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Transportable pulsed-power generator for high-energy experimentation

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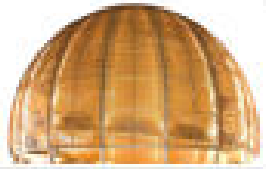
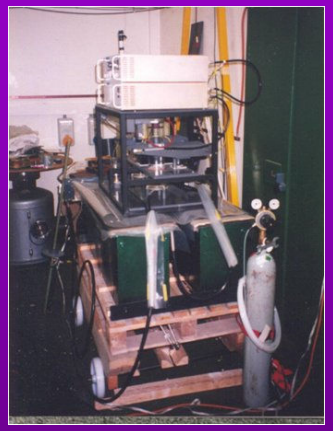


Content

- Transportable systems
- The pulsed power generator
- Experimental results
- Conclusions

Transportable systems

Transportable systems



25 kJ

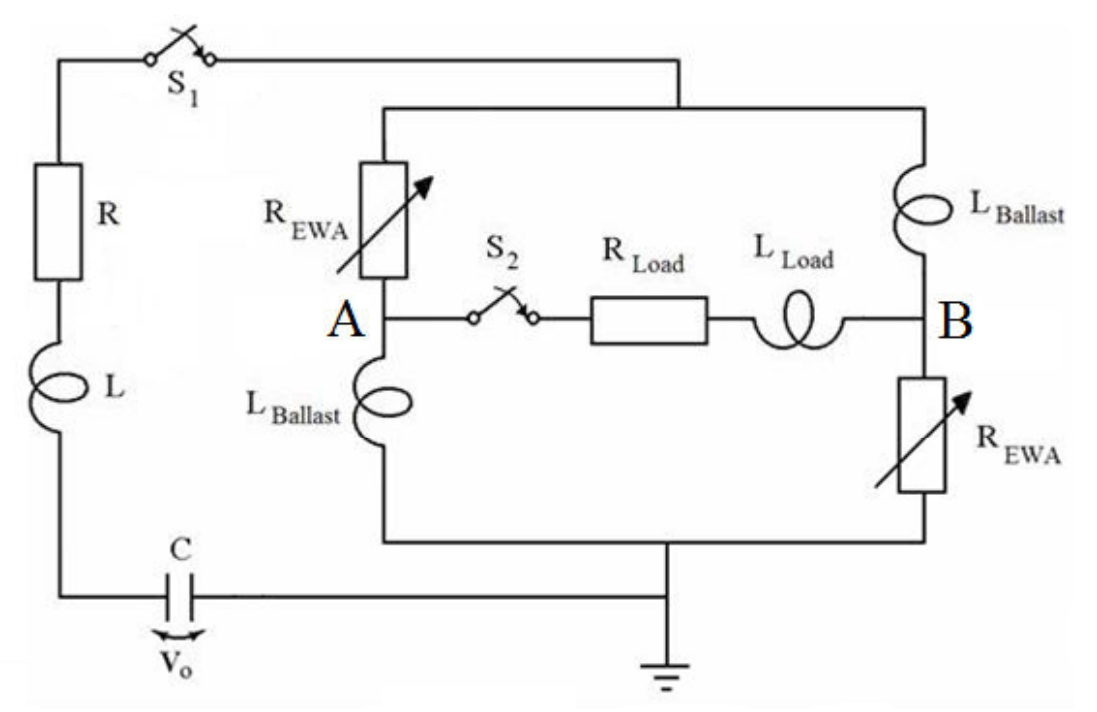
50 kJ

200 kJ

400 kJ

The pulsed power generator

Pulsed power generator (1)



Electrical scheme of the pulsed power generator

C is a capacitor bank of equivalent resistance *R* and self-inductance *L*.
It drives a pair of EWAs and a pair of ballast inductors when switch *S1* is closed.
The load is attached between the nodes A and B when *S2* closes,
near the moment of peak voltage across both EWAs.

