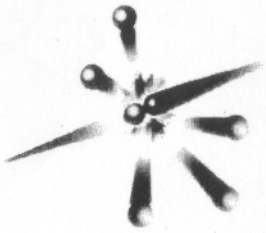
Stanford Linear Accelerator Center



Accelerator Structure Test Area Operation Results

R. Loewen

ASTA X-Band Structures
Testing 1992-1999

Name	From	Type	Vg	Peak E_{acc}
26 cm	**SLAC**	**C.I.**	**3.3%**	**108† max**
75 cm	**SLAC**	**C.I.**	**4.8%**	**90† max**
24 cm	**CERN**	**C.I.**	**1.1%**	**153† max**
1.8 m DS1	**SLAC**	**C.G.**	**11.8–3.0%**	**68† avg**
1.3 m M2	**KEK**	**C.G.**	**10.0–1.9%**	**85 avg**

† limited by available power

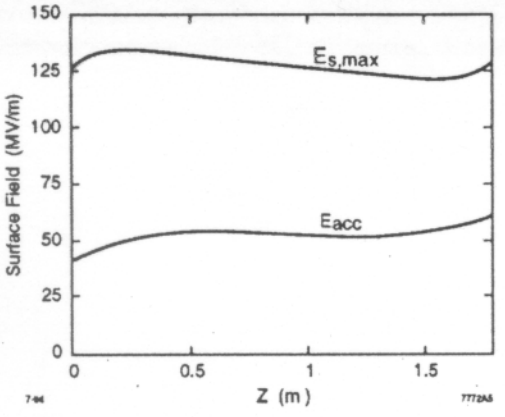


Fig. 7. Calculated peak surface and accelerating gradient along the 1.8 m detuned accelerator section.

bremsstrahlung of field emitted electrons. Figure 6 shows the momentum-analyzed average dark current measured for two different gradients with the 45° spectrometer (refer back to Fig. 1). The collimator slit width was set at 5.3 mm. The relatively flat top of the two curves indicates that the dark current was captured fairly uniformly along the structure.

For the 1.8 m detuned structure, the accelerating gradient along the length is shown in Fig. 7. The profile is almost flat like in a conventional constant-gradient structure: the first cavities have a thinner disk, larger iris aperture, and somewhat lower accelerating field; the last cavities have a thicker disk, smaller iris aperture, and somewhat higher accelerating field. The peak surface field on the disk edges varies by less than 5% along the whole structure. Figure 8 is a record of the RF processing: it took 30 hours over a two-day period to reach an average accelerating gradient of 50 MV/m. Figure 9 shows input and output RF waveforms for the two arms of the couplers. For a total peak input of 98 MW and output of

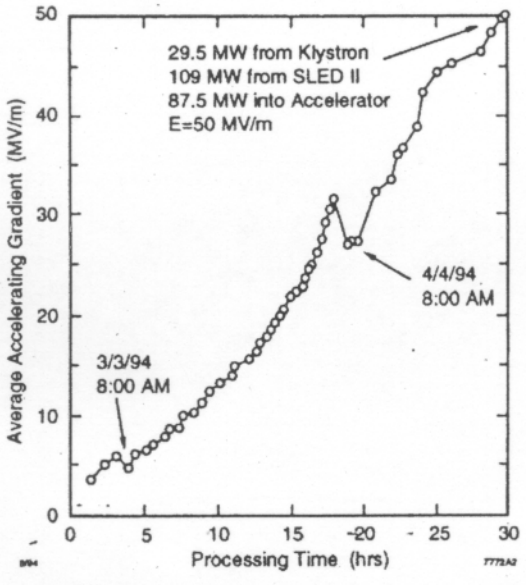


Fig. 8. Radio frequency processing schedule for the 1.8 m detuned accelerator section.

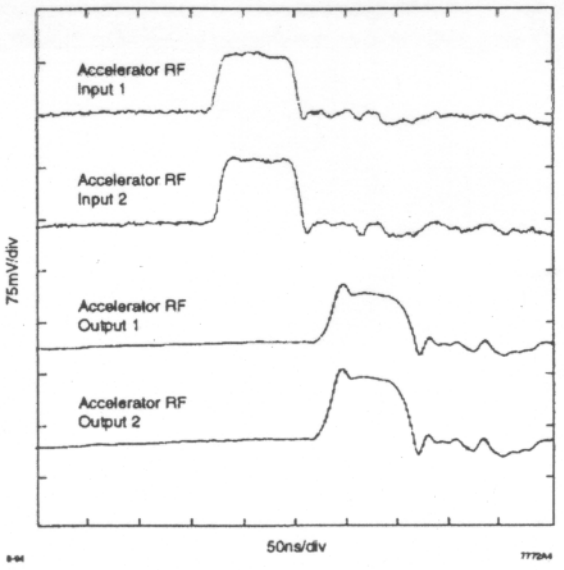


Fig. 9. Input and output RF waveforms for the 1.8 m detuned section at average accelerating gradient of 53 MV/m.

27.6 MW, the average accelerating gradient was 53 MV/m. The dark current as a function of accelerating gradient was plotted in Fig. 10 to be compared with the results for the 75 cm section. Note that there was not enough RF power available to process the 1.8 m structure to even higher gradient. According to our experience [2], the dark current might have been further reduced if the available RF processing power had been higher.

