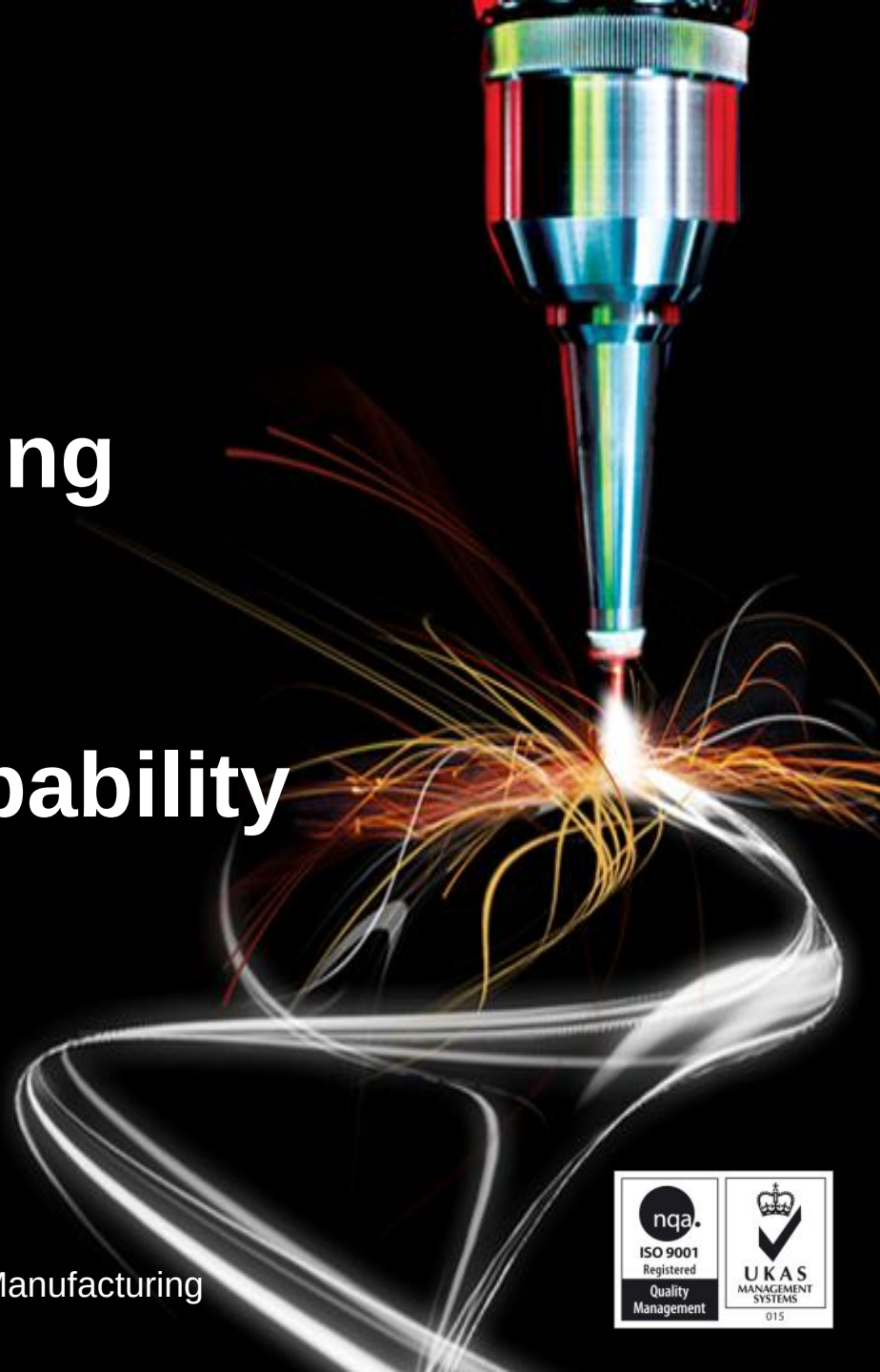
SPI® Lasers

Enhancing Cutting Productivity by utilising Pierce Detection capability

March 2018



Marking | Cutting | Welding | Micro Machining | Additive Manufacturing

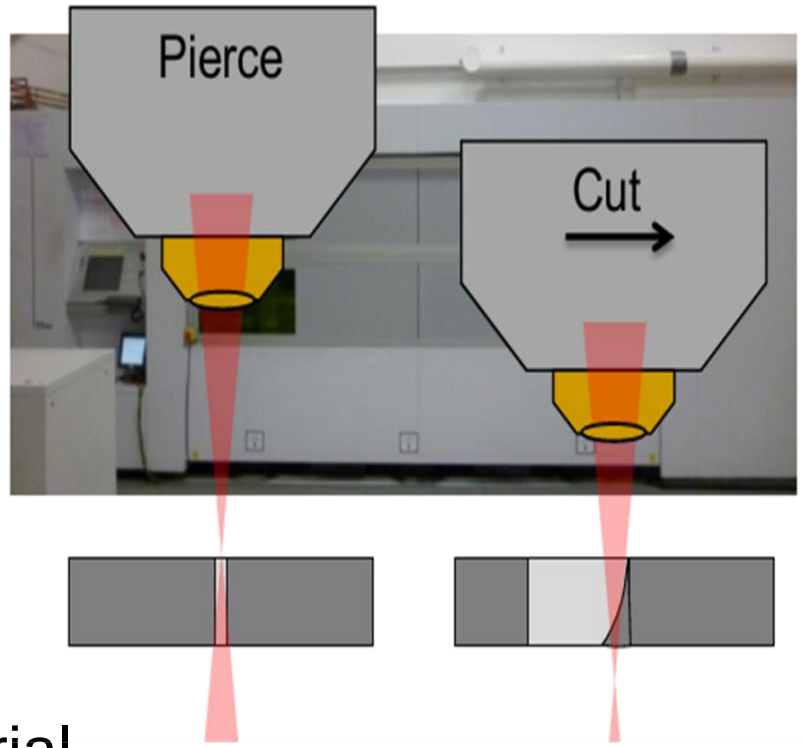
nqa. ISO 9001 Registered Quality Management

UKAS MANAGEMENT SYSTEMS 015

What is Piercing?

Pierce Phase:

- Cutting Head is static:
  - generally in a defocused position
  - Particularly for thicker material
- Laser beam is allowed to drill through the metal:
  - as melt is formed, the pressure of the gas expels the melt



Cutting Phase:

- Focus Head moved down to cutting position
- Head is moved relative to the material
- Laser beam cuts through the metal
  - Assist gas blows melt through bottom of kerf.

Pierce Detection Systems

- **Almost all flat sheet cutting processes have a large number of pierces**

- **All Laser Cutting Systems need some form of pierce detection to operate economically:**
  - Without it, long pierce dwell times have to be programmed
  - These can be up to 3 times longer than needed:
    - Due to processing variations
  - More important as material thickness increases.

- **Many commercial systems are available, but usually mean:**
  - Extra optical surfaces in beam path
    - particularly undesirable for multi-kW systems!
  - Larger process head space
  - Increased system cost.

Pierce Detect Feature

- **An SPI breakthrough invention for increased productivity**
- **Comes as standard in redPOWER PRISM and QUBE lasers**

redPOWER® PRISM

OEM Lasers with Efficiency & flexibility for macro materials processing.

2kW – 6kW

CW Fiber Laser

redPOWER® QUBE

Fully Featured Lasers with Power & control for cutting, welding & micro-machining.