Pulsed power generator (2)

- Capacitor bank: C = 106.26 μF charged to an initial voltage V_0 = 23.86 kV (stored energy 30 kJ); R = 10 mΩ; L = 40 nH
- The two EWAs are identical. Each is made from 4 parallel-connected high-purity copper wires 465 mm long and 250 μm in diameter
- The two identical ballast inductors each have an inductance $L_{Ballast}$ = 8.3 μH
- The total load inductance, including the HV connections, is about L_{load} = 10 μH

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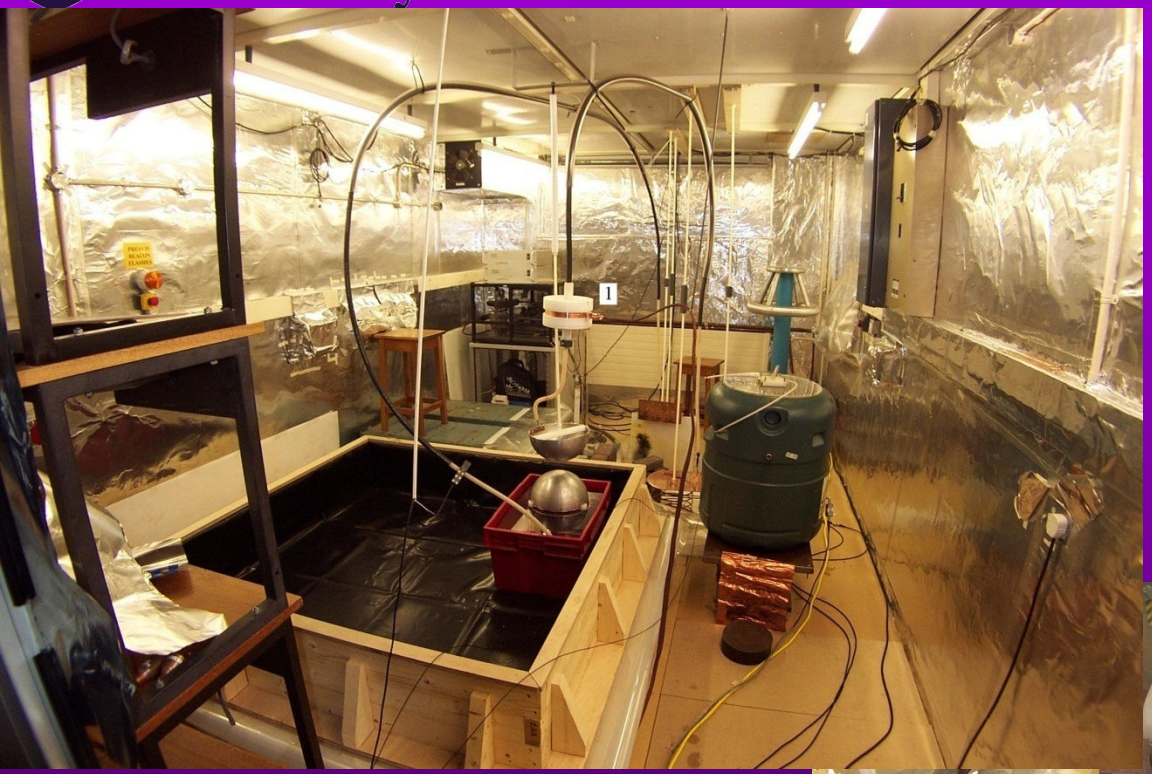
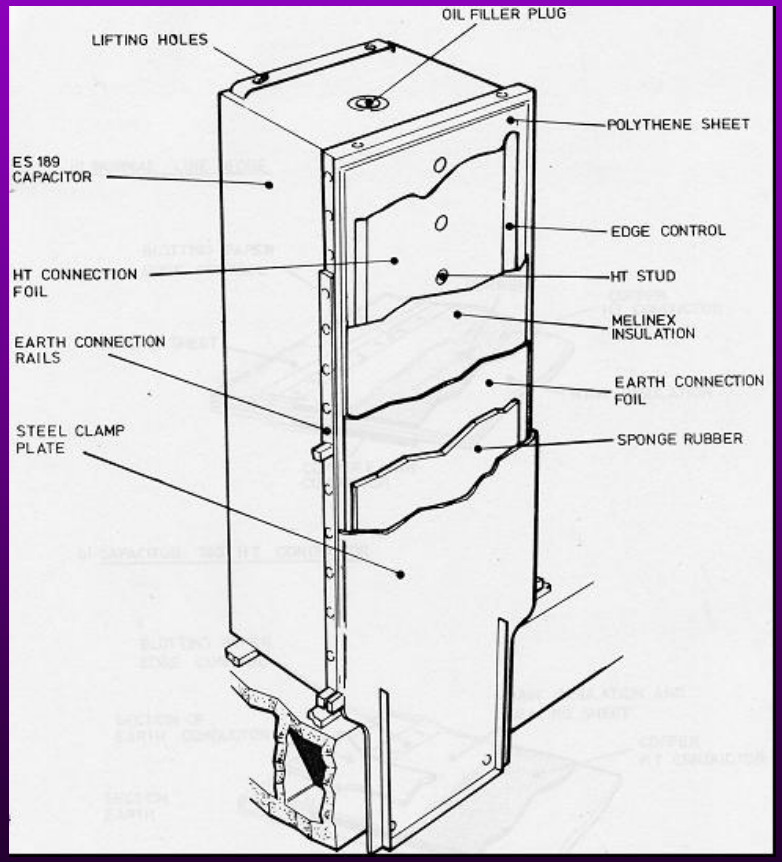
Pulsed power generator in the laboratory



