HIGH VOLUME METALIZING
REDUCE RISK
INVEST WISELY
IMPROVE PROFITS

J. Lynema

MERIDIAN AUTOMOTIVE SYSTEMS

A. Plaisted

SOLERAS LTD.

G. Vergason

Vergason Technology, Inc.

Presented by James Lynema, 2007 SVC Conference

High Volume Metalizing

- **Production Pressures**
- **Processing Definitions**
- **Production Requirements**
- **Profit Leaks**
- **Summary**

Production Pressures

- **Improve throughput and quality**
- **Reduce costs**
- **Coated substrates being integrated in larger and higher value-add assemblies**
- **Issues not market unique**
- **Coordinating improvements and efforts**
  - Industrial user
  - Equipment supplier
  - Consumable supplier
- **Global competition in a “flat world”**
- **Increased recycling focus**

Processing Definitions

Large Batch Systems: non-synchronous

- **Aluminum coating – thermal based**
- **Polymer top coating – DC, AC, some RF**
- **Large floor space requirements**
  - Large chamber ~2 meter diameter
  - Fixturing storage and stripping
- **Reduced quality yields ~90%**
- **Usually in expensive clean-room**
- **Substrates boxed and transported**
- **Multiple operators**
- **20 to 40 minute cycle times – process dependent**

Processing Definitions

Rapid Cycle Systems: synchronous production

- **High & low melting point metals – sputter/cat arc**
- **Polymer base & top coatings – AC, some RF**
- **Reduced footprint**
  - Chambers to match molding machine output <1 meter diameter
  - Smaller and fewer fixtures
- **Increased quality yields - >99%**
- **No clean-room required**
- **Substrates coated directly after molding**
  - Clean, warm, dry
- **Single operator**
- **0.5 to 6 minute cycle times – process dependent**

Production Requirements

Define the coatings & deposition techniques

- **Metals**
  - Low melting point only – thermal
  - High melting point only – sputtering or cat arc
  - All temperature ranges – sputtering
  - Metal and/or reactive coatings – DC or AC power
- **Base and top coatings**
  - Plasma polymerization – DC, AC, RF, ?
  - High pressure or low pressure processing
  - Plasma cleaning/etching

Production Requirements

- **Select production mode**
  - Synchronous
    - Highly automated
    - Very little substrate storage
  - Large batch
    - Highly manual
    - Much substrate storage
- **Work closely with suppliers in selection to optimize resources**
  - Personnel, equipment, consumables

Production Requirements

- **Contracts are won on a cost per part basis**
- **Floor space layouts**
  - Footprint, conveyors, work area, fixturing/consumable storage, support equipment
- **Capital investments**
  - Coating system, ancillary tools, fixtures, automation
- **Personnel**
  - Level of training required: operators to production planners

Production Requirements

- **Production costs**
- **Overhead**
- **Utilities**
  - Electric, chilled water, compressed air
- **Consumables**
  - Metal for deposition, gases, liquids, operational and maintenance materials

Production Requirements

- **Cost per cycle estimates –** rapid cycle, $800,000 machine amortized over 5 years, aluminum with polymer base & top coating, 2.7 square meter coating zone, 57,200 cycles/yr

Machine	$2.80
Labor	$1.92
Utilities and consumables	$1.50
Cost per cycle (CPC)	$6.22

Cost per part = divide CPC by number of parts

Profit Leaks

- **Mismatch in the application of the coating system, consumables, utilities and personnel**
- **Over and under utilization wastes money and stresses the resources**
- **Can be greatly reduced with close cooperation between industrial user, equipment supplier and consumable supplier**

Profit Leaks

Coating system profit leaks

- **Incorrectly sized chamber**
- **Wrong pumping package**
- **Venting with wet, room air**
- **Deposition power supply sizing**
  - Match with metal material and cooling
- **Poor management of cooling water**
  - Sediment, minerals, temperature, flow
- **Calibration of pressure gauges, liner cleaning**

Profit Leaks

Target/Cathode leaks

- **Match thermal expansion of target and backing plate, ductile for flattening**
- **Vacuum braze improves cooling uniformity & operates at higher temperatures**
- **Screen out poor bonds by underwater ultrasonic or phased array testing**
- **Avoid thermal stress by explosive clad or other room temp processes**

