Product presentation HEUFT *InLine* ^{II} *IXS*

The HEUFT *InLine* ^{II} *IXS* is the flagship of the HEUFT *InLine* ^{II} family. It combines the superior optical camera inspections with the HEUFT *eXaminer* technology which is available exclusively from us. The combination of optical base inspection and pulsed X-ray base inspection demonstrably increases the detection rate of glass splinters significantly especially in small amounts of residual water from the washing machine or rinser. (Please refer to slides 14 to 16 and 20 to 23)

The device can also be ordered without X-ray components as an option. Thus they can be retrofitted later if required.

The solid construction of the device is necessary in order to meet the strict requirements for radiation protection. Therefore an open, freely accessible version without machine table is currently inconceivable for this device.

What does the abbreviation IXS stand for?

IXS stands for **I**nLine **X**-ray **S**mall. The X could also stand for e**X**aminer. Small refers to the comparison with its predecessor the HEUFT *InLine IX* which was considerably longer.

Target group

The HEUFT *InLine* ^{II} *IXS* is typically used for inspecting empty glass containers along beverage and food packaging lines. All types of disposable glass containers and returnable glass bottles are typical containers. In this case it provides unique possibilities on the market especially when looking for glass in glass.

PET containers can also be inspected on a HEUFT level as usual. However the USP of the X-ray base inspection is of secondary importance here.

Which HEUFT *InLine* should I sell?

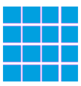
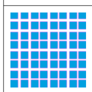
It is important to understand the potential customer's task and then to prepare a tailor-made offer with excellent price / performance ratio.

Presentation

I will explain below what can be seen on the presentation slides and what can be said about them. We have deliberately not used much text when creating the presentation. The text should always be in the speaker's mind and the slides should not be cluttered for a presentation to be good. This is the reason for this description. Please learn it so that you bring it to life during the presentation. In this way you will get the most out of the material.

Please send an email to marketing@heuft.com should you have any questions, suggestions or do not understand something. Therefore all of us responsible for designing and looking after the presentations can access this. Furthermore we work closely with the Product Managers when creating the presentation. You can also ask them for advice if something is unclear.

Symbols used

	Number of cameras used for the inspection.
	Number of views which are photographed. The full resolution of the camera is available for the one view if the number of views is identical to the number of cameras. The resolution of the cameras is divided accordingly if the number of views is greater that the number of cameras. ATTENTION: this does not have to be a disadvantage! It always depends on the individual case whether a high resolution is needed.
	Single resolution. The camera picture is used for four views in the single and double sidewall.
	Double resolution compared with the single and double sidewall. The camera picture is only subdivided into two views during the fourfold sidewall whereby these have twice the resolution.
	Fourfold / eightfold resolution compared with the single and double sidewall. The camera picture is no longer subdivided in the case of the sixteen-fold sidewall. Thus each view obtains the full camera resolution and the resolution is four times as high as the single and double sidewall. In addition we photograph the upper and the lower area of the container separately. In other words we separate it again. This results in us effectively

	operating with an eightfold resolution in the inspection.

Slide 1

The introduction slide provides a brief overview of the device and a few cross-industry containers and faults which can be inspected. It therefore shows that we are also involved in other sectors and that this expertise is part of the device as well.

Slide 2

The customer can identify himself with his product and his problems with it best of all. We attempt to take this into account as best we can. We can show a little of what the device actually does / can on this slide. Unfortunately we cannot list every type of container and fault. This is only a small selection which we will constantly extend.

Slide 3

This is a heading slide which introduces the topic "finish inspection".

Slide 4

We will show typical finish faults as in slide 2. We will also add 3D graphics and pictures of typical faults here in future.

Slide 5

Slide 5 explains the technical design of the finish inspection. It answers the question "How do you do it?".

The finish inspection is carried out in the belt area of the device. Blue, white and red light is directed onto the finish by means of special concentric mirrors so that the colour rings can be clearly distinguished on the finish. The finish is free from defects if they are homogeneous. However the differences are easy to identify if the rings of light are disrupted. This can be seen in the detection picture on the right.

The sealing surface as well as the underchip area can be inspected by means of this special illumination.

Special evaluation procedures can run in parallel. The finish picture is centred as a first step. The mechanical tolerances of the containers are compensated in this way in an extremely large capture range and with the measurement of at least 32 pixels in the area of the reflections.

