

Design Limitations for MEBT Kicker

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Fermilab

Main kicker parameters

Length [m]	0.5
Gap, $2d$ [mm]	17
Effective voltage, V	200
Kicker efficiency	0.9?
Voltage at kicker entrance, V	223?
Average power [W]	500
Peak power [W]	1000
Wave impedance [Ω]	50
Phase velocity, v/c for 2.1 MeV	0.0669
Bandwidth [MHz]	>500

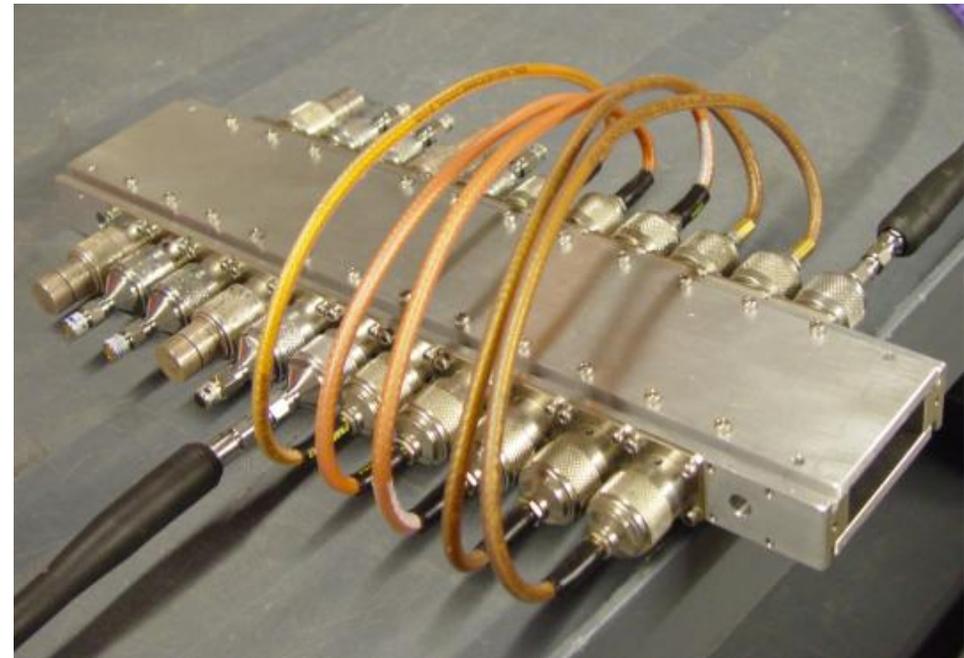
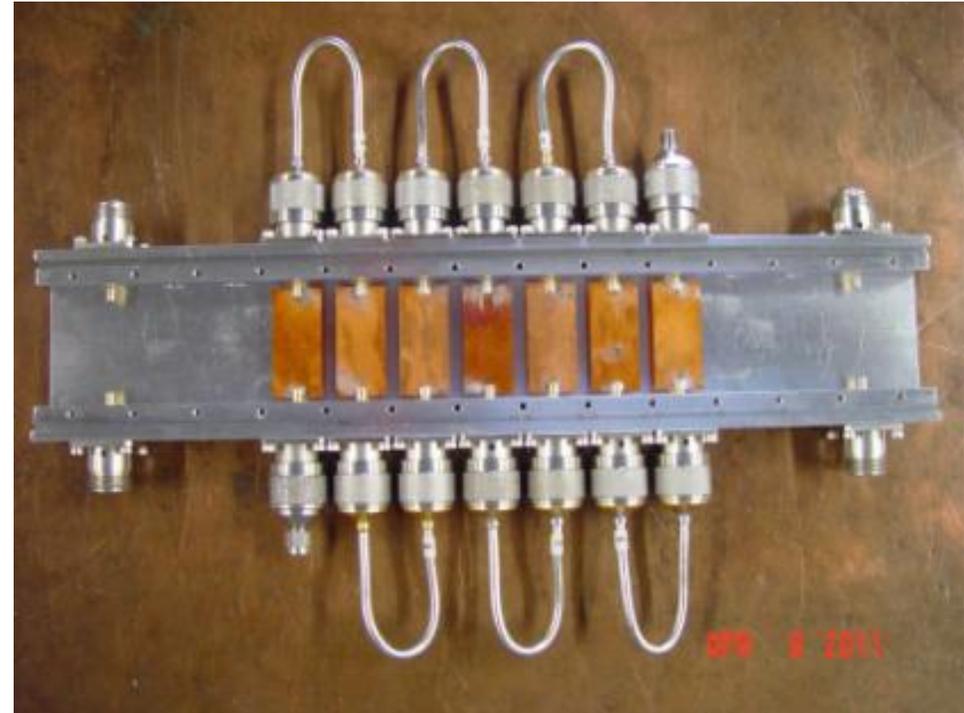
- Four kickers required for MEBT