Profit Leaks

Improper specification of target/cathode purity

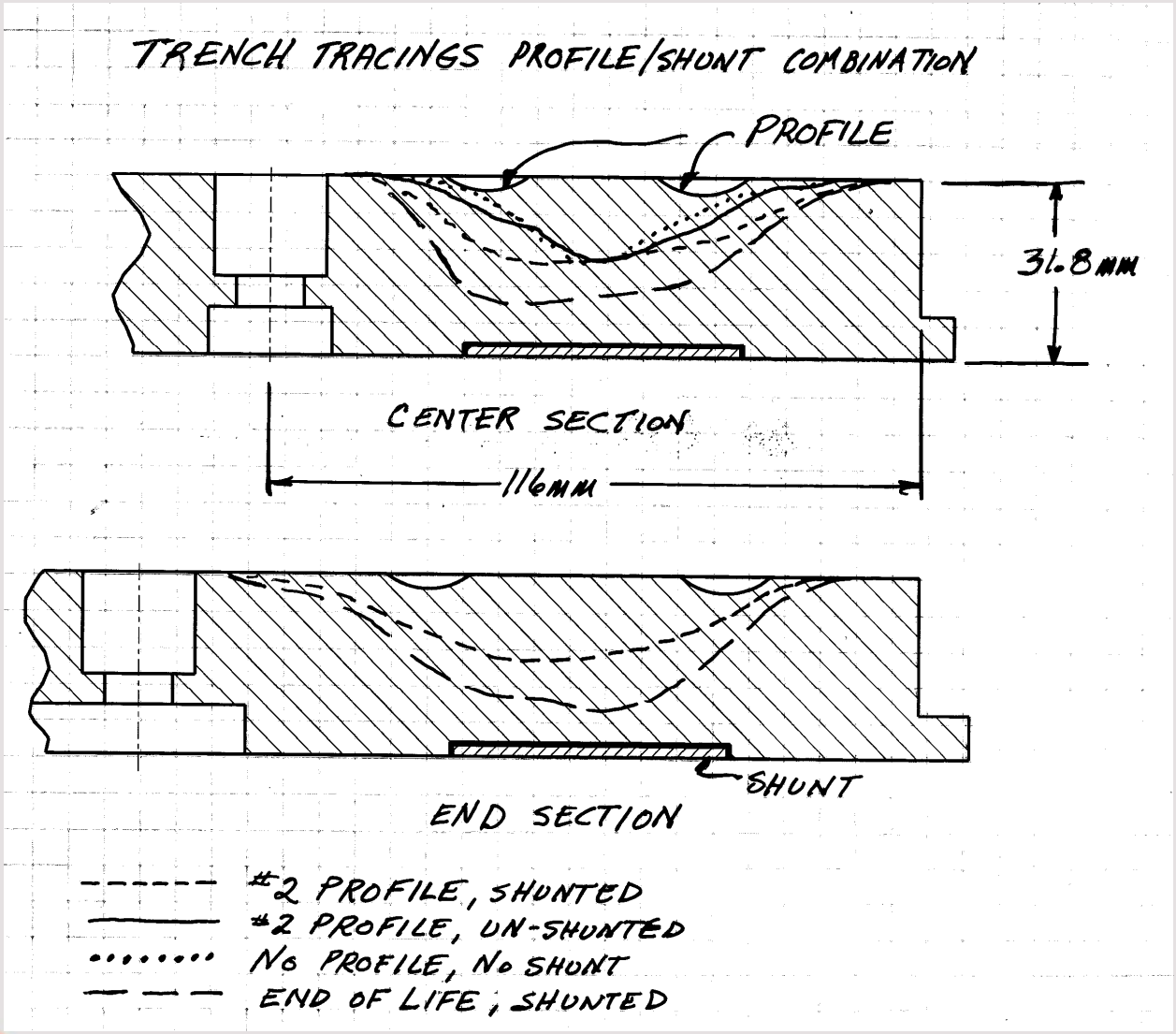
- **Adding additional 9 (99.XXX) can double or triple the material price**
- **Proving a target is 99.999% pure can be as costly as making it**
- **Reducing target poisoning elements by adding purity is expensive, better to reduce the specific contaminant at a lower cost**
- **Specifications for oxygen below 500 ppm, when acceptable deposited metal films analysis was at 25,000 ppm**

