CTF3 Kickers and Septa

K.D. Metzmacher

CERN

AB/BT

Prepared with input from

Tony Fowler and Luc Sermeus for kickers

Jan Borburgh for septa

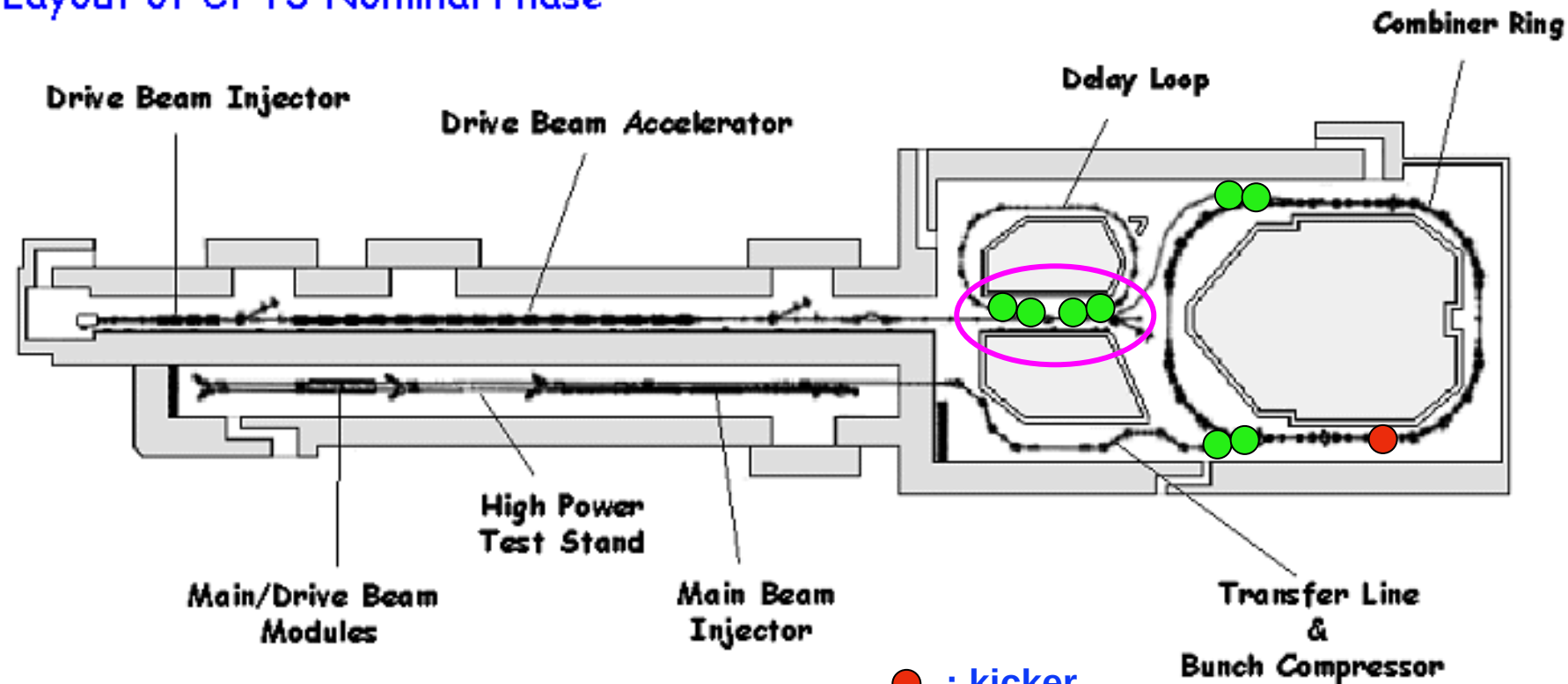
CTF3 Kickers and Septa

- Requested engagement of Beam Transfer group by CTF
- What can be proposed by BT group concerning
  - Injection + Extraction septa of Delay Loop
  - Injection + Extraction septa of Combiner ring
  - Extraction Kicker of Combiner ring

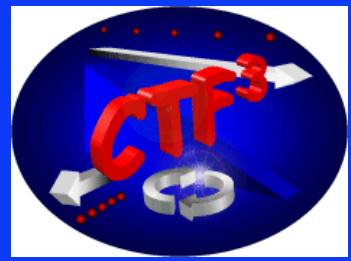
Kicker subject is still evolving

CTF3 Kickers and Septa

Layout of CFT3 Nominal Phase



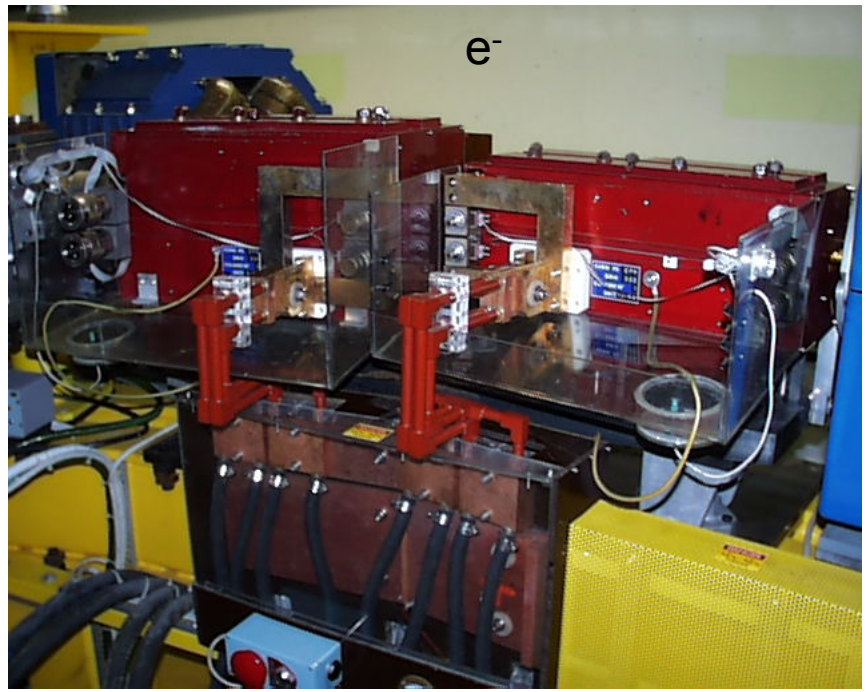
Delay loop Septa



- Septa will be recovered from former EPA ring.
- 1 thin followed by 1 thick septum at injection; same for extraction.