2kW – 8kW

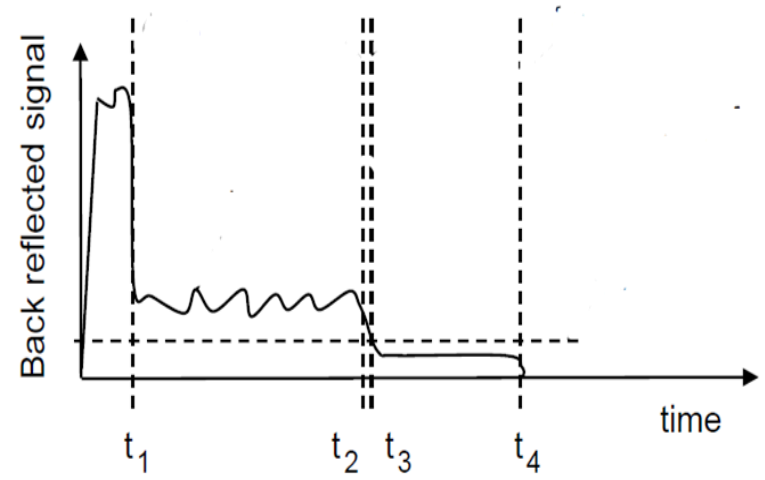
CW Fiber Laser

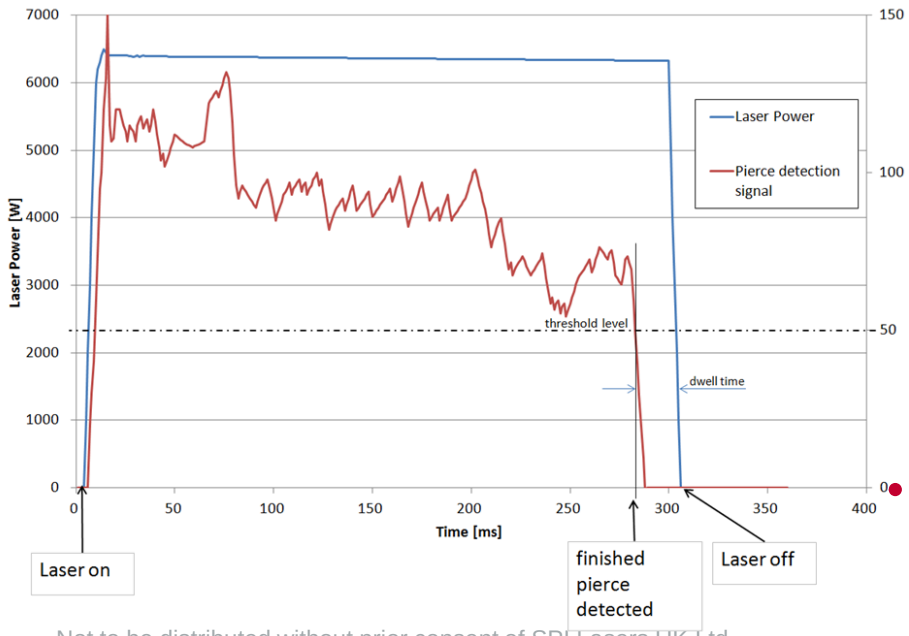
More information on the stand.

- **SPI Lasers have developed a proprietary system that is integrated into existing Fiber Laser hardware and software**
  - Gives added value to multi-kW Fiber Lasers using a High Power Combiner
- **Ready to integrate into System controller PLC**
  - A clear digital i/o signal is presented when pierce through is detected.

How does Pierce Detect work?

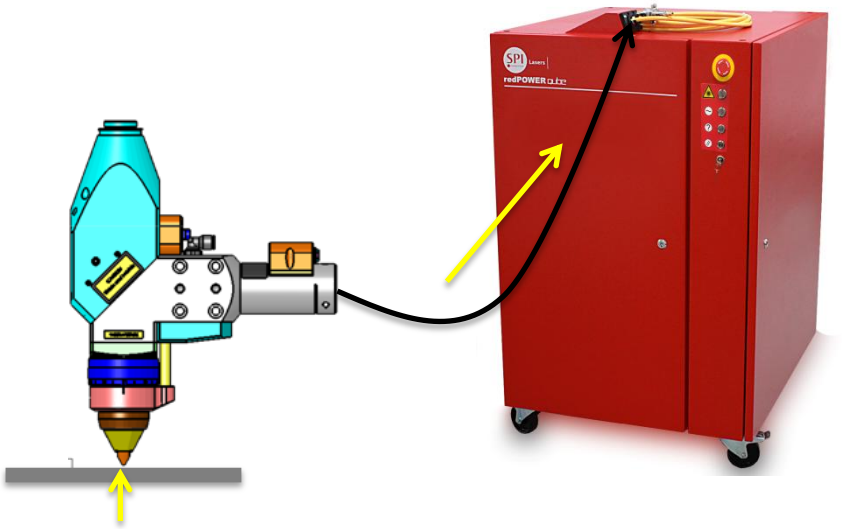
Back Reflection during the Piercing Process

