Focus topics | September 2026

Beyond the HP/11 Meet the HP/15

For two decades the HP/11 has been the reference minifocus X-ray tube for high-resolution and high throughput radiography. The HP/15 keeps everything that made it trusted, and reengineers the rest for digital detectors, in-line inspection and computed tomography.

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x-ray

Inspection changed, the source had to follow

Three shifts reshaped industrial NDT over the last twenty years. Together they changed what an X-ray source has to deliver — and exposed where the legacy design reached its limits.

1

Film → digital detectors

Digital detector arrays (DDAs) have a coarser pixel pitch than film, so more geometric magnification is needed. That demands a smaller, cleaner focal spot — without sacrificing power.

2

Single shots → in-line & CT

Throughput and 3D reconstruction reward a broad, even beam and a focal spot that stays homogeneous across the full emission angle, not only on the central ray.

3

Occasional → continuous use

Inspection now runs around the clock at high duty cycles, making thermal robustness and uptime as decisive as raw image quality.

The HP/15 answers all three: a cleaner, more symmetric focal spot for sharper images, a wider usable beam for more speed, and two focal spots for built-in uptime.

70%+

larger usable beam area (50°×40° vs 40°×30°)

2x

identical, thermally separated focal spots for redundancy

0

workarounds — even resolution without tilting the tube

Why the HP/11 became the reference

When digital detectors arrived, geometrical magnification became essential, something film never required. The HP/11 was engineered to make that possible.

Film has very high intrinsic resolution and can sit directly against the part, so even a relatively large focal spot produces sharp radiographs. Digital detectors changed the rules. Their larger pixel pitch means the image must be magnified geometrically to recover detail — and the moment you magnify, the size of the focal spot starts to blur every edge.

That blur is geometric unsharpness: the focal spot is not a point, so each feature casts a penumbra whose width grows with magnification and with focal-spot size. To magnify and stay sharp, you need a small focal spot — but a small spot concentrates heat on a very small area of the target, which limits power and therefore speed.

The HP/11 resolved that tension with three coordinated design moves: a redesigned target topology and cooling system, a carefully chosen target angle that keeps the heated area large while projecting a small optical spot, and redesigned electron optics to shape the beam. The result, small spot, high power, became a de facto industry reference, adopted across the market.

One spot, two sizes

The thermal focal spot is the real area heated by the electron beam on the target. The optical focal spot is what the detector "sees" — that area projected toward the image. By tilting the target, a large heated area is foreshortened into a small projected spot.

This is the central trick of every minifocus tube: spread heat over a large thermal spot (more power, longer life) while presenting a small optical spot (sharp images). The art is doing it without distorting the spot or starving the beam at the edges of the field — exactly where the HP/11 left room to improve.

Four limits that shaped the HP/15

1 **An imperfect focal spot**
The HP/11 small spot carries satellites "wings" at top and bottom. They add unsharpness and make resolution unequal depending on the orientation X or Y.

2 **Half the tube, unused**
Today's applications run almost exclusively on the small focal spot, so the HP/11's large spot is rarely put to work.

3 **A tilting workaround**
Most users tilt the tube ~4–5° toward the cathode to even out dose, which stretches the focal spot and trades away sharpness.

4 **Downtime hurts**
When a tube degrades, the whole inspection line can stop. Unplanned replacement is costly in both parts and lost production.

A cleaner spot is the foundation of a cleaner image

Resolution starts at the source. The shape of the focal spot is printed into every radiograph and every CT slice.

The HP/11 small spot is very compact in the X direction but elongated in Y, where the wings live. Because unsharpness follows the spot's shape, edges perpendicular to one axis come out sharper than edges perpendicular to the other, resolution is direction-dependent. In CT, where the part rotates through every orientation, that asymmetry smears fine features and reduces contrast on small defects.

The HP/15 reshapes the spot. Through revised electron optics and target design, it is more symmetric and more compact, with the wings removed. The improvement holds not just on the central ray but across the emission angle, which matters because the detector views the spot at an angle that changes across the field.