EPA designation	SM331	SM332
Septum thickness [mm]	19.2	6.6
Number of turns	12	4
Max. current [kA]	2.75	2.75
Gap (h × w) [mm^2]	25 × 90	25 × 90
Physical length [mm]	580	580
Electrical resistance [mΩ]	9.2	3.1
Cooling water flow [l/min.]	20	60
Magnetic length [m]	0.5	0.5

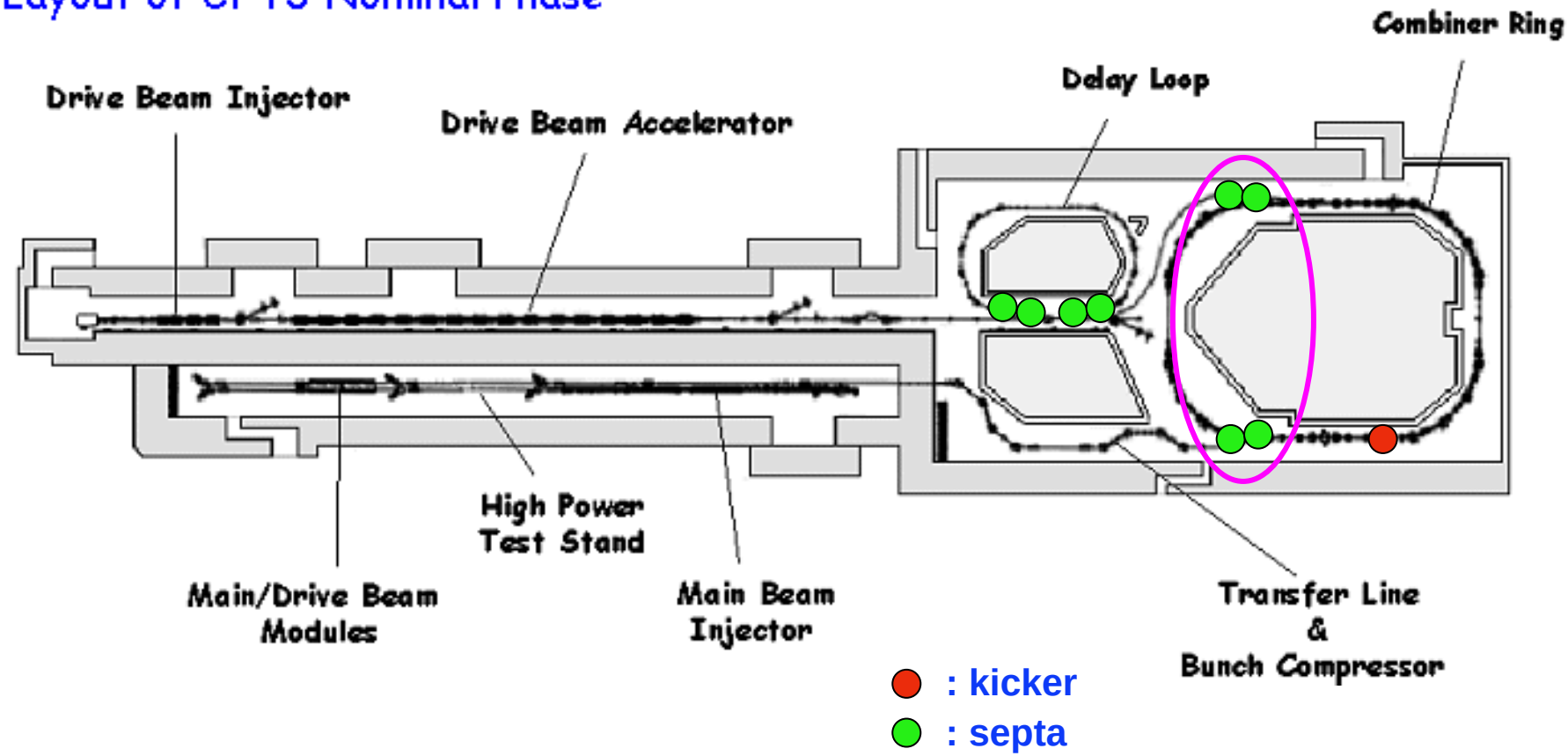
Delay loop Septa



Injection septa of positrons and electrons at EPA

CTF3 Kickers and Septa

Layout of CFT3 Nominal Phase



Combiner ring Septa

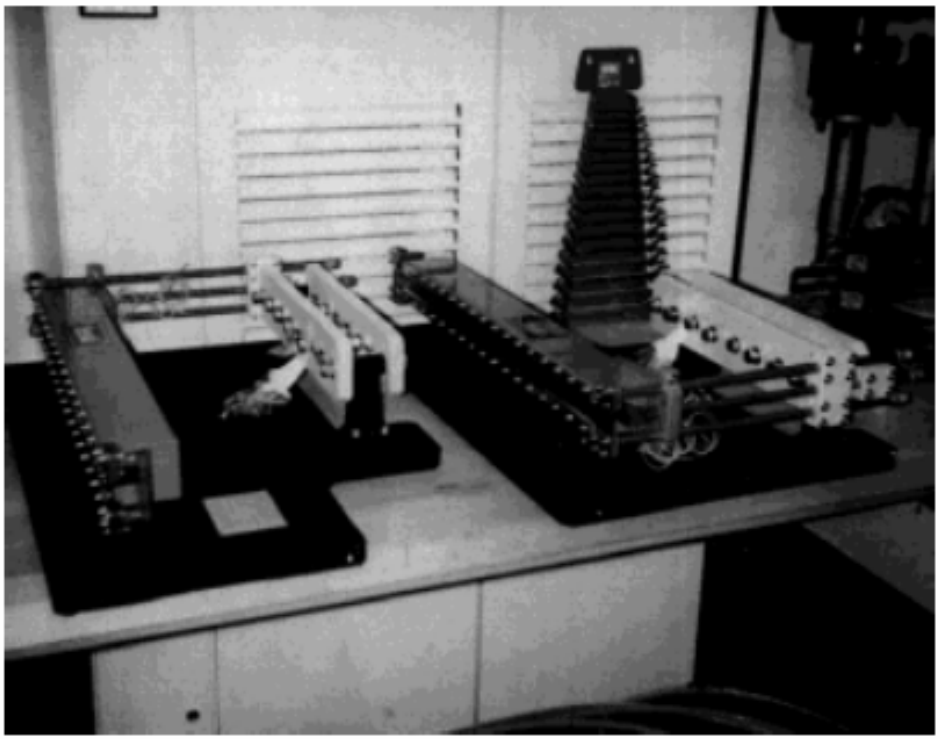
- 1 injection area and 1 extraction area, each using 1 thin and 1 thick DC septum, run in series electrically.
- Thin septum is an extrapolation of a DAΦNE septum.
- Thick septum is based on septum designed for TERA, which was an evolution of the EPA septa.
- Total deflection to be provided per extraction is 209.4 mrad.
- Construction is proposed to be done in collaboration with CIEMAT.

