



BFET – Crack Detection

Balance Field Electromagnet Technology
适用于裂纹检测的平衡场电磁检测技术

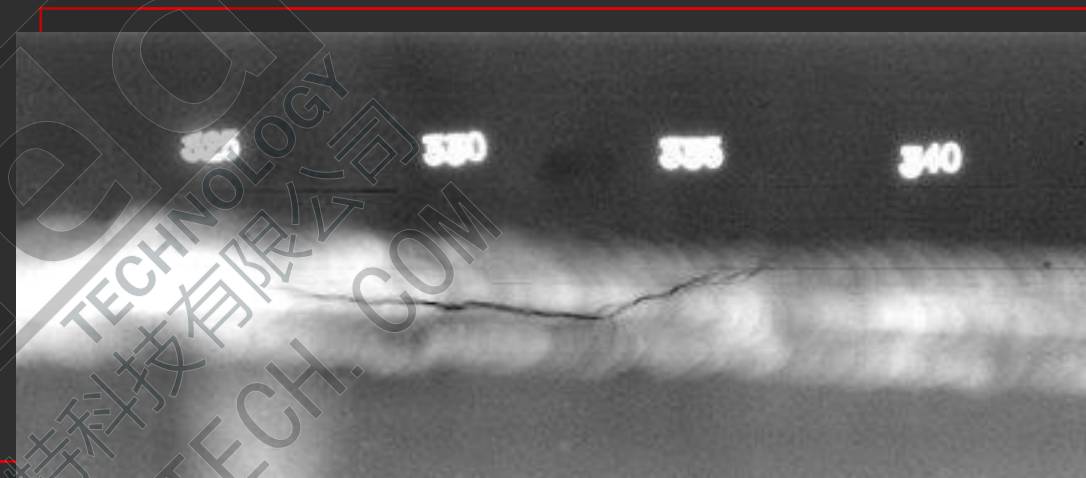
BFET for Cracking detection

用于裂纹检查的 BFET 技术



- From micro cracking to leakage: **cracking drives unpredictable situations.**

千里之堤，溃于蚁穴：微小裂纹会突然发展成无法预料的大事故。

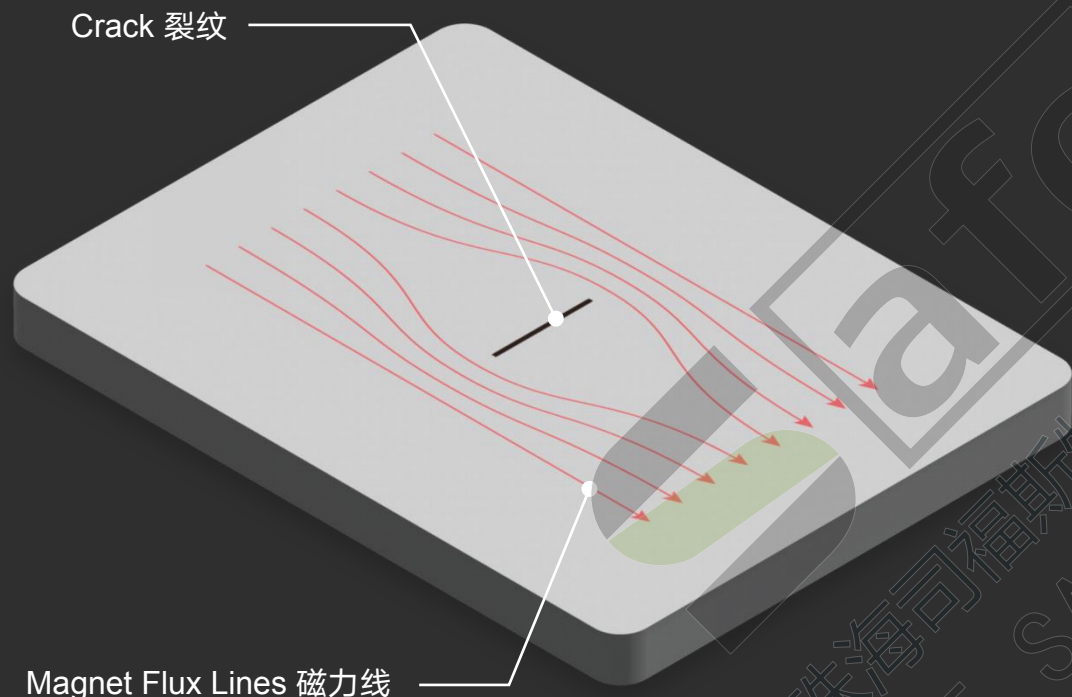


- Crack detection is very challenging for most of the UT techniques and mainly if cracking is combined with pitting and corrosion.

对于传统超声技术来说，裂纹检测是非常困难的，通常裂纹会和点蚀、腐蚀等混在一起。

Theory of the BFET probes

BFET 扫查头技术原理



Unbalanced State (defect)
非平衡状态 (有缺陷)

- Cracking and weld inspections are typically completed by traditional NDT methods such as Magnetic Particle (MT), Dye Penetrant (PT), Radiography, and specialized Ultrasonic techniques.

裂纹和焊缝检测通常采用常规的无损检测手段，例如磁粉（MT）、渗透（PT）、放射影像和专用超声技术。

- The TestTex BFET was developed as an alternative to the traditional cracking and weld NDT methods. The inspection technique can be used to detect surface and sub-surface defects in plate welds on Carbon and Stainless steel.

