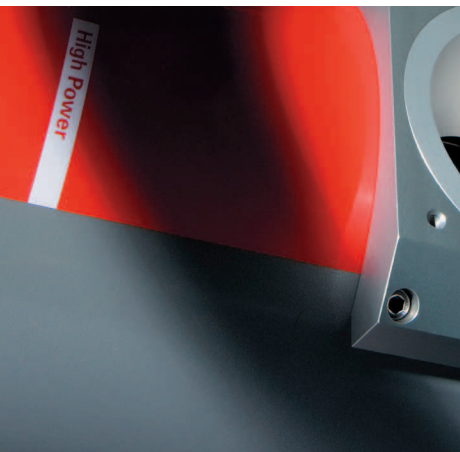


# High Power Tubes



Industrial X-Ray

Overview



05/2012 – V2, specification subject to change without notice

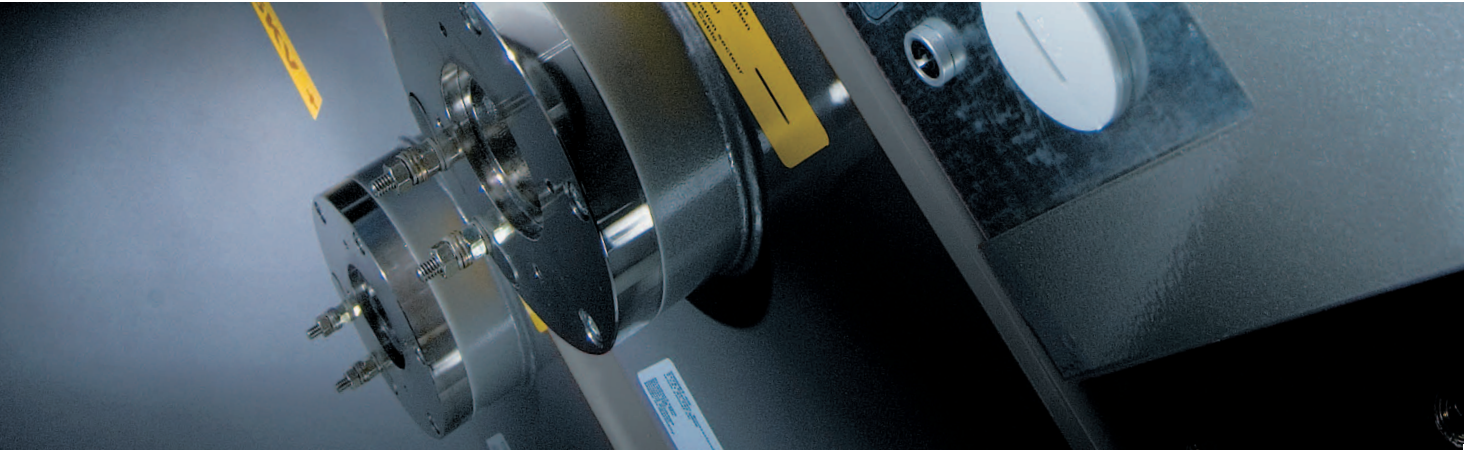
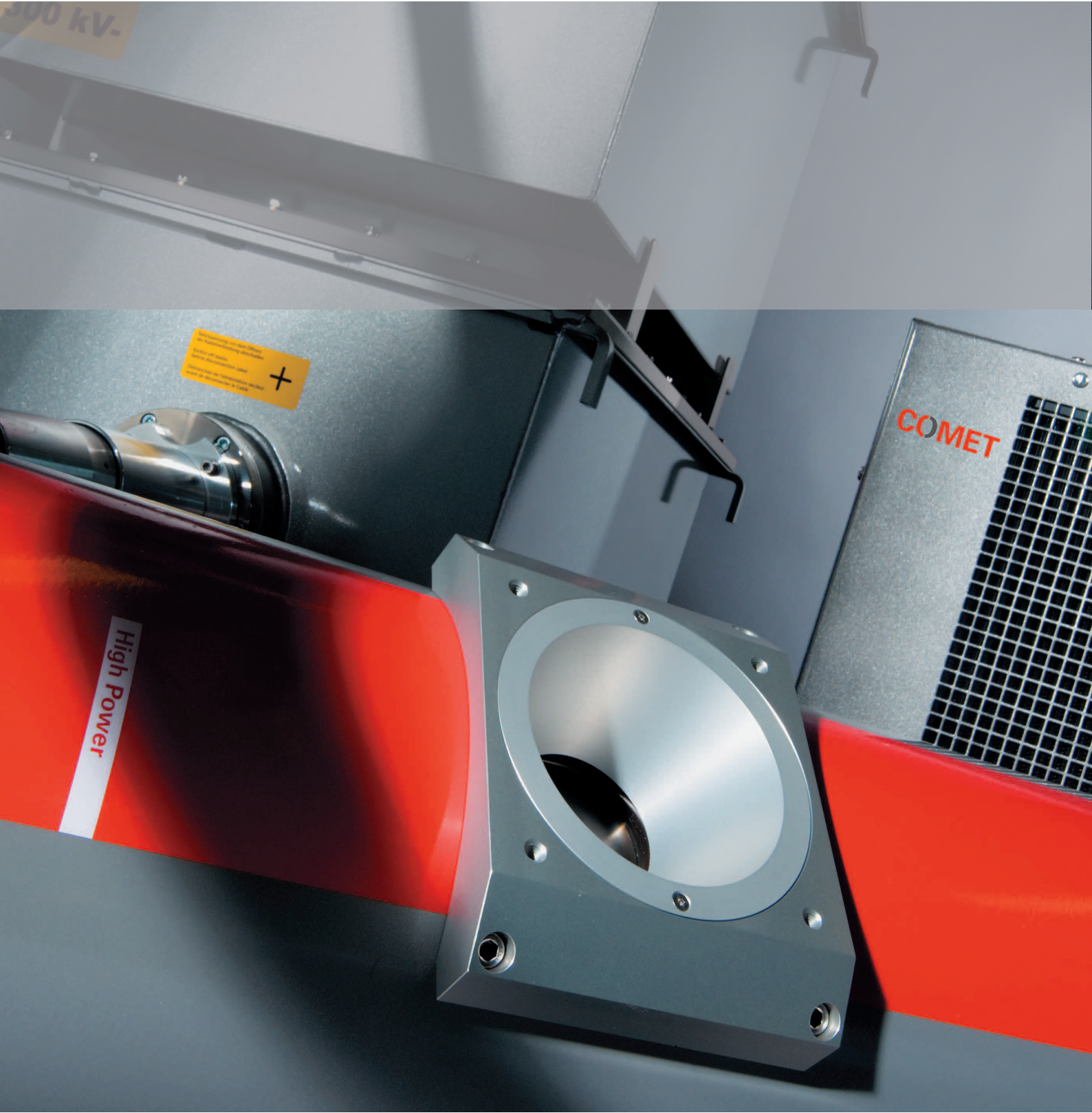
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**High Power HP Technology for X-Ray Tubes**