Combiner ring Septa

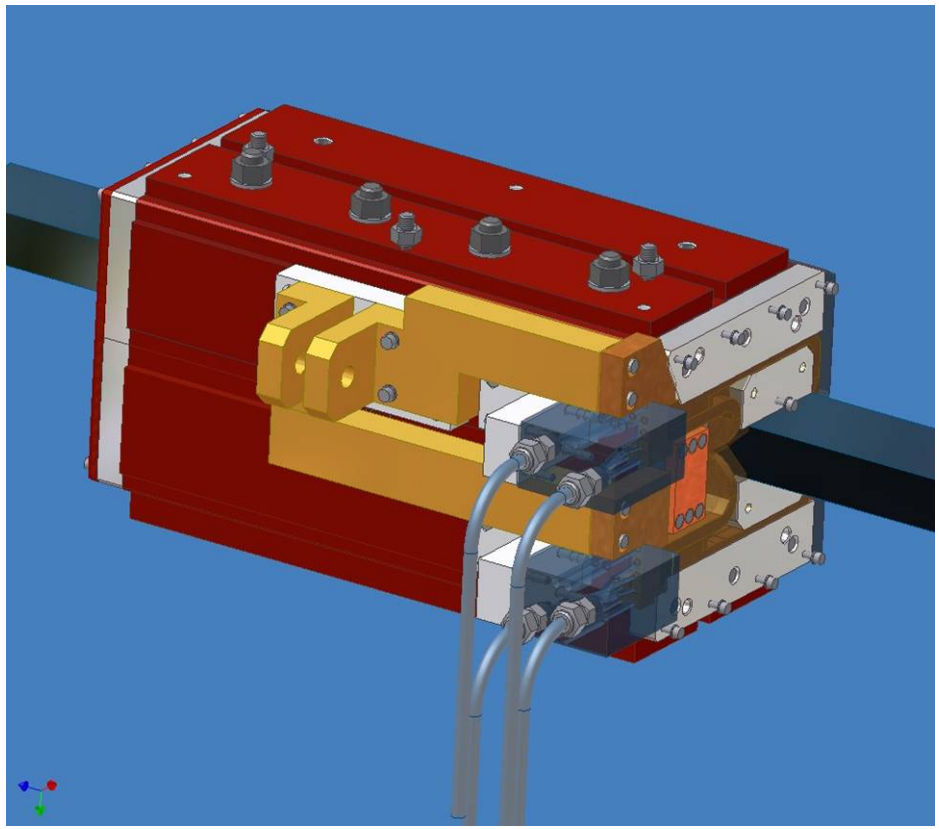
- Preliminary specifications

	thin	thick
Integrated field [mT.m]	48	161
Gap field [T]	62	248
Septum thickness [mm]	2	11.4
Septum conductor thickness [mm]	1.7	9.5
Gap h × w [mm^2]	40 × 70	40 × 80
Physical length [mm]	900	692
Magnetic length [mm]	782	650
Current [A]	1974	1974
Number of turns	1	4
Magnet inductance [μH]	2	29.6
Electrical resistance [mΩ]	0.3	0.9

Combiner ring Septa



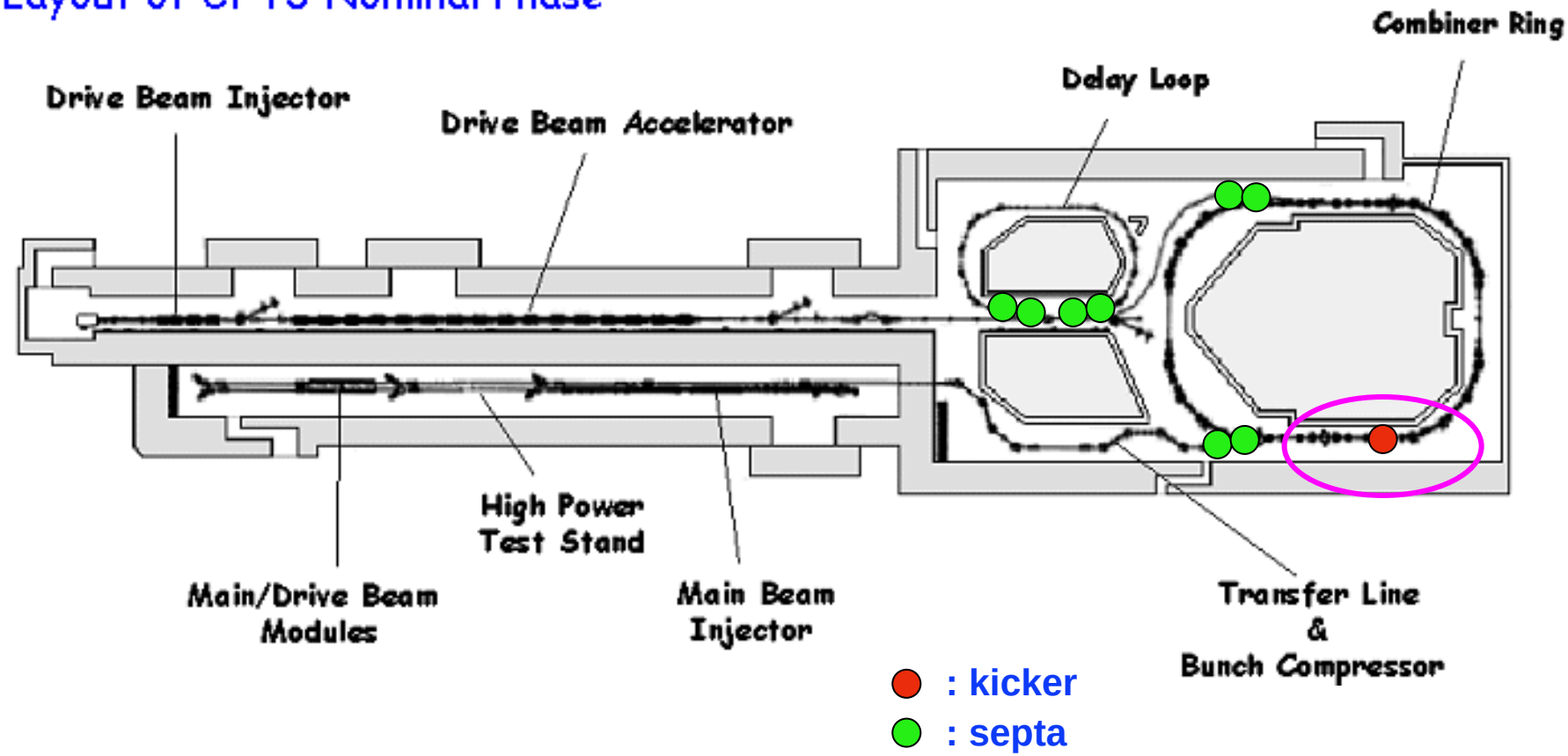
2° DAΦNE septum



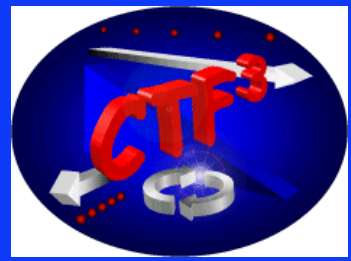
TERA thick septum design

CTF3 Kickers and Septa

Layout of CFT3 Nominal Phase



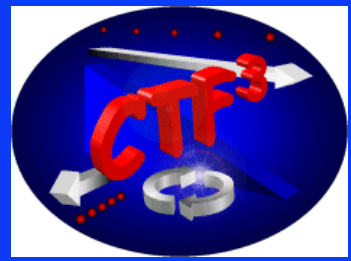
Combiner ring Extraction kicker



- Kicker preliminary specifications

Energy		300	MeV
Kick angle		5	mrad
∫Bdl		5	mT.m
Rise-, Fall-times (0 – 100 %)		≤ 70	ns
Pulse length (max.)		200	ns
Flat-top reproducibility		± 0.1	%
Flat-top stability (including droop)		± 0.25	%
Repetition rate	Initial	5	Hz
	Nominal	50	Hz
Available length (flange to flange)		2	m
Vertical aperture		≥ 40	mm
Horizontal aperture		≥ 40	mm
Field homogeneity	± 1 %	30	mm