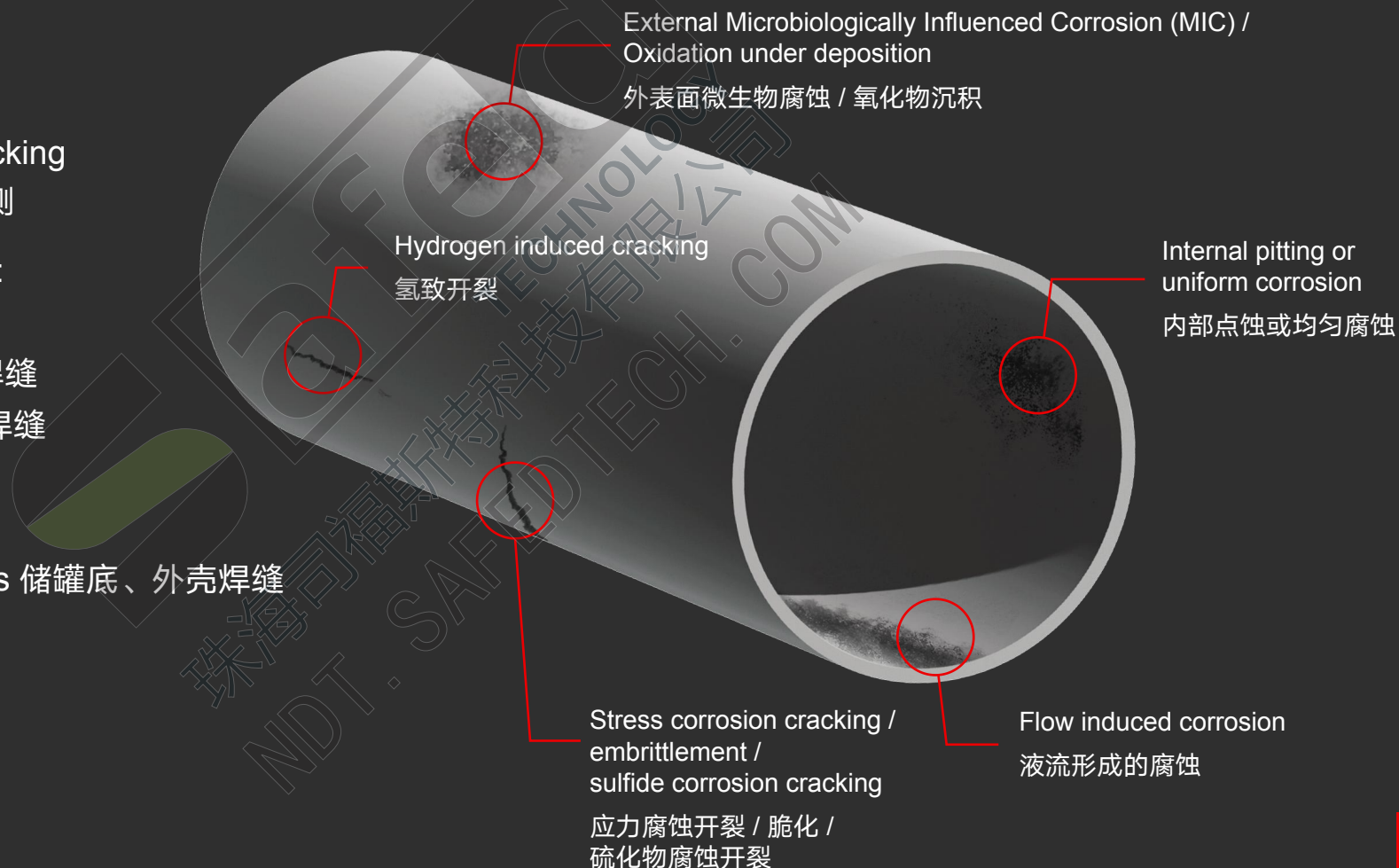
TestTex 的 BFET 技术的发展为这些传统的裂纹焊缝无损检测技术的提供了替代方案。该检测技术可用于检测碳钢、不锈钢焊缝表层及层下缺陷。

BFET for Cracking detection

用于裂纹检查的 BFET 技术

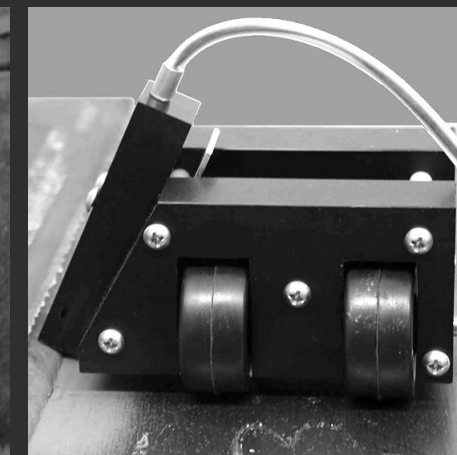
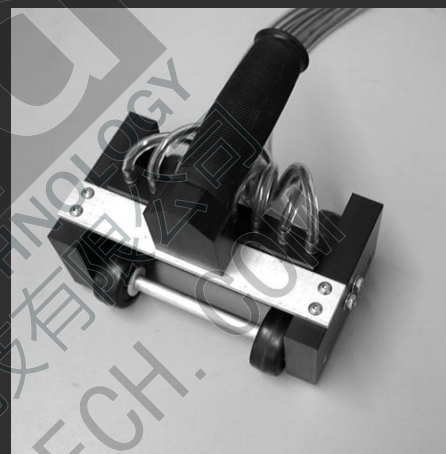
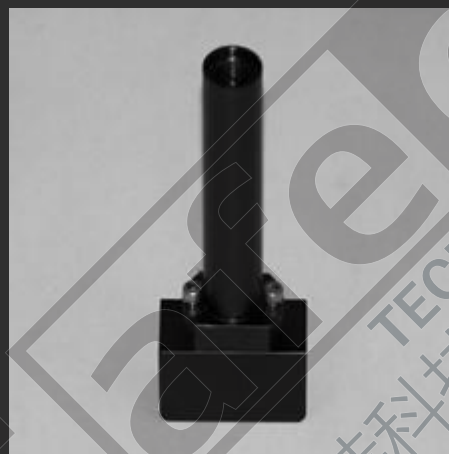
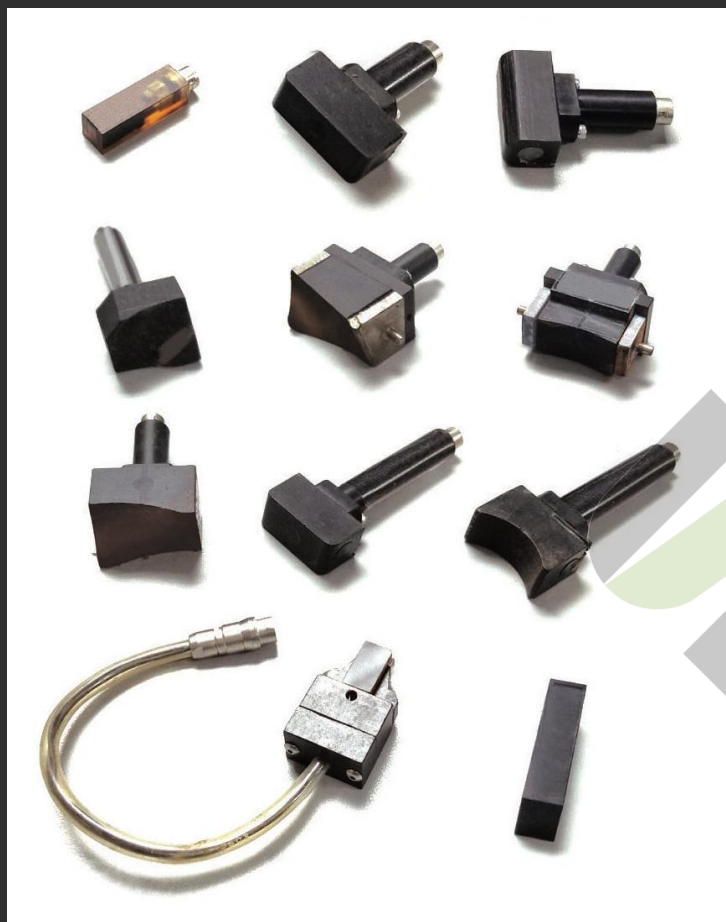