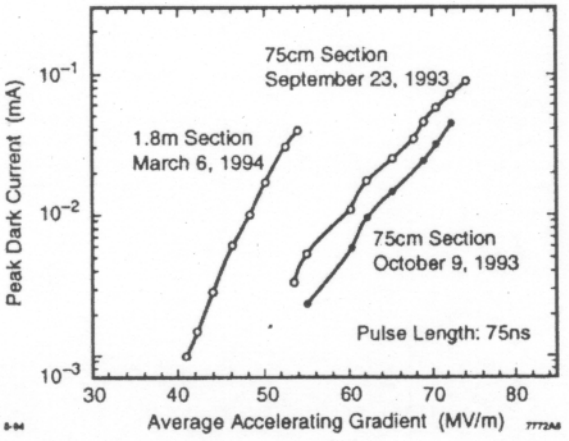
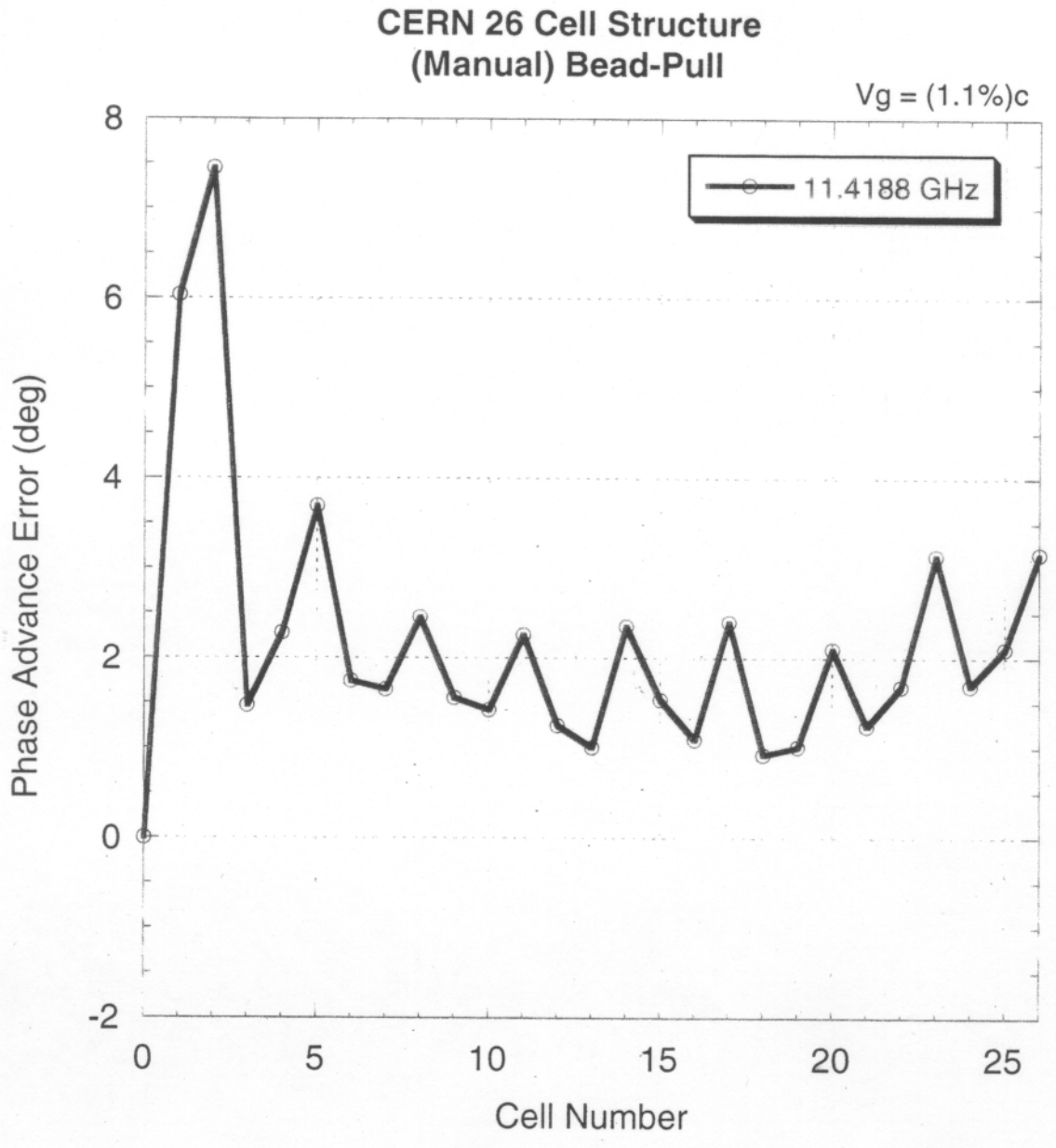


Fig. 10 Peak dark current measured by a downstream Faraday cup for the 75 cm constant-impedance and the 1.8 m detuned section as a function of average accelerating gradient.

