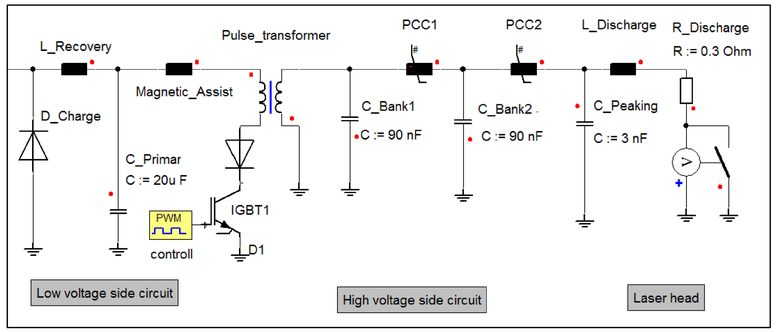
Bridge topology as primary switch for magnetic pulse compression circuit

STATE OF THE ART

Function:

•Primary switch is an IGBT with Blocking Diode
• Voltage matching with pulse transformer
• Pulse compression with non linear magnetic pulse compression cores (PCC)
• Energy recovery with recovery inductor (L_Recovery)



Disadvantages:

- The charging has to be done via the charging recovery inductor(L_Recovery).
- The primary capacitors see up to 50 % voltage reversal.
- The recovery time couldn´t be use for charging. Up to 10 % of the duty cycle couldn't be used for charging.
- The voltage reversal needs about 5 % of the reflected energy and reduces so the overall efficiency of the circuit.
- Charging inductors are bulky and produces fringing fields (depending on the design).
- The circuit cannot handle high impedance loads.
- The voltage of the IGBT is not clamped. Too short triggering of the IGBT and other failures in the circuit can damage the IGBT due to overvoltage.
- The series diode of the IGBT adds losses and is also affected by over voltage.

Advantages:

- The switch needs only very low off switch capabilities, so Thyristors and GTOs are also suited as a switch (the circuit is originally designs for such switches)
- Only one switch which is on ground potential.
- Proven design

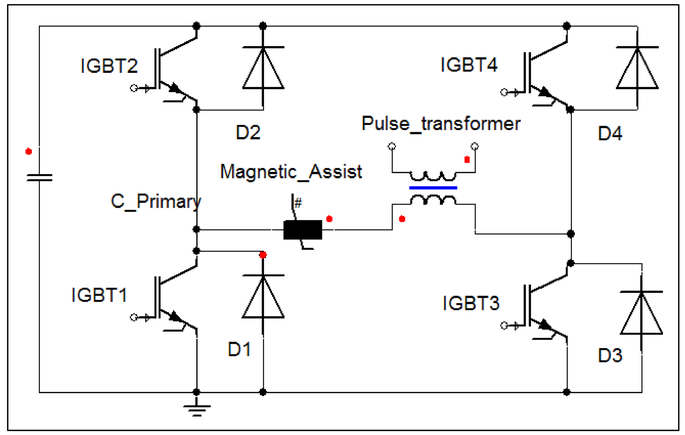
NEW DESIGN

Function:

- Primary switch is an IGBT bridge
- No change necessary for Pulse Transformer and pulse compression

Fast off switching of the IGBT after Energy transfer
Magnetic assist blocks energy back flow

- Energy recovery direct by the free wheeling diodes in the Bridge



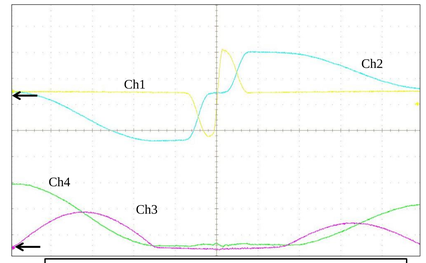
Advantages:

- Diodes and IGBTs are protected from overvoltage
- Fast voltage recovery and hence very fast recharging is possible
- No snubber circuits are necessary
- Direct charging of the bank is possible without charging inductor or charging switch
- High efficiency
- Open loop load causes no damage to the semiconductors
- No voltage reversal at the bank capacitor

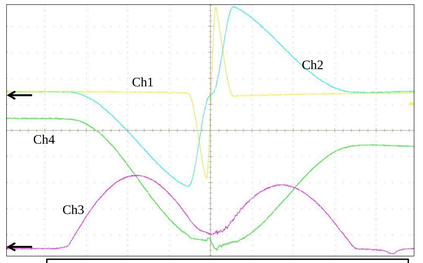
Disadvantages:

- Double amount of semiconductors
- Insulated gate drives
- Precise off switch of the IGBT
- Bigger magnetic assist

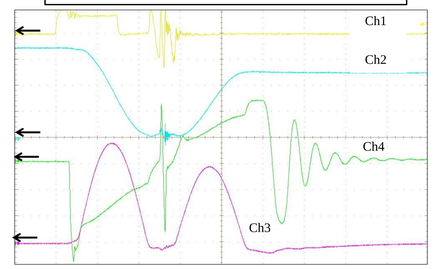
MEASUREMENTS



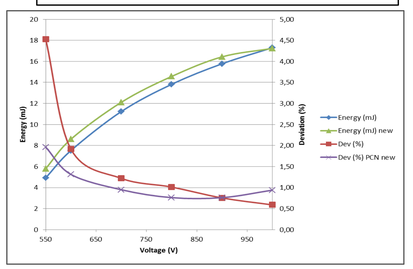
Ch1: C_Bank2 voltage (5 kV/Div)
Ch2: C_Bank1 voltage (5kV/Div)
Ch3: IGBT current (400 A/Div);
Ch4: C_primary voltage (200 V/Div)
time scale 500 ns/Div;
C_primary voltage 500 V
Short circuit load



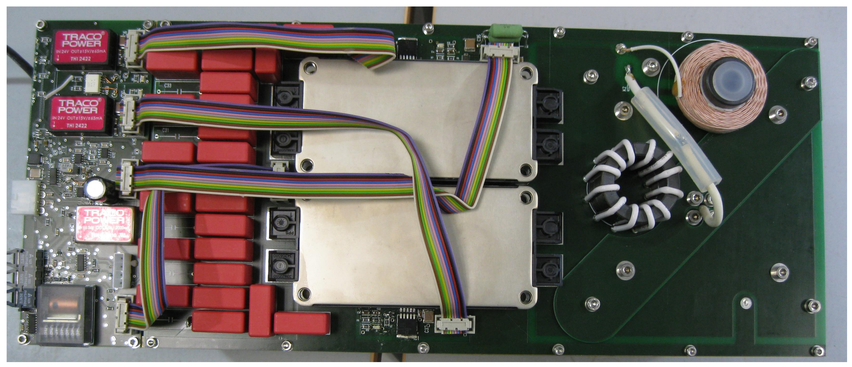
Ch1: C_Bank2 voltage (5 kV/Div)
Ch2: C_Bank1 voltage (5kV/Div)
Ch3: IGBT current (400 A/Div);
Ch4: C_primary voltage (200 V/Div)
time scale 500 ns/Div;
C_primary voltage 1000 V
Short Circuit load



Ch1: Trigger signal (5 V/Div)
Ch2: C_primary voltage (200 V/Div)
Ch3: IGBT current (400 A/Div);
Ch4: Bridge output voltage (200 V/Div)
time scale 500 ns/Div;
C_primary voltage 600 V
Short circuit load



Test on Lasertube
Repetition rate 100 Hz; KrF* Gas



Conclusion:

- The new design works
- Interesting for high repetition rate (beyond 1 kHz)
- Works with short circuit and open loop
- more Semiconductors; less inductors