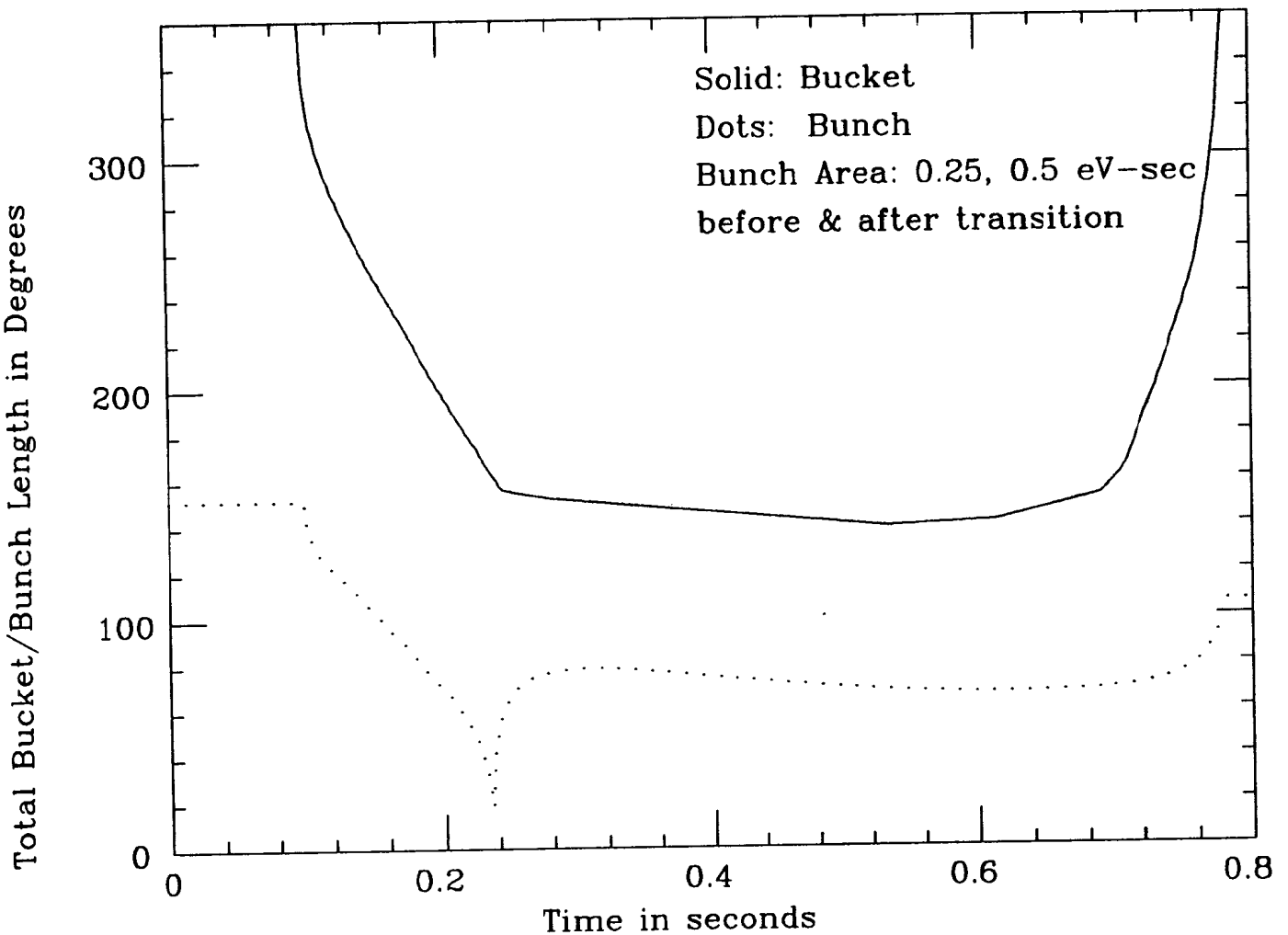

Solid: Bucket
Dots: Bunch
Bunch Area: 0.25, 0.5 eV-sec
before & after transition
Total Bucket/Bunch Length in Degrees
300
200
100
0
0
0.2
0.4
0.6
0.8
Time in seconds