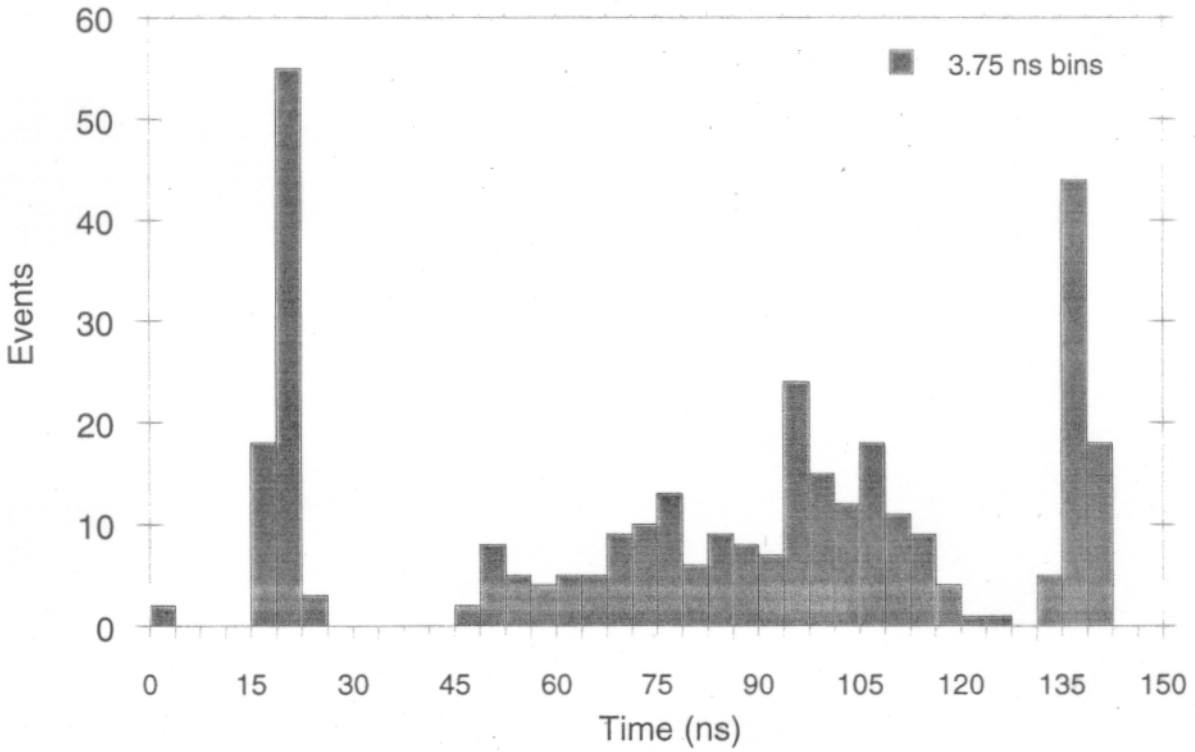
Reference

1. J. W. Wang et al, "High Gradient Studies On 11.4-GHz Copper Accelerator Structures," LINAC 92, Ottawa, Canada, August 1992; SLAC-PUB-5900 (1992).
2. G.A. Loew and J.W. Wang, "RF Breakdown Studies in Room Temperature Electron Linac Structures," (for 13th Int. Symp. on Discharges and Electrical Insulation in Vacuum, Paris, France, 1988), SLAC-PUB-4647 (1988).

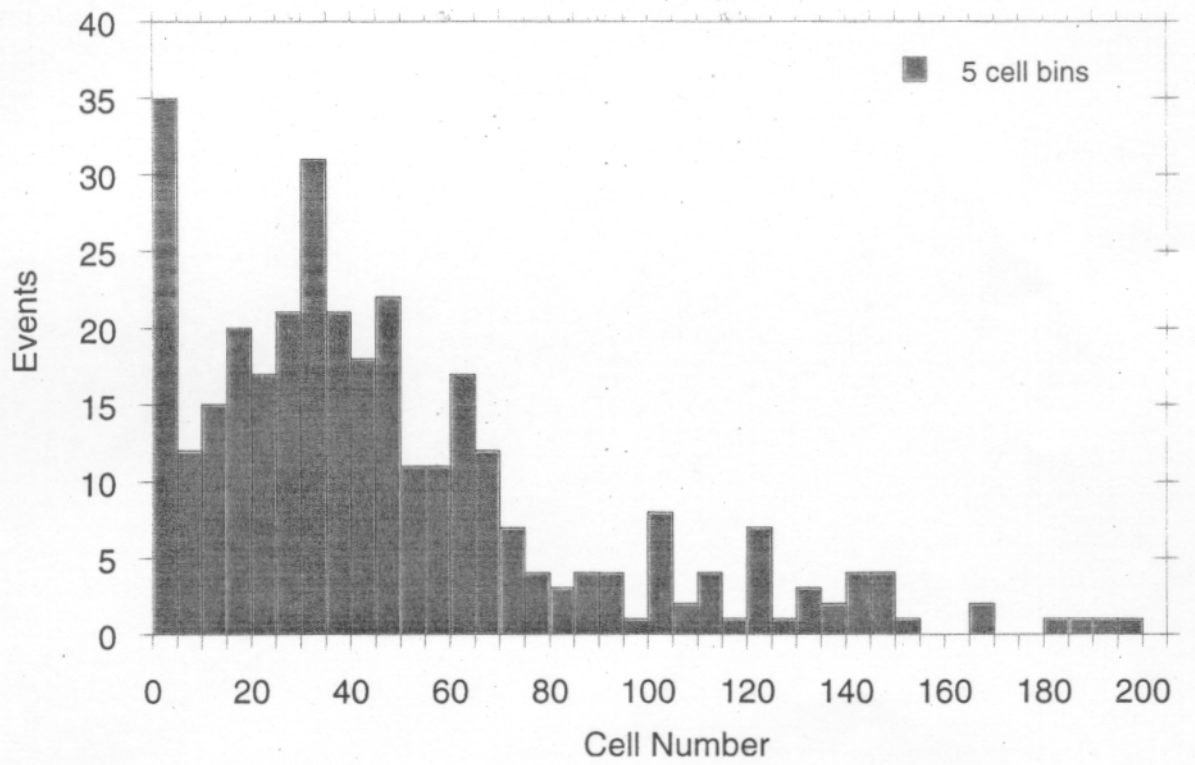

CERN 26 Cell Structure
(Manual) Bead-Pull
Vg = (1.1%)c
11.4188 GHz
Phase Advance Error (deg)
8
6
4
2
0
-2
0
5
10
15
20
25
Cell Number