- BFET to cover all kinds of cracking
BFET 技术可覆盖各类缺陷检测
- Several applications 常见应用:
 - Pressure vessels 压力容器
 - Tube to header welds 管头焊缝
 - Dissimilar metal welds 金属焊缝
 - Windmill towers 风电塔
 - General vessels 普通容器
 - Storage tank floor/shell welds 储罐底、外壳焊缝
 - Pipelines 管道
 - Bridges – Columns 桥梁建筑
 - DA tanks DA 储罐
 -



Customized BFET probes

定制化 BFET 探头



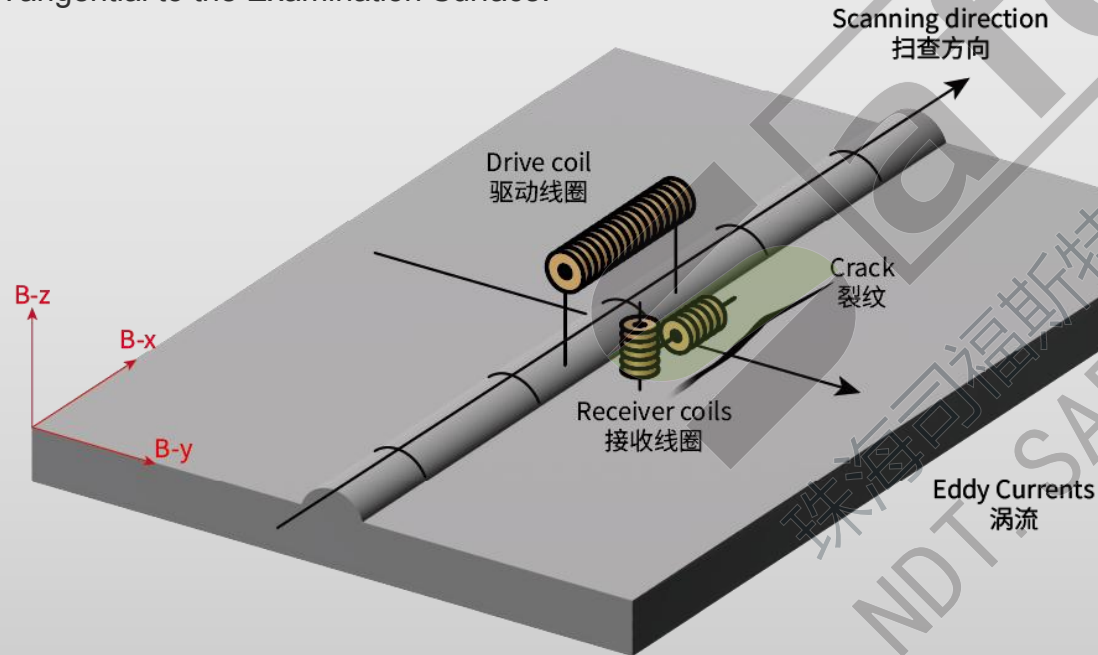
BFET Probes
specifically designed
for varies of
applications
适应各种应用场景的
定制 BFET 探头

Theory of the BFET probes

BFET 探头原理

Figure XI-821-2

Example Coil Arrangement: Tangentially Oriented Driver Coil with Passive Receiver Coils Oriented Perpendicular and Tangential to the Examination Surface.



- As a derivative of Eddy Current, the Balance Field Technique (BFET) was developed to enhance the signal responses produced from smaller defects such as cracks.
作为涡流的衍生技术，BFET 旨在增强从裂纹等较小缺陷接收信号的能力。
- Two receiver coils are wound together on one bobbin. One coil is parallel to the testing plane, while the other coil is perpendicular to it.
作为涡流的衍生技术，BFET 旨在增强从裂纹等较小缺陷接收信号的能力。