Fig. 8

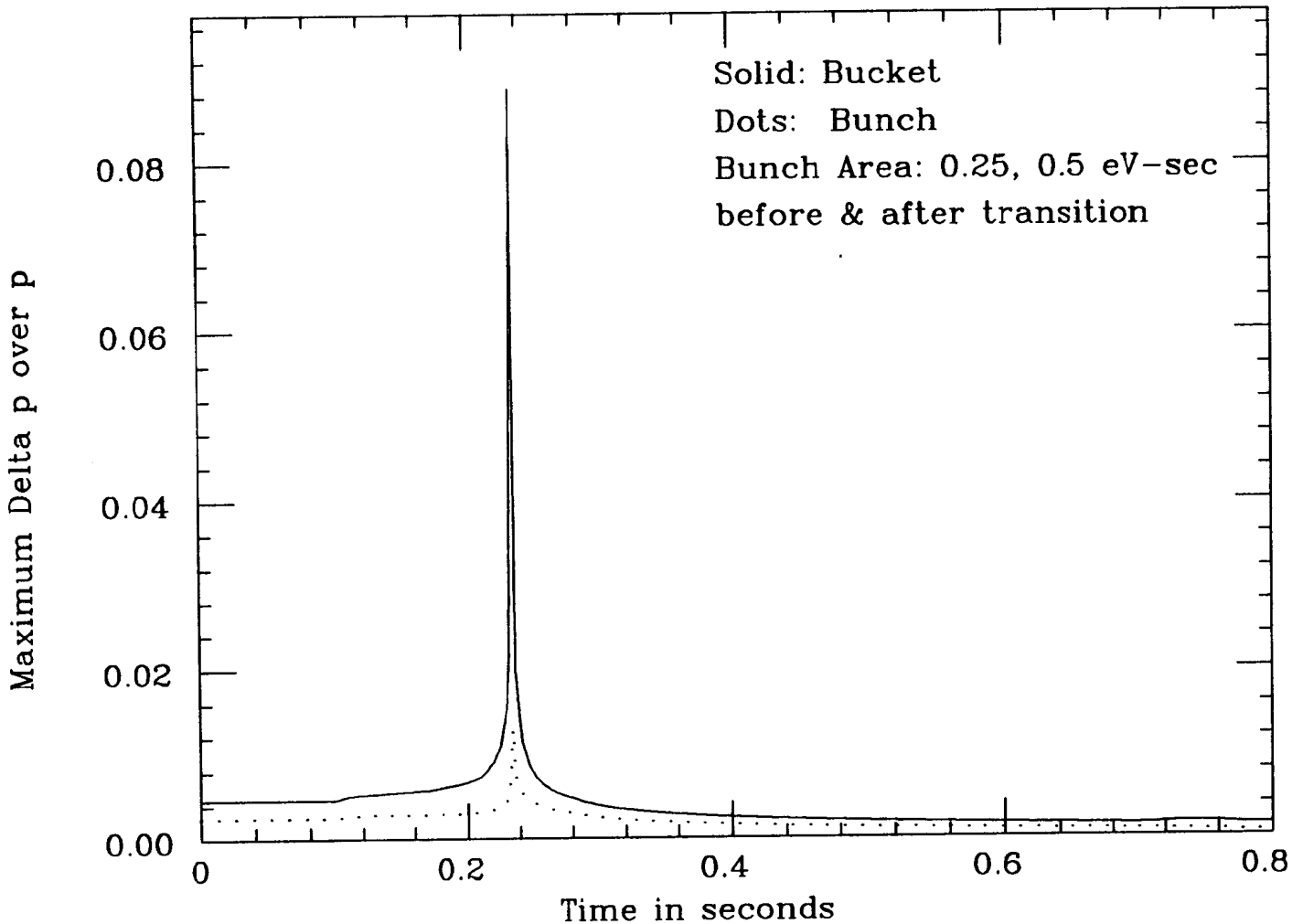
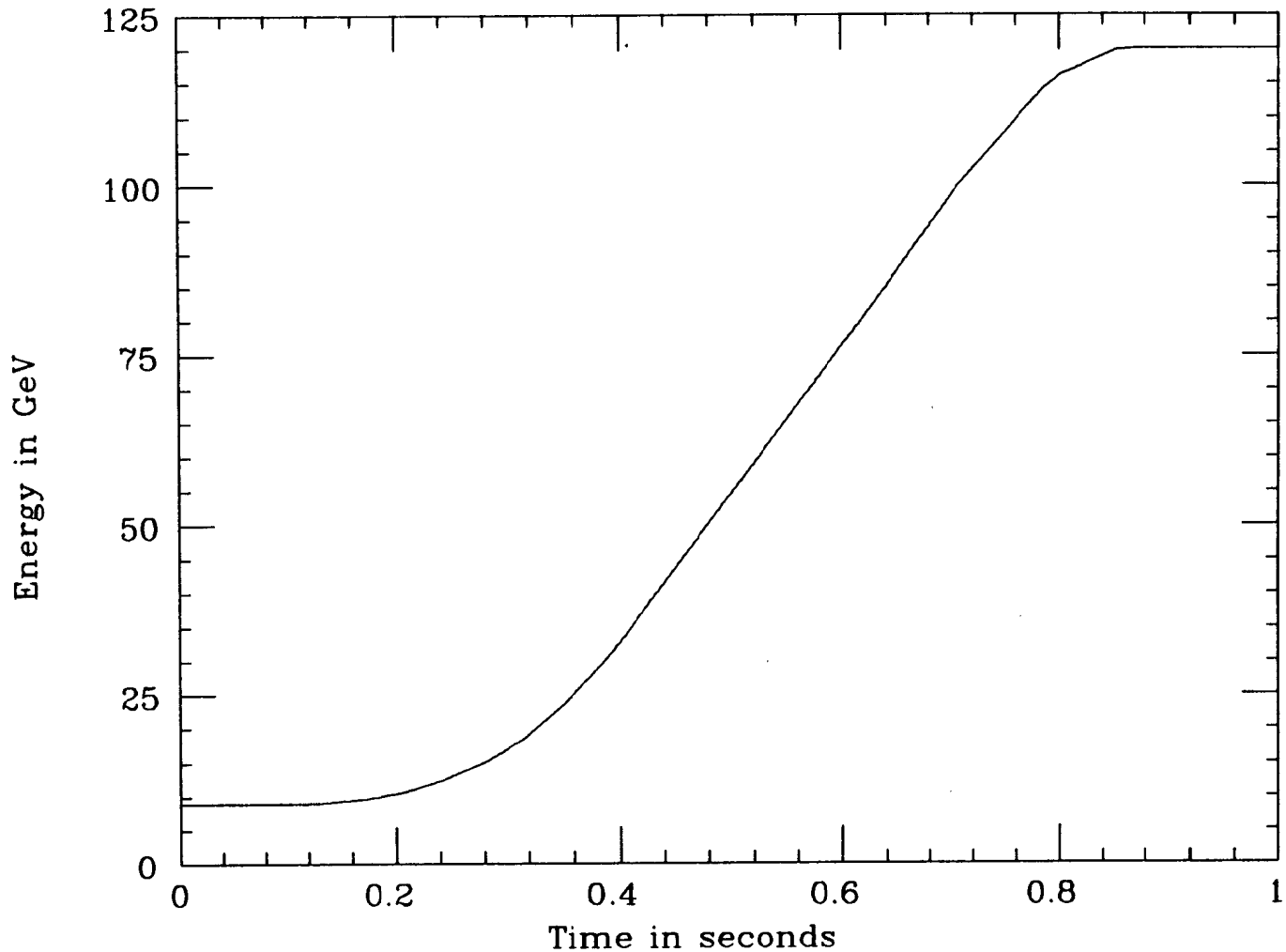