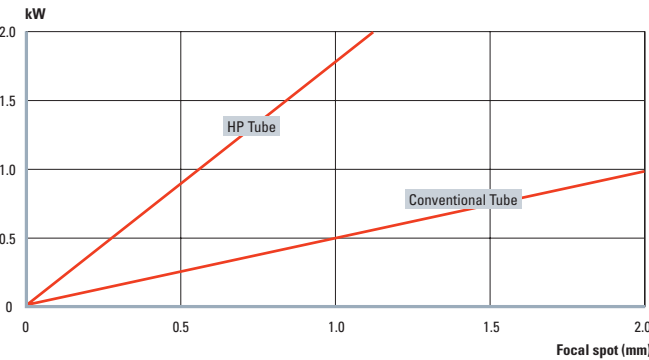
Since the invention of the X-Ray tube in 1895, the ratio between focal spot size and power has not improved significantly.

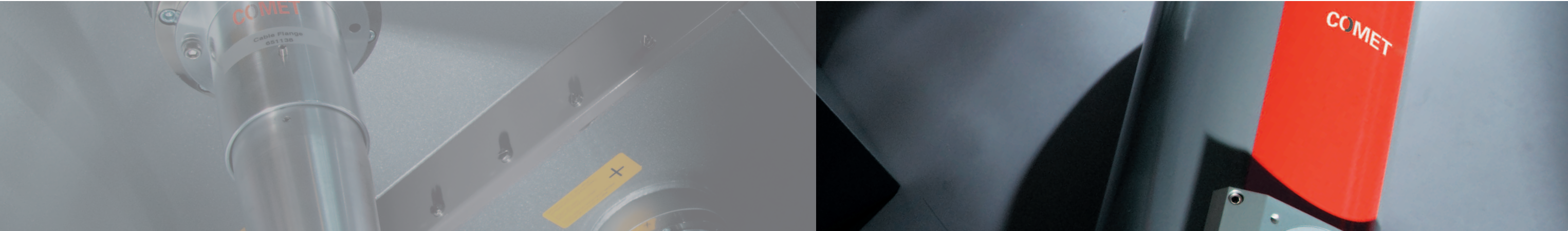
COMET AG has achieved a breakthrough in this historical relation with its new High Power (HP) technology. The HP family of X-Ray tubes has nearly doubled the power density of the conventional fixed-anode X-Ray tube.