Combiner ring Extraction kicker

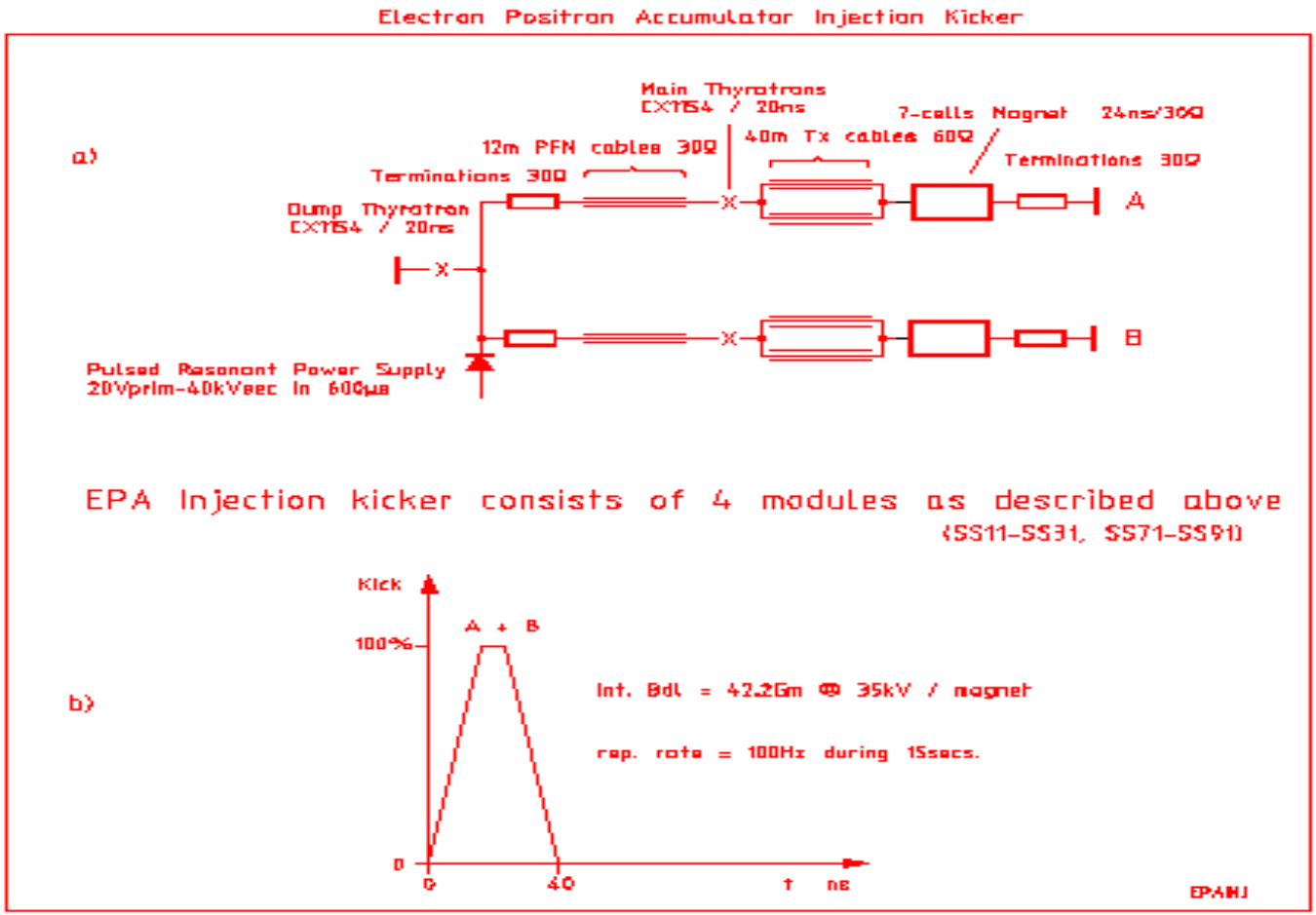


Extraction kicker requested for April 2006:

- The impedance of the kicker structure seen by the beam must be such that any induced instabilities are inconsequential. A **strip-line kicker** fulfilling this criterion can be supplied by CIEMAT but **not before end of 2006**.

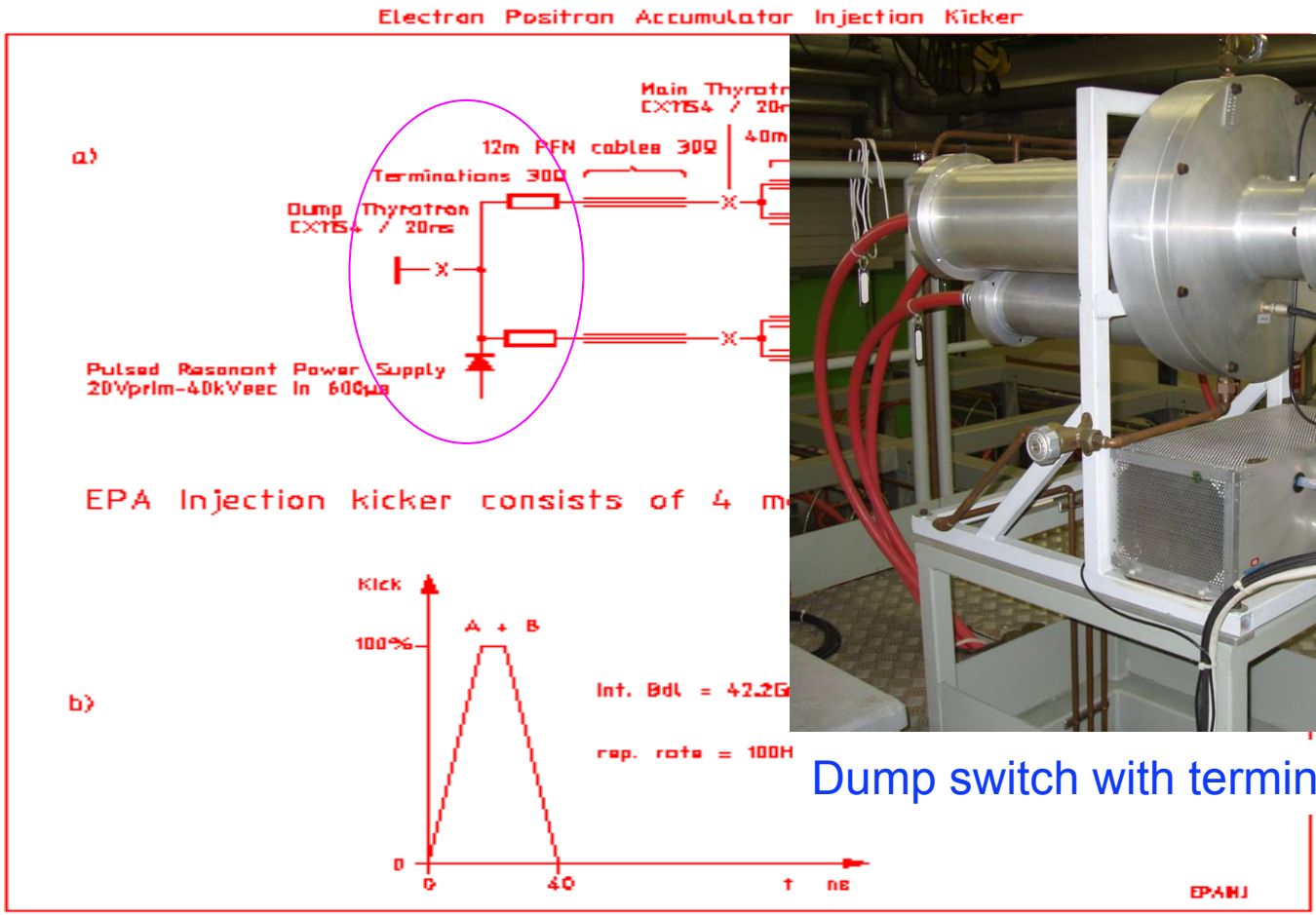
- For operation in **2006** an **existing ex-EPA kicker system**, which only partially satisfies the specifications, will be modified and installed.
  - This will employ two ferrite-cored kicker magnets whose vertical aperture is 35mm, smaller than the nominal 40mm required. The vertical restriction excludes any insertion of metallized ceramic plates to improve the impedance matching.
  - Existing hv pulsed power supplies will be used. Pulse top flatness and reproducibility remain to be measured and are not guaranteed to fulfill specifications.
  - Existing (**old**) electronics will be used with **CAMAC** controls.