Solid: Bucket
Dots: Bunch
Bunch Area: 0.25, 0.5 eV-sec
before & after transition
Maximum Delta p over p
0.08
0.06
0.04
0.02
0.00
0
0.2
0.4
0.6
0.8
Time in seconds

Fig. 9



Fi. 10

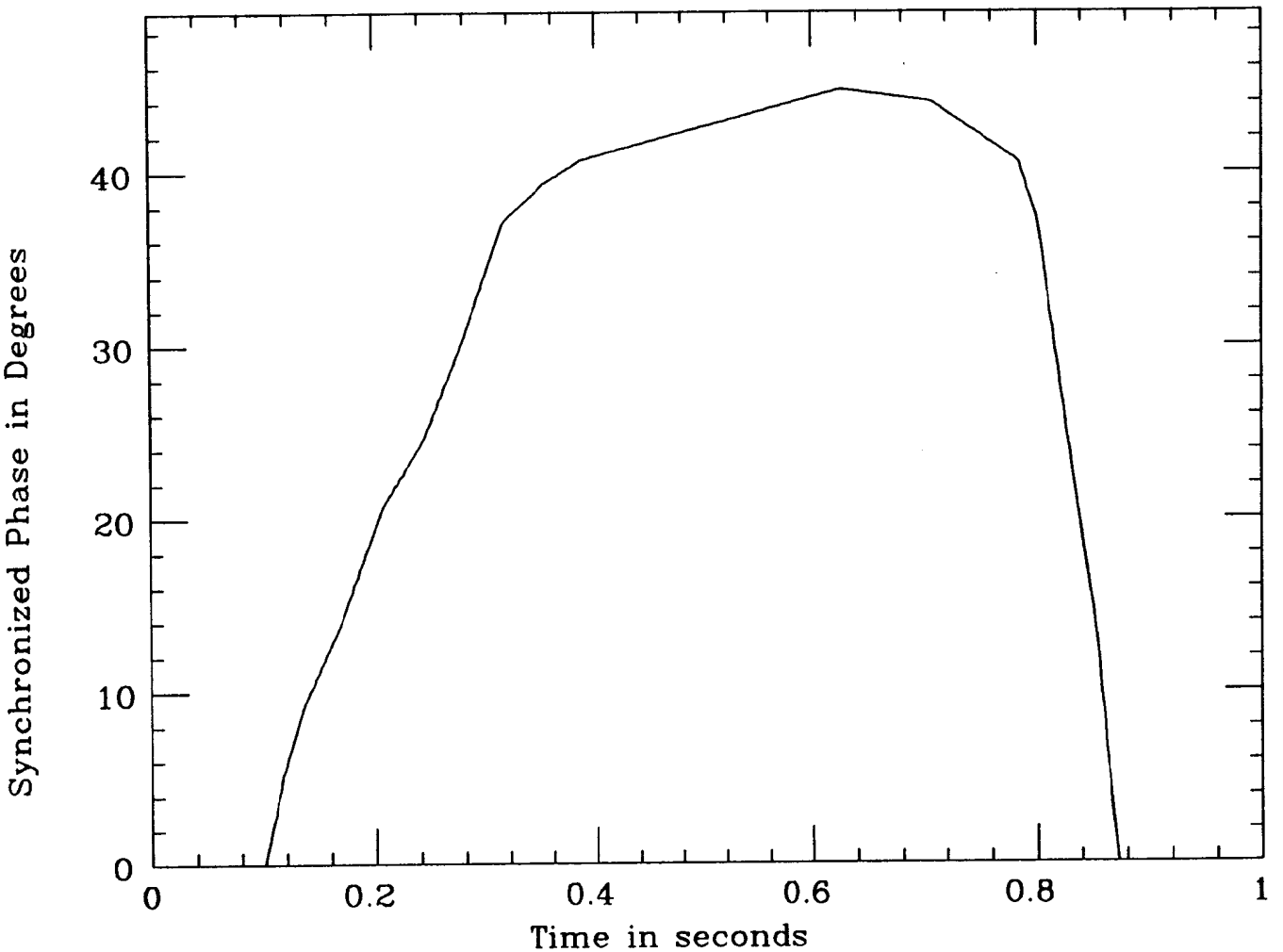

Synchronized Phase in Degrees
0
10
20
