



LEP KICKERS FOR RF DEPOLARIZATION

FCC EPOL WORKSHOP

G. Kotzian – 29 September 2022

Context / Disclaimer

- Information in this presentation is entirely based on papers and publications found from LEP times
- Experts of the time are retired.
- Details on the LEP Polarization => see presentation by J. Wenniger, WG1/Wednesday 21

→ In the following a summary of material **TAKEN FROM** past publications, concerning the “***LEP kickers for RF depolarization***”

Resonant Depolarization

TAKEN FROM: J. Wenninger, "Energy Calibration at LEP3; Lessons of LEP(2) 4 LEP3,"
2nd EuCARD LEP3 Workshop, <https://indico.cern.ch/event/211018/>

- Main workhorse and absolute reference for LEP energy calibration
- Relies on the relation between spin precession frequency ν_s and energy

Principle:

1. Have a polarized beam
2. Get a fast transverse kicker
3. Sweep the B-field and observe P_{\perp}
4. If the kicker excitation frequency matches ν_s ,
 P_{\perp} is rotated away from vertical plane \rightarrow depolarization

Transverse Feedback and LEP (1992)

TAKEN FROM: L. Arnaudon, et. al., "Transverse Feedback and LEP Performance,"
[3rd EPAC, Berlin, Germany, 24 - 28 Mar 1992, pp.66-68](#)

data processing. The **transverse feedback kickers** are also being successfully used for resonant depolarisation of electron beams for energy calibration [2].

The feedback system has been used to depolarise the electron beam for energy calibration. **A simplified version** of the hardware is going to be installed and used as dedicated depolarizer with kickers which were installed in the end of last year. In this way simultaneous excitation for resonant depolarisation and damping with feedback are made possible.

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- LEP used dedicated depolarizer kickers
- Simplified version of the Transverse Feedback Hardware
- External signal source to excite the spin rotation resonance → synthesized signal
- Single bunch polarization has been made possible in order to save time by successively depolarizing different bunches without having to wait for repolarisation.

Hardware for the LEP Transverse Feedback System

TAKEN FROM: S. Myers, et. al., "HARDWARE FOR THE LEP TRANSVERSE FEEDBACK SYSTEM,"
12th IEEE PAC 1987, Washington, DC, USA, 16 - 19 Mar 1987, pp.503-507

- Kickers consisted of parallel plate magnetic kickers
- Driven by a current pulsing network (pulse forming network)
- The pulsers used vacuum tubes (kicker location close to radiation environment)

- Maximum field strength

The kick required

$$\Delta y'_k = \frac{ec}{E} B_{\perp} L \quad \text{for a magnetic kicker}$$

where E is the energy of the beam to be deflected.

- Maximum magnetic field required at LEP injection ($E=20\text{GeV}$) was $B_{\perp}L = 4.3 \text{ Gm}$