Combiner ring Extraction kicker



Generator circuit diagram

Combiner ring Extraction kicker



Generator circuit diagram

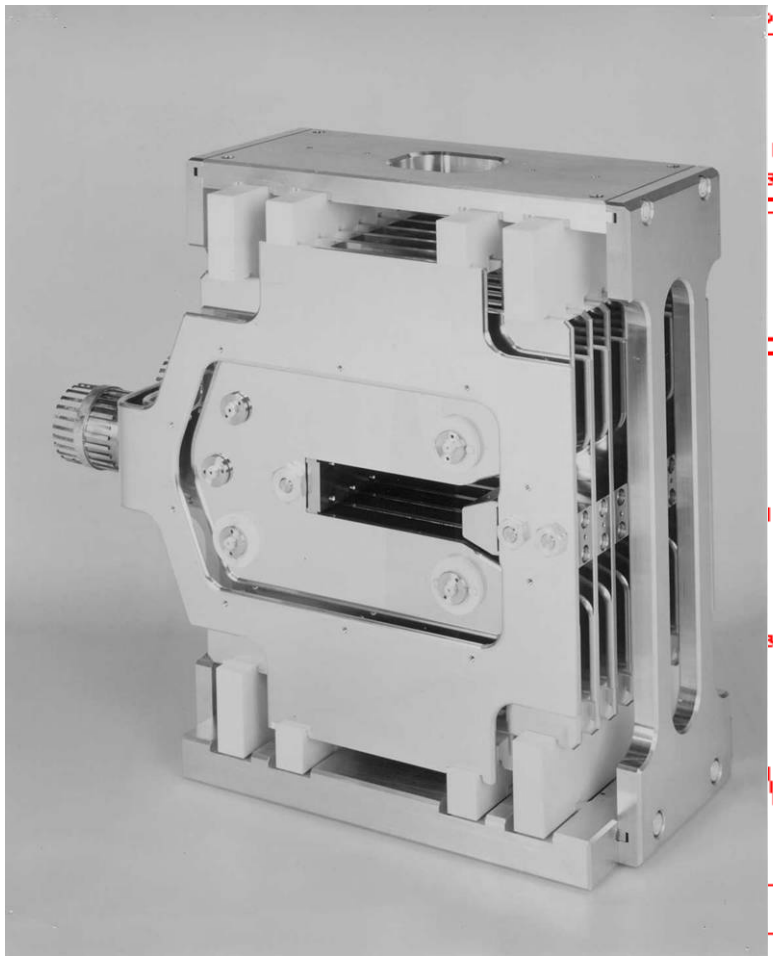
Dump switch with terminating resistors

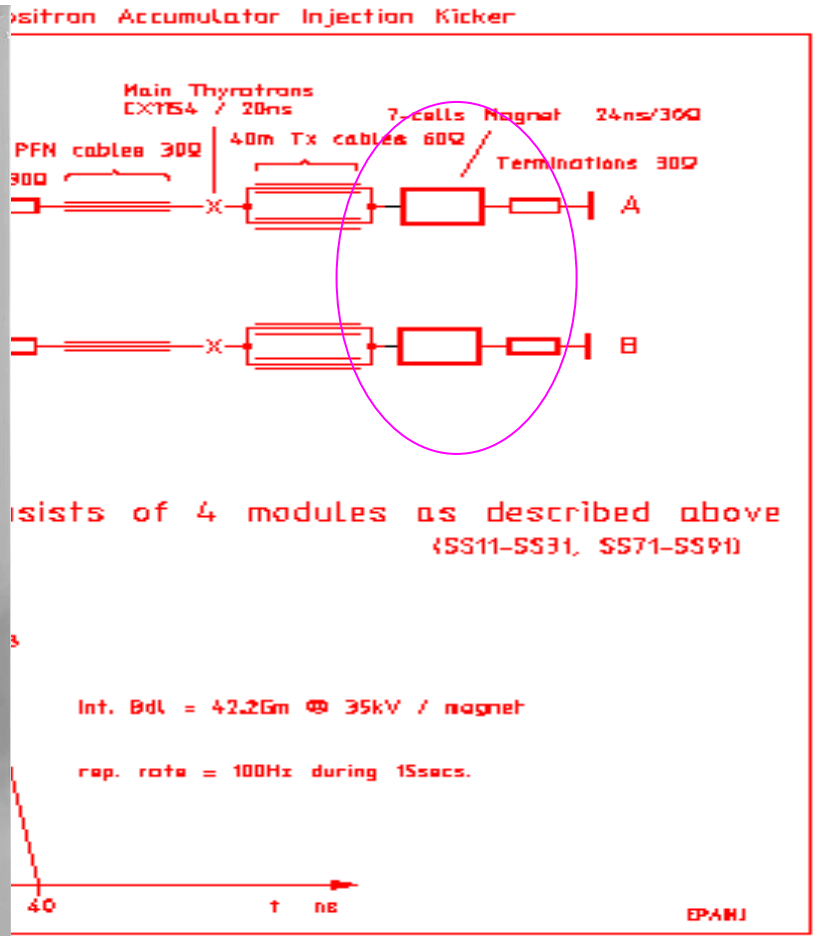
Combiner ring Extraction kicker

Two main switches housing

Generator circuit diagram

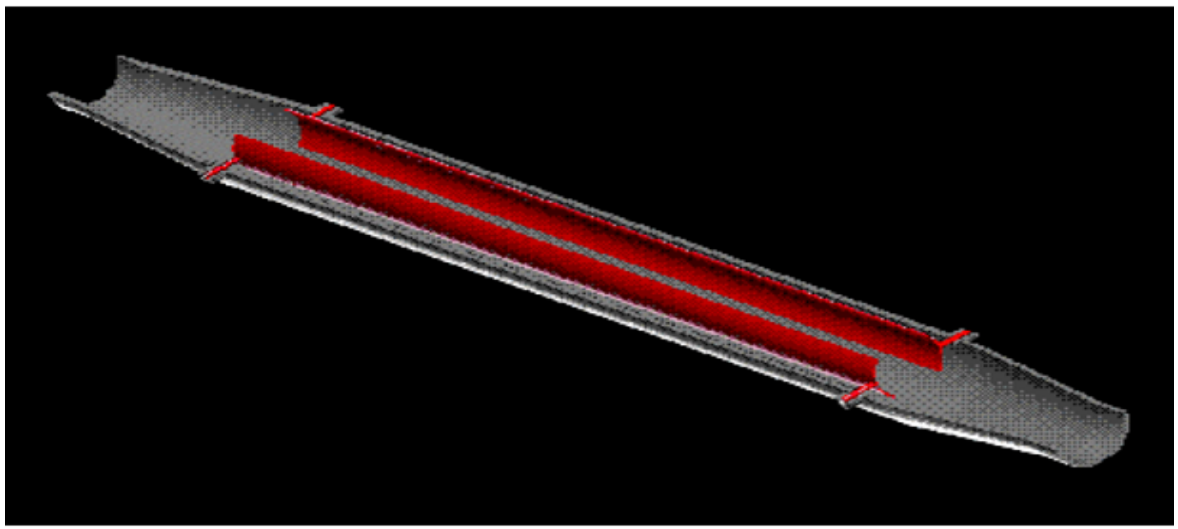
Combiner ring Extraction kicker



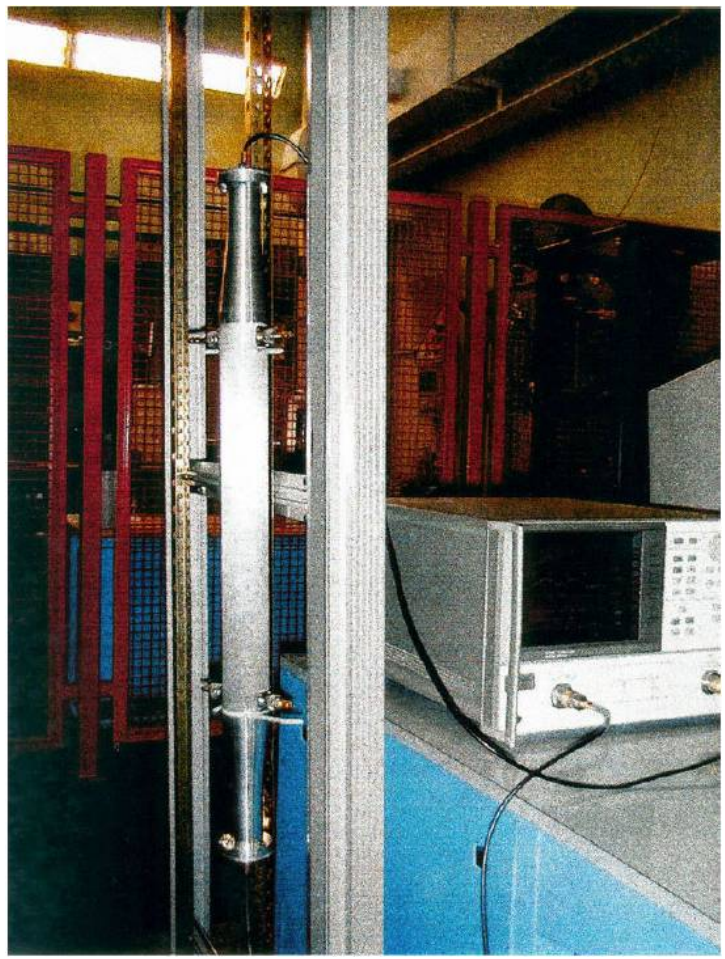