30
40
0
0.2
0.4
0.6
0.8
1
Time in seconds

Fig. 11

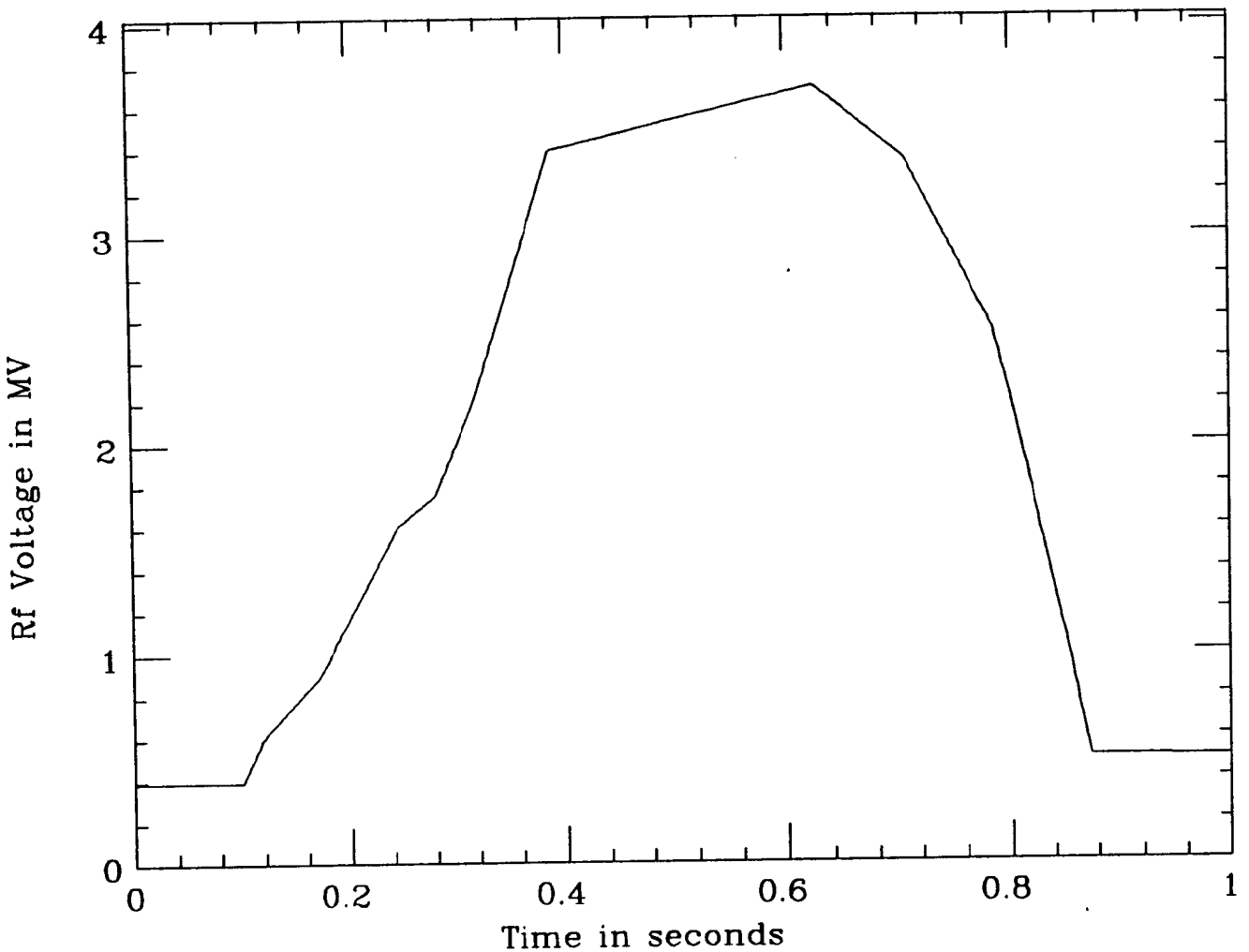


Fig. 12

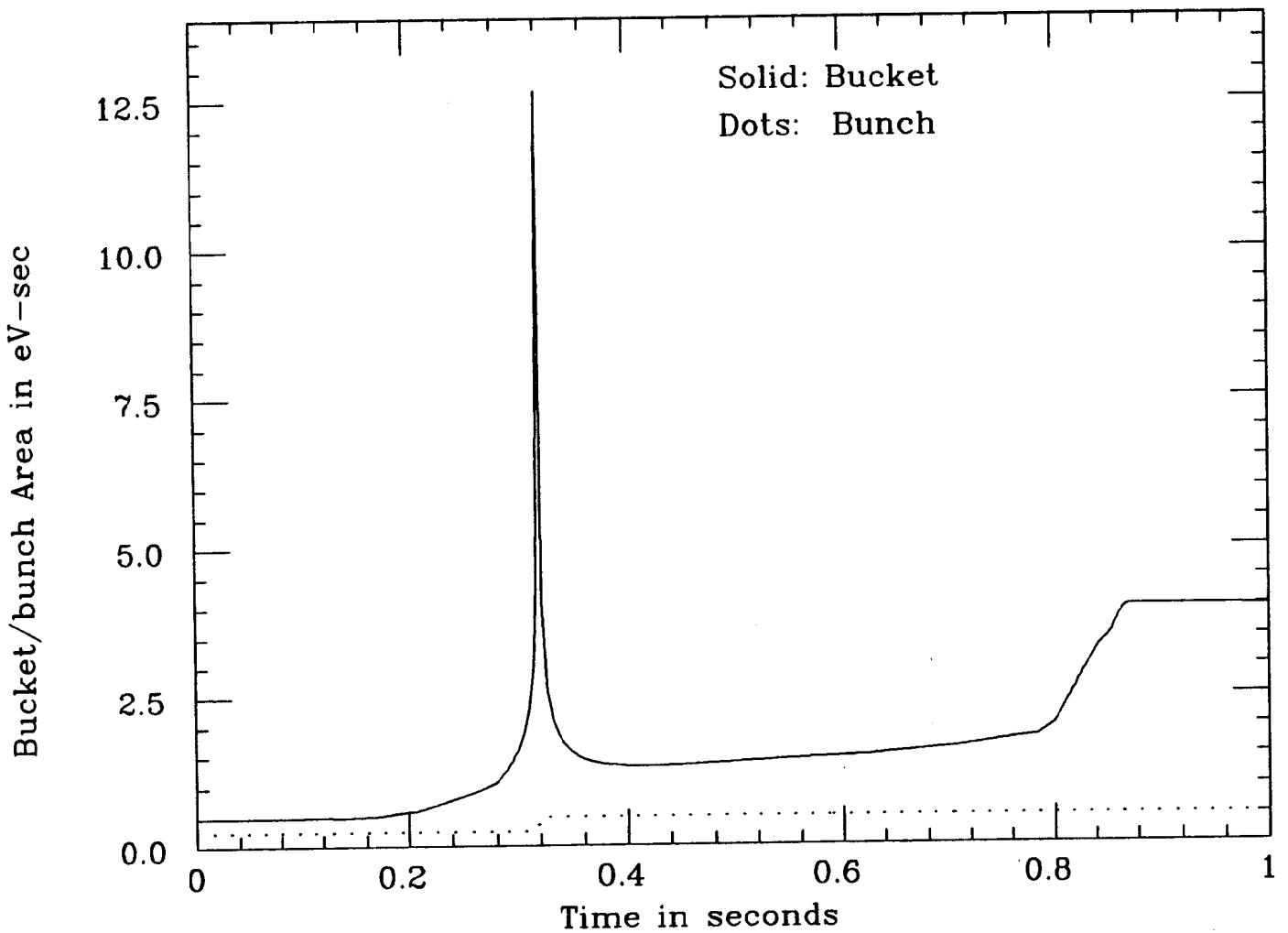

Solid: Bucket
Dots: Bunch
12.5
10.0
7.5
5.0
2.5
0.0
0
0.2
0.4
0.6
0.8
1
Bucket/bunch Area in eV-sec
Time in seconds