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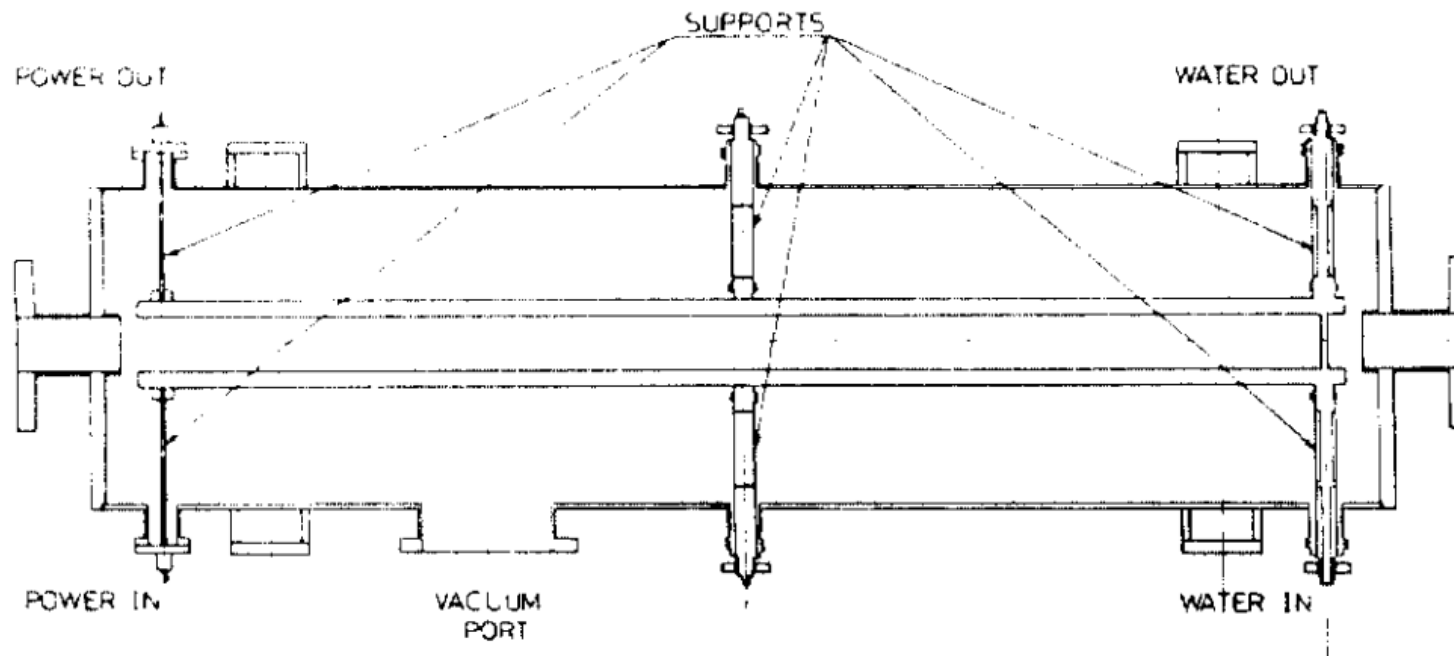
Choice of Hardware

The major consideration in the choice of the hardware was cost. Choices, or factors affecting the choice included (a) deflection by electric or magnetic systems, (c) coupling impedance to the beam, (d) minimum electronics in the tunnel and (e) absence of space in midarcs.

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It was decided that a parallel plate magnetic kicker inside the vacuum system as shown below driven by a simple current pulsing circuit would best satisfy the imposed constraints.



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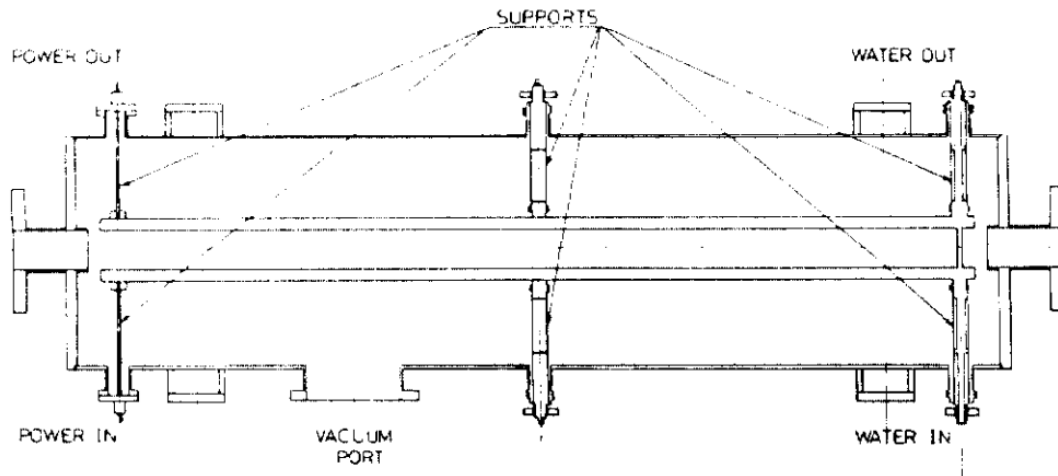


Plate dimensions

For maximum efficiency, the plates of the kicker should be as close to the beam as possible.

Cooling

It has been estimated [4] that about 200 W will be dissipated in the kicker tank due to higher order mode losses at 3 mA beam current.

Mechanical construction

The kicker tank and electrodes are made from stainless steel. Making the electrodes hollow provides both a stiff lightweight structure and an efficient network of cooling channels.