**The Benefit of the HP Innovation**

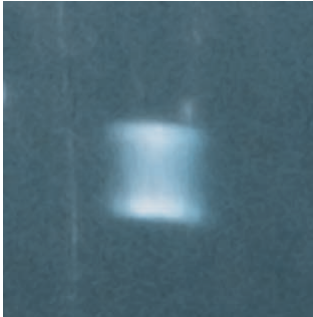
- Higher power with the same focal spot size. With higher power, shorter exposure times are possible. The result is higher throughput through the inspection process.
- Smaller focal spot at the same power. Previously, when striving for finer resolution, the customer had to sacrifice power (and thus throughput) to achieve a smaller focal spot. You must no longer suffer this compromise.
- Longer tube life. The lower Anode temperature results in less thermal stress and leads to a longer tube live.

**Power/Focal Spot Ratio**





1 mm focal spot of a conventional MXR-160/20. At 640 W (maximum power) the temperature reaches 1500 °C.



1 mm focal spot of the HP tube MXR-160HP/20, same focal spot size, same power, but with 900 °C, a significantly lower temperature. The power can be increased to 1000 W before the temperature reaches 1500 °C.

**The Demanding Challenge to Increase the Power Density of an X-Ray Tube**

- X-Ray tubes operate in extreme conditions:
- Ultra high vacuum technology (10–9 mbar)
  - Temperatures up to 1500 °C
  - Rough environment
  - Expectations to live more than 10 years

To make an X-Ray tube more efficient, one must go to work on the focal spot, the very small place where the electron beam strikes the heavy-metal target and produces X-Rays. The power dissipation by a standard X-Ray tube is approx 300 W/mm². With our revolutionary new construction of the anode we reach 600 W/mm². This success of COMET’s development team was the result of the convergence of unconventional thinking, the use of the latest simulation techniques and more than 50 years of experience in the construction of X-Ray tubes.

**What Are the Trends?**

In the coming years, digital detectors will increasingly replace traditional X-Ray techniques such as film and image intensifiers. The consumer’s demand for cost-effective products dictates that everything must be more efficient. Productivity must be increased. Cycle times must be shorter. With digital detectors, already flux-starved imaging chains will be at their limits just to produce adequate pictures. The public’s increasing demand for safer products will push manufacturers to find even smaller defects, thus increasing the need for high-resolution X-Ray inspection.

**Our Response**

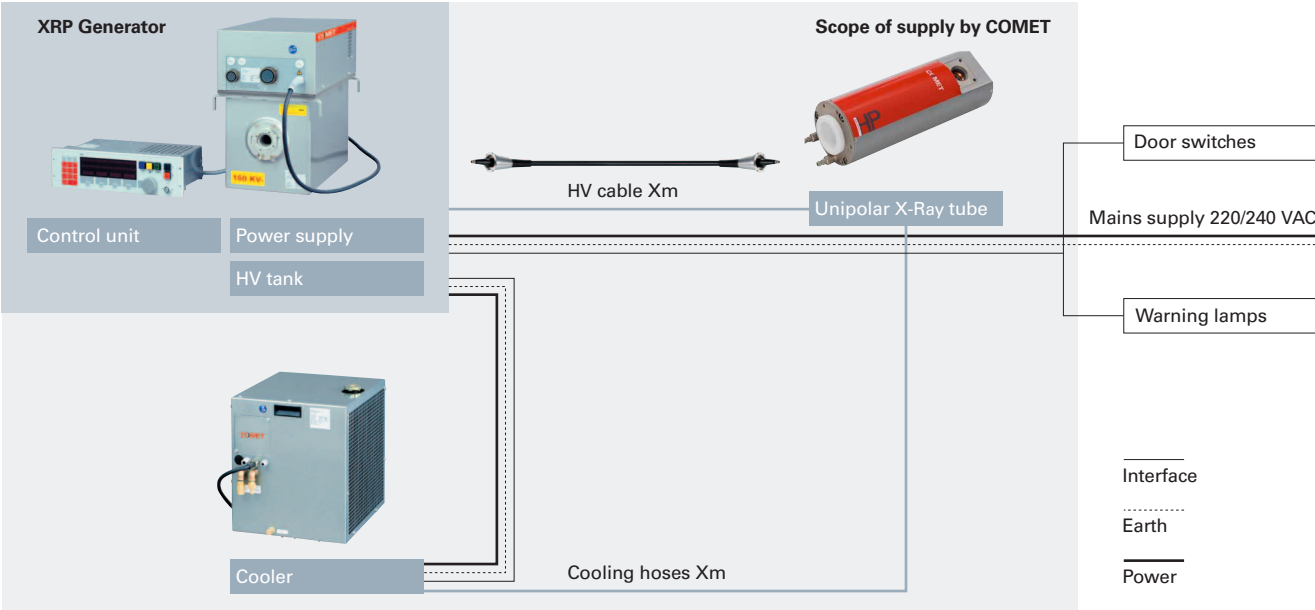
To meet the challenges evoked by these trends, COMET invented the HP technology and thereby revolutionized the X-Ray industry. Smaller focal spots with more power enable our customers to develop “best in class” solutions. Today, COMET offers a broad portfolio of tubes based on HP technology in the range from 75 kV to 600 kV.