Generator circuit diagram

Combiner ring Extraction kicker



Cut-away section of the strip-line kicker



Strip-line kicker (mounted vertically)
under test for shunt impedance measurements
at **Frascati**

Shunt impedance of the deflecting mode is >60 kΩ

Combiner ring Extraction kicker

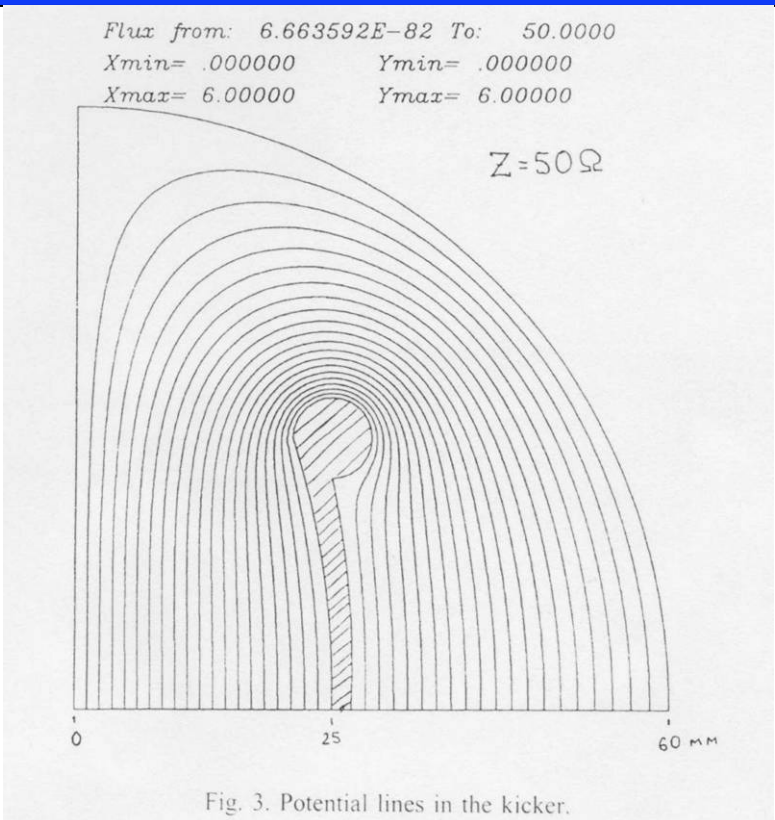
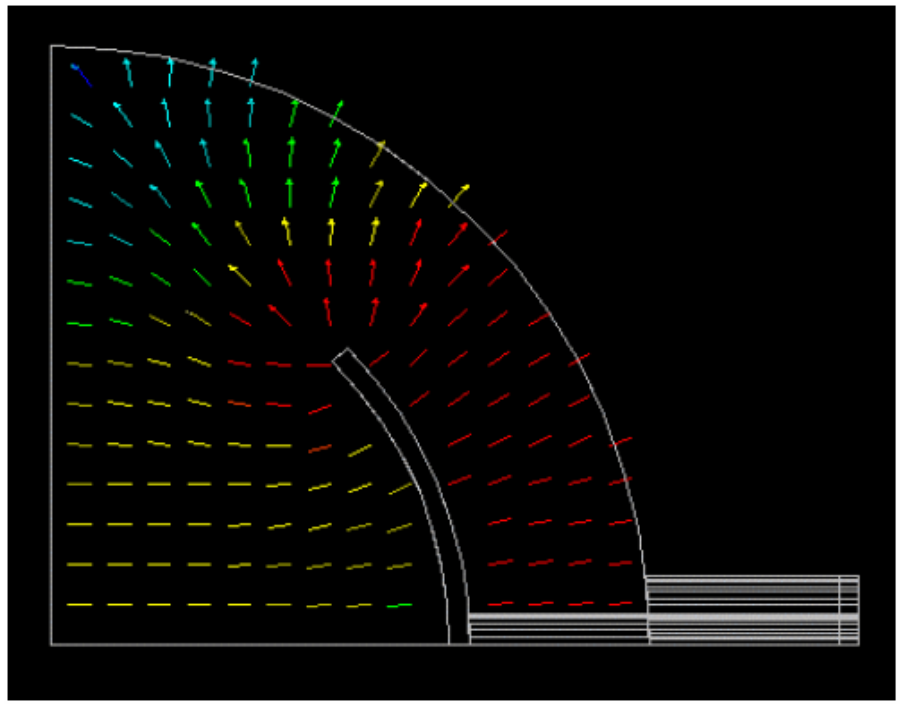


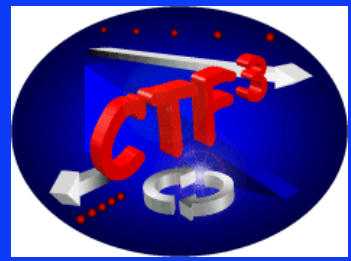
Fig. 3. Potential lines in the kicker.