Major design choice

- Separate plates with diagonal connections
- If properly designed suggests the bandwidth more than 1 GHz

Questions to be addressed

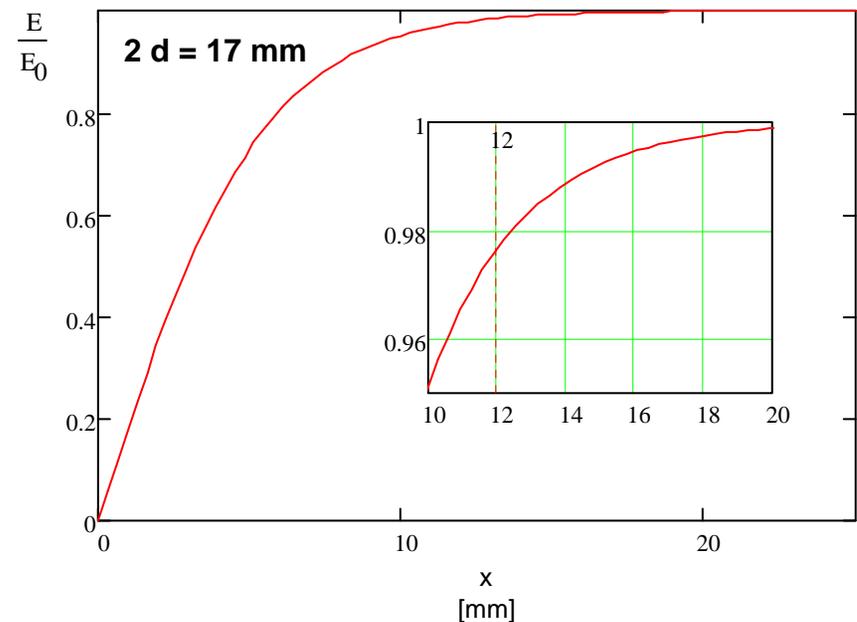
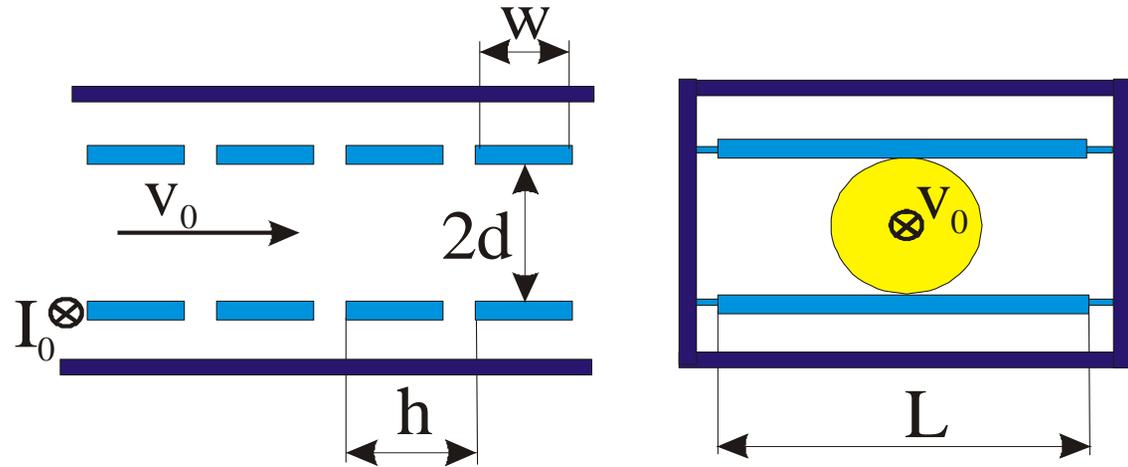
- Geometry of electrodes
 - ◆ length
 - ◆ width
- Support of electrodes
- Cooling
- Operation in vacuum