**About the Business Unit Industrial X-Ray**

COMET Industrial X-Ray is an experienced supplier of components and modules for industrial X-Ray applications and is proud of its reputation as the preferred engineering partner in terms of innovation potential, know how, flexibility and speed. Our product range features X-Ray tubes and sources with small focal spot resolution up to 6 kW in output for more power demanding requirements. From the smallest footprint for use in portable units to 600 kV fixed gantry systems that are suitable for cargo screening, we offer a solution.

Unipolar X-Ray Source

Diagram of a Unipolar X-Ray Source XRS and its environment.



“One Stop Shop” for Industrial X-Ray Sources:  
COMET’s XRS Modules

COMET is pleased to offer all of the necessary components for a customized X-Ray Source: The new XRS modules each contain a COMET X-Ray tube, high voltage generator with cables and coolers designed for easy

integration that will optimize system performance. All XRS modules are factory prepared and tested for hassle free installation and operation. This novel solution demonstrates COMET’s continuous commitment and investment in delivering real added value to our worldwide customer base.

High Power Tubes – Configuration Information (examples)

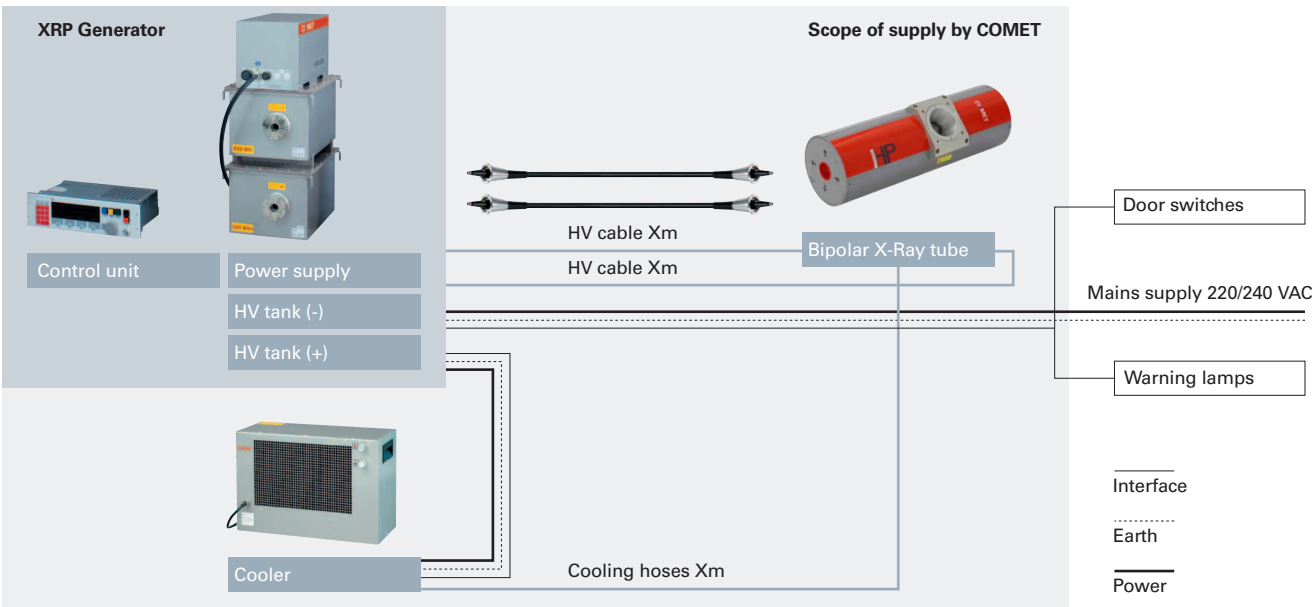
Overview of tubes and fitting module components; high voltage generator, high voltage cable and cooler.