Profit Leaks

Use ideas, such as surface profiling developed by other industries

- **Careful placement of small secondary groves in a target surface initiates erosion over the trench walls**
  - Result is a shallower wider trench, longer target life, and a more stable plasma over the target life
- **Compact Disc optical media uses thousands of profiled targets annually**
  - Profiles started in 1993 and are now universal
  - Benefits are life, deposition uniformity, and stability

Reduction Of Sputter Target Trench With Profiles

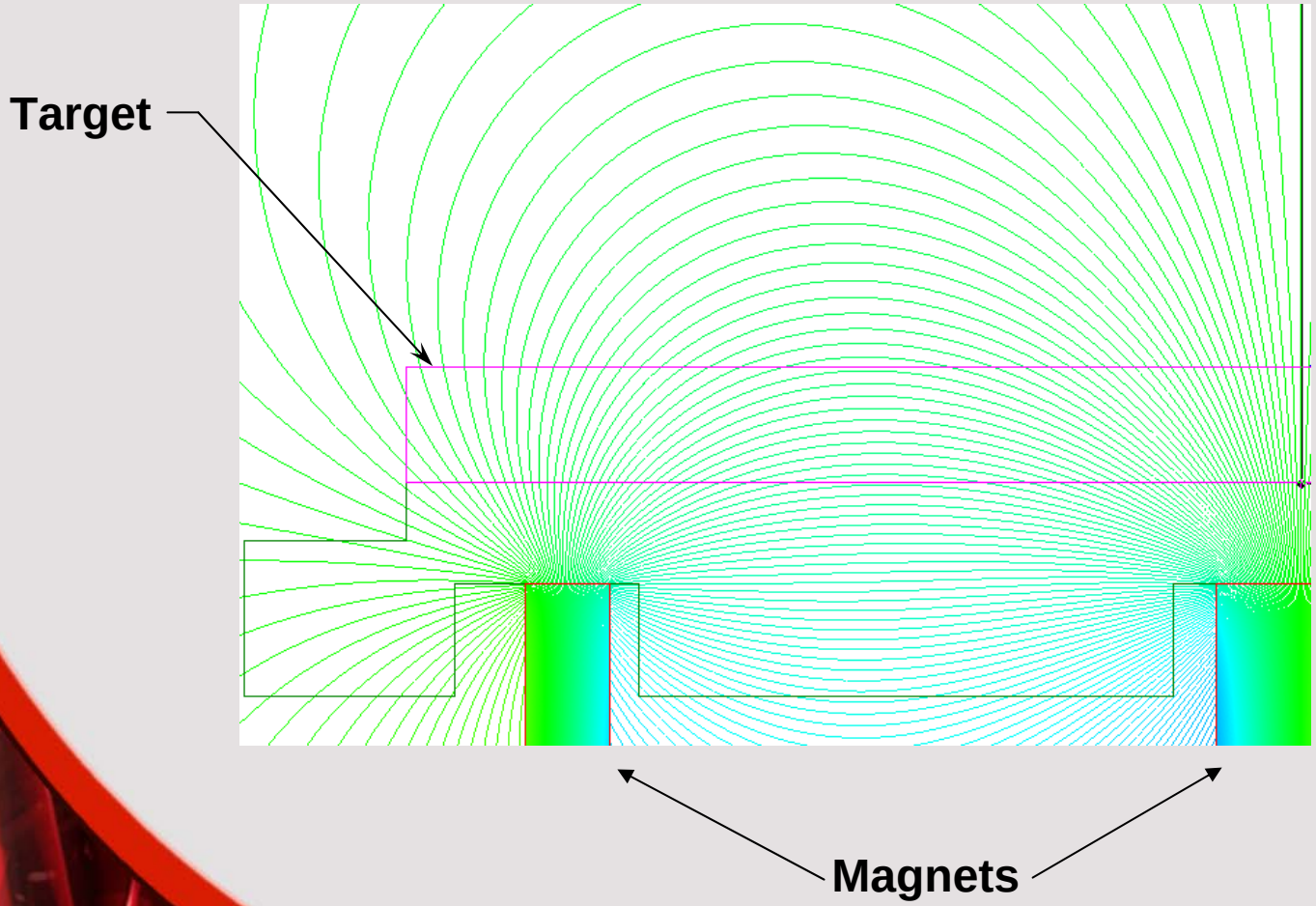


Profit Leaks

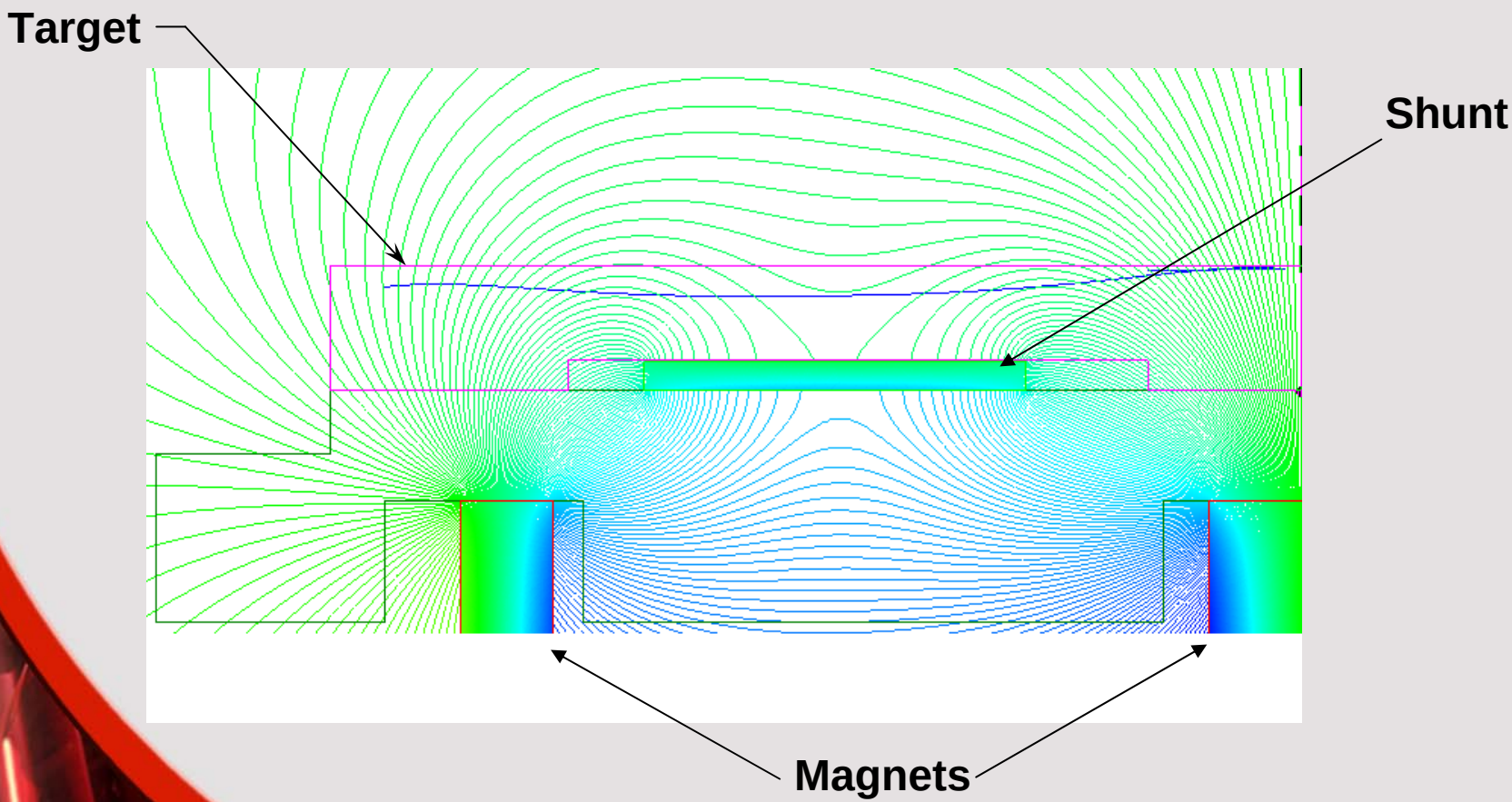
Underestimating benefits of magnetic shunts

- **Profile technique starts erosion trench on a wide base**
- **As trench deepens, profiles contribute less and less**
- **A magnet shunt to enhance magnetic field shape is then introduced**
- **Technique developed by IBM in 1993 but never widely published or applied**

