**1.3 GHz INNOVATIVE SOLID STATE RF POWER AMPLIFIER AND OTHER EXAMPLES OF TURNKEY ACCELERATOR COMPONENTS**

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**RF SSPA Last References**

<table>
<thead>
<tr>
<th>Power (kW)</th>
<th>Frequency (MHz)</th>
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<tbody>
<tr>
<td>100</td>
<td>0.1</td>
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<tr>
<td>10</td>
<td>10</td>
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<tr>
<td>1</td>
<td>100</td>
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<td>0.1</td>
<td>1000</td>
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- **GSI 325MHz 7x300W PULSED**
- **BNL 700MHz 20kW CW**
- **JLAB 1427MHz 500W CW**
- **TRIUMF 1200MHz 700W CW**
- **IREP 700MHz 1kW CW**
- **JLAB 768MHz 7kW CW**
- **HBD 1300MHz 10kW CW**
- **HBD 1300MHz 8x1kW CW**
- **HBD 1300MHz 2x4kW CW**
- **HBD 1300MHz 5kW CW**

... and many more!

**30 000 amplifiers delivered since 1975**

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**Sigmaphi**

More than 30 years experience in accelerator technologies:
- Turnkey beamline systems from optics to installation and alignment
- Magnets, vacuum
- Power supplies
- RF amplifiers
- Fast injection/extraction systems
- High voltage decks
- Superconducting systems (NbTi, MgB$_2$...) including quench detection and high stability power supplies

**Examples of other turnkey systems**

JINR 70 meters heavy ions beamline designed, manufactured, installed and aligned by Sigmaphi.

Co-optimized design for magnets and power supplies:

- **Power consumption reduction : 7.5%**

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**RF SSPA installed at HZDR**

**World Wide first 1.3 GHz Solid State Power Amplifier**

Installed in 2011 at Helmholtz Zentrum Dresden-Rossendorf (Germany) to replace klystrons

- 8 power amplifiers 10 kW CW, Max output VSWR at 1.3 GHz: 4/1 at full power, ∞ at 50%.
- Power supply : SIGMAPHI Electronics Primary Switch 28 or 50V
- 4 years running feedback :
  - 600 transistors in total widespread on 8 amplifiers. Only 5 transistors replaced.
  - Efficient preventive maintenance, huge savings compared to klystrons.

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**Conclusion**

After 4 years operation, HZDR team is happy to have changed for solid state power amplifiers. Maintenance is easier and cheaper than klystrons.

Since then, Sigmaphi increased the power density to reduce 1.3GHz amplifiers footprint (for HZB and Cornell University), and developments are ongoing on higher efficiency amplifiers at full power.