| TUBE            |              |                      |                   |                          |               | GENERATOR      | HIGH VOLTAGE CABLE    | COOLER      |              |
|-----------------|--------------|----------------------|-------------------|--------------------------|---------------|----------------|-----------------------|-------------|--------------|
| Type            | Ordering No. | Nominal tube voltage | Continuous rating | Focal spot acc. EN 12543 | Terminal type | Type           | Type/Xm               | Type        | Ordering No. |
| MXR-75HP/20     | 915376.51    | 75 kV                | 1000W             | d=1.0 mm                 | CA11          | XRP-75/1000/1  | L3/75-CA11-CA11-Xm    | XRC-1001-WA | 20033773     |
| MXR-75HP/20 FB  | 915380.51    | 75 kV                | 1000W             | d=1.0 mm                 | CA11          | XRP-75/1000/1  | L3/75-CA11-CA11-Xm    | XRC-1001-WA | 20033773     |
| MXR-160HP/11    | 915370.51    | 160 kV               | 800W/1800W        | d=0.4 mm**/d=1.0 mm      | R24           | XRP-160/2250/2 | N3/160-R24SL-R24SL-Xm | XRC-3001-WA | 10008640     |
| MXR-160HP/FB    | 915359.51    | 160 kV               | 1000W             | d=1.0 mm                 | R24           | XRP-160/2250/2 | N3/160-R24SL-R24SL-Xm | XRC-3001-WA | 10008640     |
| MXR-160HP/20    | 915357.51    | 160 kV               | 1000W/1000W       | d=1.0 mm/d=1.0 mm        | R24           | XRP-160/2250/2 | N3/160-R24SL-R24SL-Xm | XRC-3001-WA | 10008640     |
| MXR-225HP/11    | 915371.51    | 225 kV               | 800W /1800W       | d=0.4 mm**/d=1.0 mm      | R24           | XRP-225/2250/2 | P3/250-R24SL-R28SL-Xm | XRC-3001-WA | 10008640     |
| MXR-225HP/11 FB | 915362.51    | 225 kV               | 800W /1800W       | d=0.4 mm**/d=1.0 mm      | R24           | XRP-225/2250/2 | P3/250-R24SL-R28SL-Xm | XRC-3001-WA | 10008640     |
| MXR-320HP/11    | 915368.51    | 320 kV               | 800W/1800W        | d=0.4 mm*/d=1.0 mm       | R24           | XRP-320/4500/2 | N3/160-R24SL-R24SL-Xm | XRC-4501-OA | 10008642     |
| MXR-320HP/11 AX | 915368.58    | 320 kV               | 800W/1800W        | d=0.4 mm*/d=1.0 mm       | R24           | XRP-320/4500/2 | N3/160-R24SL-R24SL-Xm | XRC-4501-OA | 10008642     |
| MXR-320HP/11 FB | 915388.51    | 320 kV               | 800W/1800W        | d=0.4 mm*/d=1.0 mm       | R24           | XRP-320/4500/2 | N3/160-R24SL-R24SL-Xm | XRC-4501-OA | 10008642     |
| MXR-451HP/11    | 915369.51    | 450 kV               | 700W/1500W        | d=0.4 mm*/d=1.0 mm       | R28           | XRP-450/4500/2 | P3/250-R28SL-R28SL-Xm | XRC-4501-OA | 10008642     |
| MXC-451HP/11    | 915705.51    | 450 kV               | 700W/1500W        | d=0.4 mm*/d=1.0 mm       | R28           | XRP-450/4500/2 | P3/250-R28SL-R28SL-Xm | XRC-4501-OA | 10008642     |
| MXR-600HP/11    | 915378.51    | 600 kV               | 700W/1500W        | d=0.4 mm*/d=1.0 mm       | R30           | XRP-600/4500/2 | F3/300-R30-R30-Xm     | XRC-4501-OA | 10008642     |

\*Threshold: 25% / \*\*Threshold: 30%

Bipolar X-Ray Source

Diagram of a Bipolar X-Ray Source XRS and its environment.