The wide variety of possible masks with different independent evaluation methods combined with the very fine segmentation of the ring masks (resolution approximately 1°) make very sensitive inspections possible with very low false rejection rates at the same time.

Slide 6

The inner finish

Slide 7

This is a heading slide which introduces the topic "sidewall inspections".

Single, double, fourfold, sixteen-fold sidewall?! What does this mean?

In HEUFT jargon this means the number of cameras with which the inspection is carried out. In contrast our competitors also like to describe the views as x-fold sidewall. It is always worth asking exactly when it is argued against us so that we do not compare apples with oranges. Because after all subdividing the camera picture into several views of the container means a reduction in the resolution available per view. Here the sidewalls by comparison:

HS sidewall	Cameras	Views	Resolution comparison
Single	1	4	1x
Double	2	8	1x
Fourfold	4	8	2x
Sixteen-fold	16	16	4x / 8x

Slide 8

We will show typical sidewall faults here as in slide 2. We will also add 3D graphics and pictures of typical faults here in future.

Slide 9

The fourfold sidewall shown here is recommended for all customers who are looking for a future-proof investment. It is ideally suited for all types of containers due to the double resolution compared with the double sidewall (two views per camera picture instead of four) and a front surface inspection from all four sides of the container. It is also ideal for embossing, ACL and other container features which hide the back of the container because we do not have to look through the container.

The principle of rotating in the belt corresponds to that of the double sidewall. A special gap between the containers is not required either. The difference is that a photograph is taken both from the front and the back of the container in the infeed. The same then occurs in the outfeed.

Features / advantages:

- double resolution means that smaller fault sizes can be detected
- eightfold view of all the front surfaces of the container means that there are no blind spots hidden by container features
- well suited for containers with embossing, ACL or other container features which cause obstructions
- no infeed worm and no container gap required which means a non-wearing, stress-free and quiet transport without change parts

Slide 10

This is a heading slide which introduces the topic "base inspections".

Slide 11

We will show typical base faults here as in slide 2. We will also add 3D graphics and pictures of typical faults here in future.

Slide 12

The optical base inspection is carried out in the belt area. The inspection system consists of an in-house developed LED strobe and an optic tower.

The picture is divided among up to three cameras in the optic tower. As a result not only the base inspection but also the inner sidewall inspection and a special more accurate base inspection for transparent faults can be carried out at the same position with the same flash. HEUFT had a patent for this procedure which has already expired. However we are the inventors of the principle of carrying out several inspections at the same position.

The base strobe comprises approximately 630 LEDs arranged concentrically in rings. The rings can be switched and controlled separately. Therefore it is possible to adapt the brightness to the diameter of the container. On the one hand this ensures that only the LEDs that are actually required are "burdened" and on the other hand that the picture is not overexposed with regard to the brightness and therefore an extremely good and bright illumination of the base occurs. In addition the brightness of each ring can be controlled separately. These functions make a flexible, homogeneous and therefore optimal illumination of the base possible in any situation.

Slide 13

The container bases are also inspected in the HEUFT *InLine ^{II} IXS* by an X-ray base inspection based on the HEUFT *eXaminer* technology in addition to the optical base inspection. It can be proven that glass splinters, especially in residual moisture, are detected much more reliably due to the unique pulsed X-ray technology. Only one X-ray pulse of 1 ms is emitted per container which results in an extremely low radiation emission and very sharp images.

Therefore X-rays are required for only 36 seconds per hour with a production of 36,000 containers per hour.

Further important and interesting information about the HEUFT *eXaminer* technology can be read here:

https://heuft.com/aktuelles/news-uebersicht/r%C3%B6ntgentechnologie-am-puls-der-pr%C3%A4zision-examiner-teil-1

Slide 14

The challenge of detecting glass splinters in glass containers is significantly increased by the residual moisture which remains from the washing machine or rinser. The smallest amounts of water suffice in order to make the edges of broken glass invisible or to weaken the contrast at the edges to such an extent that it becomes very difficult to achieve a reasonable ratio between detection reliability and false rejection rate especially in the area of the knurling marks.

Glass splinters can be detected extremely well with X-ray technology regardless of water and other residual moisture since glass has a significantly higher density than water.

