III. GENERAL SESSIONS - ACCELERATOR TECHNOLOGY

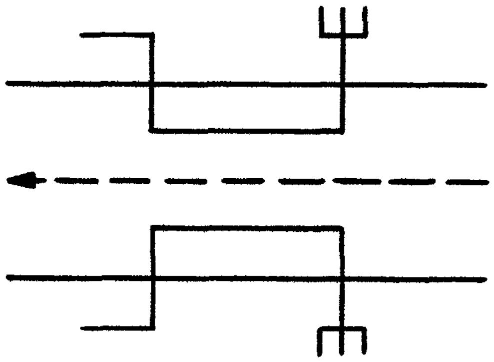
Following the plenary sessions, areas of common interest were determined and a preliminary schedule for the remainder of ICANS-III was adopted for discussions related to accelerator technology.

The basic approach for each topic decided upon was to have a few individuals discuss their advances and/or operating experience, identify the problem areas, and then use that to launch a broader discussion. During the discussion periods specific inquiries were made and plans and ideas for the individual projects were bounced off other experts in the room.

Much of the text for the topics chosen stems from questions and discussion. No attempt has been made to identify the questioners; summaries related to the various discussions follows.

A. Extraction Systems, D. W. Hudgings, LASL

The kicker magnet specifications adopted at this time call for an 80-Gauss, 3-m long, 3-inch aperture magnet to be used for horizontal extraction. One approach considers a parallel plate device operating in the TEM mode (see the sketch below).



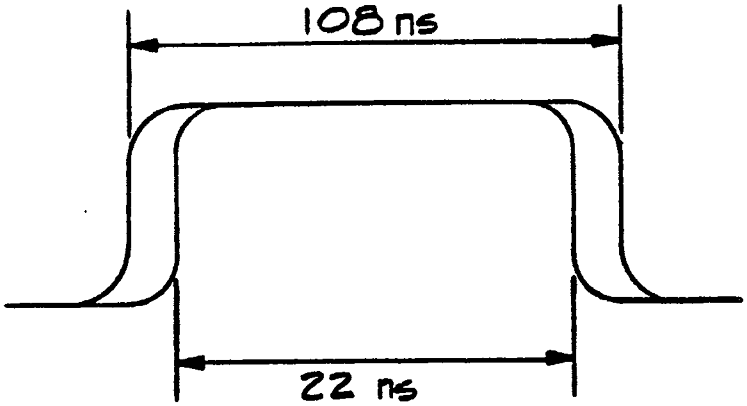
$$F = q(\varepsilon + v \times B); \quad E = cB$$

So

$$F = F_m(1 \pm 1/\beta)$$

The sign in the equation depends on the direction which you drive the magnet. For our choice here, we pay the price that the time window is less by the transit time plus the filling time.

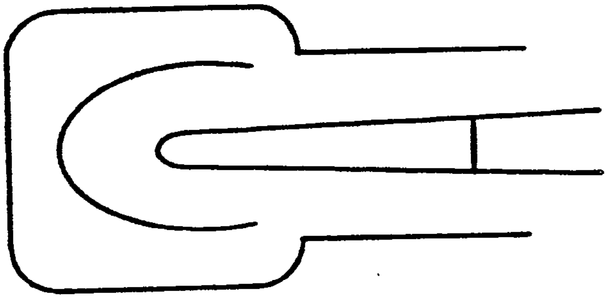
For the pulse requirement we do not separate the jitter and the rise time (as shown in the following sketch).



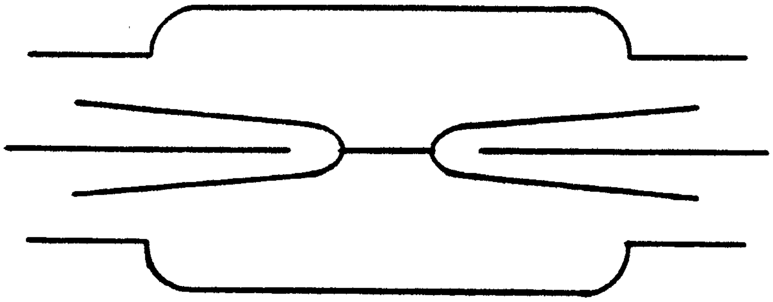
For a 3-m structure the pulse amplitude required in the push-pull mode is ± 50 kV.