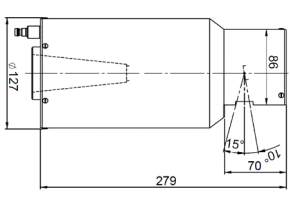
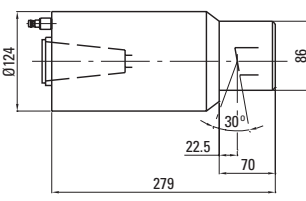
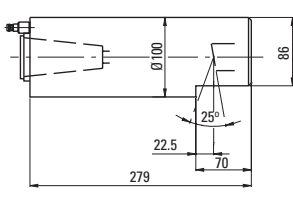
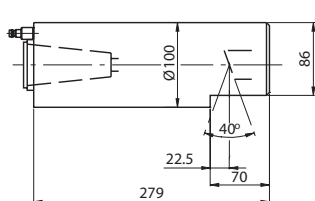
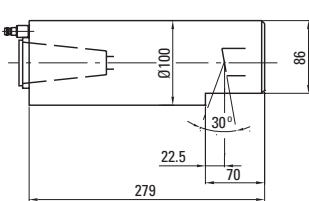
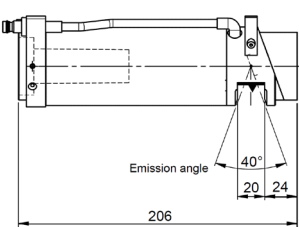
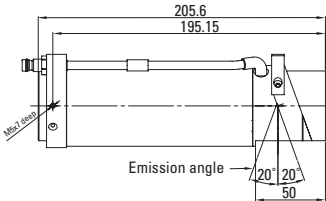
|                            | MXR-75HP/20 | MXR-75HP/20 FB | MXR-160HP/11             |  | MXR-160HP/20            | MXR-160HP/FB   | MXR-225HP/11             | MXR-225HP/11 FB          |
|----------------------------|-------------|----------------|--------------------------|--|-------------------------|----------------|--------------------------|--------------------------|
| Ordering No.               | 915377.51   | 915380.51      | 915370.51                |  | 915357.51               | 915359.51      | 915371.51                | 915362.51                |
| Nominal tube voltage       | 75kV        | 75 kV          | 160 kV                   |  | 160 kV                  | 160 kV         | 225 kV                   | 225 kV                   |
| Continuous rating          | 1000W       | 1000 W         | 800 W / 1800 W           |  | 1000 W / 1000 W         | 1000 W         | 800 W / 1800 W           | 800 W / 1800 W           |
| Focal spot acc. EN 12543   | d = 1.0 mm  | d = 1.0 mm     | d = 0.4 mm* / d = 1.0 mm |  | d = 1.0 mm / d = 1.0 mm | d = 1.0 mm     | d = 0.4 mm* / d = 1.0 mm | d = 0.4 mm* / d = 1.0 mm |
| Filament current, max.     | 3.7 A       | 3.7 A          | 4.1 A / 4.1 A            |  | 4.1 A / 4.1 A           | 4.1 A          | 4.1 A / 4.1 A            | 4.1 A / 4.1 A            |
| Filament voltage, typical  | 2.8 V       | 2.9 V          | 2.9 V / 7.3 V            |  | 4.2 V / 4.2 V           | 3.0 V          | 2.9 V / 7.3 V            | 2.9 V / 7.3 V            |
| Inherent filtration        | 0.8 mm Be   | 1.0 mm Be      | 0.8 mm Be                |  | 0.8 mm Be               | 0.8 mm Be      | 0.8 mm Be                | 1.0 mm Cu                |
| Target material            | W           | W              | W                        |  | W                       | W              | W                        | W                        |
| Target angle               | 20°         | 20°            | 11°                      |  | 20°                     | 20°            | 11°                      | 11°                      |
| Radiation coverage         | 40° x 40°   | 40° x 100°     | 40° x 30°                |  | 40°                     | 60° x 25°      | 40° x 30°                | 90° x 25°                |
| Leakage radiation, max.    | 1 .5 mSv/h  | 1.5 mSv/h      | 2.5 mSv/h                |  | 2.5 mSv/h               | 2.5 mSv/h      | 5 mSv/h                  | 10 mSv/h                 |
| Cooling medium             | Water       | Water          | Water                    |  | Water                   | Water          | Water                    | Water                    |
| Cooling medium flow, min   | 4 l/min     | 4 l/min        | 4 l/min                  |  | 4 l/min                 | 4 l/min        | 4 l/min                  | 4 l/min                  |
| Temperature at inlet, max. | 40°C        | 40°C           | 35°C                     |  | 35°C                    | 35°C           | 35°C                     | 35°C                     |
| Weight                     | 2.1 kg      | 2.1 kg         | 8 kg                     |  | 8 kg                    | 8 kg           | 11 kg                    | 11 kg                    |
| Terminal type              | CA11        | CA11           | R24                      |  | R24                     | R24            | R24                      | R24                      |
| Mounting flange            | -           | -              | 4512-104-87121           |  | 4512-104-87121          | 4512-104-87121 | 4512-104-87131           | 4512-104-87131           |
| Locking device             | -           | -              | 941002                   |  | 941002                  | 941002         | 941002                   | 941002                   |