Fig. 13

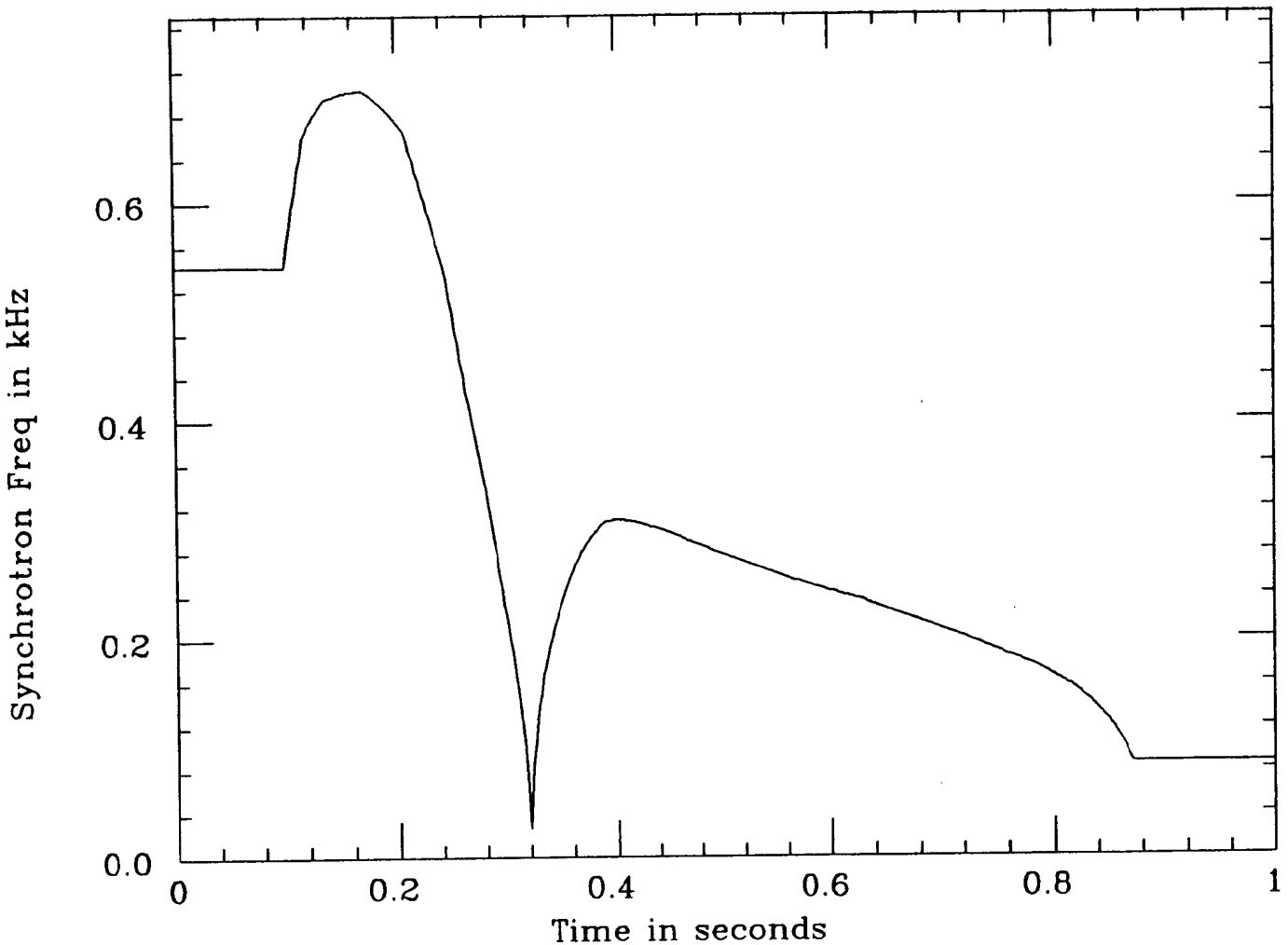

Synchrotron Freq in kHz
0.0
0.2
0.4
0.6
0
0.2
0.4
0.6
0.8
1
Time in seconds

Fig. 14

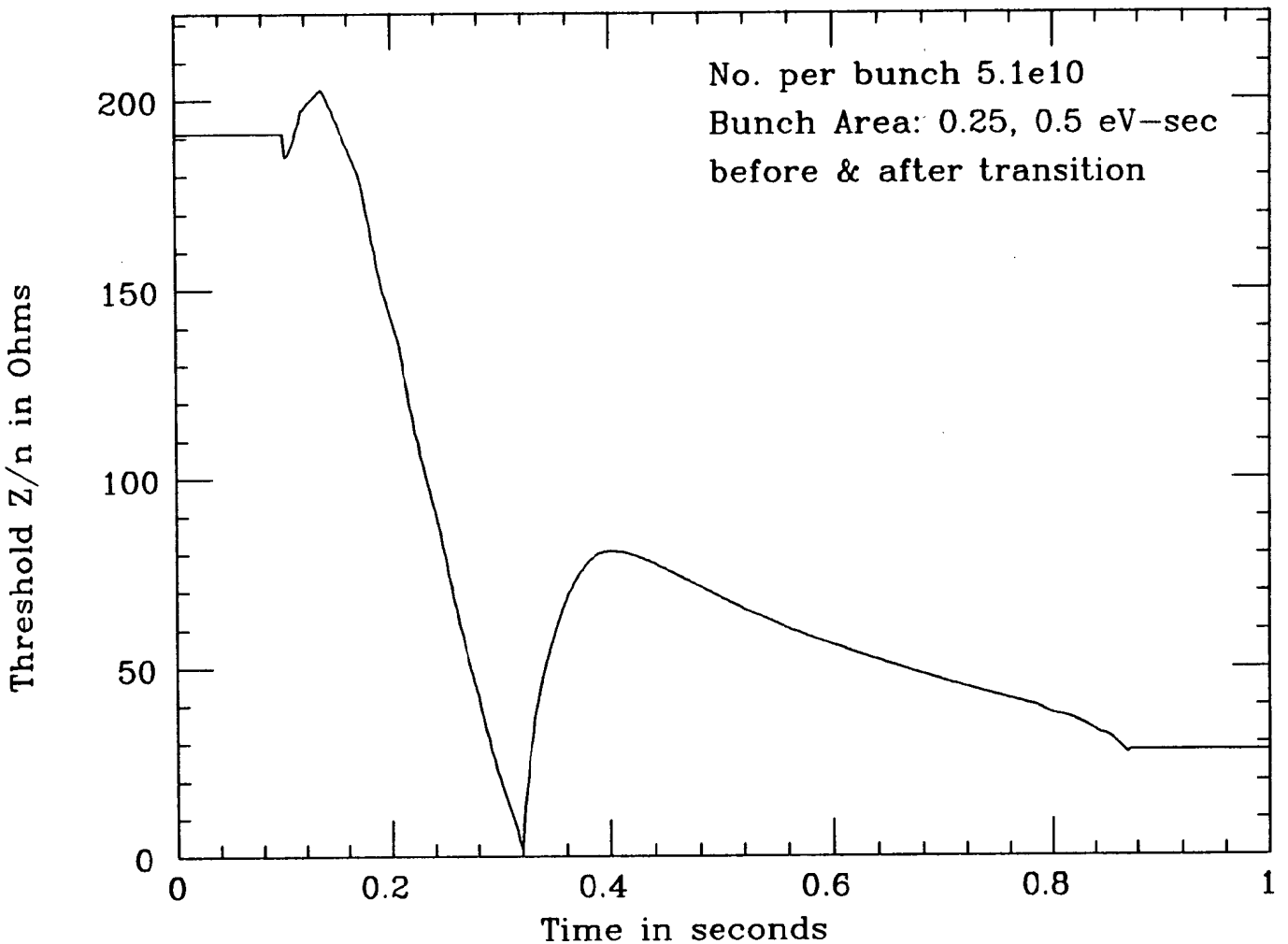

No. per bunch 5.1e10
Bunch Area: 0.25, 0.5 eV–sec
before & after transition
Threshold Z/n in Ohms
200
150
100
50
0
0
0.2
0.4
0.6
0.8
1
Time in seconds