Capacitors

BICC Type	ES 189
Capacitance	51 μF
Inductance	7 nH
Resistance	1 mΩ
Energy (at 25 kV)	16 kJ

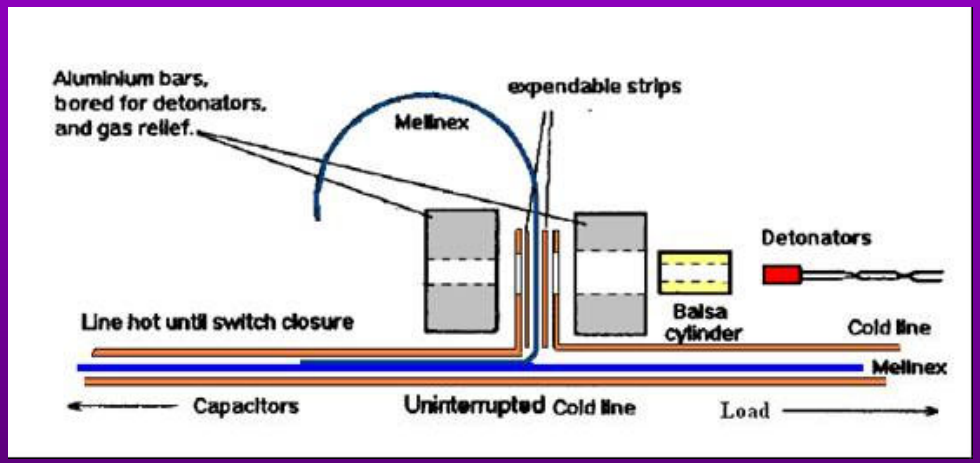
Nominal Parameters

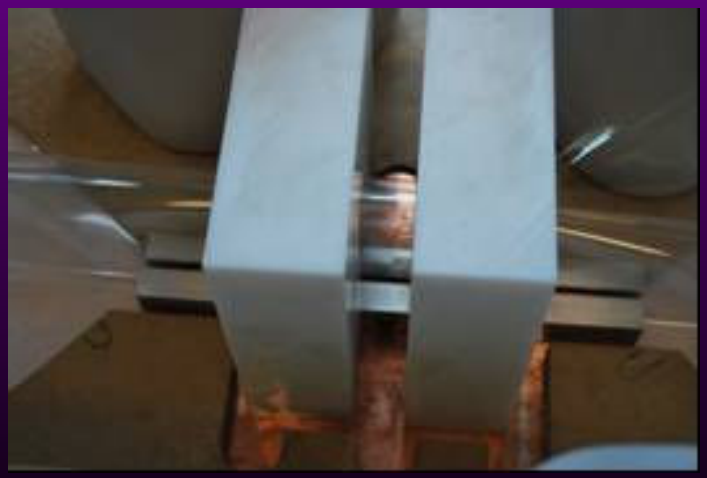


BICC ES 189 capacitor layout

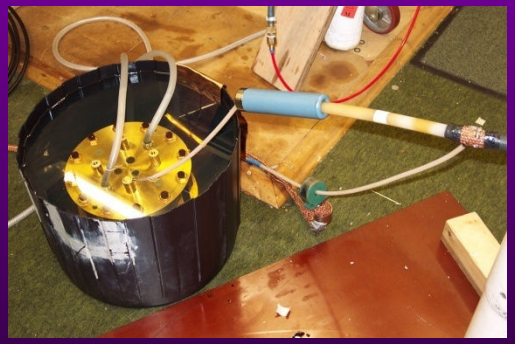
Ballast inductors and EWAs