\*Threshold: 30 %

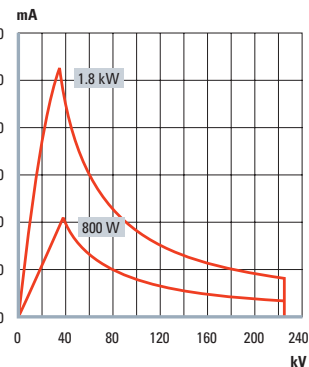
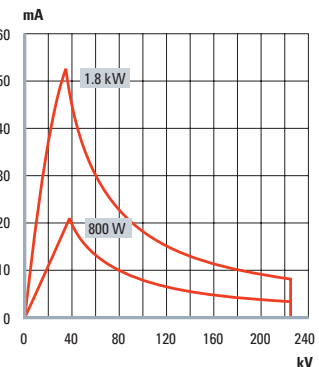
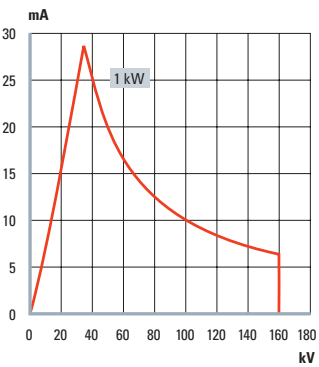
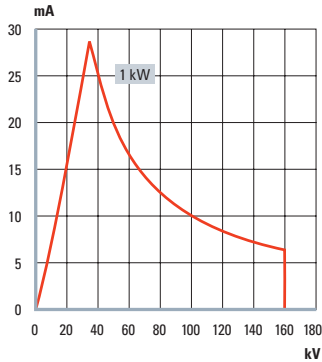
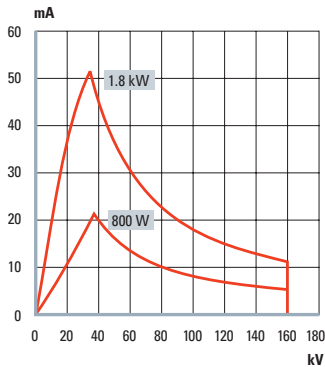
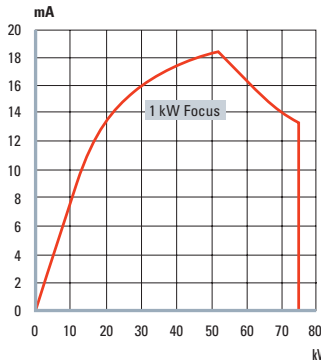
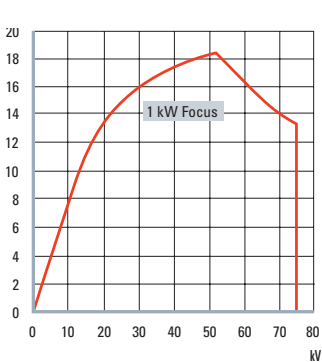
\*Threshold: 30 %