Slides 15 & 16

The difference between an optical and an X-ray based inspection when detecting glass splinters can be clearly seen here. The glass is also very difficult for the human eye to see in the camera image in the area of the knurling marks. On the other hand the foreign object is clearly and reliably detected in the X-ray image.

Slide 17

The IR residual detection for detecting oil is described here. We can also adapt the LED illumination to the container diameter flexibly here in the same way as the base inspection. The inspection takes place within the belt. The IR light is sent towards a receiver through the container. Oil is detected when the IR light is attenuated by the oil and less arrives at the receiver.

Slide 18

There is an HF residual liquid detection integrated in the HEUFT *InLine* ^{II} *IS* in order to provide maximum safety against residual lye in the containers. There is enough room between the inspection modules of the device due to the new mechanical design. In purely mathematical terms the HEUFT *InLine* ^{II} *IS* thereby even has a shorter installation length than a HEUFT *InLine* ^{II} *IR* with double sidewall. It is assembled immediately behind the device at the conveyor because an HF residual liquid detection cannot be integrated there.

The sensor measures from below and not from the conveyor at the side as in the case of the HEUFT *InLine* ^{II} *IR* and therefore it can be adjusted more finely and can measure more accurately.

Slide 19

The new intelligent infeed check of the HEUFT *SPECTRUM* ^{II} generation makes the reliable sorting out of containers which can cause damage when entering the inspector possible. Therefore damaged, lying, too high, too wide, too thin and misshapen containers are detected and rejected reliably. Furthermore an intelligent camera developed by HEUFT makes the reliable identification of foreign containers and different container colours possible. An additional HEUFT *SX* before the HEUFT *InLine* was necessary for this up to now.

This and the previously related operation of two devices with different user interfaces (HEUFT *PILOT* / HEUFT *NaVi*) become obsolete with the new generation of infeed check. The infeed check is fully integrated in the user interface of the HEUFT *InLine* and can be operated centrally from there.

Why is the infeed check intelligent?

Strictly speaking the camera developed by HEUFT is above all intelligent. It contains an image processing card which evaluates the inspection pictures directly on the spot. Only the result is then sent to the HEUFT *InLine* / the system or directly rejected by the rejector before the HEUFT *InLine*. Another device or a central computing unit is not needed for this. The time-consuming and therefore performance diminishing transmission of the pictures to such a system is also omitted.

Slide 20 – independent performance record

HEUFT sold a HEUFT *InLine II IXS* empty bottle inspector of the latest generation with the unique X-ray base inspection to a large German brewery group at the end of 2015. The VLB carried out this performance record for this device after installation and commissioning.

This test has been carried out at all the brewery group sites since 1991. A comprehensive "machine index" was created from the data determined in this way. In a nutshell this is a ranking list of corresponding machines from different manufacturers at different locations.

Slide 21 – what is the VLB?

The VLB (Versuchs- und Lehranstalt für Brauerei in Berlin e.V. – Research and Educational Institute for Brewing in Berlin) offers an independent performance test for empty bottle inspection machines (benchmarking) as part of its activities.

Slides 22, 23 and 24

What's the point?

The test for the HEUFT *InLine II IXS using brown 0.5 litre long neck returnable bottles* was divided into three parts and three fault categories. Some explanations are needed in order to differentiate them clearly from each other, not to mix them up and to understand what all this means in concrete terms which this document tries to provide.

The same set of faults has been used since 1991 in order to be able to compare the results over the years and thus determine whether an investment in a new empty bottle inspector also leads to an increase in the detection rate. These are the "relevant faults" for the machine index. However there has been an extended set of faults since 2011 because modern inspectors are becoming more and more powerful. This is referred to as "all faults types" in the report.

Why three parts?

Parts 1 and 2

Parts 1 and 2 are the standard specified tests for the comparable evaluation of the inspection performance of the different devices within the machine index of the brewery group. This index records the performance of all the corresponding machines within the brewery group.

By way of explanation: the performance of an empty bottle inspector depends on much more than the settings of the inspections. The quality of the containers also has a decisive influence. It is possible that the settings have to be slightly defused so that the rejection rate does not increase too much if the tolerances in some batches from the glassworks are too large or even containers from different glassworks are combined. The same can be the case with old empties (e.g. heavy wear => scuffing) and high demand. It is often undesirable to reject such cases in order to achieve performance.