High-Coulomb detonator activated closing switch (S1)





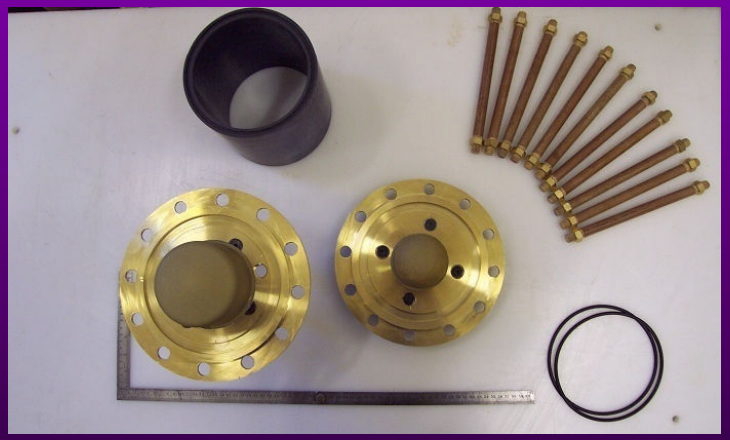
Ancillary equipment



Aqueous high-power resistive load

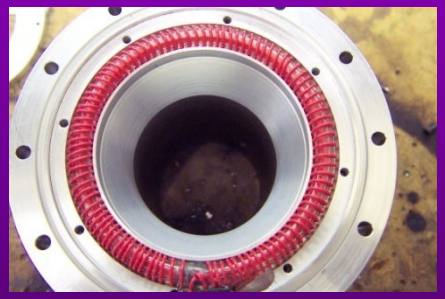
Spark-gap in ambient air

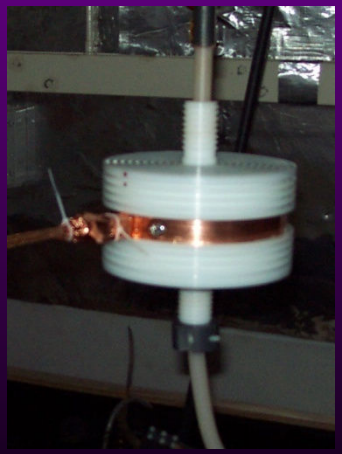
Alternative switch technologies for S2



SF6 pressurised spark-gap (components)