BFET approved by ASME Section V

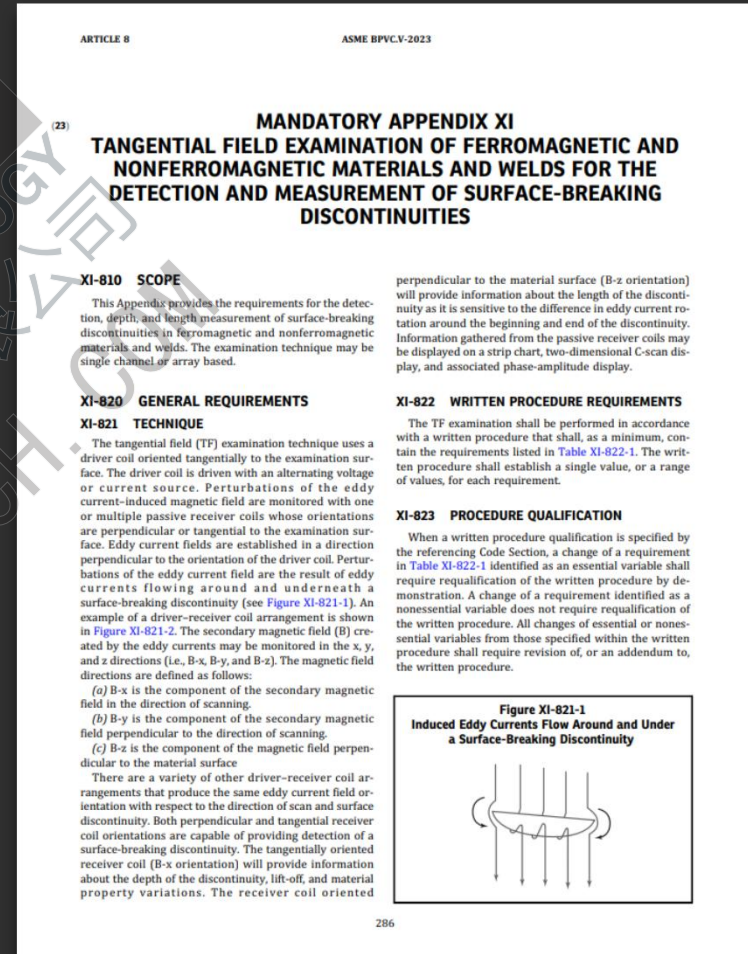
BFET 技术通过 ASME Section V 标准

BFET was incorporate in ASME V version 2023.

BFET 技术收录于 ASME V 2023 版。

On review of the technique it was established that the Tangential Eddy Current Technique and Lift off Compensation Technique use very similar electromagnetic configurations and the document was adjusted to incorporate these BFET techniques as well ACFM does not use phase information so has another appendix in the ASME.

涡流技术和提离补偿技术运用了非常类似的电磁设置，该文档是根据为了包含 BFET 技术，由于 ACFM 涡流不采用相位信息，因此 ACFM 包含在 ASME 的另一章节附件里。



BFET Inspection Benefits



BFET 的技术优势

-
- ✓ Replace Dye Penetrant and Magnetic Particle tests for a safer and clean environment
可替代渗透和磁粉检测，打造更加安全、清洁的环境
 - ✓ Detects surface and sub-surface cracking up to 9mm deep
可检测表面及下方最多 9mm 深处裂纹
 - ✓ Inspects ferrous and nonferrous metals (Stainless Steel)
可检测铁磁性和非铁磁性金属（例如不锈钢）
 - ✓ All surfaces with or without coatings (up to 15mm coating)
可检测所有无涂层及表面带有最多 15mm 厚涂层的工件
 - ✓ Test speeds is very fast up to 30cm/sec
检查快速，速度高达 30cm/秒
 - ✓ Minimal surface preparation, no couplant
仅需要最低程度的表面处理，无需耦合剂
 - ✓ 3D Viewer for better analysis of the defects
3D视图方便您更好地进行缺陷分析
 - ✓ Testex can design special probes and scanners according to specific requirements
Testex 可根据特殊需求定制探头和扫查器
-

BFET Software

BFET 软件



BFET software makes detection fast and accurate

BFET 软件使缺陷检测更加快速和精确

- Frequency range 5Hz-30KHz
频率范围 5Hz - 30KHz
- Real time data processing
实时数据处理
- Data displayed in horizontal, vertical, and impedance planes
数据按水平、垂直和阻抗来显示
- Noise and liftoff signals can be rotated away from flaw signals
噪音和提离信号可以通过旋转与缺陷信号分离
- Up to 8 channels for 3D analysis
3D 分析支持最多 8 个通道数据

BFET – the only solution on Stainless



BFET – 不锈钢检测的不二之选



- **UT / RT:** Start of CSC is too small
超声 / 射线：曲面校正（CSC）起始太小
- **PT / MT:** Ok, but too late or you need to have access to the inner side
渗透 / 磁粉：可行，但等发现为时已晚，或需要进入内部
- **AE:** Can be, but difficult on stainless steel
声发射：可能有效，但在不锈钢上较为困难

Could find INTERNAL CRACKS up to 8mm subsurface?

其他技术是否有办法探测内表面下 8mm 深处的裂纹？

The CLAW for HRSG

HRSG 检查用机械爪



The CLAW for HRSG (High Recovery Steam Generator) using BFET probes and camera

搭载 BFET 探头及摄像头的余热锅炉 HRSG 检查用机械爪

- Mechanical platform built for BFET flaw detection
专门为 BFET 缺陷检测而设计的机械式搭载平台
- Optimally orient the sensors with respect to the upper toe of the weld while allowing a rotation about the tube
优化的传感器排列，可到达焊缝上缘并绕管道旋转
- The scanner has several degrees of freedom and axes of motion for the 2 sensors to be oriented correctly as they rotate about the tube
扫描探头有若干自由角度以及多运动轴向，以便 2 个传感器在绕管道旋转时正确定向