Therefore the performance record was divided into a test with very sharp settings () and another with "realistic" operating settings ().
The test with the sharp settings should show what the inspector can accomplish under almost ideal conditions (as is possible under test conditions). However it should not be concluded from the term "ideal conditions" that they cannot be achieved. Some of the factors, e.g. container transport, can be easily influenced but require good, critical powers of observation and a good understanding of the connections. Thus it is usually possible to create much better conditions than initially thought which significantly increases the detection performance.

The test under operating settings is based on the settings which were optimised for the ambient and container conditions along the filling line where the device was installed.

To sum up: there was a test with **sharp settings** and one with **operating settings**.

Part 3

The third test is a special case. It should evaluate the performance of the X-ray base inspection () independently of Parts 1 and 2 and the other inspections in the device.

In this connection the focus was on glass splinters of different shapes and sizes in 0.65 ml tap water as residual liquid (this corresponds to the water content when breathing out four times!) which may be left behind by the washing machine.

The surface tension of the water causes poor contrasts at the edges of the broken glass during the optical base inspection even with this small amount of residual liquid. The edges are much more difficult to identify. The pulsed X-ray technology available exclusively from HEUFT was integrated into the HEUFT *InLine II IXS* in order to be able to find exactly such splinters better in future. This works because glass has a much higher density than water.

Where are the results and where are the values?

Take it easy! We have to look at the fault types once again before we arrive at the results in order to interpret them correctly.

As mentioned above the test relates to three fault types:

- Relevant fault types (machine index)
- All fault types
- Glass splinters

Four bottles were prepared for each fault for the relevant and all fault types. These four bottles were each inspected 25 times whereby for each of the bottles an additional four good containers were also inspected in order to determine the false rejection rate. This results in a total number of 2900 runs for all the faults.

The test for the X-ray base inspection results in a total number of 1500 runs. One hundred runs were carried out for each of the 15 categories of splinters in this case.

Relevant fault types (machine index)

The **21 relevant fault types** are the fault types used to test all the devices in the performance index in order to compare the results with each other in the long term. To begin with they were deliberately chosen to be challenging in order to be able to assess future decisions whether, objectively speaking, newer inspection devices actually achieve an increase in performance.

Relevant fault types for the machine index

Marking	Area	Fault description
M1	Finish	Chip – outside H x W x D in mm: 3 x 5 x 3
M2	Finish	Chip – continuous H x W x D in mm: 3 x 5 x max
S2	Sidewall	Dirt – opaque H x W in mm: 4 x 4 (10 mm below the bottle bulge)

S3	Sidewall	Dirt – opaque H x W in mm: 4 x 4 (25 mm above the bottle base)
S4	Sidewall	Dirt – opaque H x W in mm: 4 x 4 (shoulder area)
S5	Sidewall	Dirt – opaque H x W in mm: 4 x 4 (bottle body)
S6	Sidewall	Dirt – opaque H x W in mm: 8 x 8 (10 mm below the bottle bulge)
S7	Sidewall	Dirt – opaque H x W in mm: 8 x 8 (25 mm above the bottle base)
S8	Sidewall	Dirt – opaque H x W in mm: 8 x 8 (shoulder area)
S9	Sidewall	Dirt – opaque H x W in mm: 8 x 8 (bottle body)
B2	Base	Dirt – opaque H x W in mm: 2 x 2 (base centre)
B3	Base	Dirt – opaque H x W in mm: 2 x 2 (base rim above base knurling)
B4	Base	Dirt – opaque H x W in mm: 5 x 5 (base centre)
B5	Base	Dirt – opaque H x W in mm: 5 x 5 (base rim above base knurling)
G1	Objects	Glass splinter – cuboid L1: > 5mm - < 6mm H: >2.5mm
G1	Objects	Glass splinter – flat L1: > 10mm - < 11mm H: >2.5mm
G1	Objects	Glass splinter – needle shaped

		L1: > 7mm - < 8mm L1:L2 = 2:1
G2	Objects	Cigarette packet film (one)
G3	Objects	Paper clip (bent open, above base knurling)
R1	Residual liquid	Tap water (HF module) > 1 mm above base centre
R2	Residual liquid	Edible oil (IR module) > 3mm above base centre