Magnetic field lines simulation



Transverse E-field simulation
HFSS code

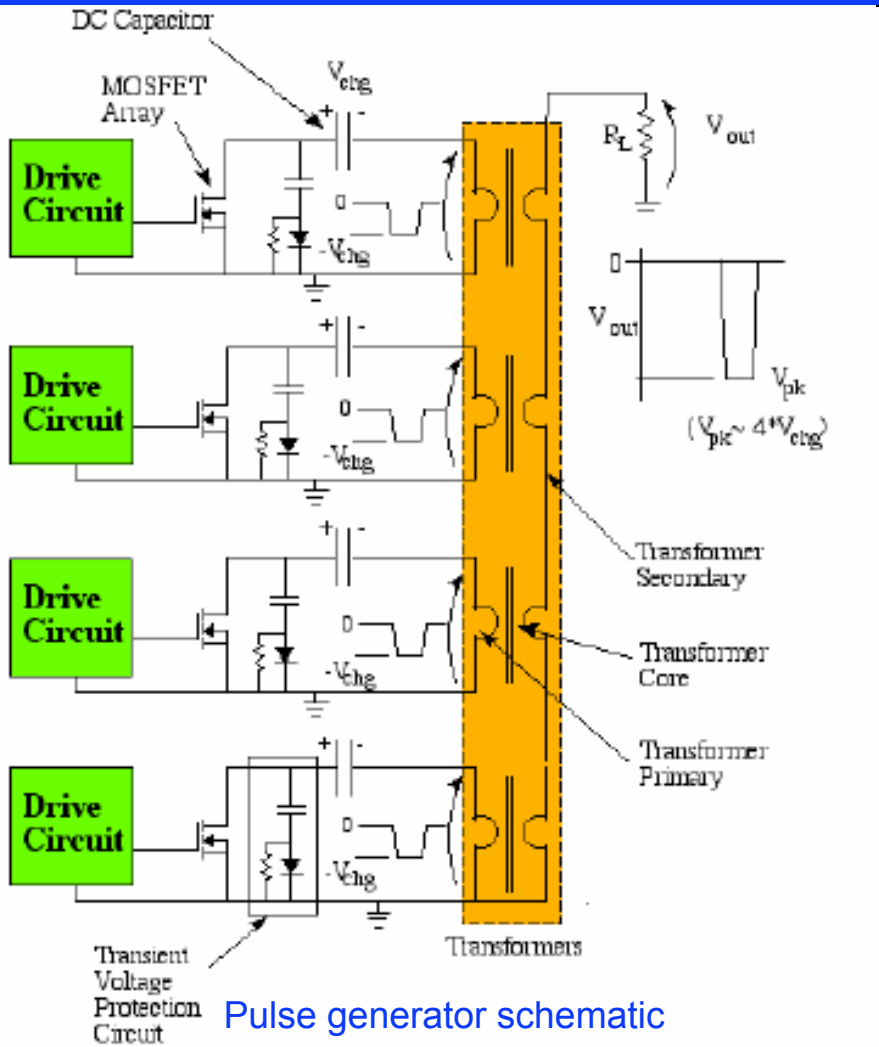
Combiner ring Extraction kicker



Strip-line kicker powering

- The electrodes must be pulsed with separate, opposing polarity power supplies.
- These pulsed power supplies could be obtained by modification of **ex-EPA** equipment. New electronics would be required. Pulse top flatness and reproducibility characteristics are not yet known.
- Alternatively power supplies based on the **"voltage adder"** circuit topology developed at **Lawrence Livermore Laboratory** could be employed. These would satisfy the pulse top requirements, and would permit up to 5MHz burst-mode operation (CLIC). Uses latest technology (**semiconductor** rather than thyratron switches). Could be ready for early 2006.

