FERMILAB-LU-120

RF Structure Measurements at the Argonne Advanced Acceleration Test Facility

April 22, 1988

On 6–7 April a workshop was held at Argonne to examine R&D possibilities using the Argonne Advanced Accelerator Test Facility (A^3TF). Interest was focused on plasma wakefield acceleration and plasma lenses for linear collider final focus. The linac used by A^3TF has been used by Fermilab and Los Alamos to investigate accelerator components. The workshop gave some attention to whether the facility adds to the usefulness of the linac for $Z_{||}/n$ or transverse mode excitation studies of components.

Matters of Interest

- Characteristics of A^3TF
- Motives for measurements with beam
- Ideal facility
- Missing features of A^3TF for FNAL linac
- Possible enhancement of A^3TF
- Proposal for exploratory tests

A^3TF Characteristics

DRIVER		
Energy	21	MeV
Charge	(2) 5	nC
Bunch width	(9) 5	ps
ε_L	~ 6	keV ps
ε_T	10	π mm mrad
r_{rms}	1.6	mm
Δz_{rms}	1.1	mm
$\beta^*_{x,y}$	0.3	m
WITNESS		
Energy	15	MeV
Charge	~ 1	pC
Time delay	-0.2–1.8	ns
$\beta^*_{x,y}$	1	m
LINAC		
RF	1.3	GHz
Cycle	800	Hz

Good & Bad Arguments for A^3TF Beam Measurements

G Fully independent technique for finding modes

g Identifies only modes which couple to beam

g Direct measurement of effect of deflecting mode on beam

b Establishes relative importance of modes as seen by beam

B Close modeling of end use

Ideal Beam Test

No single facility is ideal. It would be very helpful to have a witness follow the driver in phase with the fundamental mode, *i.e.* at $\beta = 0.57$, but 200 MeV protons are pretty stiff to get much deflection measurement and 110 keV electrons don't sound like a bargain either.

If one can get long delays one can integrate the measured wakefield to get a wake potential equivalent in principle to frequency domain measurement. The ability to get a *transverse* wakefield measurement at various orientations of the beam dipole moment seems valuable.

What's lacking?

- Long delay times (100's of ns)
- Test section length (for an entire tank)

Possibility of Enhancement

The linac can be multipulsed so that a second driver could be used as a (time-quantized) witness. Because both positive and negative witness delay is available, a witness produced by a second driver could lead it and sample wake of first driver at any number of bucket delays + variable delay. Unfortunately, negative delay range does not cover full bucket width.

For 21 MeV electrons it is possible (practical?) to make a fast kicker ($\tau_r < 2$ ns) that would remove the second driver from the high energy line after target; then all variable delay is available.

Proposal

If

the double pulse mode of operation can be established without satellites between,

then

I propose we attempt to measure $Z_{||}(\omega)$ and $Z_{\perp}(\omega)$ of a 1 m DAW section. Measurements to include $\cdots$

- longitudinal wake potential over all available time to ~ 1 ms

- transverse ditto, at least 3 orientations of beam dipole moment

- sampling scope output of probes near gap & at coupler (if avail.)

- fourier analysis of all three above