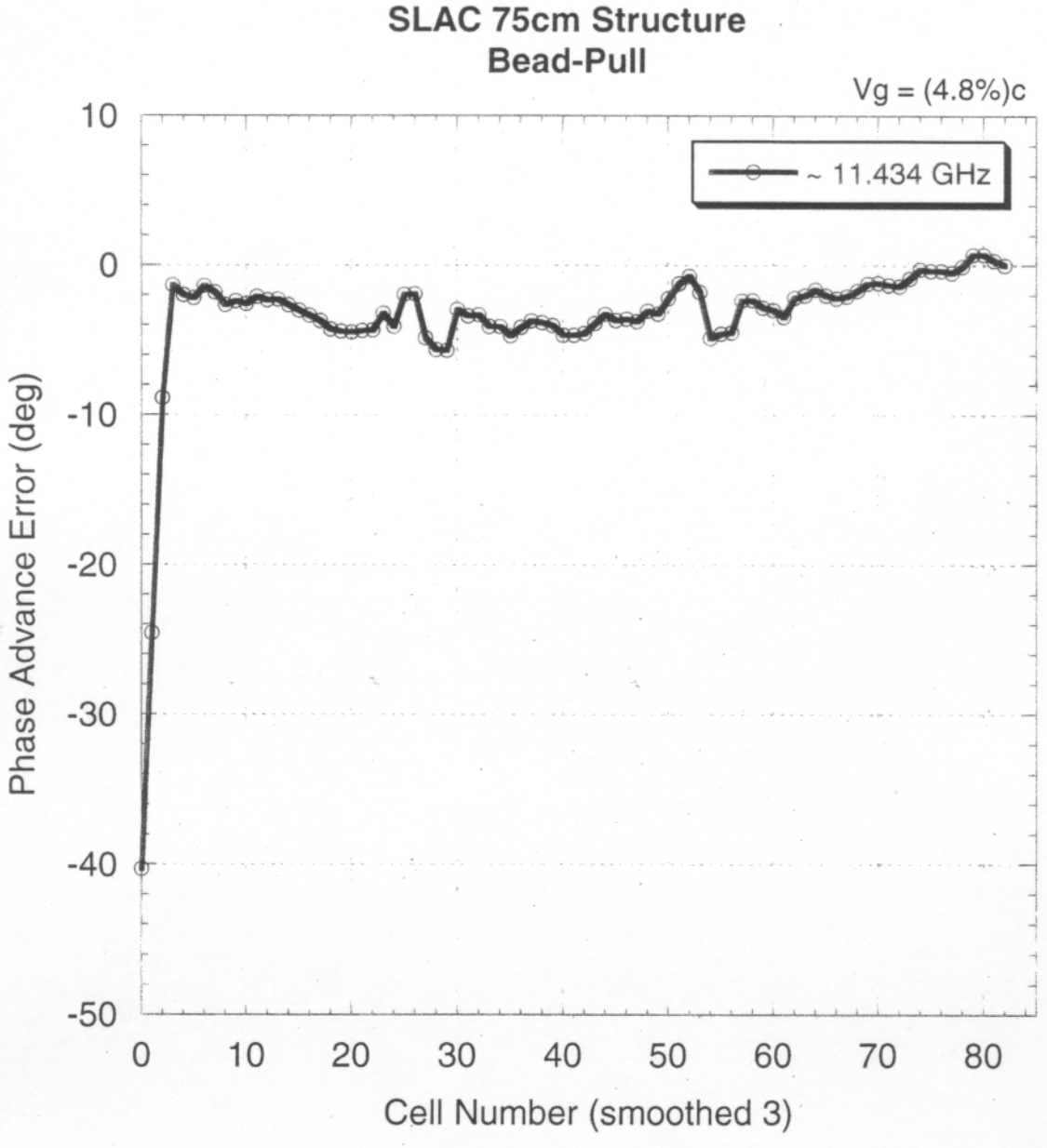
DS1 Processing Study: 330 Breakdown Events

Location of the Breakdown Along the Pulse (150ns)



Location of the Breakdown Along the Structure (206 Cells)




SLAC 75cm Structure
Bead-Pull
Vg = (4.8%)c
~ 11.434 GHz
Phase Advance Error (deg)
10
0
-10
-20
-30
-40
-50
0
10
20
30
40
50
60
70
80
Cell Number (smoothed 3)

KEK M2 Structure Test at ASTA

Test Setup

- 2 combined klystrons using SLED-II 150ns delay lines at 60 pps.
- RF system conditioned to >300 MW before installing structure.
- No gun but downstream faraday cup to measure dark current.
- Primary interlock was RF reflected arc detector (5MW, next pulse).
- Vacuum pumping poor and most sensitive at input end. [s1]

Conditioning Summary

- Over 560 hours of high voltage running time.
- Over 440 hours of active processing (~78%). [s2]
- Majority of processing done with automated computer system. [s3]
- Stopped testing due to schedule and processing progress. [s4]

High Gradient Performance

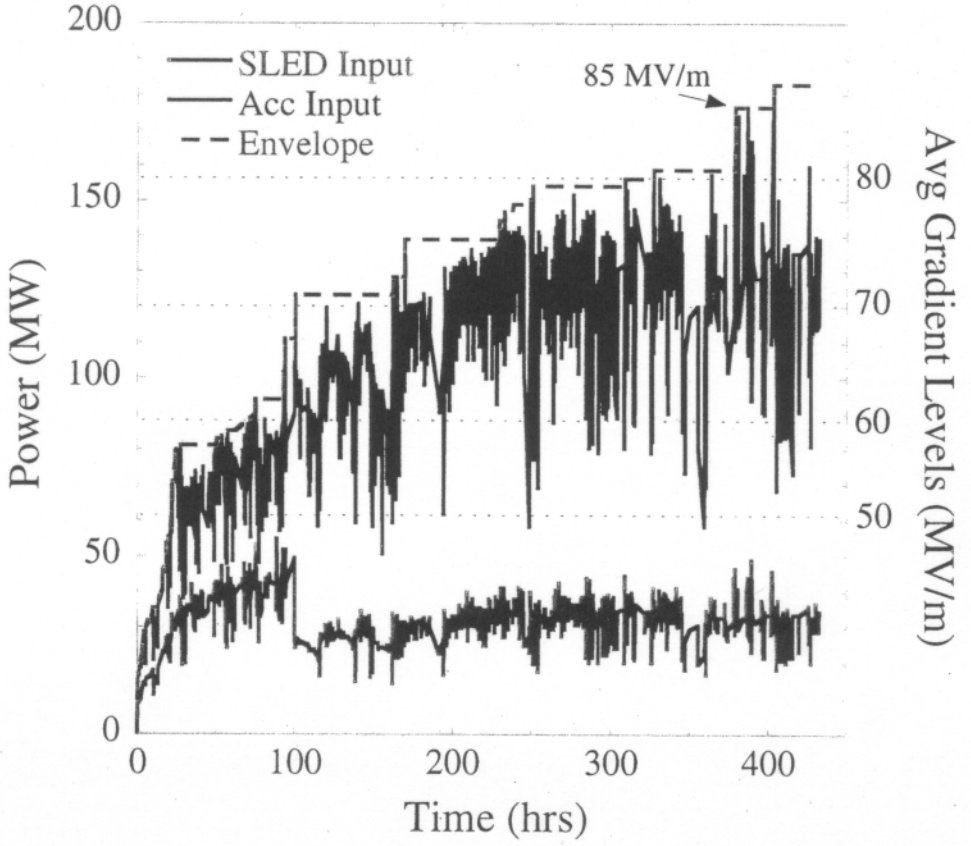
- Only a few arcs and <25 hours to reach 50 MV/m avg. gradient.
- 75 MV/m avg. gradient without any arcs for ~1 hour.
- 85 MV/m peak avg. gradient ~10 seconds.
- Dark current an order of magnitude less than DS1 (1995). [s5]