Fig. 15

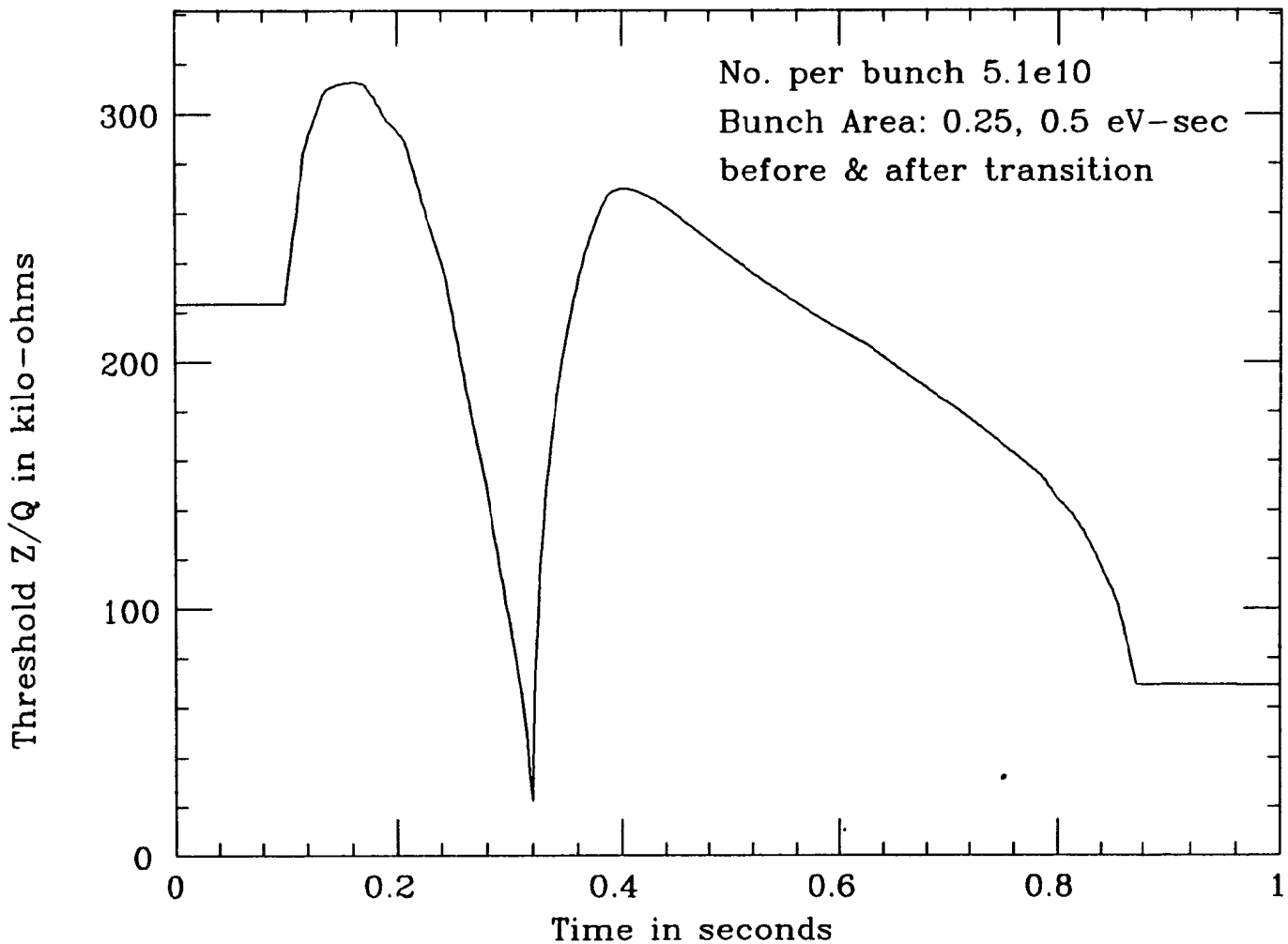

No. per bunch 5.1e10
Bunch Area: 0.25, 0.5 eV-sec
before & after transition
Threshold Z/Q in kilo-ohms
300
200
100
0
0
0.2
0.4
0.6
0.8
1
Time in seconds