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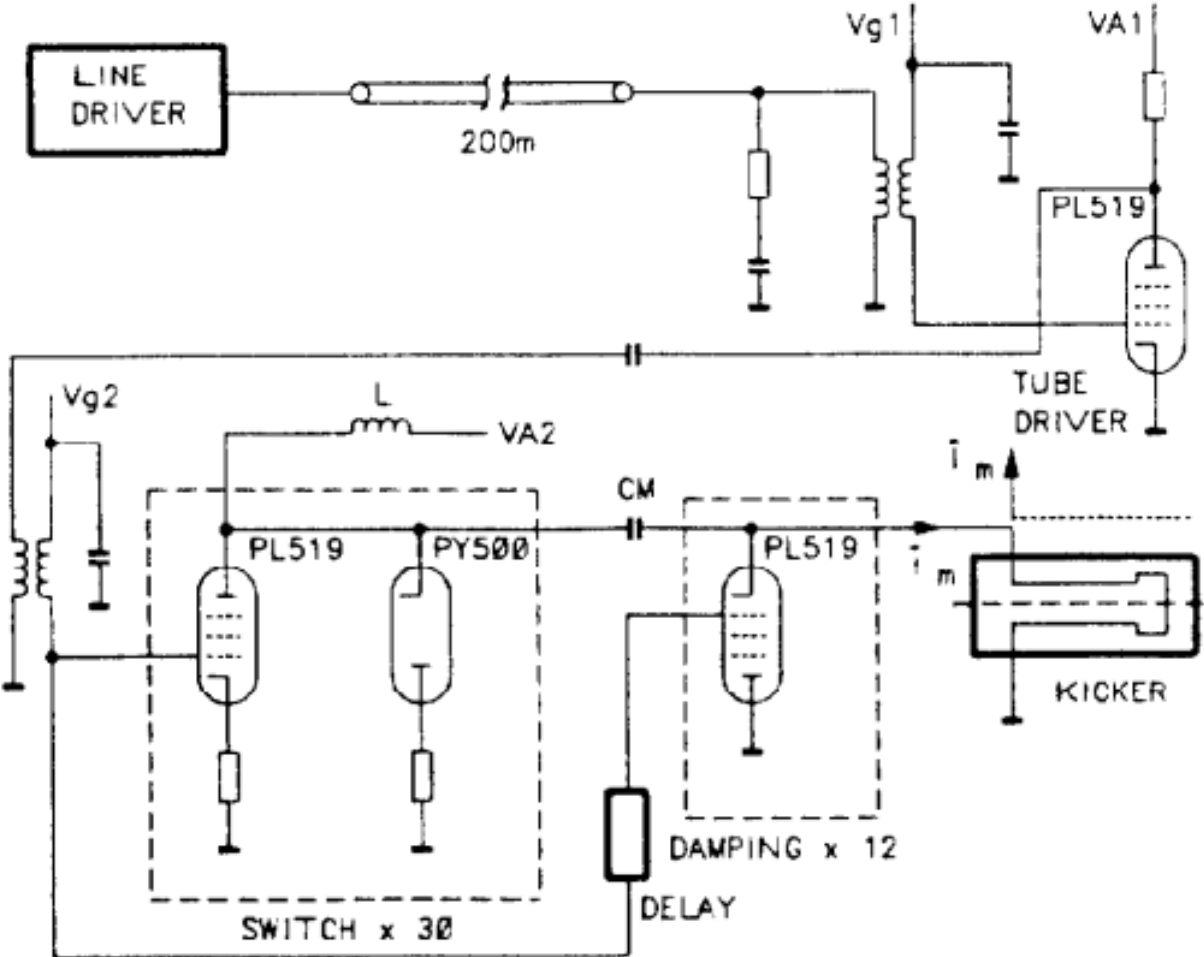


Fig. 3 shows a circuit diagram of the current pulser which operates as follows. By closing the switch which is formed by modules of 10 parallel pentodes and diodes, the charging capacitor is discharged in series with the kicker inductance so creating the sinusoidal current pulse in the kicker plates. The diodes take the negative part of the pulse current. At the end of the pulse, the switch is opened to recharge the charging capacitor through the inductance in the anode circuit, and the four damping pentodes are closed to clamp the voltage over the kicker.

Summary – LEP kickers for RF depolarization

- Same kickers as for the Transverse Feedback system
- Kickers consisted of parallel plate magnetic kickers
- Driven by a pulse forming network, based on vacuum tubes

- New technology available ...



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