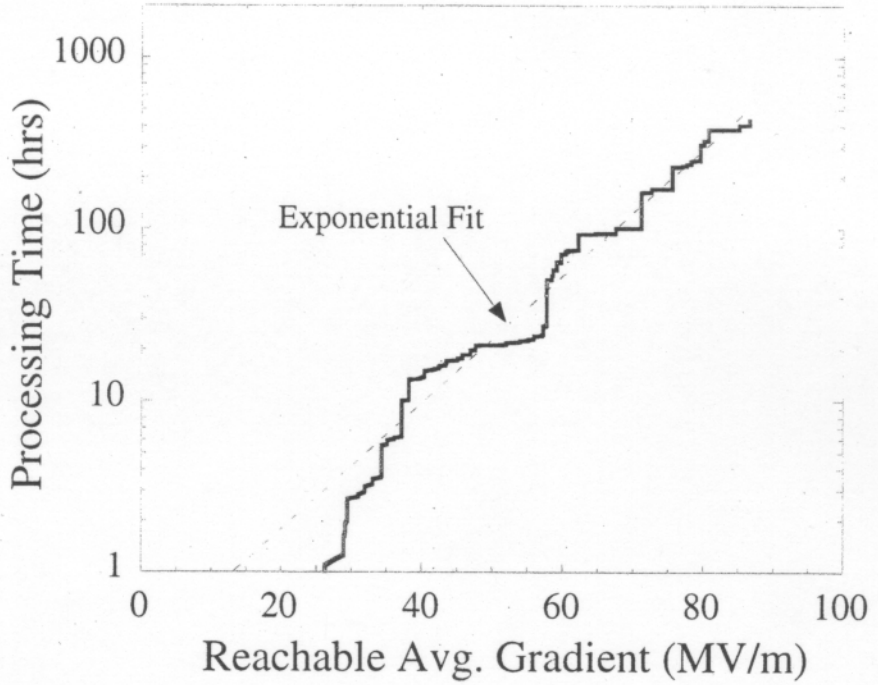
Permanent Effects Due To Processing

- Estimated over 3000 arcs at >50 MV/m.
- Noticeable damage to irises at input of structure. [s6]
- Input VSWR comparable but bead-pull shows >2 MHz shift at input end and 30 deg. accumulated phase error! [s7–9]