Fig. 16

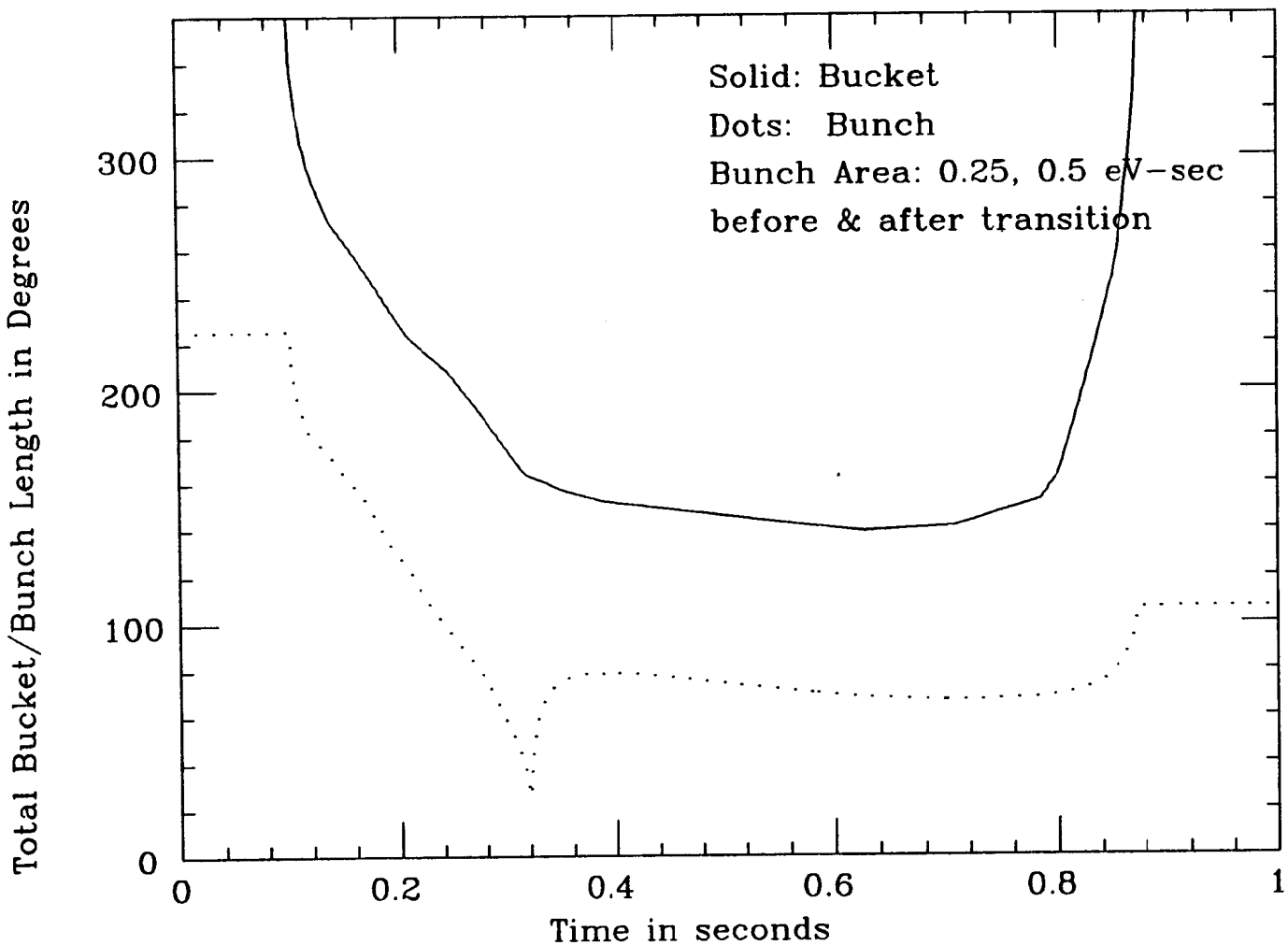

Solid: Bucket
Dots: Bunch
Bunch Area: 0.25, 0.5 eV-sec
before & after transition
Total Bucket/Bunch Length in Degrees
300
200
100
0
0
0.2
0.4
0.6
0.8
1
Time in seconds