Geometry of electrodes

- Field non-uniformity ($\Delta E/E$) has to be within 2% for a 16 mm in diameter

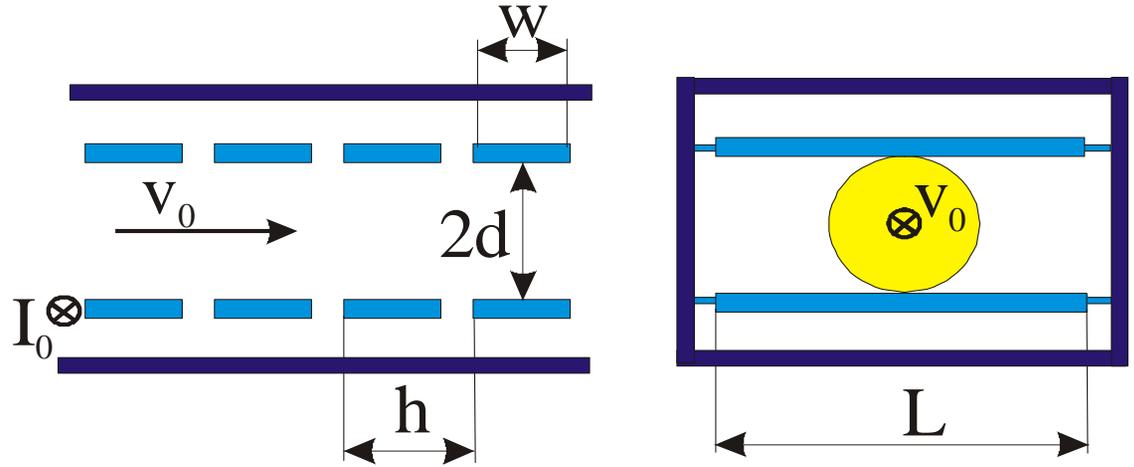
- ◆ That determines that the plate length, L , has to be more than $16+2*12=40$ mm
- ◆ Let's put $L=40$ mm



Geometry of electrodes (continues)

■ Period

- ◆ Large period results in loss of the effective bandwidth
- ◆ Too small period increases number of electrodes and shortens length of diagonal connection



■ 18 mm period (h) and 15 mm plate width (w) are a good compromise

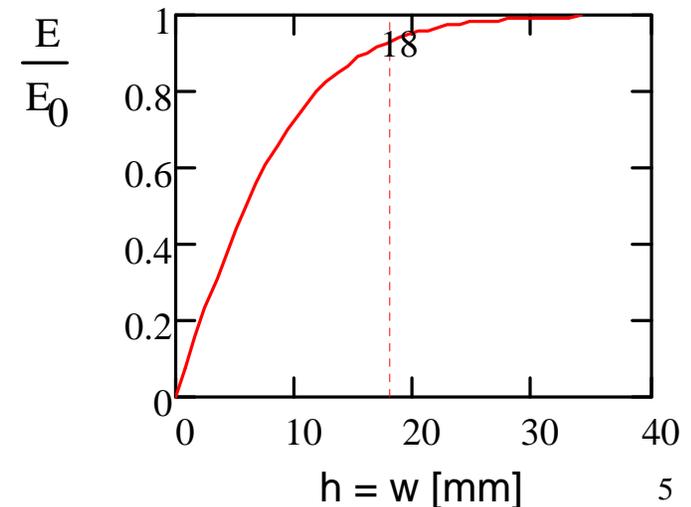
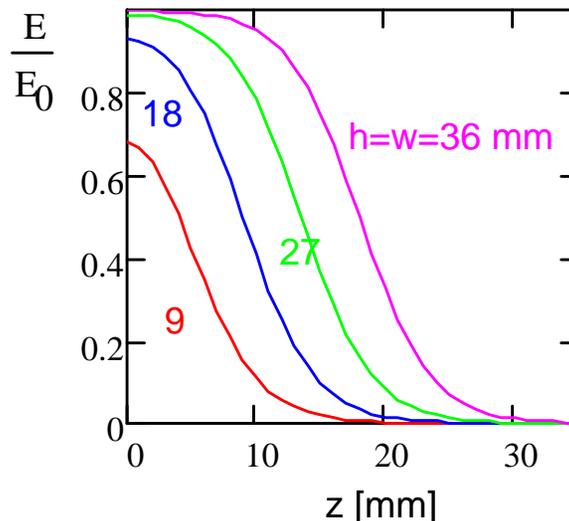
- ◆ w can be adjusted to compromise between kicker efficiency and coupling between plates ($w \in [13, 15]$)