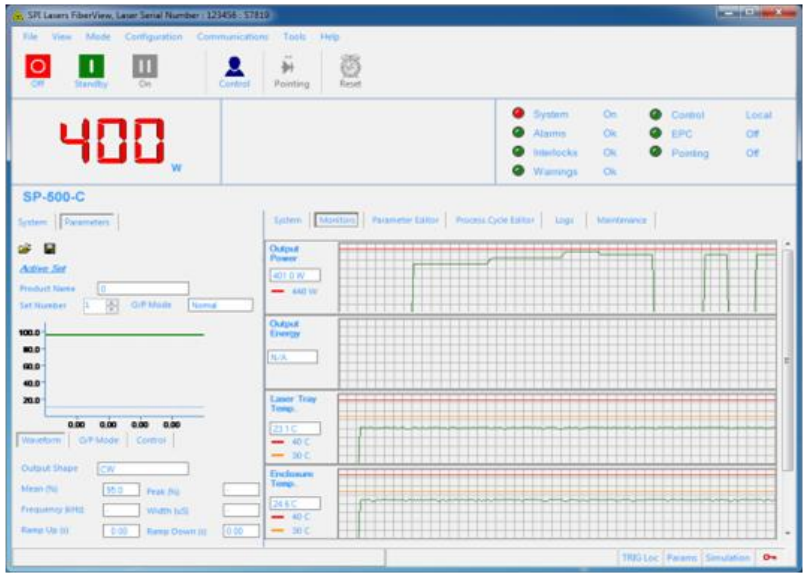




- **The Cutting Head focuses the Laser output onto the workpiece**
- **Some Laser radiation undergoes Back Reflection (BR) from the workpiece**
- **The BR shows a characteristic time variant signal:**
  - t1 : large BR
  - t1-t2 : laser light couples into the material forming a melt giving low unstable amount of BR
  - t2-t3: Pierce through occurs
  - t3-t4: Pierced. Low amount of BR from the material
- **Typically the difference in BR from t2 to t3 is just a few Watts.**