R. Loewen
ISG3 1/27/99

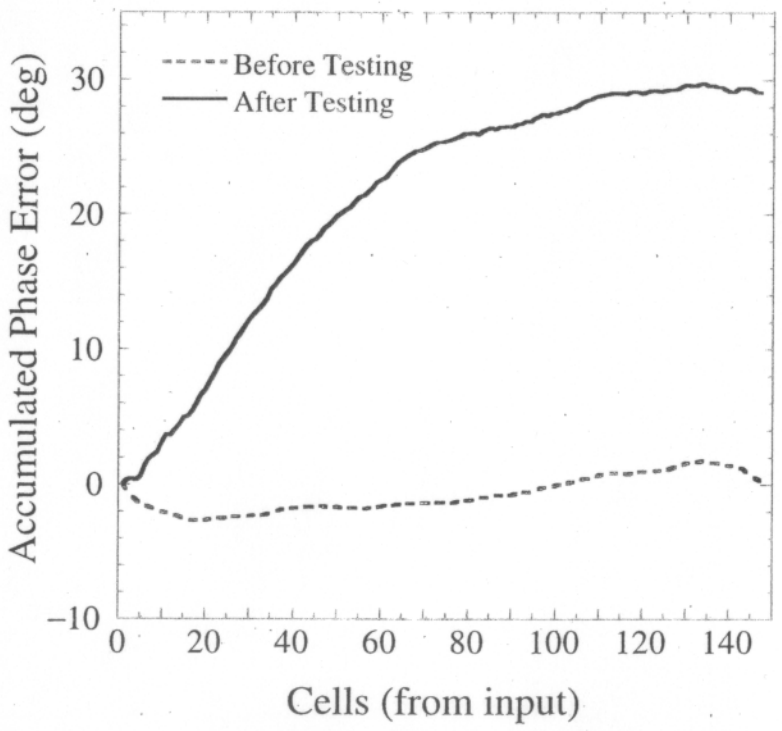
M2 Forward Processing History



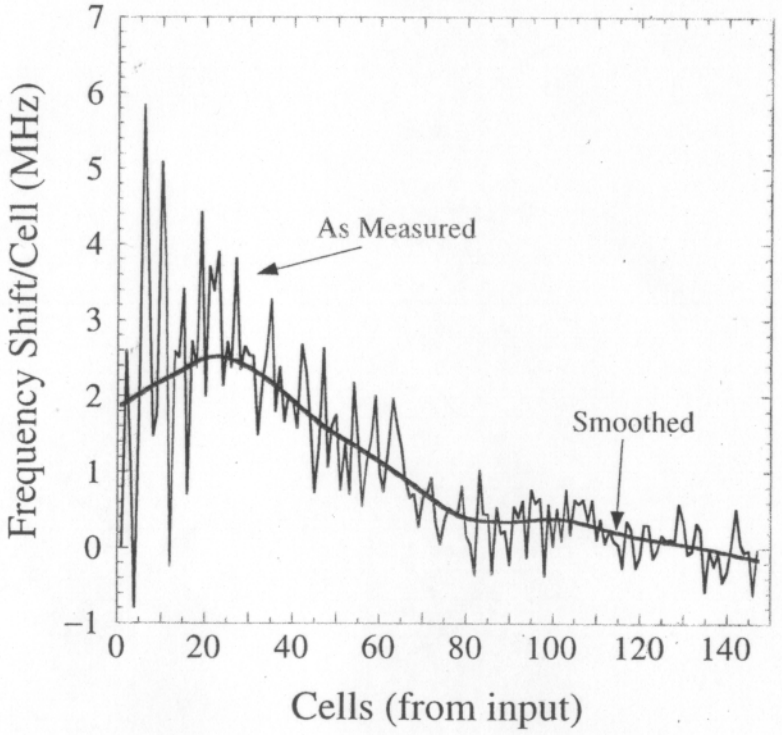


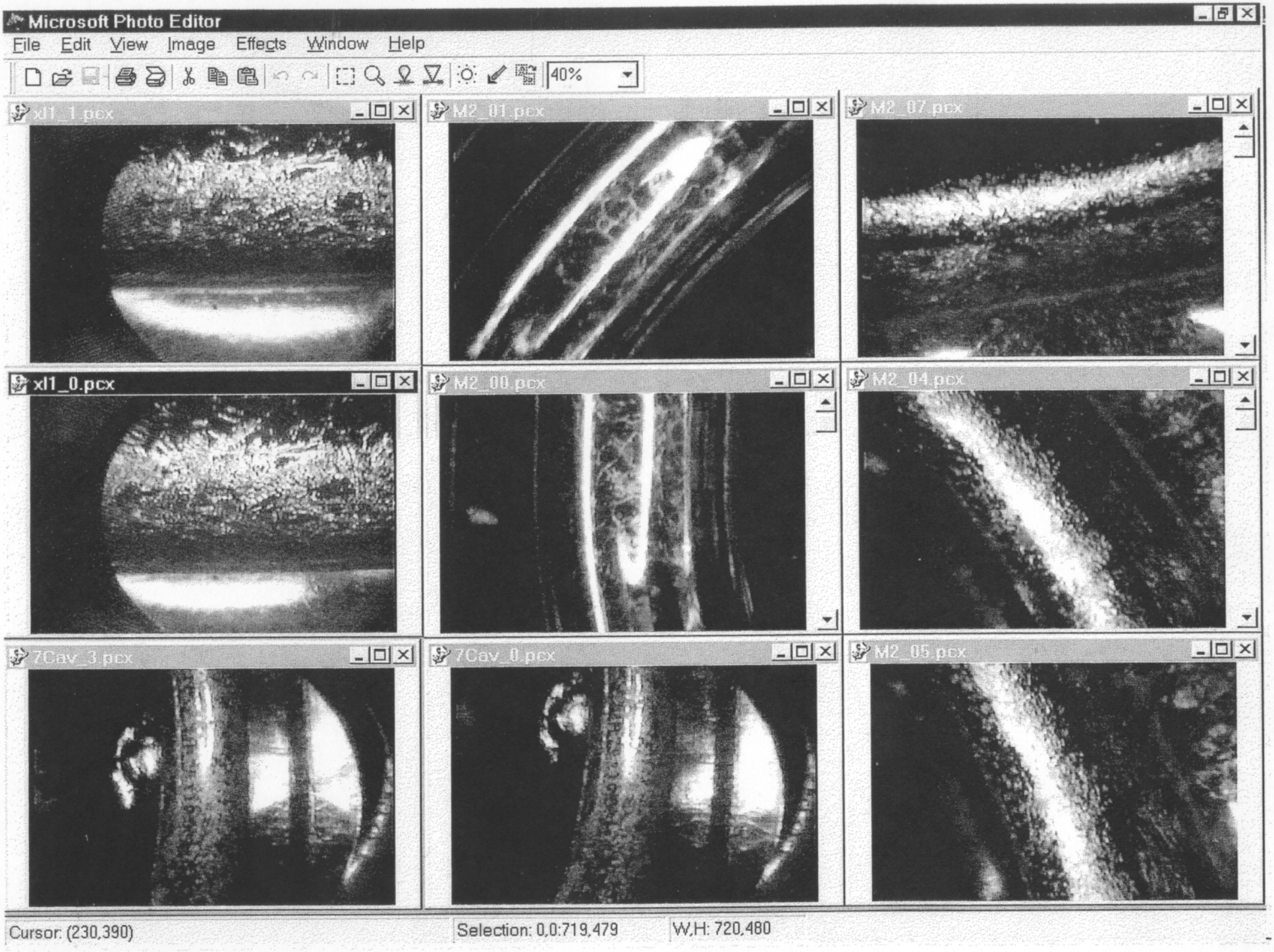
M2 Phase Advance Measurements Before and After Forward Processing to 85 MV/m