Electrical diagnostics



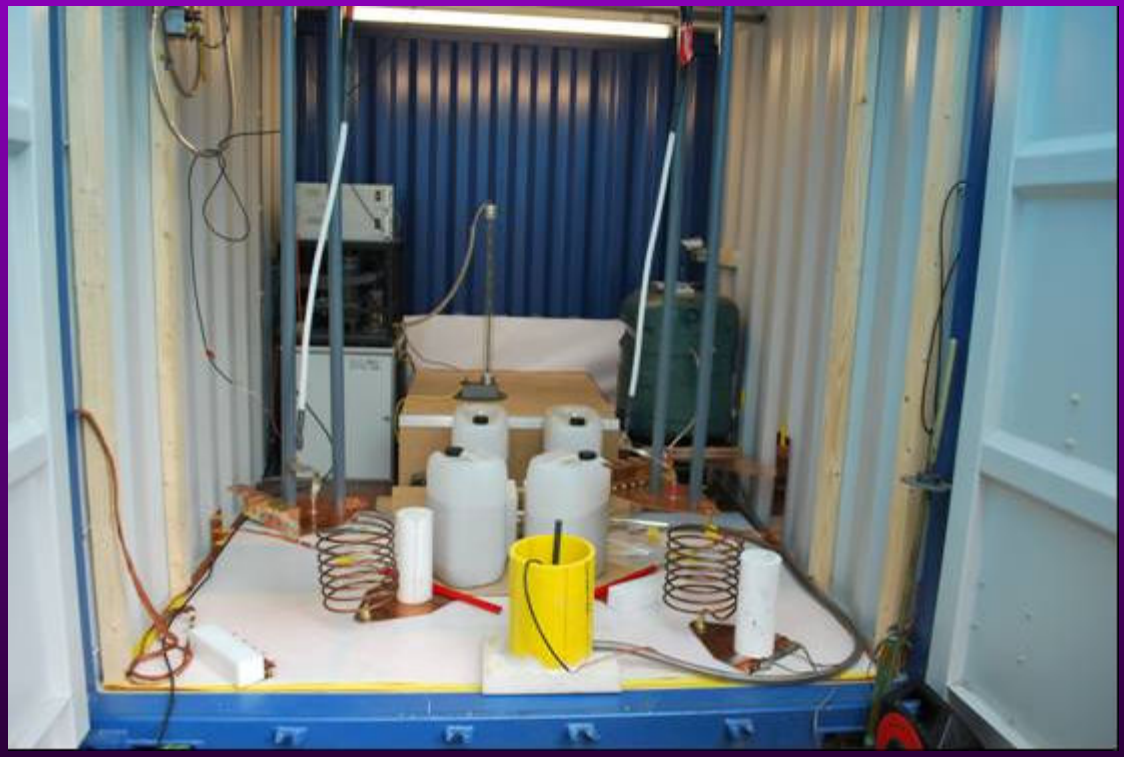


Self-integrating Rogowski coil
rise-time: 1 ns

300 kV voltage probe

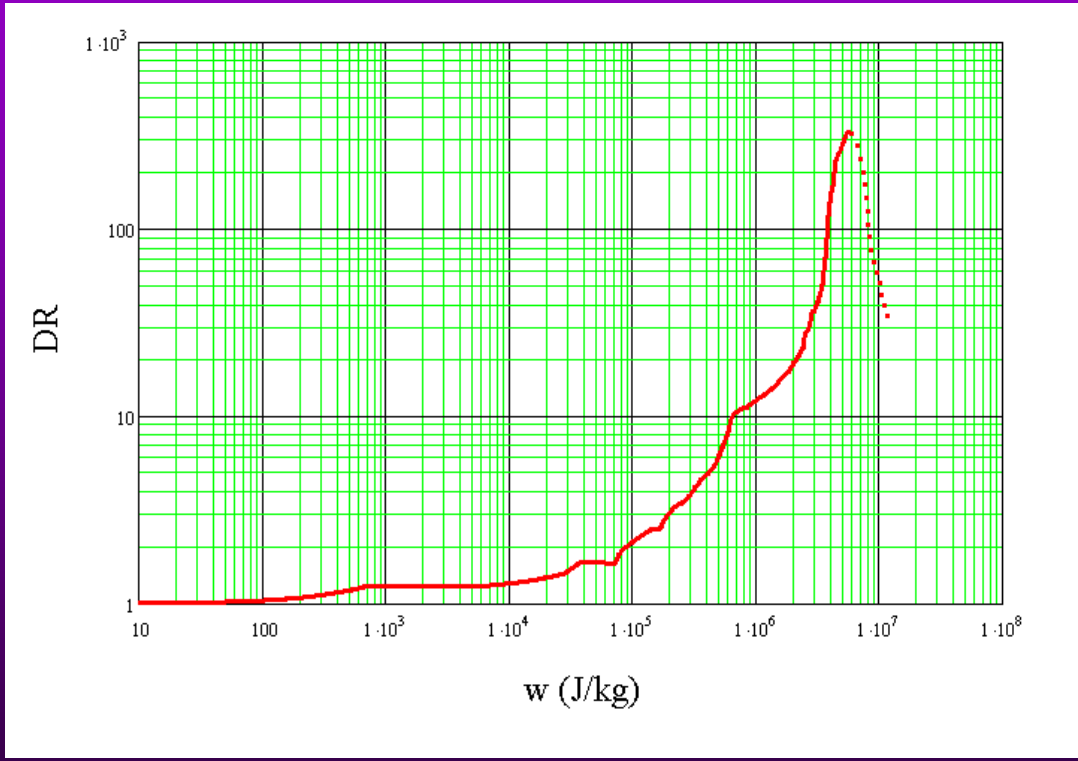
1 MV voltage probe

