Presentation
CERN
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Company information

- Jema Energy designs and manufactures bespoke **static power converters** for the Power, Oil & Gas, Railways and Research sector.
- Located in San Sebastian, northern Spain.
- Founded in 1953.
- 100 employees (50% engineers).

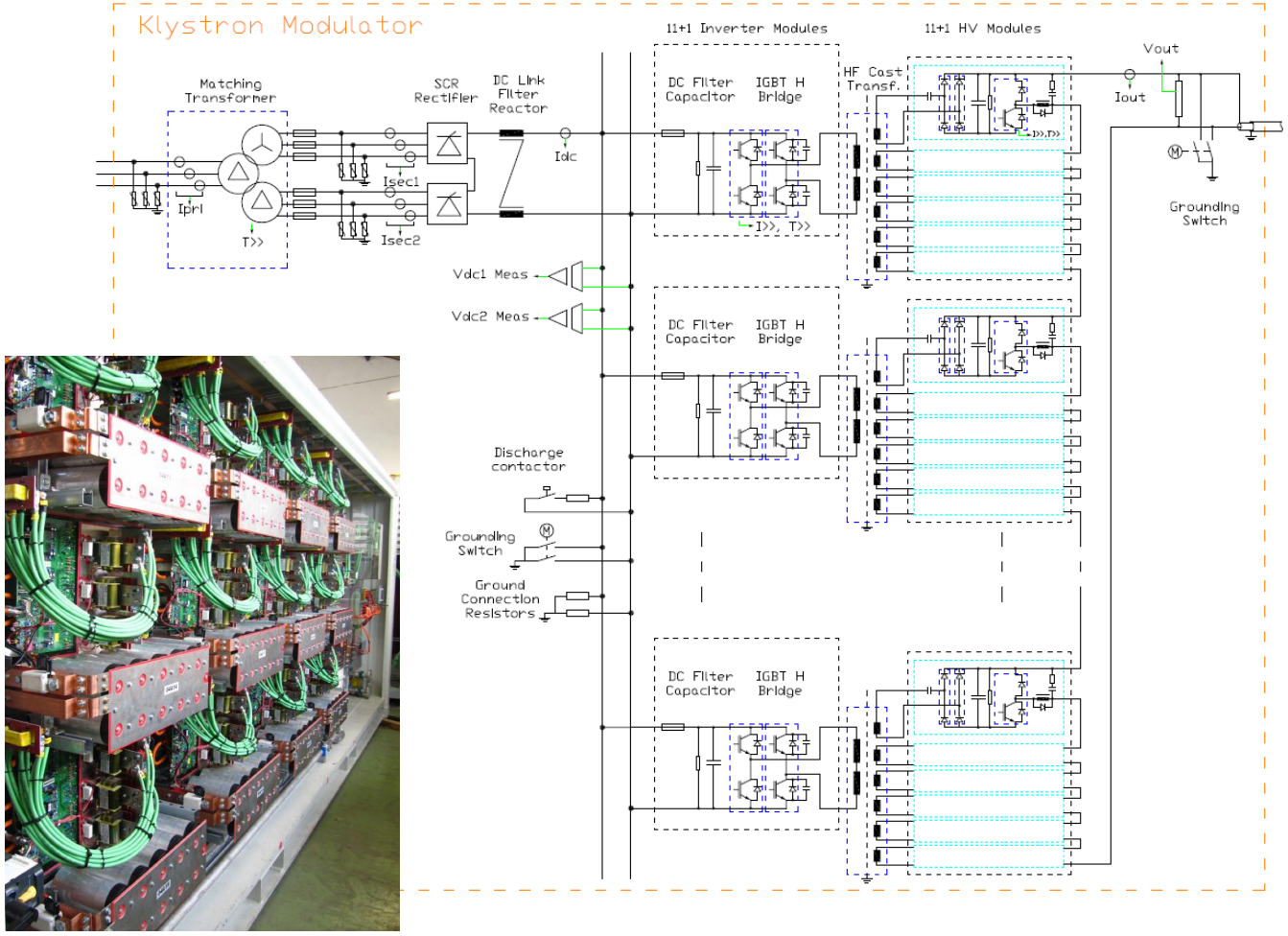
Products for research sector

- High Precision power supplies for magnets
- High Current power supplies
- SVC and STATCOM for power quality
- Solid State Crowbar
- High Voltage switched mode modulators for RF tubes (e.g. klystron and gyrotron)