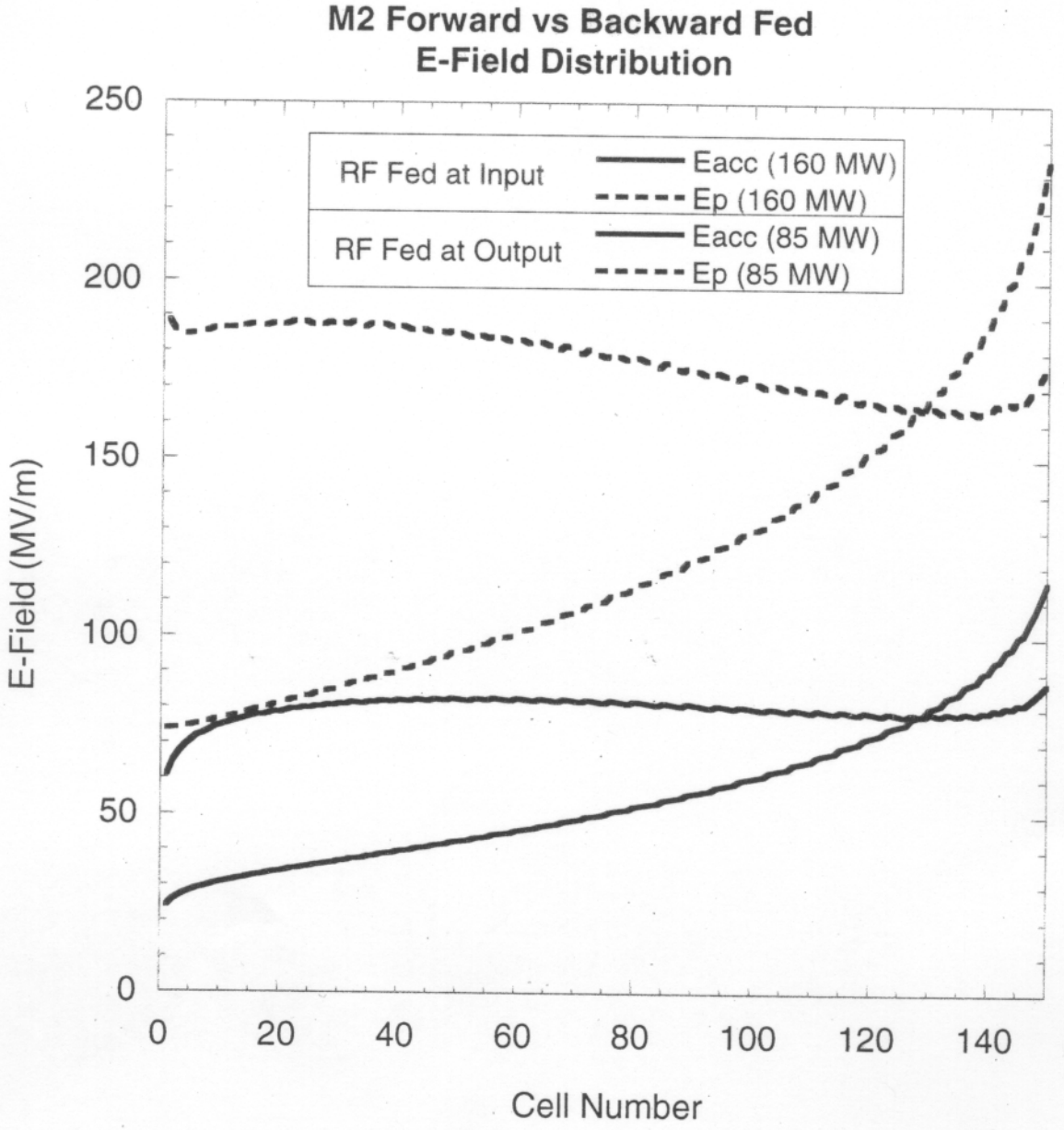
Integrated Phase Advance Error Along the Structure.



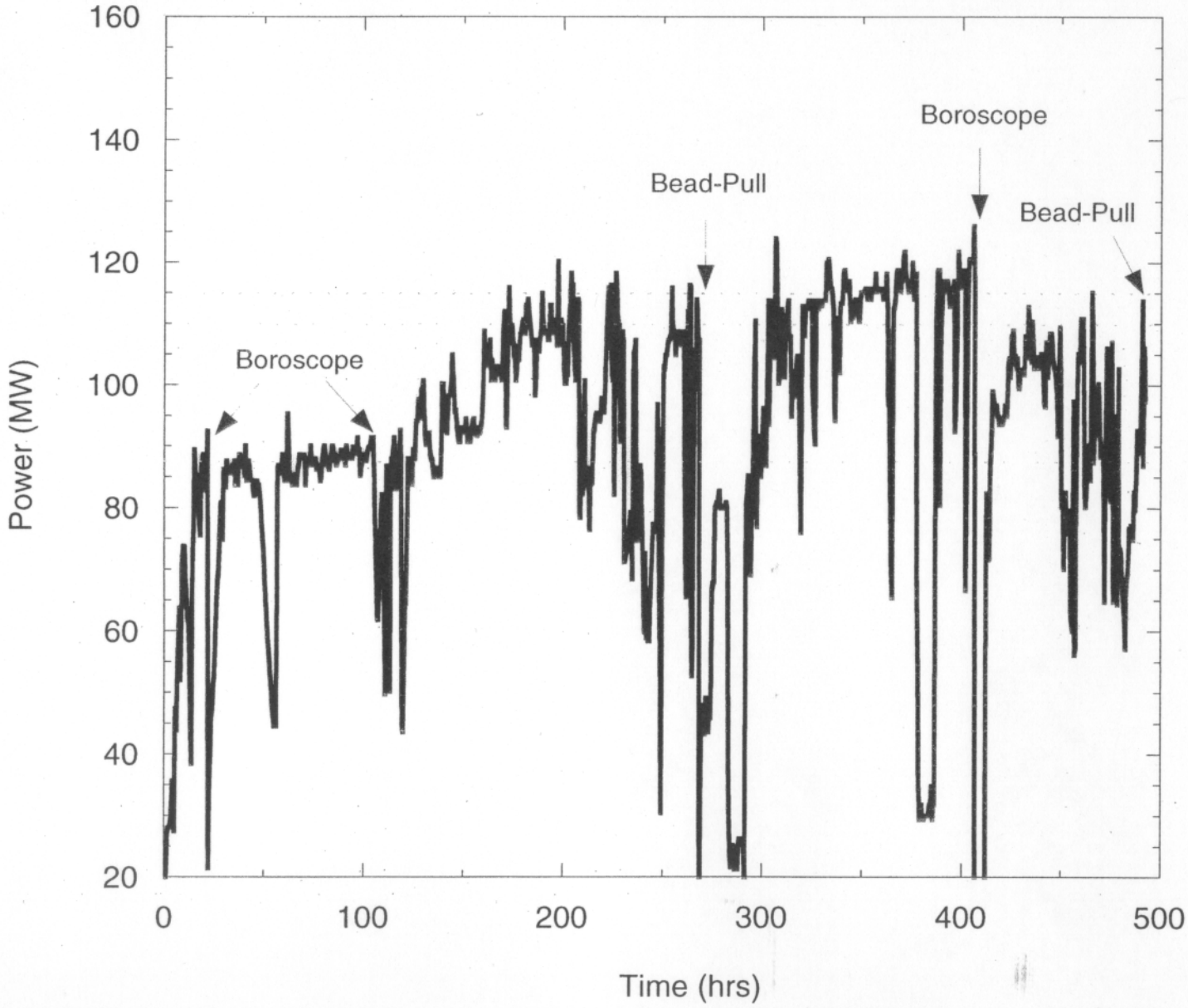
Corresponding Frequency Shift of the Cells.