Detecting the Back Reflection signal

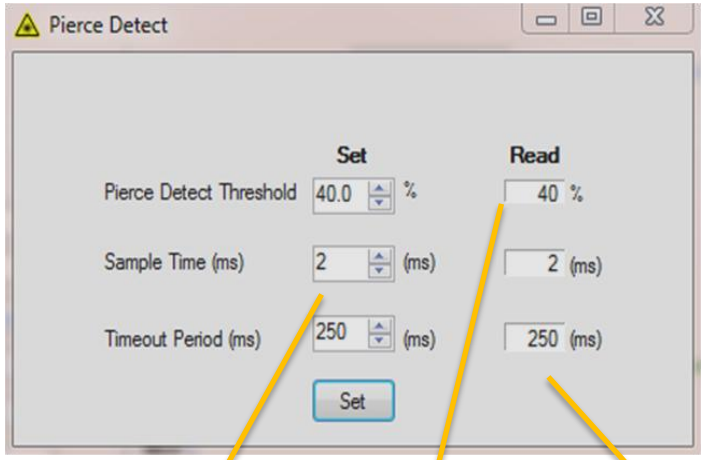


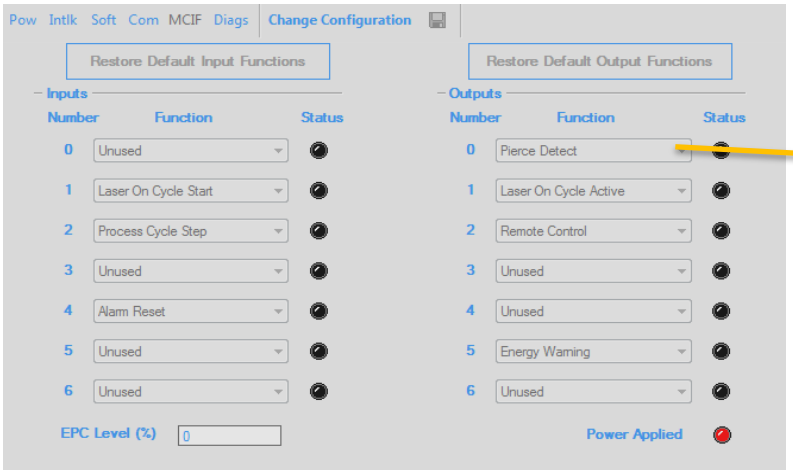


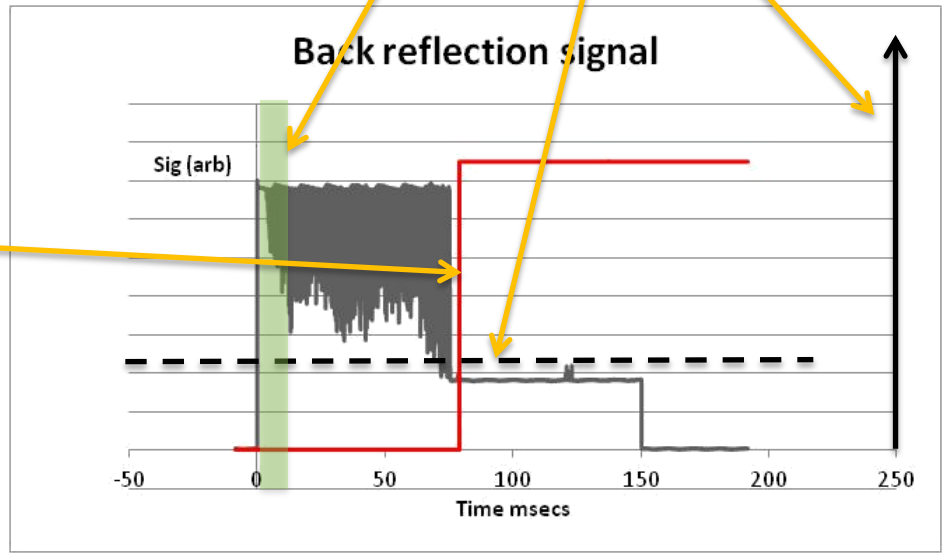
- **BR light is collected by cutting head onto fiber:**
  - Some light is rejected by PIPA-Q patented protection system to stop damage to fiber termination
  - Some travels along fiber core and cladding into laser cabinet
- **Detectors in the High Power Combiner (HPC) Tray detect the BR:**
  - And distinguish from outward going laser light
- **Signal passed to laser control system for processing**
- **Laser controlled through dedicated FiberView software.**

Pierce Detect Control

- **FiberView software analyses the signal to produce a Pierce Detect Flag**
- **The flag is available on one of configurable digital outputs on the Machine Interface**
- **User programmable variables enable the detection point to be tailored to any process**
- **Signal resets at end of laser pulse:**
  - Automatically ready for next laser operation.