The CLAW for HRSG

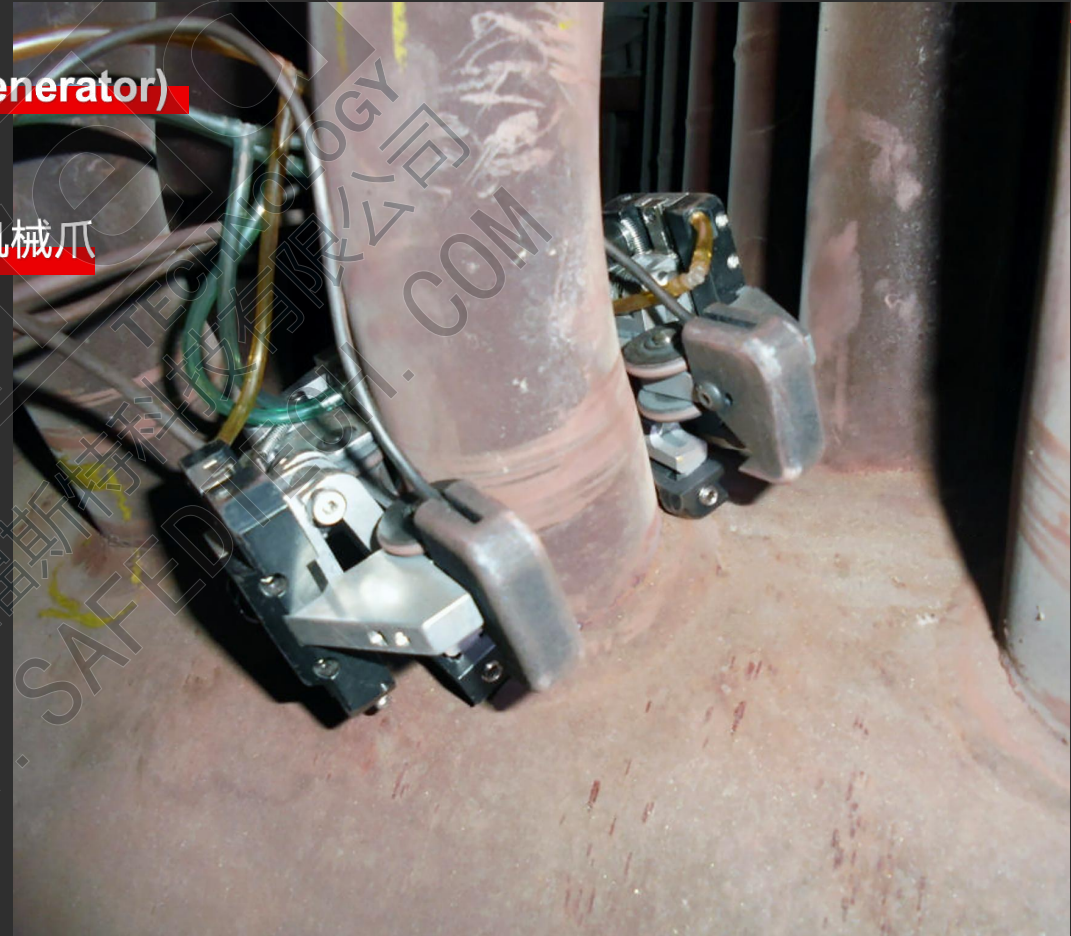
HRSG 检查用机械爪



The CLAW for HRSG (High Recovery Steam Generator) using BFET probes and camera

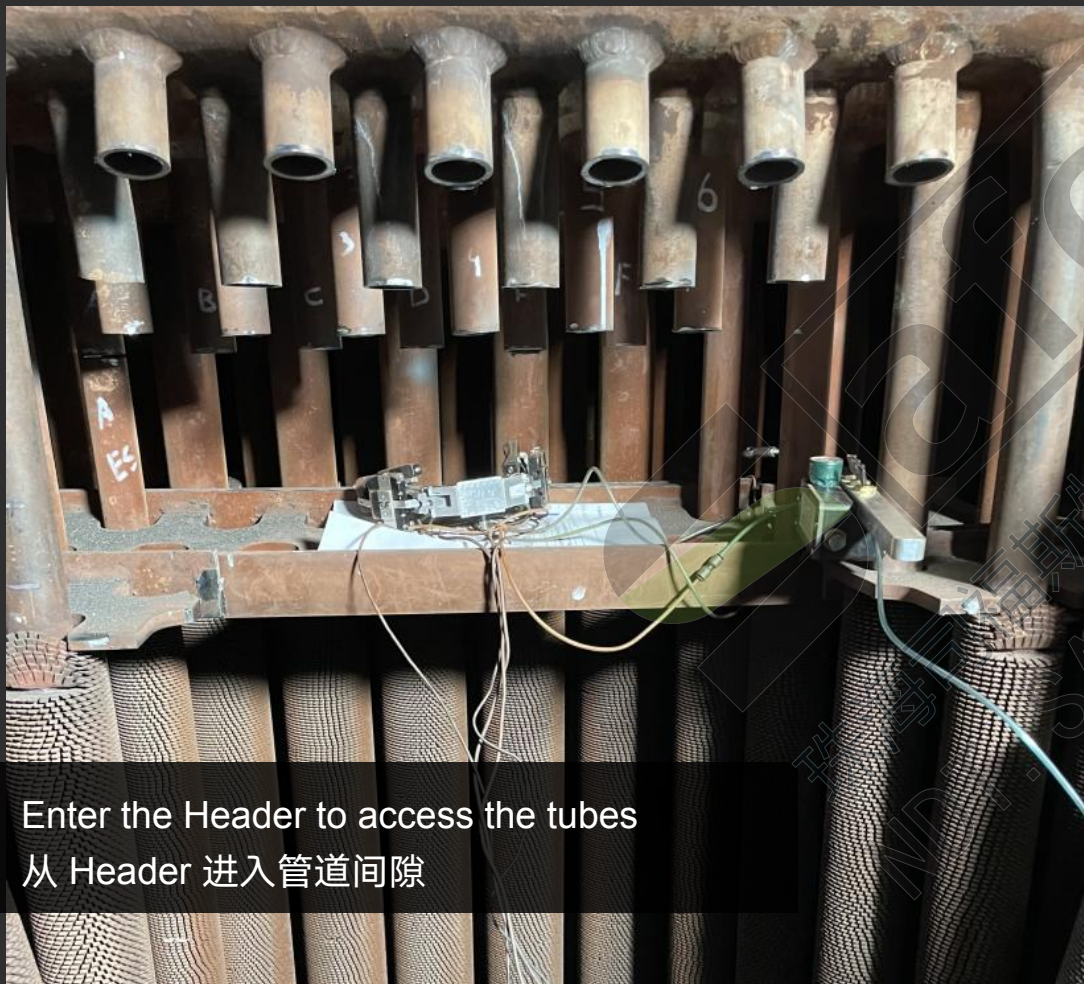
搭载 BFET 探头及摄像头的余热锅炉 HRSG 检查用机械爪

- The scanner can be unfolded to reach past the first row tubes to the second row and in some case the third row
扫描探头可以展开越过第一排管道到达第二排管道，甚至某些情况下可到达第三排
- The amplitude tells more about the size of the defect.
波形振幅可以更好地反映出缺陷尺寸
- The equipment can replay the movement combined with the video for further inspections and comparisons
设备可以结合视频回放动作，以便进一步检查和比较