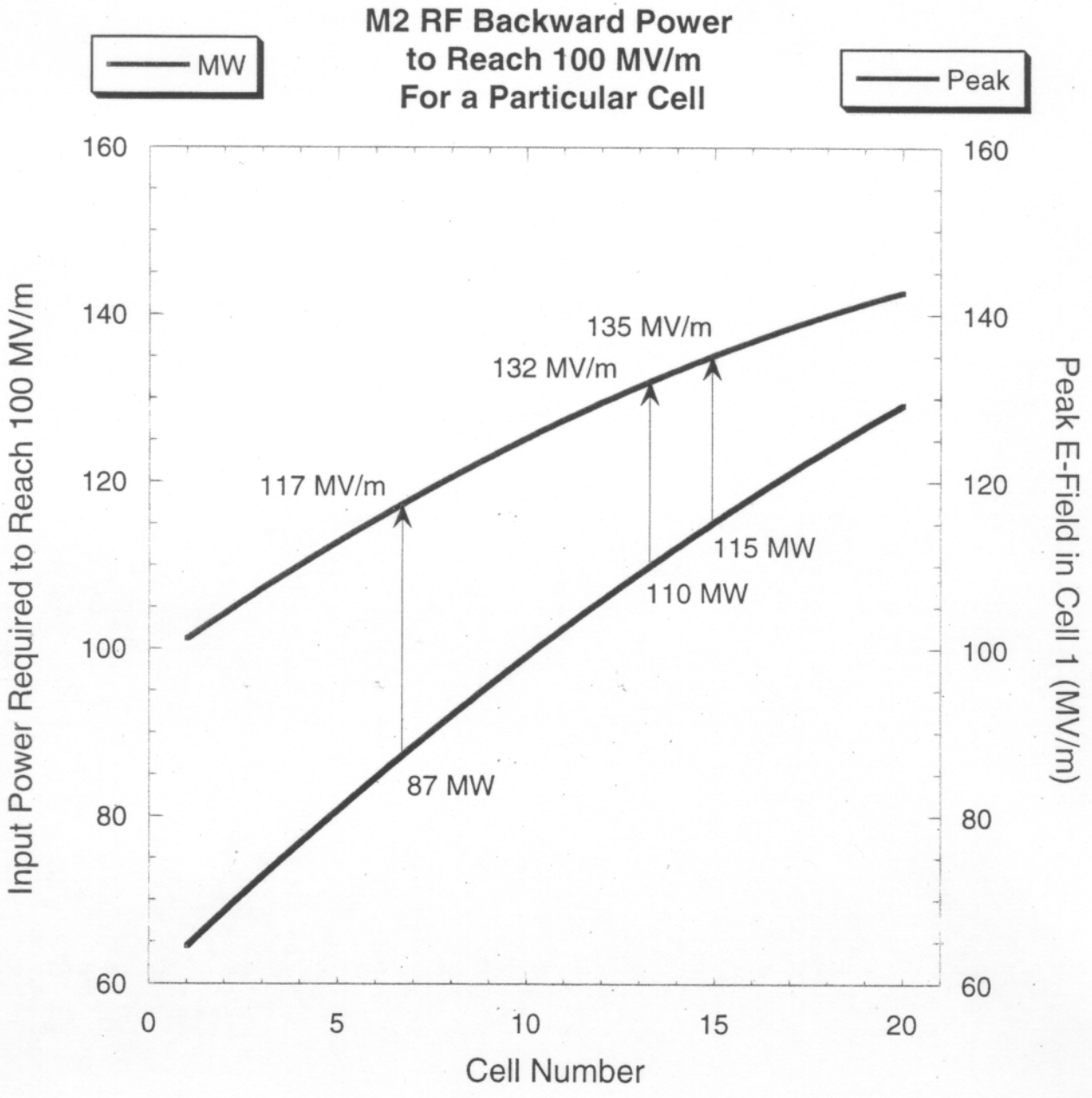



Microsoft Photo Editor
File Edit View Image Effects Window Help
40%
xl1_1.pcx
M2_01.pcx
M2_07.pcx
xl1_0.pcx
M2_00.pcx
M2_04.pcx
7Cav_3.pcx
7Cav_0.pcx
M2_05.pcx
Cursor: (230,390)
Selection: 0,0:719,479
W,H: 720,480


M2 Forward vs Backward Fed
E-Field Distribution
RF Fed at Input
Eacc (160 MW)
Ep (160 MW)
RF Fed at Output
Eacc (85 MW)
Ep (85 MW)
E-Field (MV/m)
250
200
150
100
50
0
0
20
40
60
80
100
120
140
Cell Number

Backward Processing of the M2 Structure




M2 RF Backward Power
to Reach 100 MV/m
For a Particular Cell
MW
Peak
Input Power Required to Reach 100 MV/m
Peak E-Field in Cell 1 (MV/m)
Cell Number
160
140
120
100
80
60
0
5
10
15
20
135 MV/m
132 MV/m
117 MV/m
115 MW
110 MW
87 MW

M2 Integrated Phase Advance Error