Homogeneous X/Y resolution

A symmetric spot means an edge is rendered with the same sharpness whatever its orientation. For 2D radiography that means crisper, more consistent images. For CT it means cleaner reconstructions, better small-defect visibility, and fewer orientation-dependent artifacts.

Focal-spot shape



Figure 1. The HP/11 spot is elongated in Y with wings top and bottom; the HP/15 spot is symmetric and compact, with the wings designed out — giving homogeneous resolution in X and Y.

A wider beam and what it buys you

A bigger usable field is not just convenience. It changes the geometry you can build and the speed you can run.

The HP/15's 15° target and anode assembly open the usable beam to 50° radial × 40° axial, against 40° × 30° for the HP/11, roughly 70% more usable area at the same distance. Just as important, the spot stays clean and small across that wider angle, so the extra coverage is genuinely usable, not just brighter in the middle.

More dose, more speed

A larger field lets you move the detector closer to the source for a given coverage. Dose at the detector scales with the inverse square of the distance, so closing that gap delivers markedly more dose, which you can spend on faster acquisition at the same resolution, or on higher resolution at the same speed.

No more tilting

X-rays are generated just beneath the target surface and must pass through the target material before leaving the tube. Toward the anode side, they travel through more material and are more strongly attenuated. This dose reduction is known as the heel effect.

A 15° target angle reduces attenuation and moves the significant dose falloff toward the edge of the usable field. HP/11 users can compensate by tilting the tube approximately 4–5° toward the cathode. However, this changes the angle at which the detector views the spot, stretching it in the length direction by more than a third. The HP/15 is designed for 15° from the outset, providing more uniform dose and a small focal spot without this trade-off.

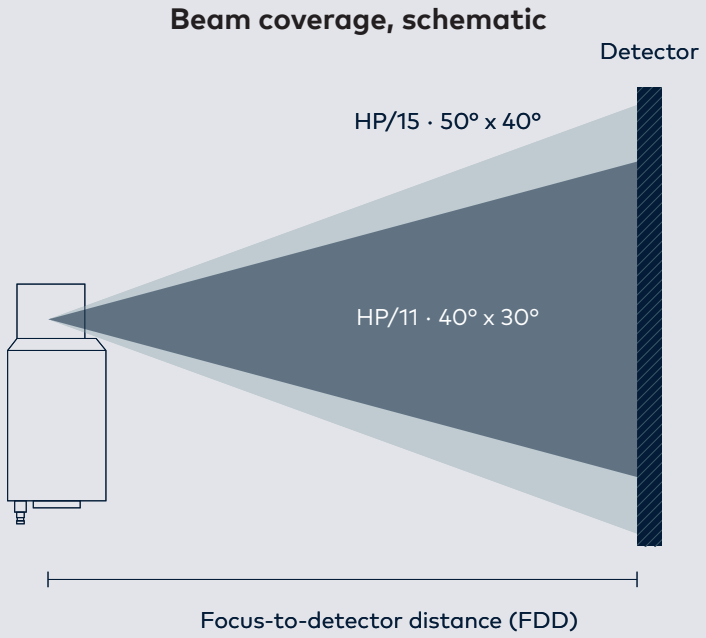


Figure 2. The wider HP/15 beam allows a shorter detector distance while maintaining full illumination, delivering substantially more dose through the inverse-square effect (1/FDD²).

Two spots, one insurance policy

The spot that used to sit idle now keeps the line running.

Instead of a large spot that sits idle, the HP/15 carries two nearly identical small focal spots, thermally separated on the target. The second is effectively a built-in spare. If the first degrades, you switch to the second and keep inspecting rather than stopping the line for an emergency tube change.

Plan service, don't fight fires

Used the same way, the second spot has a similar lifetime to the first, so replacement can be scheduled into a maintenance window instead of striking mid-production. That also means less local spare inventory to finance and store.