All fault types

As mentioned above modern empty bottle inspectors are always achieving better results. For this reason the level of difficulty for the detection was increased by defining **eight additional faults** which, for example, are significantly smaller:

Additional faults which are not included in the relevant fault types

Marking	Area	Fault description
S1	Sidewall	Chip – outside (partly in the area of the scuffing rings)
S2	Sidewall	Dirt – opaque H x W in mm: 2 x 2 (10 mm below the bottle bulge)
S3	Sidewall	Dirt – opaque H x W in mm: 2 x 2 (25 mm above the bottle base)
S4	Sidewall	Dirt – opaque H x W in mm: 2 x 2 (shoulder area)
S5	Sidewall	Dirt – opaque H x W in mm: 2 x 2 (bottle body)

S10	Sidewall	Film detection – transparent H x W in mm: 8 x 8 (bulge, base, shoulder and body)
B1	Base	Chip – outside in the area of the base knurling
B6	Base	Film detection – transparent H x W in mm: 5 x 5 (base centre)

Glass splinters

The glass splinters were created specifically for part 3 of the X-ray base inspection test (compared to the optical detection) and are not yet part of the set of the standard fault types of the other tests. It was "thrown" into one of the long neck bottles filled with 0.65 ml tap water in order to simulate contamination by residual liquid.

Set of faults for testing the X-ray base inspection 0.65 ml residual liquid was in the container in each case (tap water)		
Marking	**Area**	**Fault description**
Q1	Base	Glass splinter – cuboid 1 L1: > 2 mm - < 3 mm H: <2 mm
Q2	Base	Glass splinter – cuboid 2 L1: > 3 mm - < 4 mm H: < 2.5 mm
Q3	Base	Glass splinter – cuboid 3 L1: > 4 mm - < 5 mm H: < 2.5 mm
Q4	Base	Glass splinter – cuboid 4 L1: > 5 mm - < 6 mm H: < 2.5 mm
Q5	Base	Glass splinter – cuboid 5 L1: > 6 mm - < 7 mm H: < 2.5 mm
P1	Base	Glass splinter – flat 1 L1: > 2 mm - < 3 mm H: > 1 mm - < 2.5mm
P2	Base	Glass splinter – flat 2

		L1: > 3 mm - < 4 mm H: > 1 mm - < 2.5mm
P3	Base	Glass splinter – flat 3 L1: > 6 mm - < 7 mm H: > 1 mm - < 2.5mm
P4	Base	Glass splinter – flat 4 L1: > 8 mm - < 9 mm H: > 1 mm - < 2.5mm
P5	Base	Glass splinter – flat 5 L1: > 10 mm - < 11 mm H: > 1 mm - < 2.5mm
N1	Base	Glass splinter – needle shaped 1 L1: > 3 mm - < 4 mm
N2	Base	Glass splinter – needle shaped 2 L1: > 4 mm - < 5 mm
N3	Base	Glass splinter – needle shaped 3 L1: > 5 mm - < 6 mm
N4	Base	Glass splinter – needle shaped 4 L1: > 6 mm - < 7 mm
N5	Base	Glass splinter – needle shaped 5 L1: > 7 mm - < 8 mm

The results

Part 1 – sharp settings

- Machine index (only relevant fault types): **100% (100.00%)**
- Detection rate for all fault types: **100% (100.00%)**
- False rejection rate: **0%**

Part 2 – operating settings

- Machine index (only relevant fault types): **100% (99.905%) ***
- Detection rate for all fault types: **98% (98.00%)** †

- False rejection rate: **0%**

* Why 99.905%? The faults were prepared in four test bottles each of which was inspected 25 times by the device. 4 x 25 makes 100. This means that each run accounts for 1%. The fault was not detected in two cases. Thus the detection rate fell directly to 99%. The value of 99% is still considered to be fulfilled since there are only whole percentage values in the machine index. The final result is then rounded. 90% of the faults were detected with 100% and thus the HEUFT specifications were clearly exceeded.