JEMA Modulator: Topology in between the Marx Modulator and the HF transformers based solution

Target Features:

-Low output voltage ripple
-Low output voltage droop
-Low stored energy
-Modular design, incorporated spares
-Dry solution, no oil
-Easily reconfigurable solution
-High Reliability, high MTBF
-Maintainability, low MTTR
-Costs reduction



Advantages of the modulator:

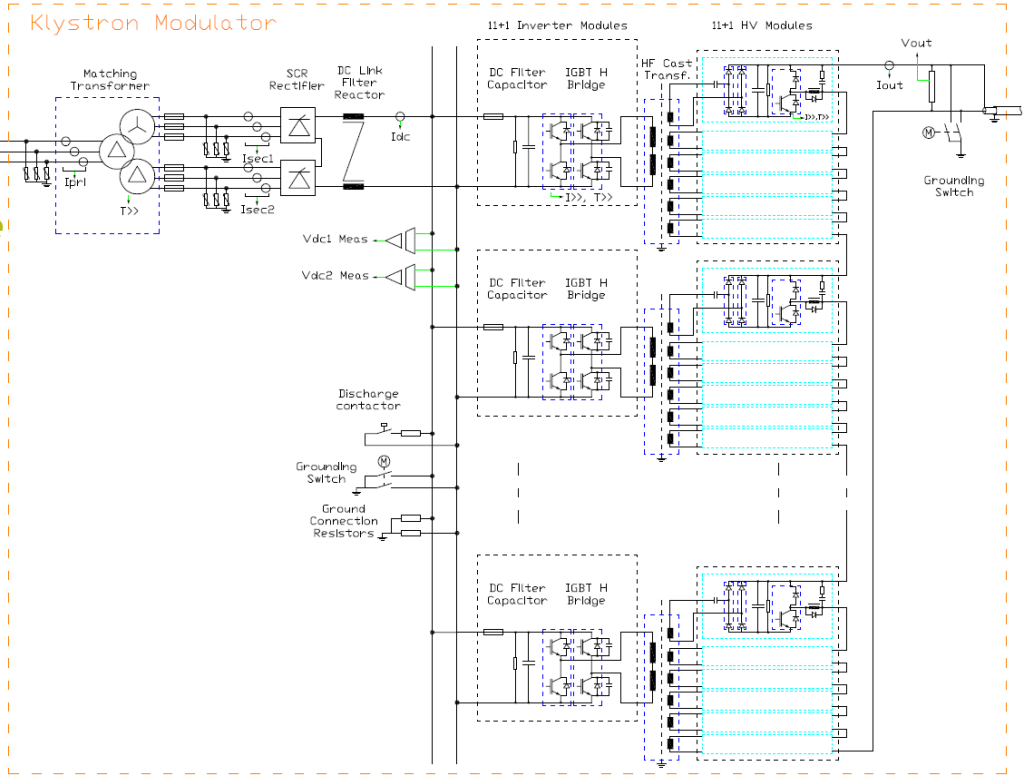
-Low output voltage ripple:
- *Medium Frequency switching (4kHz)*
- *'Intermediate' C value in HV stage*
- *Phase shift of the inverter modules -> ripple compensation*

-Low output voltage droop
- *Capacitors in HV stage actively charged during the pulse*

-Low stored energy
- *IGBT at the output blocks energy transfer*

- Modular Design. Incorporated spares:
- *N + 1 Modules: Inverter +Transformer & + HV stage*
- *No intervention required for enabling spare module*

- Dry solution: No oil:
- *Cast Epoxy Resin Transformers*
- *Air insulation*



Klystron Modulator

Advantages of the modulator:

-Easily re-configurable solution:

- *Modular solution enables easy dimensioning to higher / lower voltage, current and duty cycles*

- Reliability. High security margins for high MTBF:

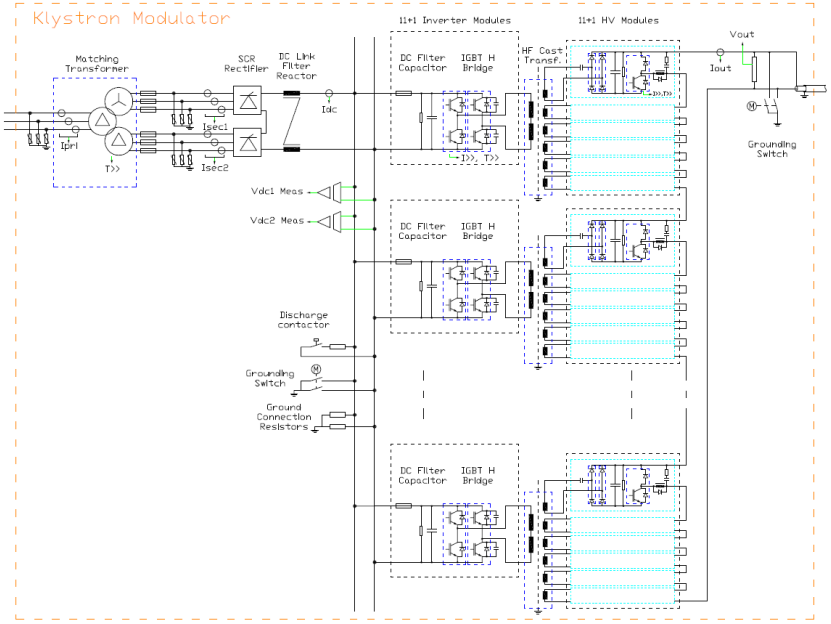
- *Inverters switching at medium frequencies (4kHz)*
- *-Conventional Transformer + Rectifier input stage*
- *Only industry standard components are used.*
- *HV stage active components are self protected.*
- *-No series connection of transistors or diodes*
- *-High security margins in V and I rating*

- Maintainability. Easy and fast maintenance for high MTTR:

- *Modular construction. Reduced spare parts requirement*
- *No elements inside oil tank*
- *Water connections do not need to be removed for faulty parts exchange.*

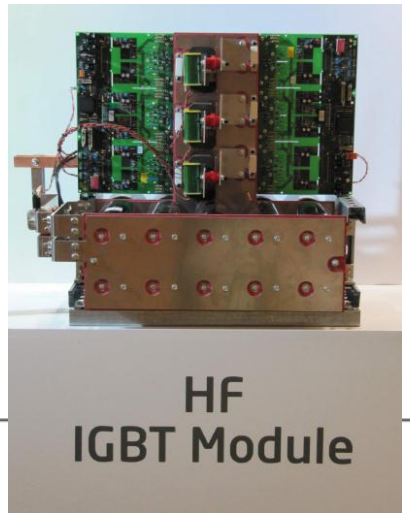
- Costs reduction:

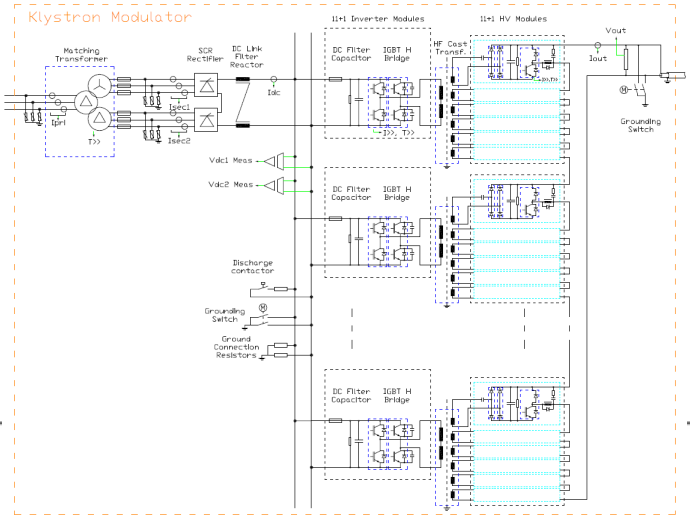
- *Modular components*
- *-Industrial standard components used*



Approach to CLIC requirements

- **Pulse voltage: 150 kV ->** Currently, up to 120kV. Tested at 200kVdc
- **Pulse current: 160 A ->** Currently, 160A output obtained
- **Peak power: 24 MW ->** Possible, due to modular approach
- **Rise & fall times: 3 µs ->** Currently, 8 µs . Could be optimised below 5 µs
- **Flat-top length: 140 µs ->** Probably, increase of inverters frequency
- **Repetition rate 50 Hz ->** OK
- **Flat-top stability 0.85 % ->** Can be obtained, by correctly choosing the output modules capacity
- **Pulse reproducibility PPR 10 ppm ->** Would require revision of measurements hardware





Thank you for your attention!