Figure 3. Because the spots are thermally separated, wear on the first does not compromise the second — turning an unplanned failure into a planned, scheduled service.



Focal-spot images of the HP/11 (top) and HP/15 (bottom), showing the improved spot shape and symmetry.

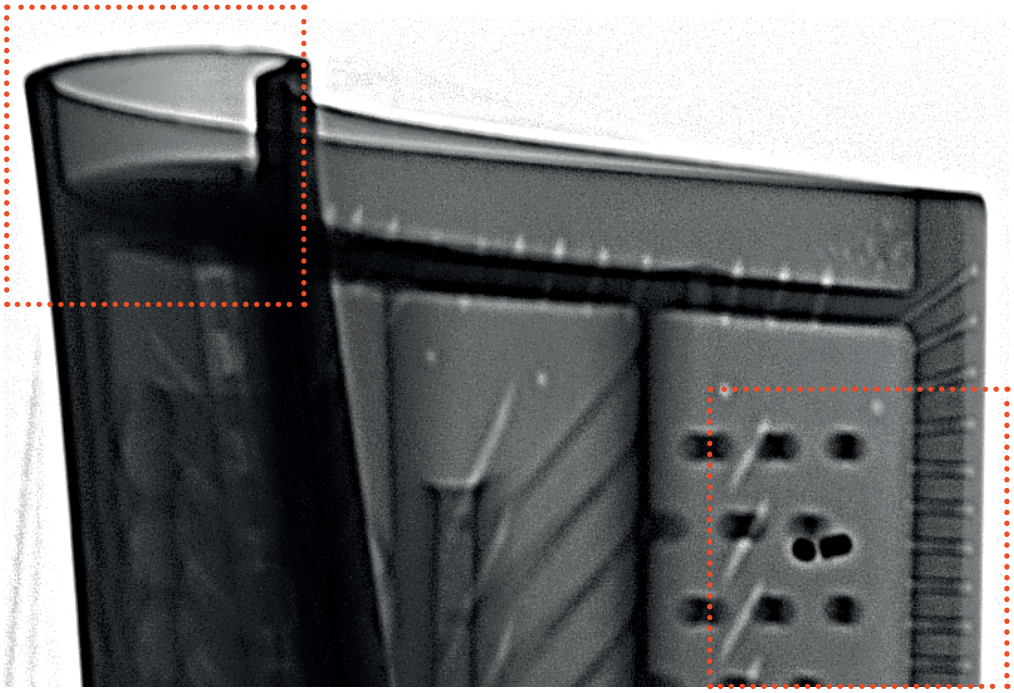
A note on standards

Many users know the MXR-225HP/11 as a 0.4 mm tube. That value comes from EN 12543-2:2008, evaluated at a 30 % threshold, which does not include the wings of the focal spot. Since the 2021 revision, EN 12543-2 uses the Integrated Line Profile method, the same method as ASTM E1165-20. This method includes the wings, because a real radiograph includes them too. Measured this way, the same focal spot is 0.63 mm. All values in this document follow ASTM E1165-20, for both tubes.