† 98% is a great value! As mentioned above these are all types of faults including those intended to bring the inspector to its knees regarding the detection rate and are not even within the customer's specifications. There are also chips in the scuffing area which should not cause rejection under operating settings. With a detection rate of 98% we are clearly at the top of the list and show that the HEUFT InLine II IXS defines the state of the art – and defines it so well that the fault types already had to be extended in order to really bring it to its knees. Almost 80% of the faults are detected with 100%. Particular attention should be drawn to the 2 mm x 2 mm opaque sidewall faults (S2, S3, S4 and S5) – two of which are detected with 100%. The detection rate is 97.75% for all four faults.
And do not forget these are customer-specific operating settings!

Part 3 – X-ray base inspection

- Greatest increase in the detection rate by means of X-rays: **+29%**
- Average increase in the detection rate by means of X-rays: **>7%**

What does all this mean now?!

*"We can achieve a **100% detection rate** with a **0% false rejection rate**. Period!"*

And we are also the absolute technology leader when it comes to significantly stricter fault requirements:

*"We can achieve a **100% detection rate** with a **0% false rejection rate**. Period!"*

And even with slightly less sharp settings (customer requirements, ambient conditions and container quality) more is still possible due to our decades of expertise:

*"We can clearly exceed the guaranteed **detection rate** with a **0% false rejection rate**. Period!*

And the X-ray base inspection is really worth it:

*"We can achieve up to a **29% better detection rate** for glass splinters in 0.65 ml residual liquid with the X-ray base inspection. Period!"*

And not only the detection accuracy is high. The inspection is also highly efficient:

*"We achieve a **false rejection rate of 0%** for ALL tests".*

A web report was also published on this subject:

https://heuft.com/aktuelles/news-uebersicht/detektion-fehlausleitrate-heuft-spitzenwerte

Slide 25

This deals with additional equipment. HEUFT not only supplies a device but a turnkey solution. We have all the necessary equipment in our portfolio for this. This is also at the usual high HEUFT level.

Slide 26

The different rejection systems are introduced here. Here is a table regarding their suitability.

Please note: the HEUFT *e-mono* has been revised and now has (among other things) a longer stroke which was further developed in response to projects with heavy (filled) containers! This is, to put it simply, an electrically powered HEUFT *mono*. It was never intended for dynamically laning containers onto parallel conveyors and the bin. Such a compact rejection system is being designed.

Slide 27

We offer everything from conveyor mechanics and conveyor control in the container transport field.

The HEUFT *conveyor* stands for high-quality and well-thought solutions regarding conveyor construction. Thus HEUFT has developed an extensive and flexible modular conveyor system which is suitable for every installation position based on decades of experience in project planning. The construction is directed exactly at the special requirements in the inspection and rejection sections. Only a stable construction makes a permanently quiet inspection and trouble-free rejection possible. Investments in this area pay off with regard to an increase in effectiveness in production.

Conveyor construction combined with the conveyor control system. We have the HEUFT *synchron* on offer here. It ensures an efficient, careful and quiet container transport at all times. Our customers benefit from our many years of experience here too.

Why do we also deal with "what's around" the device?

A good container transport is also always required for the inspection to function correctly. Containers which slide around can cause high false rejection rates because the container tracking is not functioning correctly. As a result a large number is rejected after the inspector and even though it is not responsible in any way the device is blamed.

False rejection rates and even crashes can occur when containers are pushed into the inspector due to a bad conveyor control system which can cause a stop with complex clearing up work. This happens inside the inspector and therefore the blame is also placed here again.

Furthermore the best inspection is pointless if the faulty containers are not rejected consistently and reliably. This is all about a perfect interaction between conveyor control and rejection.

Past experience has shown that this has caused major problems again and again regarding co-operation with third party manufacturers. Thus the blame was passed back and forth and the customer suffered. That is why all these important components are available from one source at HEUFT. In this way we ensure that our inspectors operate efficiently and reliably.

Slide 28

We also provide solutions for every application in the area of production data acquisition (PDA) and line analysis in real time with the HEUFT *PROFILER* family.

The HEUFT *PROFILER elemental* is the entry level variant. It is installed on the customer's PC and only covers production data acquisition for the HEUFT devices.

The HEUFT *PROFILER* is a server solution in conjunction with a HEUFT *STRATEGY*. Here too only the data from HEUFT devices can be captured.

The HEUFT *PROFILER advanced* also makes the connection and acquisition of non HEUFT devices possible in addition to the HEUFT *PROFILER*.