RF VOLTAGE IN KURNS FFA

T. Uesugi, KURNS

The rf frequency pattern is programmed assuming +- 4 kV gap voltage. But the assumption is questionable, now.

FFA19, 2019.11.20, PSI

Rf Operation



100 MeV mode (30 Hz)



150 MeV mode (20 Hz)



No flatbase, flattop

Voltage is half of that we assumed ?

A suspicion is raised, during beam experiments.



Measured synchrotron tune was in good agreement with V=2.0 kV instead of 4.0 kV.



Measured synchronous phase of 40 deg suggests V=2.0 kV, too.

HOW THE VOLTAGE OF 4KV IS ESTIMATED





Output voltages of Final Amplifier



 $\pm 4 \ kV$

By 2:1 coupling (next slide)

Monitor output (1/1000)

L- couple feed with 2:1 winding ratio



for impedance matching.

The cooling plates, which is conductive, play a role of 2nd turn winding = 'Takagi winding method'

The gap voltage is half of input.

$$\vec{V}_{gap} = \left(\vec{V1} - \vec{V2}\right) \times \frac{1}{2}$$

A Suspicion



In case the cooling plate is touched with the chamber, for some reasons.

It probably happens ... (photo in the next slide)

Is the gap voltage reduced more ?

$$\vec{V}_{gap} = \left(\vec{V1} - \vec{V2}\right) \times \frac{1}{2} \times (some \ reduction)$$



It probably happens …

How to verify ?



(1) Directly measure the gap voltage—> hard to put probes

✓ (2) Synchrotron tunes $\nu_s \propto \sqrt{V}$ → consistent with 2kV

✓ (3) Synchronous phase $V \sin \phi_s = \frac{dE}{dN}$ → better fit with 2kV

(4) Is there any other way?

INFLUENCES IF VOLTAGE IS REALLY 2KV

Basic Operation Pattern

still works (const phi-s) in principle.

| | Intended | Reality (?) |
|-----------------------------------|----------------------------|----------------------------|
| Voltage | 4 kV | 2 kV |
| Synchronous phase | 20 deg | 43 deg |
| Bucket height @ inj. @ 100 MeV | 0.18 MeV 0.59 MeV | 0.13 MeV 0.42 MeV |
| Bucket area @ inj. @ 100 MeV | 1.0 MeV rad 3.2 MeV rad | 0.3 MeV rad 0.9 MeV rad |

Bucket area differs by factor 3

Past measurement of E-loss at foil

based on $V \sin \phi_s = \Delta E_{loss}$

(Change rf input, and measure rf phase of a bunch center)



Fig. 25: Measured synchronous phase compared to rf peak voltage. The fit curve shown is for a threshold voltage of 0.8353 V.

Capture efficiency

Possibly explains why the capture efficiency is lower (unknown factor 3) than expected in multi-particle simulation.



To do (1) Measure gap voltage directly, if possible. (2) Verify the connection between (3) Explain why