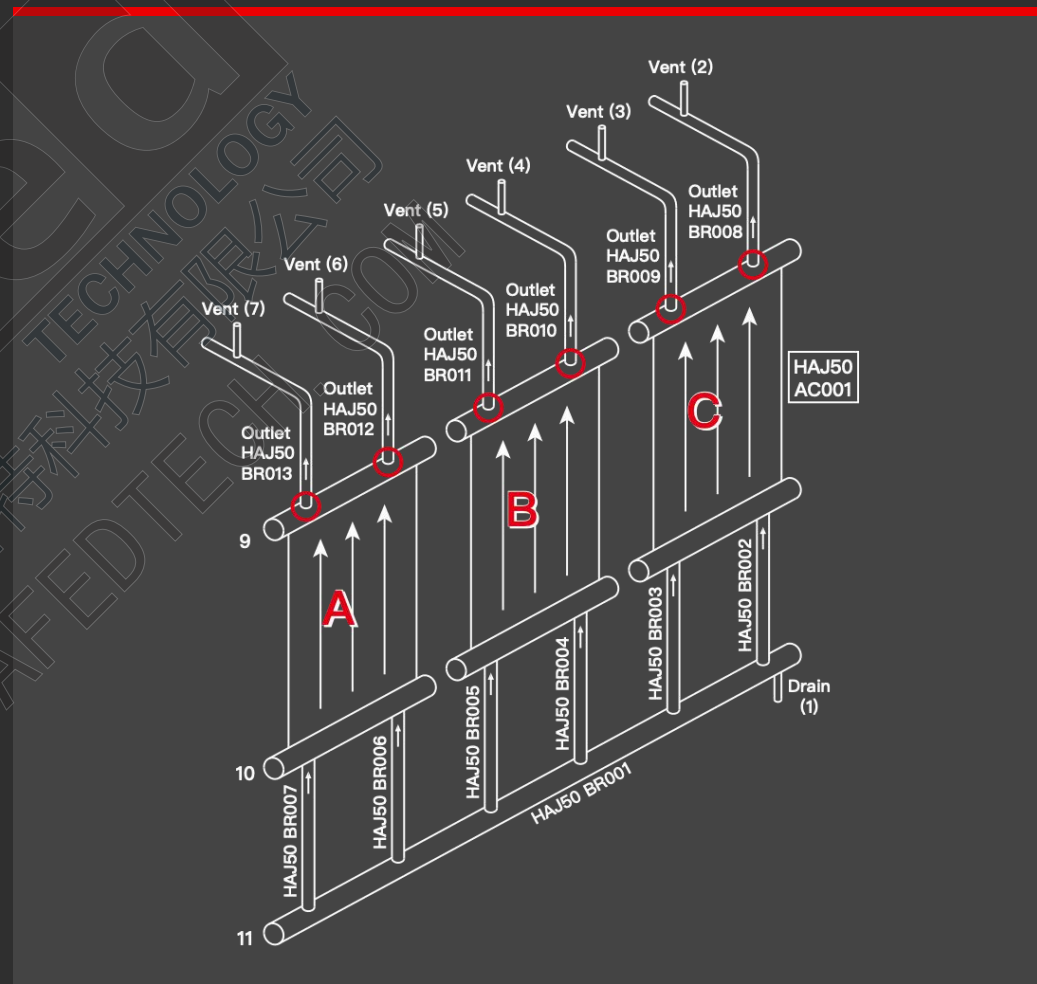


The CLAW for HRSG

HRSG 检查用机械爪

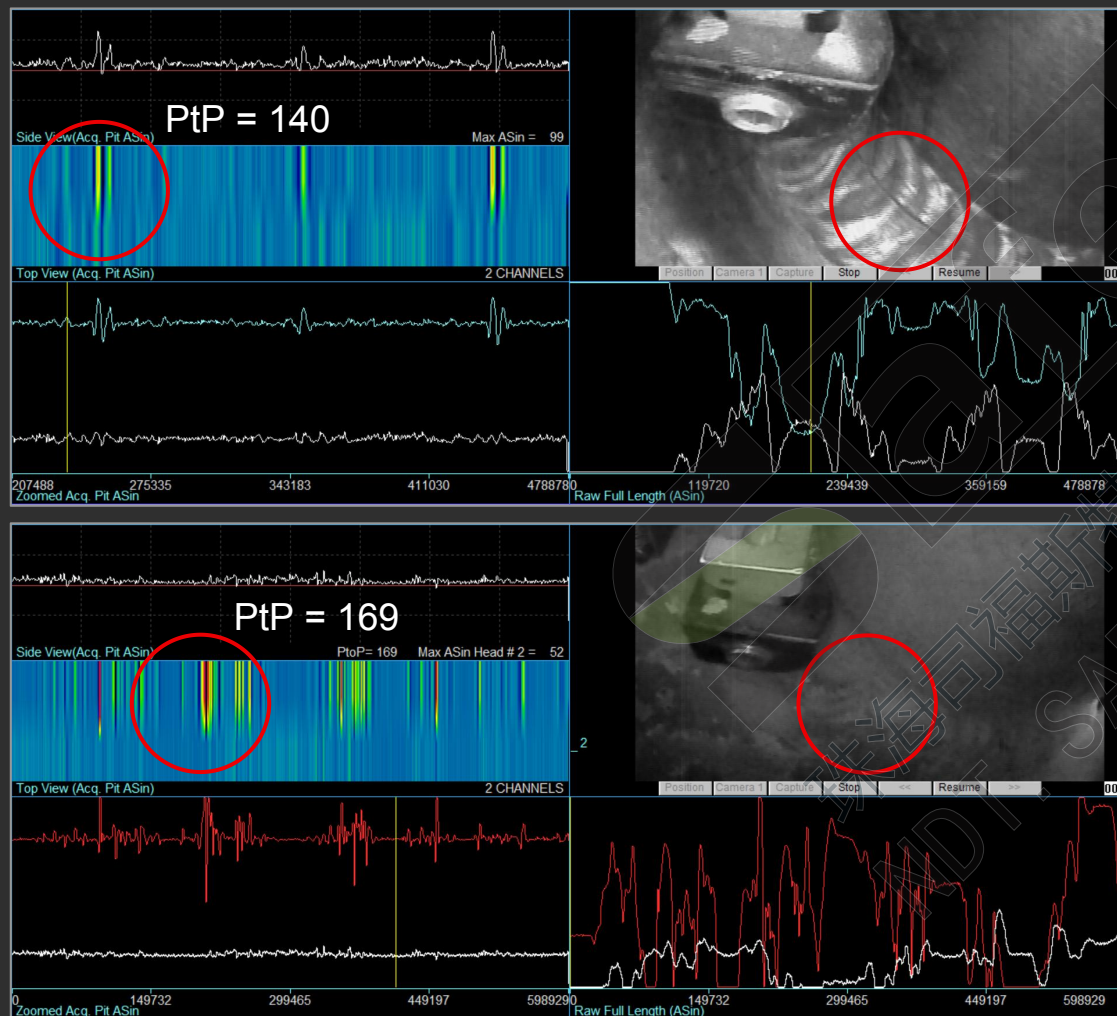


Enter the Header to access the tubes
从 Header 进入管道间隙



The CLAW for HRSG

HRSG 检查用机械爪



Calibration to get the minimal signal level
通过校准样管来确定最小的信号等级



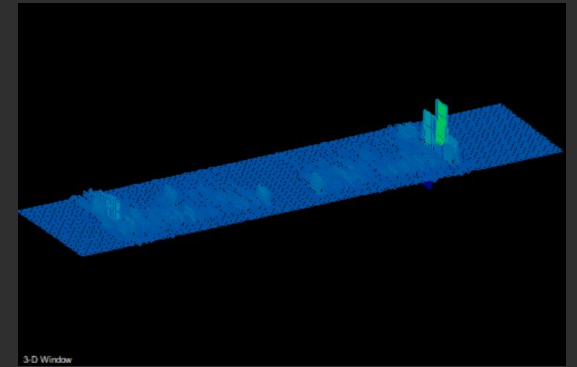
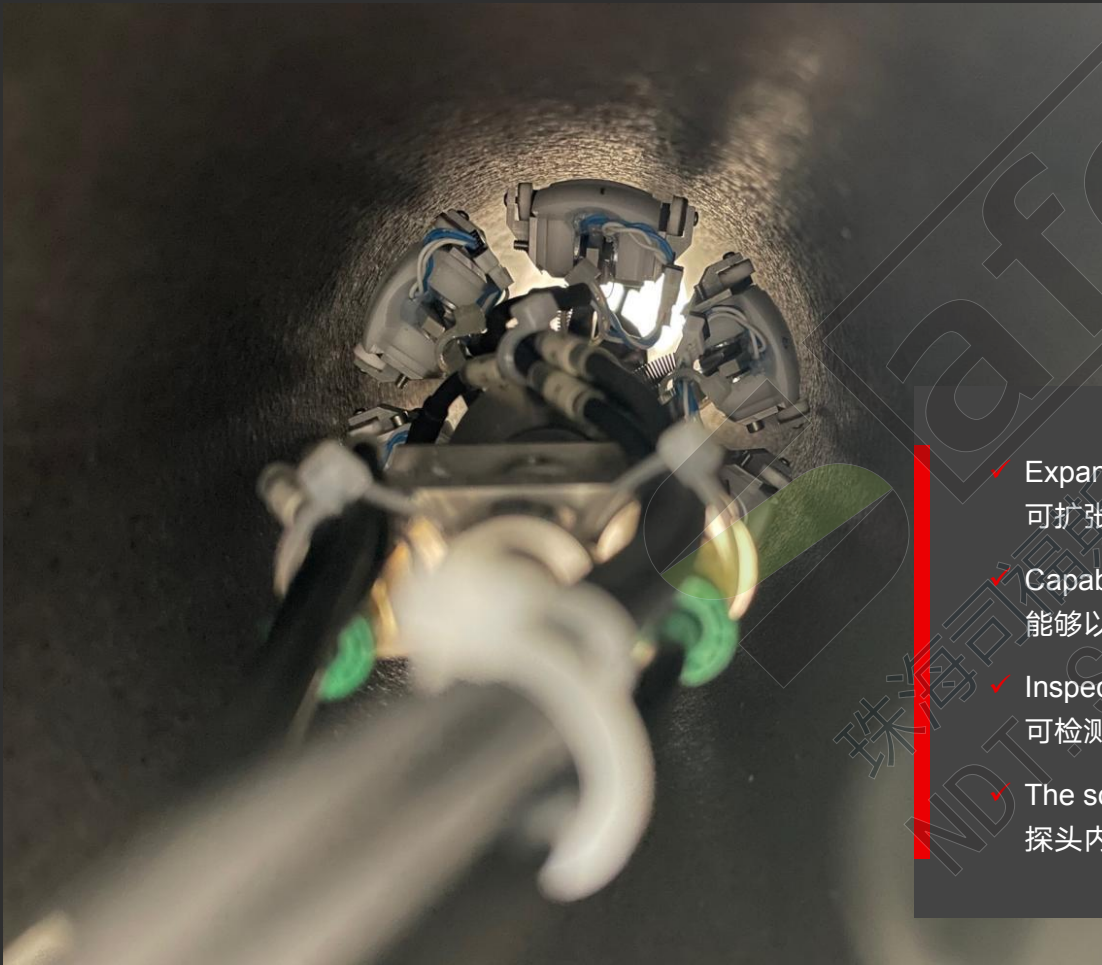
Cracking in the HAZ > 60% – length 30mm
热影响区的裂纹，深度 > 60%，长度 30mm

Example of defect with combined video and waveform
结合视频和波形的缺陷示例

BFET Expandable ID Multichannel Scanner



BFET 可扩张式内径多通道扫查器



- ✓ Expandable to cover several diameters and always keep contact with the surface
可扩张机构以适应多种内径，使探头始终紧贴内径
- ✓ Capable to detect small micro-cracking and small pittings with a speed of 30cm/s
能够以 30cm/s 的速度检测微小裂纹和点蚀
- ✓ Inspects ferrous and nonferrous metals such as Stainless Steel or Duplex
可检测铁磁性和非铁磁性金属，例如不锈钢、双相钢
- ✓ The scanner is encoded and gives combined waveform and video of the defects location
探头内置编码器，可给出缺陷位置的组合波形和视频