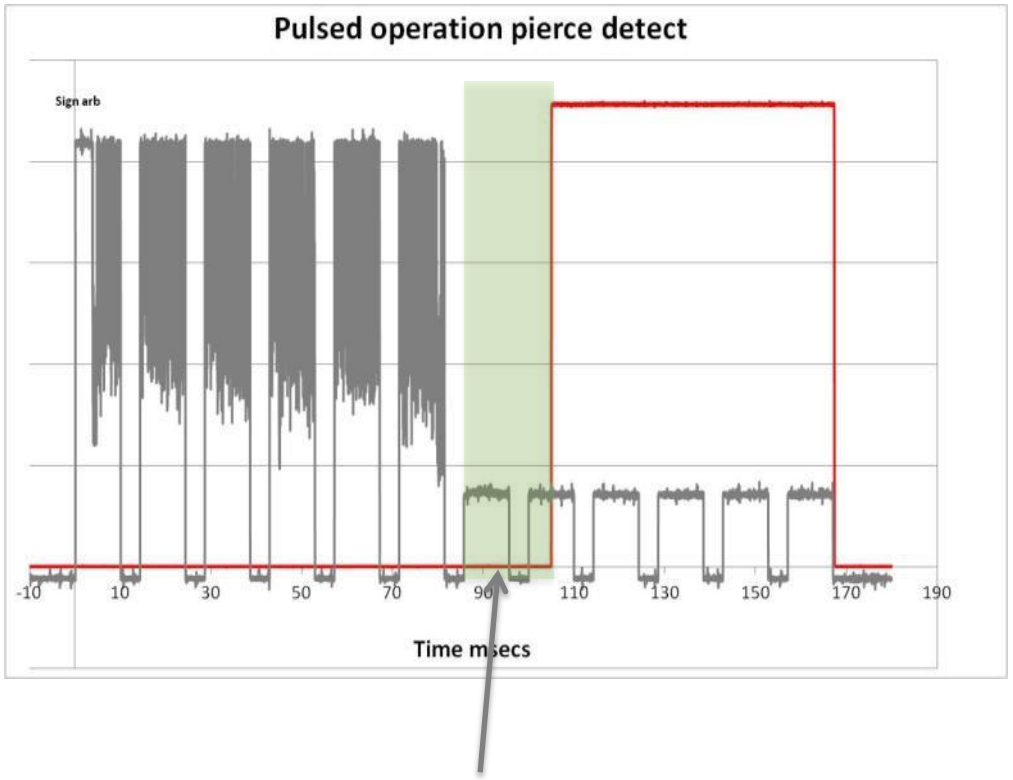






Pierce Detect - pulsed operation

- **Pulsing the laser during piercing is common practice:**
  - slower but more controlled & better quality
- **Pierce Detect also operates under pulsed conditions**
- **Set the sample time longer than laser off time between pulses.**



15msecs sample time captures the pierce point

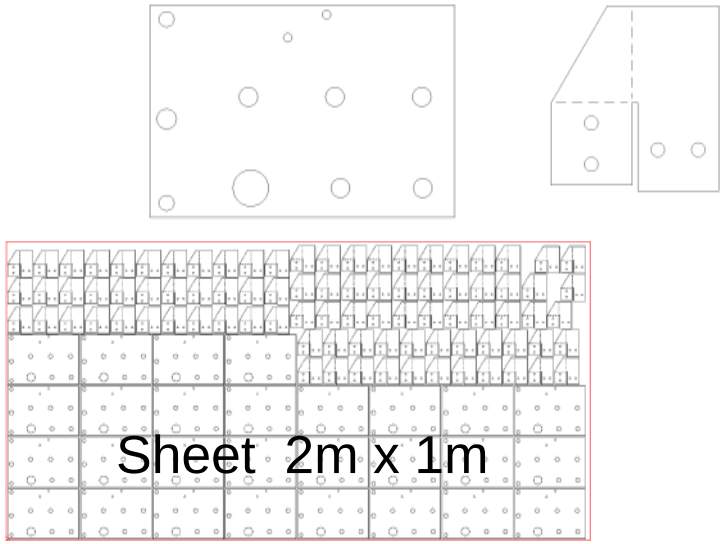
PierceDetect increases Productivity

Pierce Detection Productivity Improvement

- **A nested pattern of two parts on a single sheet has been modelled:**
  - In total:1800 pierces/sheet
- **Time to run the programme modelled with and without Pierce Detect**
- **Pierce detection shows a productivity gain of ~1hour day or ~35days/year**
- **Processing tests on Cutting System show 10-15% improvement in productivity.**

Part 1: 12 pierces/part

Part 2: 16 pierces/part

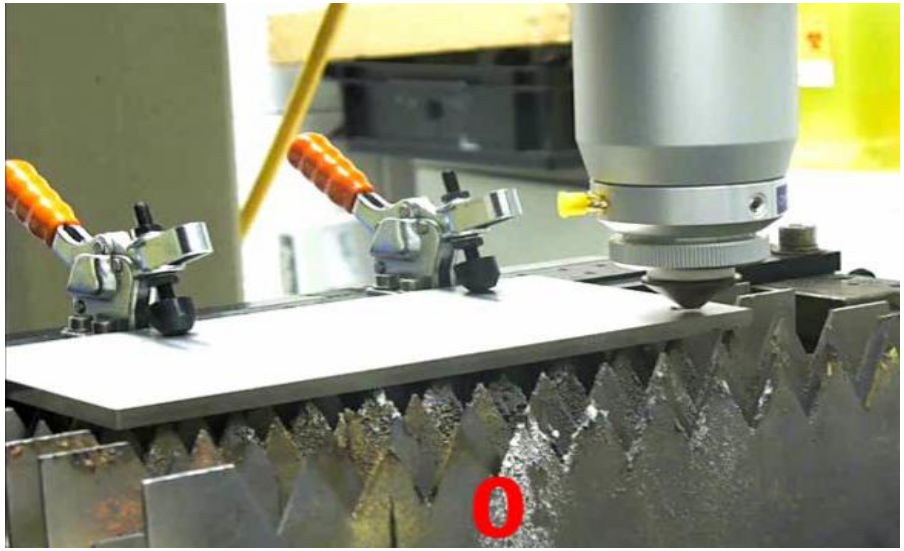


Material	Pierce time (no detect)	Time saving
12mm MS O2	50sec	12%
6mm SS N2	6sec	10%
6mm AL N2	9sec	14%