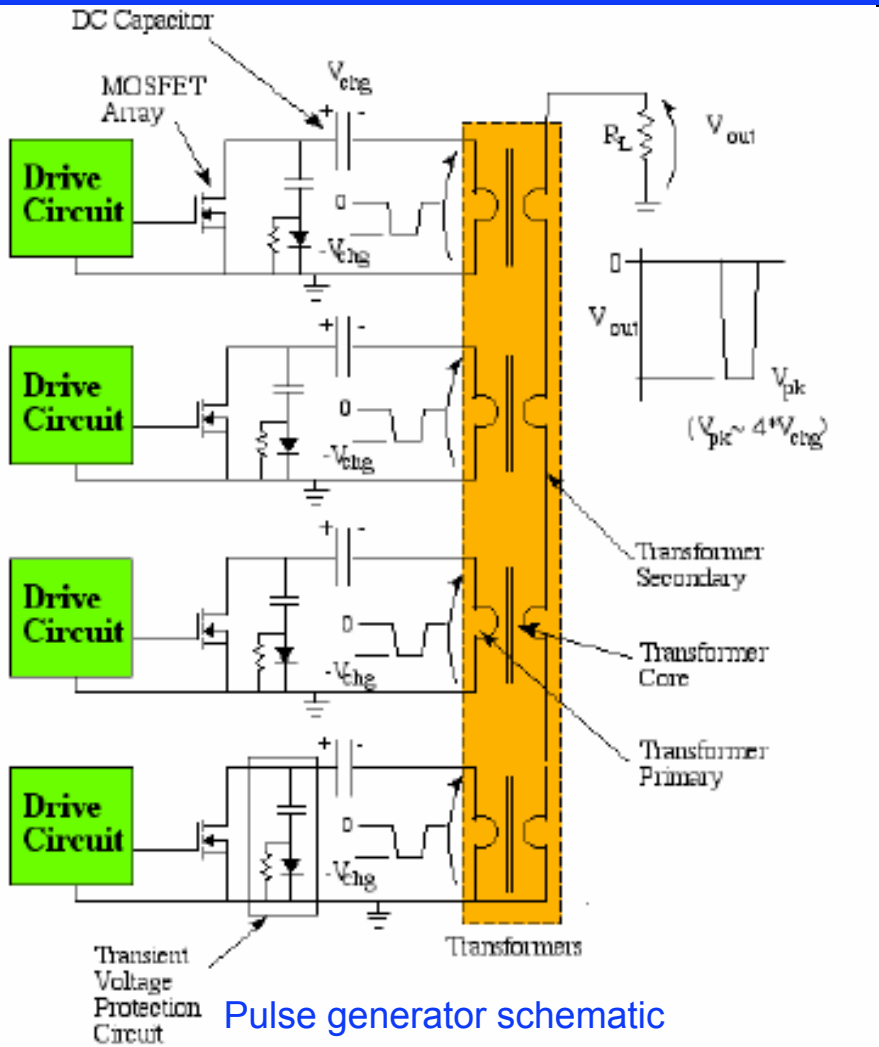
Combiner ring Extraction kicker



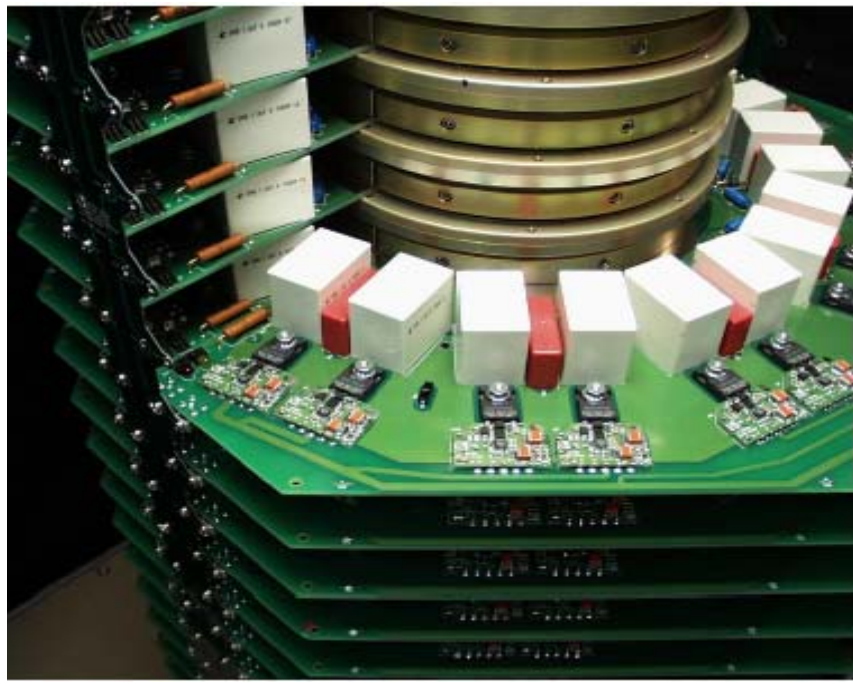
Pulse generator schematic

Four stage
Voltage Adder Topology

Combiner ring Extraction kicker

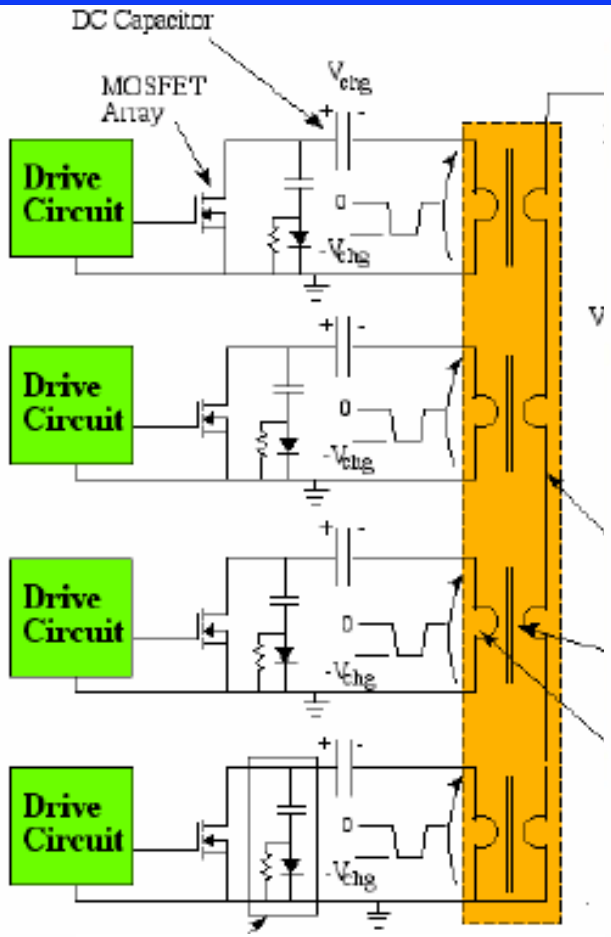


Pulse generator schematic

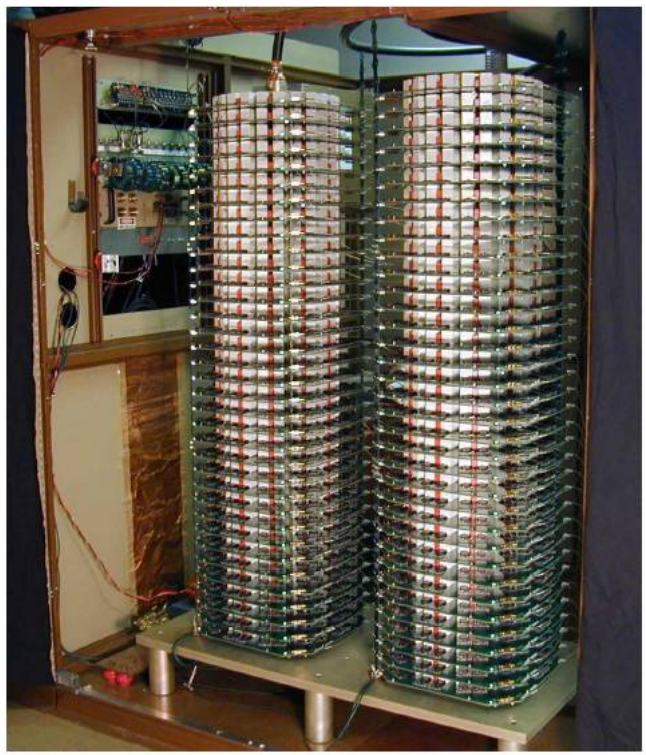


Partial view of parallel devices for current capability

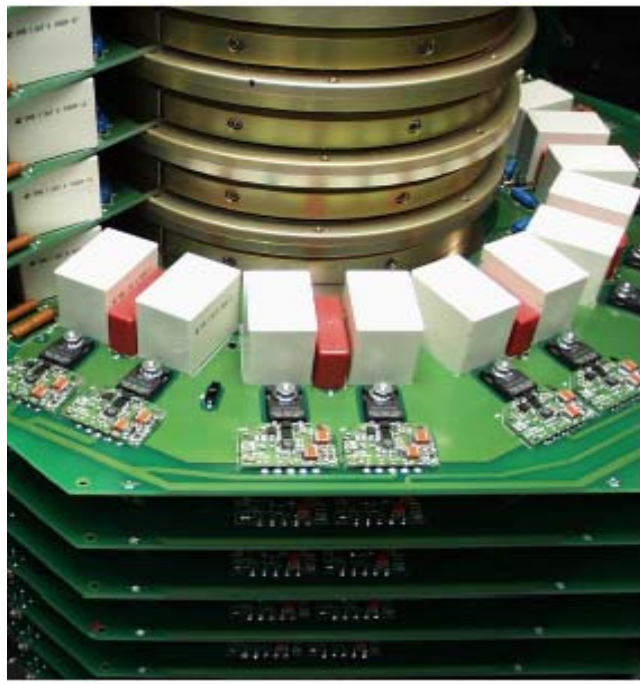
Combiner ring Extraction kicker



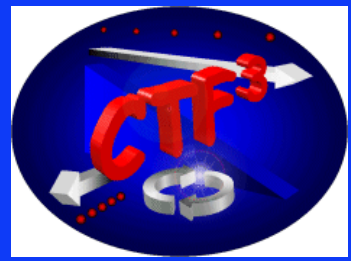
Pulse generator schematic



Assemblies of two parallel 35 serial switch stack assemblies for voltage and increased current capability



Partial view of parallel devices for current capability



Conclusions

A solution is proposed for the DL septa using existing septa (ex e^+ and e^- injection into EPA).

A collaboration are proposed with CIEMAT for the CR Septa using designs based on DAΦNE and TERA.

A temporary solution is proposed for CR kicker using existing magnets and pulse generators (ex e^+ and e^- injection into EPA).

A final solution is proposed requiring collaborations with CIEMAT for the stripline magnet and Lawrence Livermore Lab for the pulse generator.