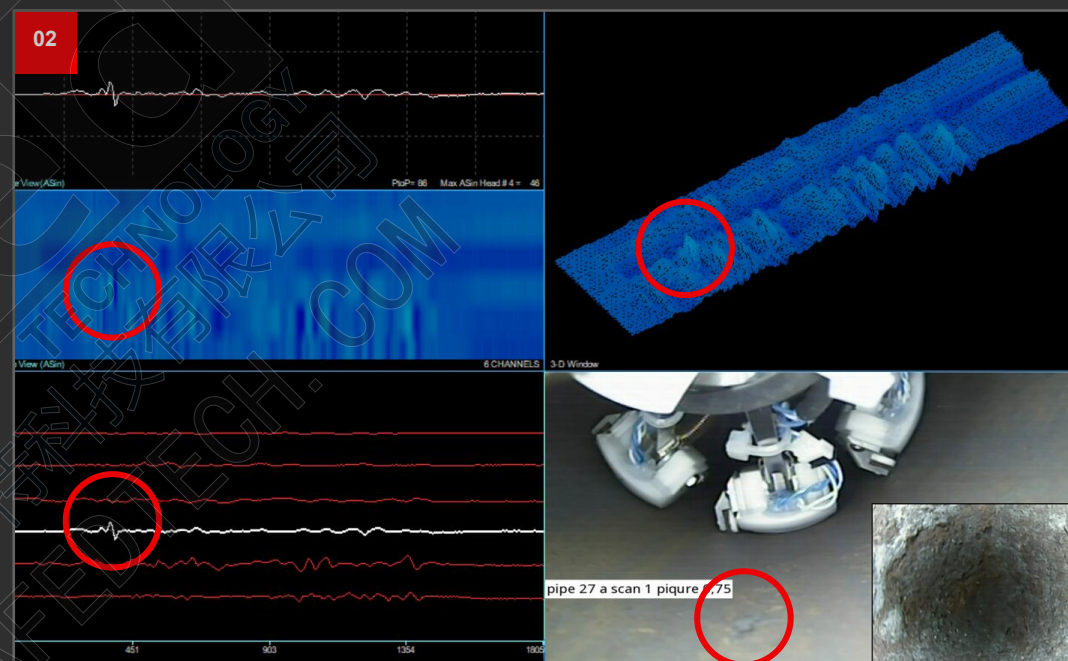
BFET Expandable ID Multichannel Scanner



BFET 可扩张式内径多通道扫查器



Cracking at 7.8m, signal value PtP: 56
在 7.8m 处检出点蚀，信号振幅 56



Pits at 0.75m, signal value PtP: 86
在 0.75m 处检出点蚀，信号振幅 86

First Tests

验证检测

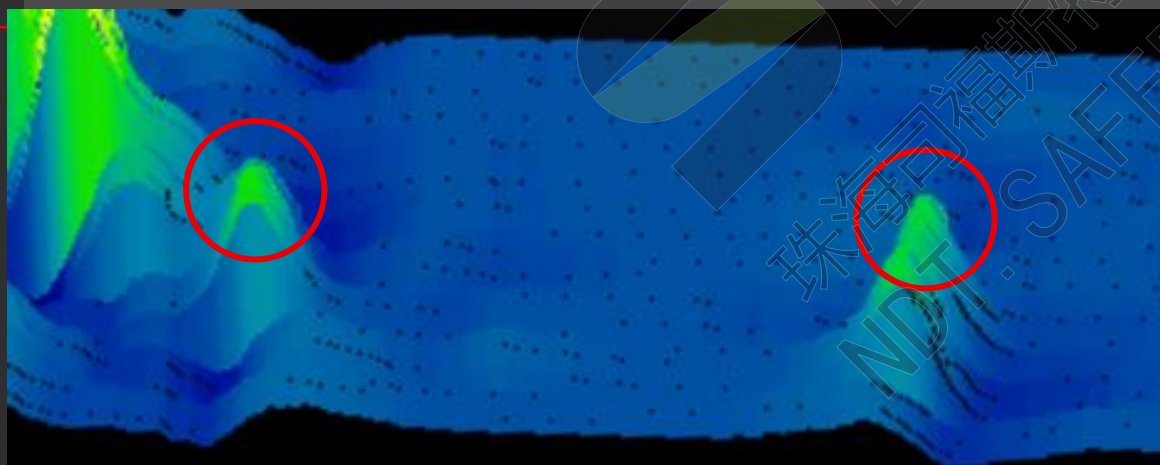


Results:

The linear probe moves inside the tube to detect external small cracking

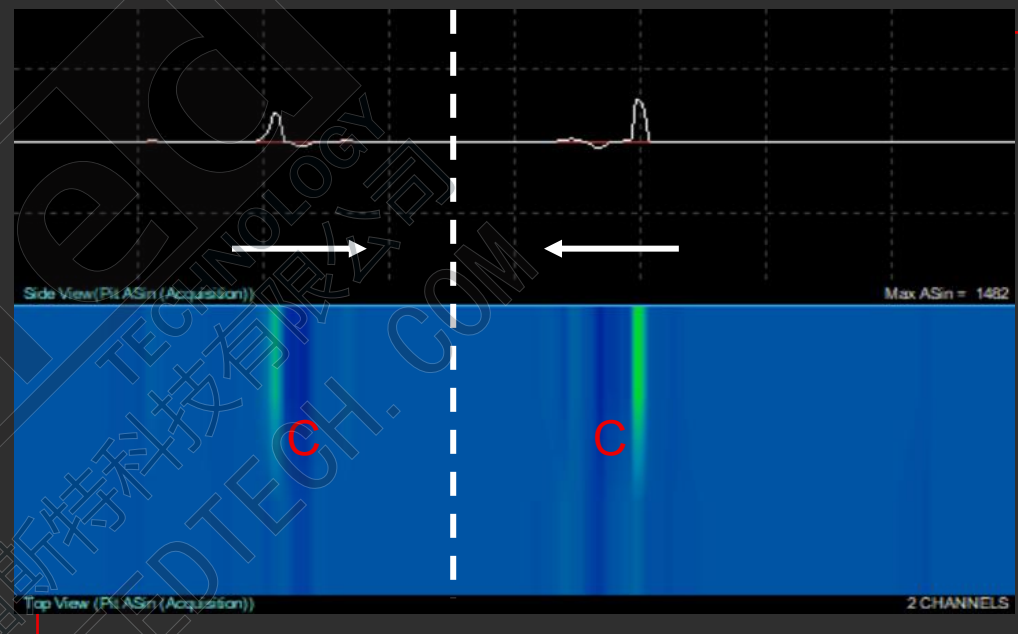
检测结果:

线性探头从管道内部伸入可检测出外部小缺陷



First Tests

验证检测



The rotating probe detects from the ID the cracking on the external HAZ

使用旋转探头可从管道内部检测到热影响区外部的微小缺陷