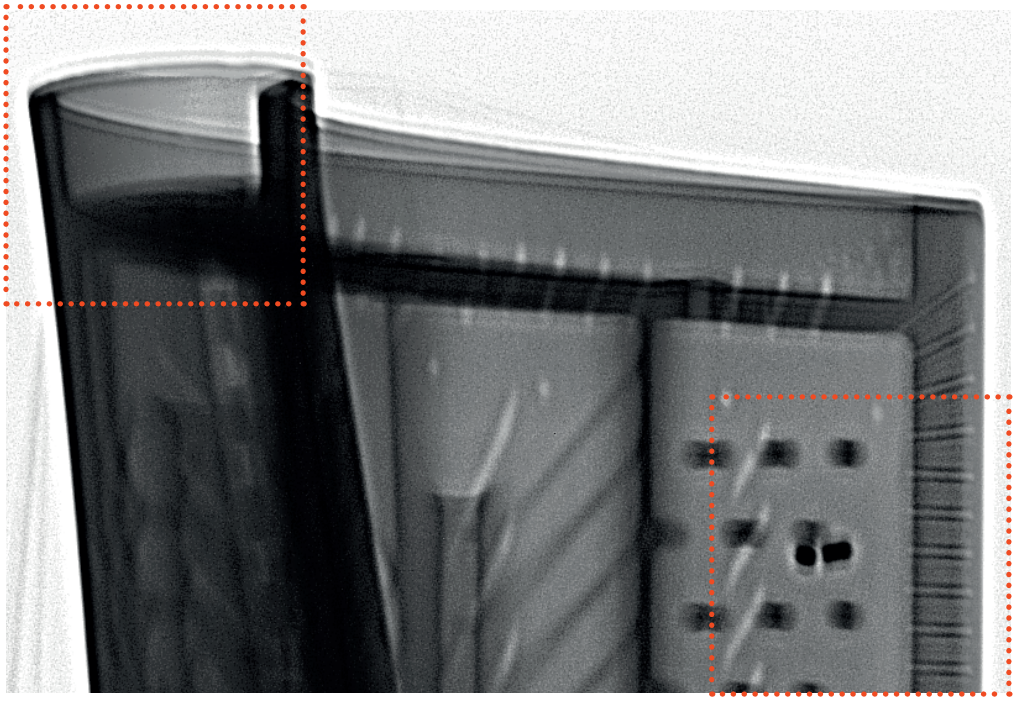
From specification to application - see the difference with HP/15

Parameters: 225 kV, 1.5 mA, 10 f, M3.96, FOD 450
Top: with MXR-225HP/15/04-04 & **Bottom:** MXR-225HP/11 tilted 4°

HP/15
Horizontal edges resolve as a single sharp line. The cooling holes hold high contrast to their edges, because a compact spot casts a narrow penumbra.



HP/11
11° target angle, tilted 4°. Same parameters. Horizontal edges break into a triple line, the upper wing, the focus, and the lower wing, each casting its own edge. The cooling holes lose contrast as their penumbrae overlap.



Measured in the lab, visible in the image

Every claim here is backed by focal-spot measurements following the ASTM E1165-20 user method, and by side-by-side images under identical conditions.

Focal-spot geometry
Measured across angle, not only on the central ray, the HP/15 holds a smaller, more symmetric spot, confirming the cleaner shape and wider usable beam.

CT image quality
On identical scans the HP/15 delivers sharper, more homogeneous reconstructions with better defect visibility and less focal-spot distortion.

Turbine-blade comparison
Same technique, same parameters: the HP/15 shows sharper Y-direction edges and more uniform resolution than the HP/11 - including the HP/11 tilted by 4°.

Clearly defined focal spots
Specifications now follow the ASTM standard, providing a focal spot size value that reflects achievable system performance.

The HP/11 is here to stay
It remains in the Comet portfolio and remains the right tube for established film and lower-magnification workflows. The HP/15 answers what has changed since then: digital detectors, in-line throughput, and CT.

Specifications of the HP/11 and HP/15

HP/11 vs HP/15 - 225 kV class

Feature	MXR-225HP/11	MXR-225HP/15/04-04	What this means for you
Target Angle	11°	15°	Root cause of gains below
Focal spots (ASTM E1165-20)	0.63 mm / 1.0 mm	0.4 mm / 0.4 mm	Smaller defects detected
Small focal-spot shape	Asymmetric, with wings	Symmetric, compact, no wings	Sharper edges, no wing blur
X/Y resolution homogeneity	Direction-dependent	Homogeneous	Same resolution in every direction
Usable beam coverage	40° × 30°	50° × 40°	Detector closer, faster scans, smaller footprint
Dose homogeneity	Typically requires ~4-5° tilt	By design, no tilt needed	Simpler integration, no tilt fixture
Small focal spots for redundancy	One	Two, thermally separated	Second spot keeps the line running
Max. continuous power	800 W	850 W	More dose, shorter exposure

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