Unshunted Cathode Magnetic Field

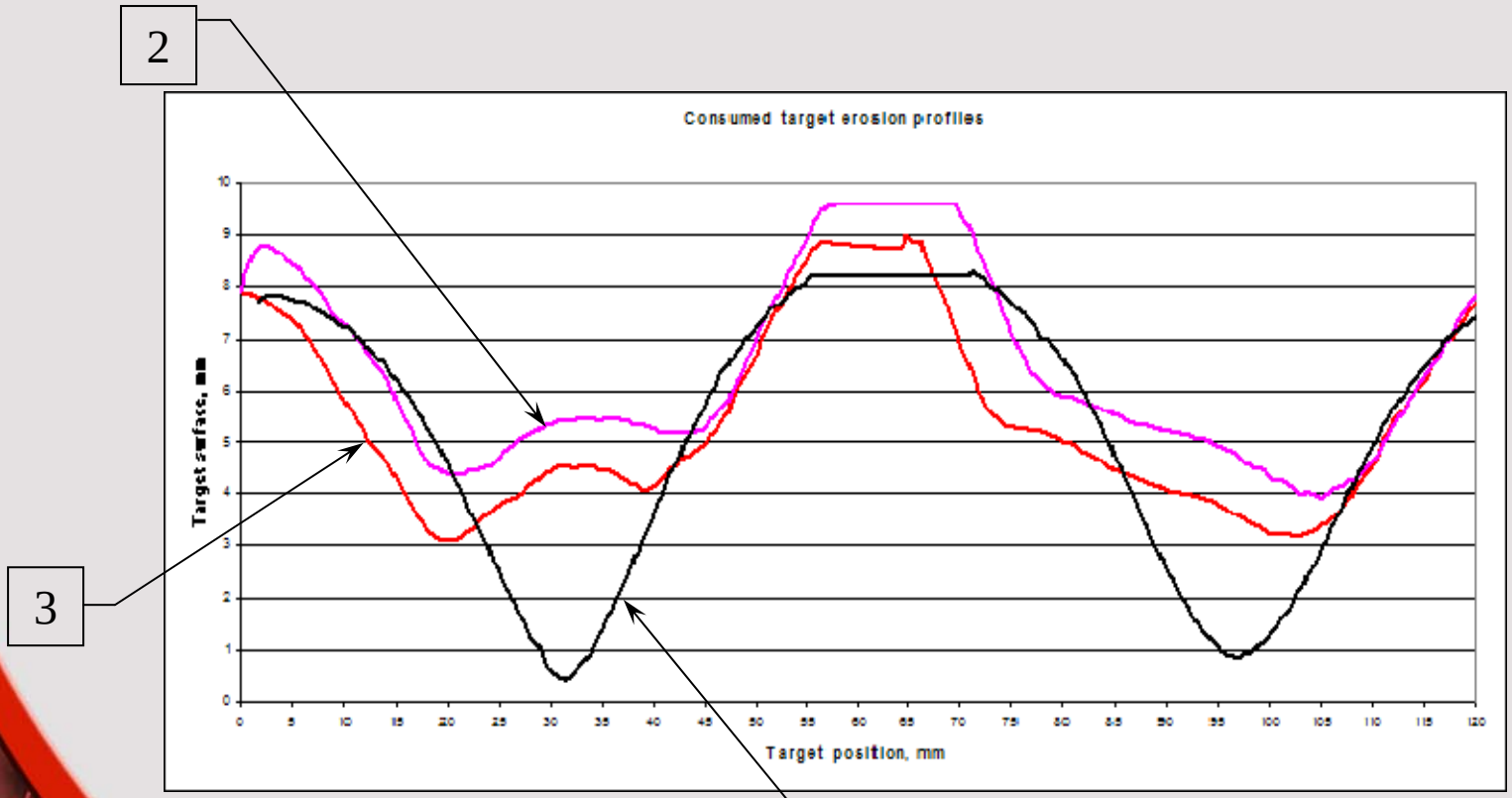


Shunted Cathode Magnetic Field



Target Erosion

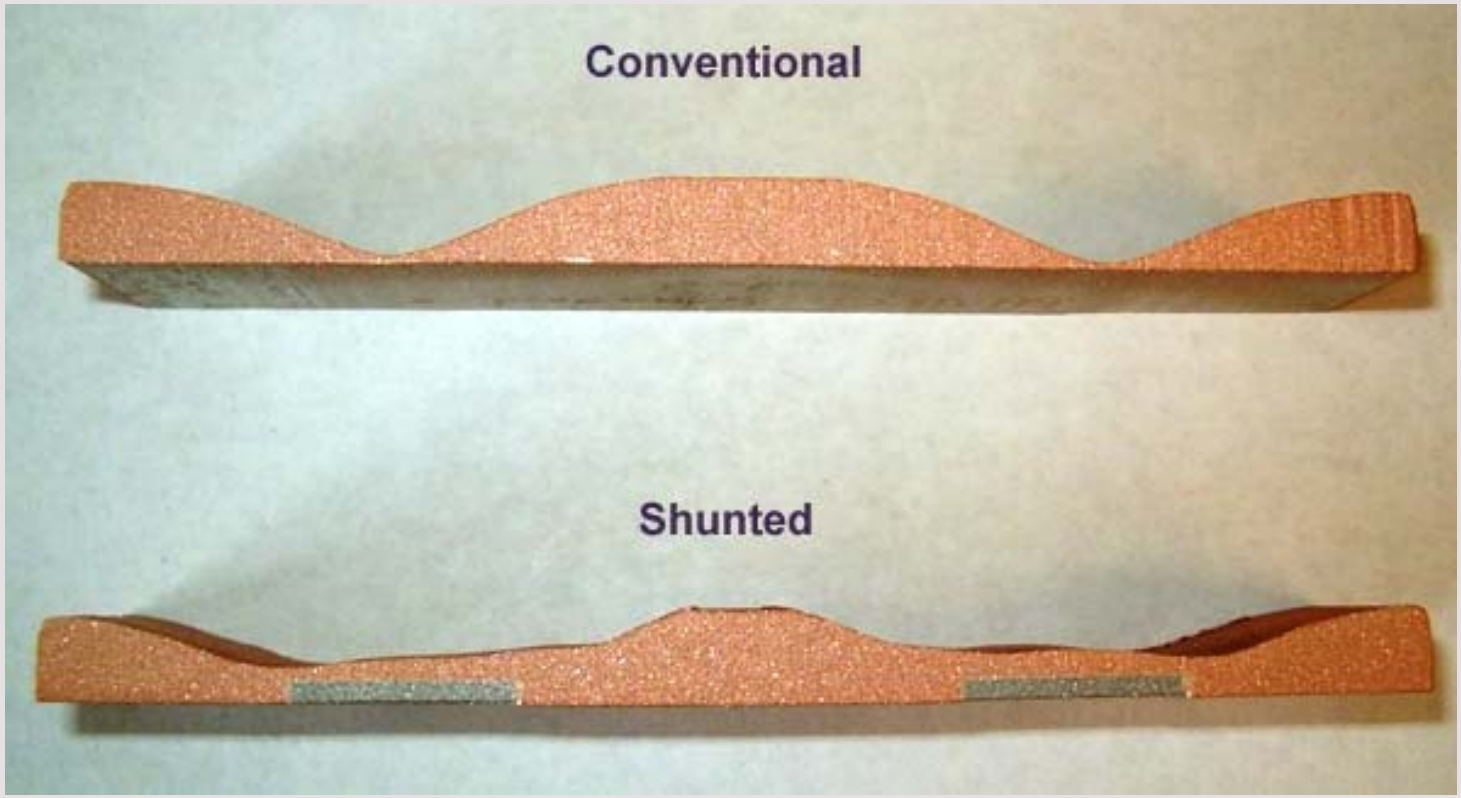
Benefits of Magnetic Shunt



Target Shunt Development

1. Initial, No Shunt
2. First Trial
3. Second Trial

Shunted Target



Profit Leaks

Not considering alternative deposition techniques

- **Rotary targets**
  - Can exceed 90% utilization of sputter targets
  - 10% of surface being heated and 90% being cooled
  - List of available materials is larger each year
  - Shortest length is about 406mm, longest 3.8 meters
  - Over 1000 cathodes in operation
  - Vacuum chamber must be designed around device
  - 10 kW per 300mm length has been acheived

Conclusion

- **All processes can benefit from focusing on common issues that rob profits**
- **Standard operating and maintenance procedures can reduce risks**
- **Adopting profit leak reduction plans can produce savings of 50% on consumables**
- **Working together the industrial user, equipment supplier and consumable supplier can yield profit benefits for years to come**