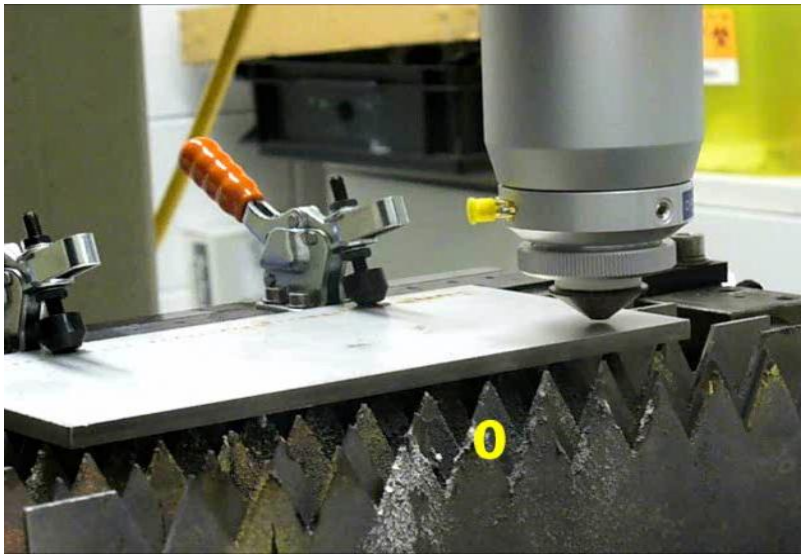
Closed Loop Pierce Detect vs Open Loop Programmed Dwell Time

- Timing comparison
- 40 holes pierced
- LHS - Pierce Detect signal triggers next step
- RHS - Fixed dwell time of 200msecs used.

Closed Loop Pierce Detect vs Open Loop Programmed Dwell Time



Closed Loop Pierce Detect

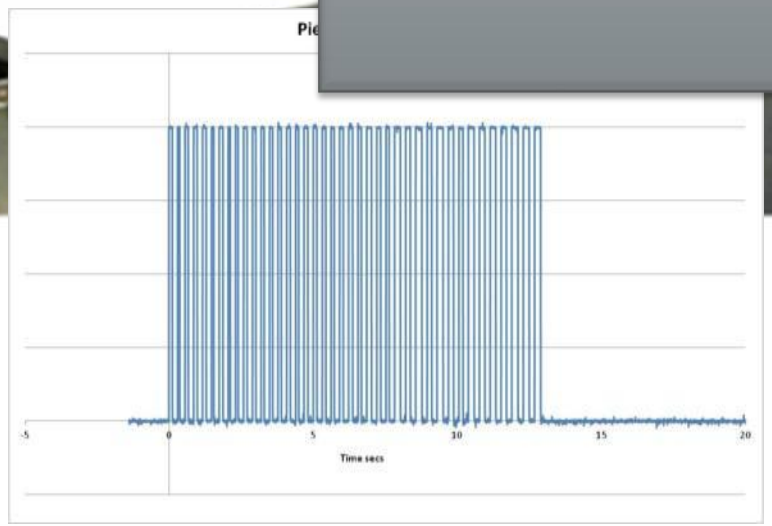


Programmed Dwell Time

Closed Loop Pierce Detect vs Open Loop Programmed Dwell Time

Accurate times:

- Pierce Detect 12.8secs
- 200ms Dwell 15.4secs
  - 20% Longer and some holes not fully pierced



PierceDetect Feature Conclusion

- **Generally, Back Reflected light causes problems during laser material processing:**
  - However, it contains information about the process, which can be harnessed to improve productivity
- **SPI Lasers have developed Pierce Detect, a proprietary system that is integrated into existing Fiber Laser hardware and software:**
  - Giving added value to multi-kW Fiber Lasers using a High Power Combiner
- **A clear digital i/o signal is presented when 'pierce through' is detected:**
  - Ready to integrate into System controller PLC.

Built-in Pierce Detection
- an SPI breakthrough invention for increased productivity