BlueArc™ Technology
Technology Introduction
What is BlueArc™?
BlueArc™ is a non-contact metal removal process using electro-erosion.
BlueArc™ at GE Aircraft Engines

https://www.youtube.com/watch?v=kn2Crf8IlMk
BlueArc™ Applicability

Optimal for high speed rough machining of tough alloys

- Water Jet & Conventional Machining
- EDM
- Plasma & Laser
- BlueArc™

Material Toughness:
- Low
- Med
- High

Metal Removal Rate (MRR):
- FR Plastics
- AL Bronze/Brass
- Iron
- Steel
- Ti
- Ni/Co Alloys
BlueArc™ Applications

Wheel Slot Cutting

Blade Root Cutting

Five Axes Blade Cutting

Drilling

Honeycomb Cutting
BlueArc™ Opportunities

Boeing 787 Side-of-Body Chords

Open Die Forgings
BlueArc™ Opportunities

Helicopter Rotor Hub
Sikorsky 53K Heavy Lift Vehicle

Forging

Finished Machined
BlueArc™ Advantaged
Control, tool motion, electrolyte & metal removal mechanisms

ECM
- Med/high speed
- Large area ionic dissolution
- Large gap ~200 µ
- Continuous current
- Large current
- Very high volume flushing

EDM
- Low speed
- Localized discharge
- Small gap ~20 µ
- 1 discharge at a time
- Limited current
- Moderate flushing

BlueArc™
- High speed
- Wide area discharge
- Small/med gap ~ 0 to 100 µ
- Multiple simultaneous discharge
- Medium current
- Flushing based on application
- High speed surface motion

BlueArc is designed for continuous, high speed machining compared to other leading technologies
BlueArc™ Drilling, Milling & Grinding

Sparks and globules

Fast feed

Electrode wheel (Steel, copper, brass, etc.)

Electrolytic coolant fills gap

Grinding application

Min contact (low force) – Electrical discharge erodes material at high rate. Allows for larger depth of cut.

Milling & drilling application

Thru tool electrolytic coolant feed

Electrode

Electrolyte

Work piece
# BlueArc™ Features & Benefits

<table>
<thead>
<tr>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large area multiple, simultaneous discharge</td>
<td>High material removal rates and larger depth of cuts</td>
</tr>
<tr>
<td>Small/med gap ~ 0-100 µ</td>
<td>Extra tool motion helps gap flushing and medium renewal</td>
</tr>
<tr>
<td>Medium current</td>
<td>Low/no force operation</td>
</tr>
<tr>
<td>High speed surface motion</td>
<td>Lower costs: up to 75% cutting tools &amp; 30% energy savings</td>
</tr>
<tr>
<td>Instant dielectric recovery</td>
<td>Metal removal can be continuous allowing more discharge/arcing per unit time</td>
</tr>
</tbody>
</table>

---

GE BlueArc Technology
September 23, 2014
BlueArc™ Titanium Alloy Process Test
Target Process Objectives
1. Maintain titanium mechanical properties after removal of HAZ
2. Reasonable finish stock allowed: 0.12” for semi-finishing and 0.03” for finishi
3. 15 in³/min MRR using medium duty machine
4. 20% cost improvement over conventional machining
5. Capable of all basic cut cross-sections
Parameters
Pocket size: 3.8”x3.8:x1.2”
Tool wear: ~3% (volume ratio)
Plunge speed: 1.2 IPM
Electrode size: 0.6” OD
Electrode material: W(93%) Cu(7%)

Pocket plunging with pecking motion

HAZ < 10 mil

Test coupons

Pocket clean up

Machine & setup
BlueArc™ Speed Limit Test

Initial position  Within power supply setting  Exceed power supply setting

IPM – max pecking speed

IPM=10  IPM=12  IPM=14
IPM=8  IPM=6  IPM=4  IPM=2

Slip

Slip

Pre-set current limit by power supply

BlueArc Speed Limit Test

September 23, 2014

GE BlueArc Technology

imagination at work

GE 16
MRR can be improved within the physical limits after optimization.

Optimization areas:
- Flushing
- Tool size
- Process window
- Control
- Tool path

*Estimation is based on preliminary test
Mitsui Seiki and BlueArc™

- Power supply and spindle tested at GE Shanghai
- Machine will be installed at GE AMSTC in Michigan
imagination at work