Loughborough transportable pulsed power generator inside its container



Experimental Results

Numerical modelling of EWA



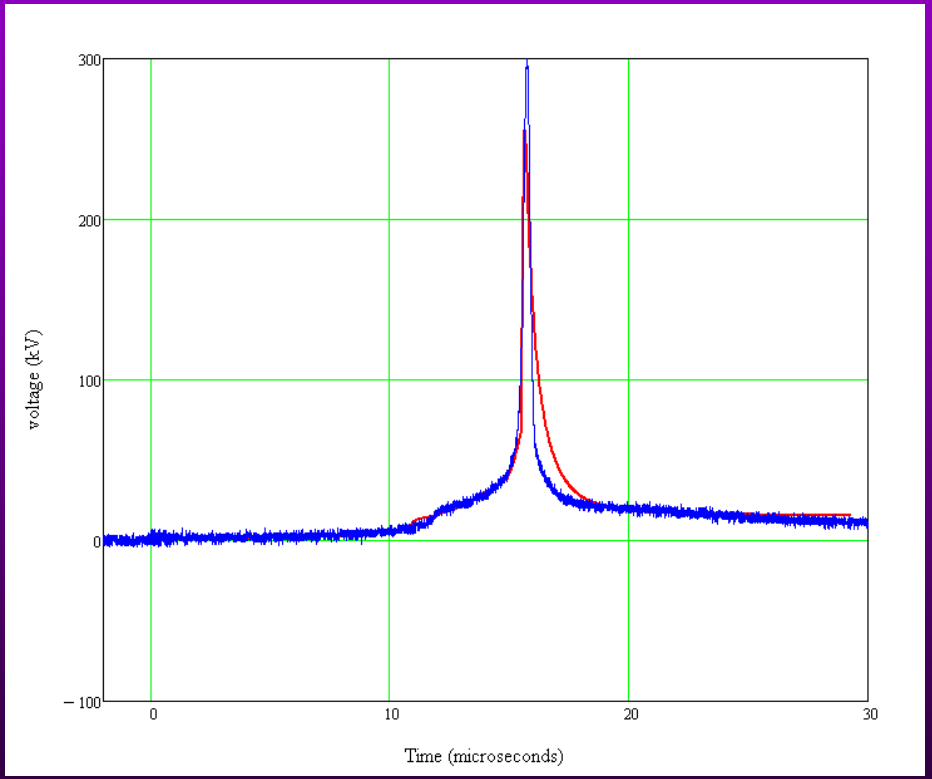
Exploding wire model (in air)