d=17 mm

$$\int E_y dz = U_0 \frac{w}{d}$$

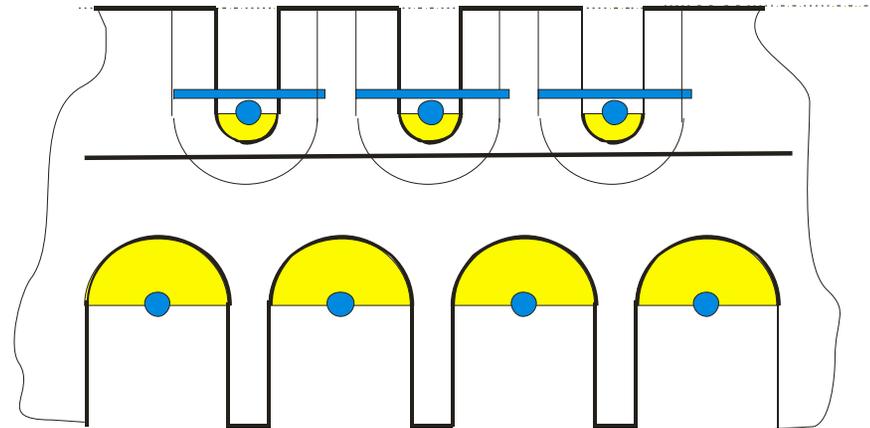
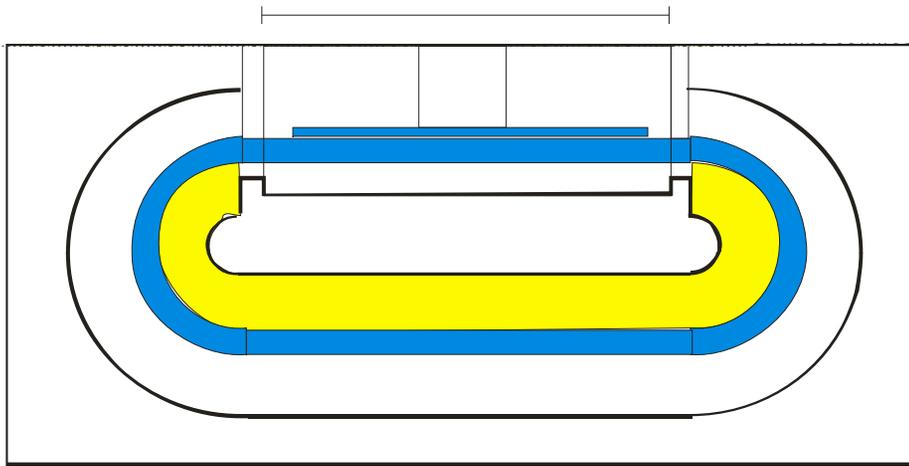
■ for h=18 mm length of diagonal connections is

$$205 / \sqrt{\epsilon} \text{ [mm]}$$



Possible Implementation for Kickers

40 mm



$d=8.5$ mm, $h=18$ mm, $w=15$ mm, "cable radii" - $b=7$ mm & $a=1.25$ mm, $\epsilon=9.6$
27 turns for 50 cm kicker

- Kicker is wound by a single piece of wire
- Electrodes are soldered (bolted?) to the wire
- Open "cable" for diagonal connections
- Alumina half rings are used for thermal contact
 - ◆ Usage of half rings instead of whole rings increases the wave velocity in the "cable"
 - ◆ Rings have to be brazed to the base and to the wire

Power loss due to finite resistivity

- For 50 cm kicker about 5% of power will be lost in the conductor
 - ◆ 50 W
- Power loss will reduce the kicker efficiency by ~1.5%
- It makes sense to limit beam power loss at the kicker to ~10 W
 - ◆ 0.1% of total beam power,
 - ◆ 5 μA beam current loss should not be a problem to catch sufficiently fast