Fig. 17

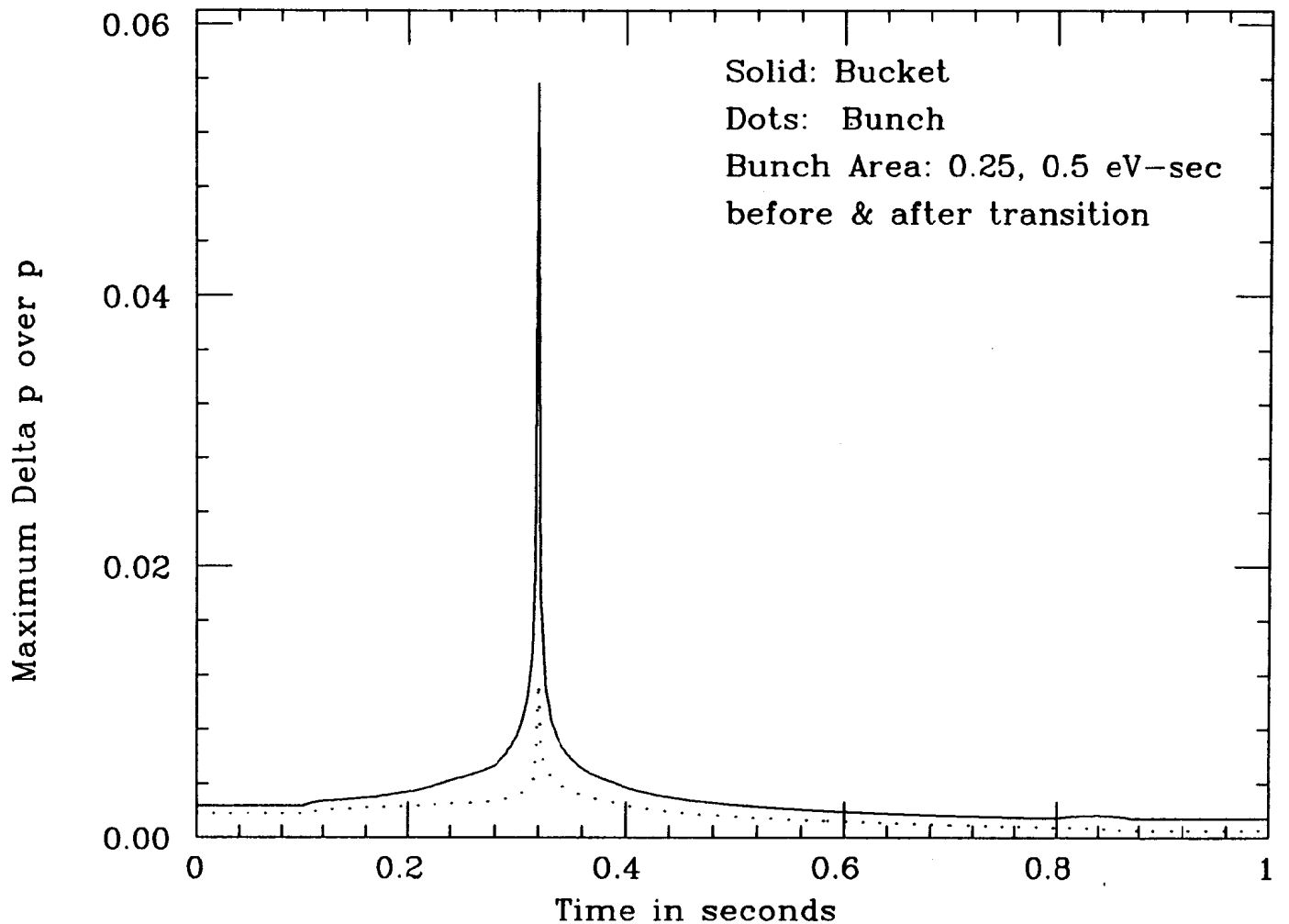

Solid: Bucket
Dots: Bunch
Bunch Area: 0.25, 0.5 eV−sec
before & after transition
Maximum Delta p over p
0.06
0.04
0.02
0.00
0
0.2
0.4
0.6
0.8
1
Time in seconds

Fig. 18