DR=R(t)/R(0) is the dynamic resistance ratio and *w* is the specific energy

Voltage generated by a single EWA

EWA:

copper wires
diameter: 250 μm
number: 4
length: 465 mm
Electric field: 6.5 kV/cm
Energy absorbed: 6.5 kJ
Voltage multiplication: 12.6



Experimental results (blue l ines)
Theoretical prediction (red line)

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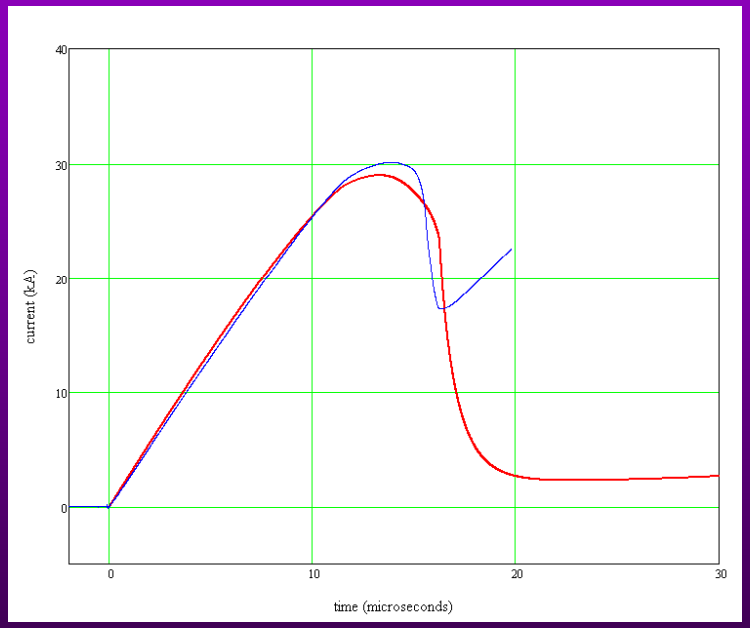
Currents

EWA



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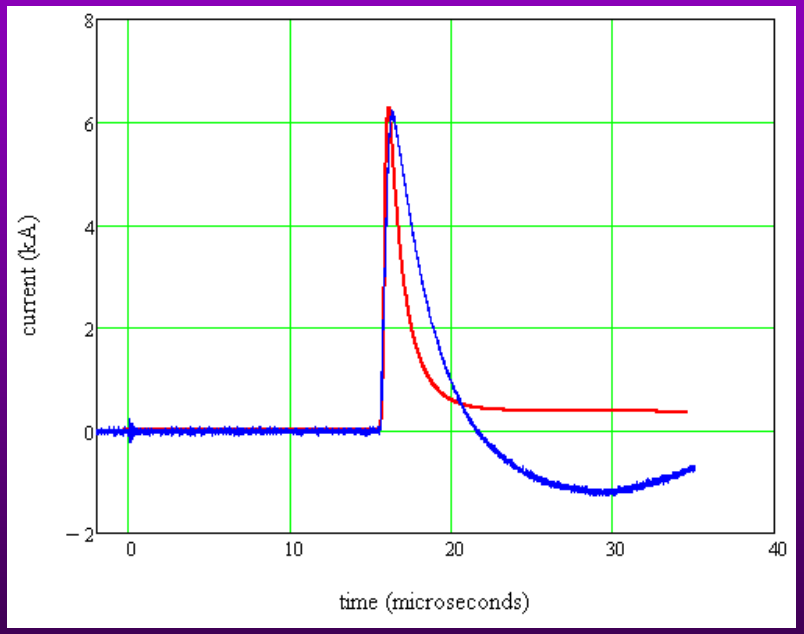
Load



Experimental results (blue l ines)
Theoretical prediction (red line)

Load: 45 Ω; Peak power: 1.7 GW

CONCLUSIONS

Main conclusions

- A transportable pulsed power generator for high-energy experimentation has been successfully developed
- The generator has a simple and very robust design
- Tens of shots have been performed without any problem
- The generator is capable of developing voltages up to 0.5 MV on high impedance loads, corresponding to an electrical power approaching 2 GW

Thank you for your attention!

Any questions?