For switching at low-repetition rates, spark gaps are all right, but for high rates their lifetimes (~ 10^7 shots) are a serious limitation. For 10^8 shots a day this would be 10 gaps. The lifetime of a thyratron is shortened by high-repetition rates also since it enters a resistive phase when it turns on. This causes a 1-kV arc drop and accelerates energetic ions towards the cathode. Expected lifetimes are 10^7 to 10^8 discharges which requires replacing thyratrons at a rate of once a day and is accompanied by prohibitive cost.

So if one settles for the transmission line approach, this means switch development. We have been looking at thyratrons and another concept called a magnetic modulator. The laser people are trying to develop switches like this. We have one to test. The test fixture will have solid state switching for charging as indicated by:

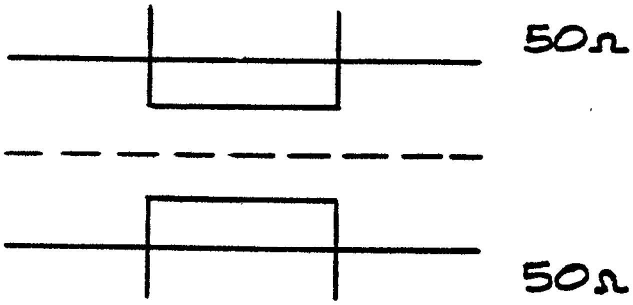


or a push-pull version shown below.



The idea is to use either this or a transformer pulse forming network.

Simultaneity is important because without it you get reflections which bounce around and hurt you later (see sketch below using 50 Ω):



1. Questions

Why not use 10 Ω? Because you have to switch five times the current.

What about deflection quality and will there not be field distortions? The answer to these questions lies in shaping the plates. In this application we are talking about 50-MW peak power so repetition rate is the problem. Our real hope is the magnetic modulator.

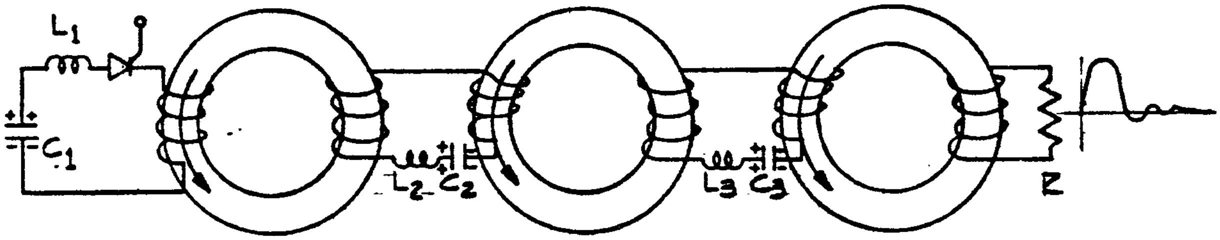
Why not use a system like the CESR kicker? We looked at it but it uses spark gaps. The other problem is that with the ferrite outside the vacuum chamber one would have to metallize the walls and to get field penetration would result in distortion. The high resistance would also exceed that of the entire rest of the ring (200 mΩ).

What is unique about Laser thyratrons? They have larger cathodes, a gradient grid, are compact for low inductance, much beefier, have low jitter but are more difficult to trigger (it takes at least 500 V). The major differences are the large reservoir and cathode.

What is the deflection uniformity across the beam transversely? About 10%, but again the plan is to put tips on the plates or to use curved plates. The ratio of the plate-width to the usable-region-width is ~ 3:1. We can show the computer field calculations if desired.

B. Magnetic Modulator, R. K. Cooper, LASL

The magnetic modulator is a series of saturable transformers with an initial condition in which all cores are saturated in the same direction. When the capacitor discharges, the core looks like a free-space inductor. The transfer of energy from the primary to the secondary depends only on the capacity in the secondary (see the sketch below):



DISCHARGE OF
C1 DRIVES FIRST
OUT OF NEGATIVE
SATURATION,
TRANSFERS
ENERGY TO C2

CHARGING OF
C2 HOLDS CORE
2 IN NEGATIVE
SATURATION.
DISCHARGE OF
C2 FIRST DRIVES
CORE 1 INTO
POSITIVE
SATURATION,
THEN DRIVES
CORE 2 OUT
OF NEGATIVE
SATURATION.

CHARGING OF
C3 HOLDS CORE
3 IN NEGATIVE
SATURATION, etc.
DISCHARGE OF
C3 DRIVES CORE
2 INTO SATURATION,
BUT SOME ENERGY
COULD BE COUPLED
BACK TO C2 IF
SATURATION NOT SOON
ENOUGH