\*Threshold: 30 %

Outline drawing



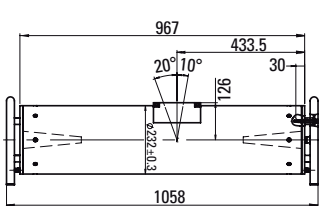
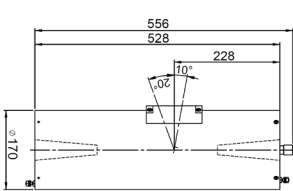
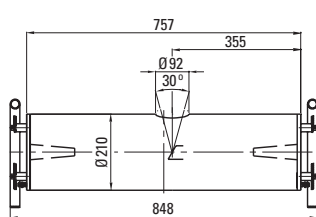
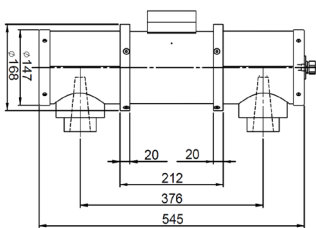
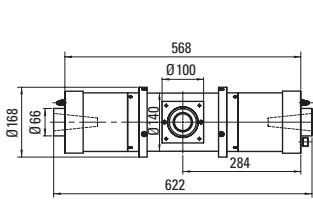
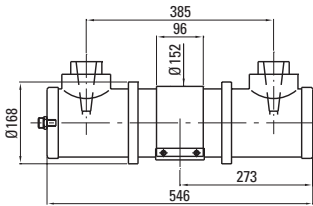
Tube diagram





|                            | MXR-320HP/11             | MXR-320HP/11 AX          | MXR-320HP/11 FB          |  | MXR-451HP/11       | MXC-451HP/11             | MXR-600HP/11       |
|----------------------------|--------------------------|--------------------------|--------------------------|--|--------------------|--------------------------|--------------------|
| Ordering No.               | 915368.51                | 915368.58                | 915388.51                |  | 915369.51          | 915705.51                | 915378.51          |
| Nominal tube voltage       | 320 kV                   | 320 kV                   | 320 kV                   |  | 450 kV             | 450 kV                   | 600 kV             |
| Continuous rating          | 800 W / 1800 W           | 800 W / 1800 W           | 800 W / 1800 W           |  | 700 W / 1500 W     | 700 W / 1500 W           | 700 W / 1500 W     |
| Focal spot acc. EN 12543   | d = 0.4 mm* / d = 1.0 mm | d = 0.4 mm* / d = 1.0 mm | d = 0.4 mm* / d = 1.0 mm |  | d=0.4mm* / d=1.0mm | d = 0.4 mm* / d = 1.0 mm | d=0.4mm* / d=1.0mm |
| Filament current, max.     | 4.1 A / 4.6 A            | 4.1 A / 4.6 A            | 4.1 A / 4.6 A            |  | 4.1 A / 4.6 A      | 4.1 A / 4.6 A            | 4.1 A / 4.6 A      |
| Filament voltage, typical  | 2.3 V / 6.8 V            | 2.3 V / 6.8 V            | 2.3 V / 6.8 V            |  | 2.3 V / 6.8 V      | 2.3 V / 6.8 V            | 2.3 V / 6.8 V      |
| Inherent filtration        | 3 mm Be                  | 3 mm Be                  | 0.5 mm Fe + 0.5 mm Ti    |  | 3mm + 2mm Be       | 3 mm + 2 mm Be           | 3mm + 2 mm Be      |
| Target material            | W                        | W                        | W                        |  | W                  | W                        | W                  |
| Target angle               | 11°                      | 11°                      | 11°                      |  | 11°                | 11°                      | 11°                |
| Radiation coverage         | 40° x 30°                | 40° x 30°                | 80° x 11°                |  | 40° x 30°          | 40° x 30°                | 40° x 30°          |
| Leakage radiation, max.    | 5 mSv/h                  | 5 mSv/h                  | 5 mSv/h                  |  | 5 mSv/h            | 5 mSv/h                  | 10 mSv/h           |
| Cooling medium             | Oil                      | Oil                      | Oil                      |  | Oil                | Oil                      | Oil                |
| Cooling medium flow, min   | 14 l/min                 | 14 l/min                 | 14 l/min                 |  | 14 l/min           | 14 l/min                 | 14 l/min           |
| Temperature at inlet, max. | 50 °C                    | 50 °C                    | 50 °C                    |  | 50 °C              | 50 °C                    | 50 °C              |
| Weight                     | 40 kg                    | 40 kg                    | 40 kg                    |  | 95 kg              | 45 kg                    | ca. 145 kg         |
| Terminal type              | R24                      | R24                      | R24                      |  | R28                | R28                      | R30                |
| Mounting flange            | 4512-104-87141           | 4512-104-87141           | 4512-104-87141           |  | 4512-104-87111     | 20032631                 | 4512-104-87431     |
| Locking device             | 940303                   | 940303                   | 940303                   |  | —                  |                          | —                  |
|                            | *Threshold: 25 %         | *Threshold: 25 %         | *Threshold: 25 %         |  | *Threshold: 25 %   | *Threshold: 25 %         | *Threshold: 25 %   |

Outline drawing



Tube diagram

