

**58<sup>TH</sup> ANNUAL  
FUZE CONFERENCE**

**July 7-9, 2015**

**Baltimore, MD**

**Plasma Firing Currents  
Causes, Consequences, and Cures**

**Thomas Nickolin**

# Contact Information

**Thomas Nickolin**

**Independent Presenter**

**Phone: 513-732-0443**

**Cell: 513-477-1334**

**Email: [tnickolin@cinci.rr.com](mailto:tnickolin@cinci.rr.com)**

# Table of Contents

- **Reasons to Use LEEFIs**
- **Basic LEEFI Construction/Operation**
- **Cause, How It Begins**
- **Undefined Path**
- **Not So Undefined**
- **Problem Detection**
- **Possible Remedies**
- **Other Plasma Worries**
- **Summary**

# Reasons to Use LEEFIs

- **Precision Timing**
  - Repeatable
  - High Resolution Electronic Control
- **Orders of Magnitude Increase in Speed**
  - From 100's of Microseconds to Microseconds
- **Increased Reliability, No dependence of Hot Wire to explosive Mix Interface**

# Reasons to Use LEEFIs (contd.)

- **Enhanced Applications**
  - **Tandem Delayed Warheads**
  - **Multipoint Initiation**
  - **Directed Warheads**
  - **Extreme Safety Over Traditional Devices**

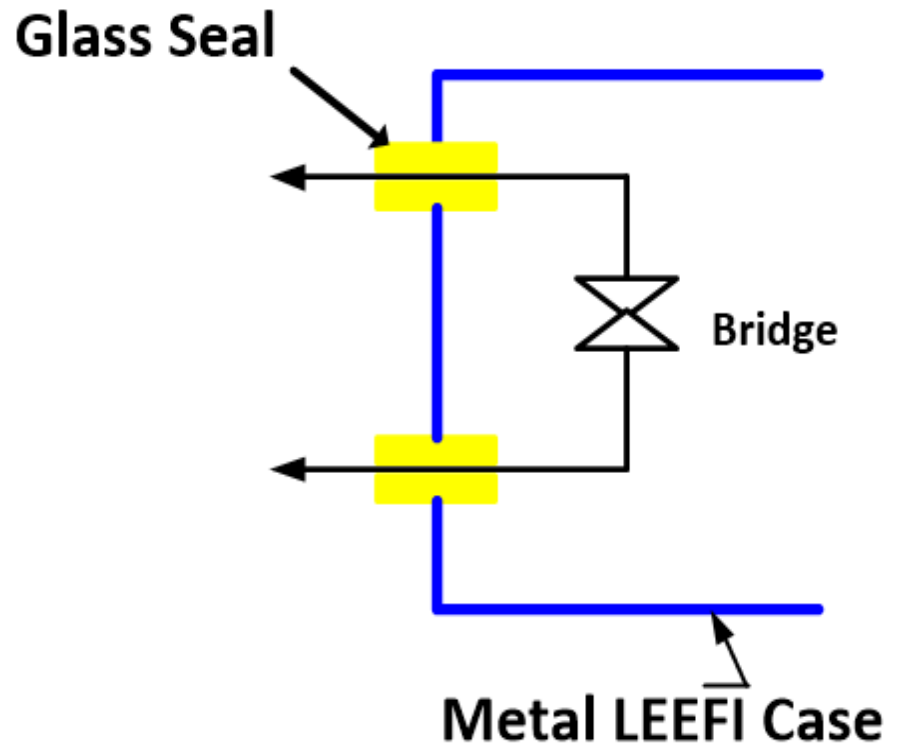
•

•

**And the List Goes On**

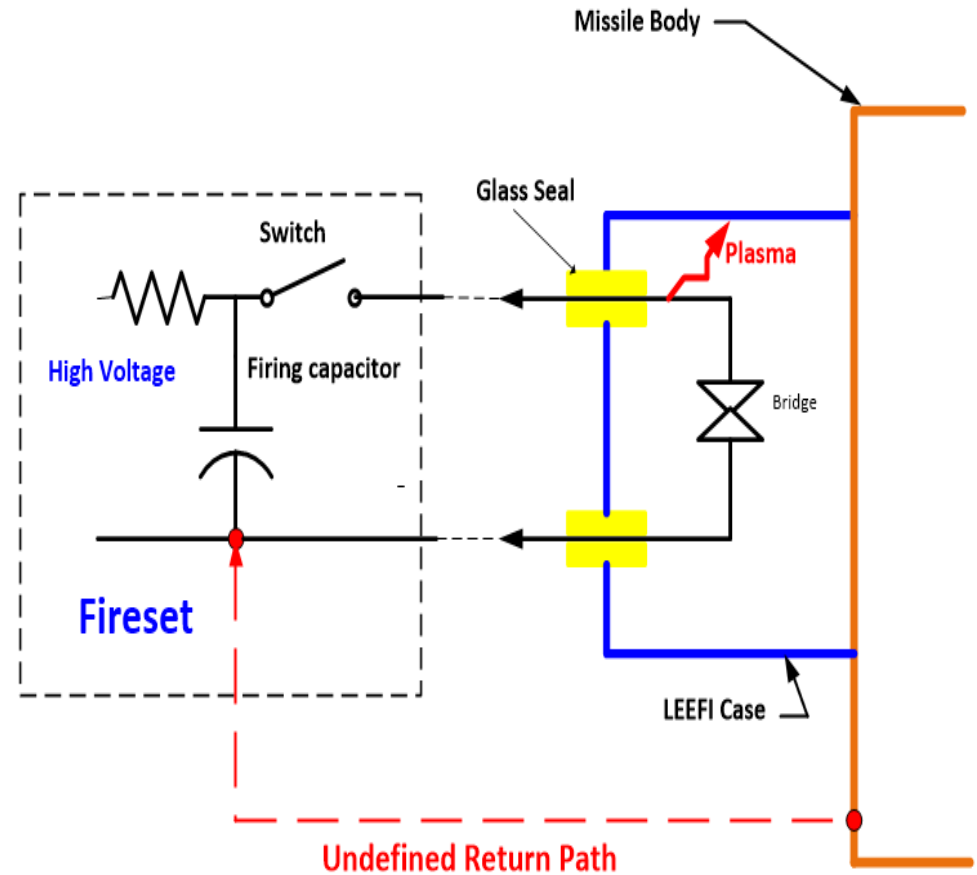
# Basic LEEFI Construction/Operation

- Hermetic
- Glass Seals
- Fired Using High Current
- Low Inductance Connections
- Secondary Explosives



# Cause, How it Begins

- Assume Firing Uses  $\frac{3}{4}$  of Available Energy
- Remaining  $\frac{1}{4}$  at  $\frac{1}{2}$  Voltage
- Plasma Connects Firing Cap. To Case
- Case Conductive to Missile Body
- Energy Must Return via Undefined Path



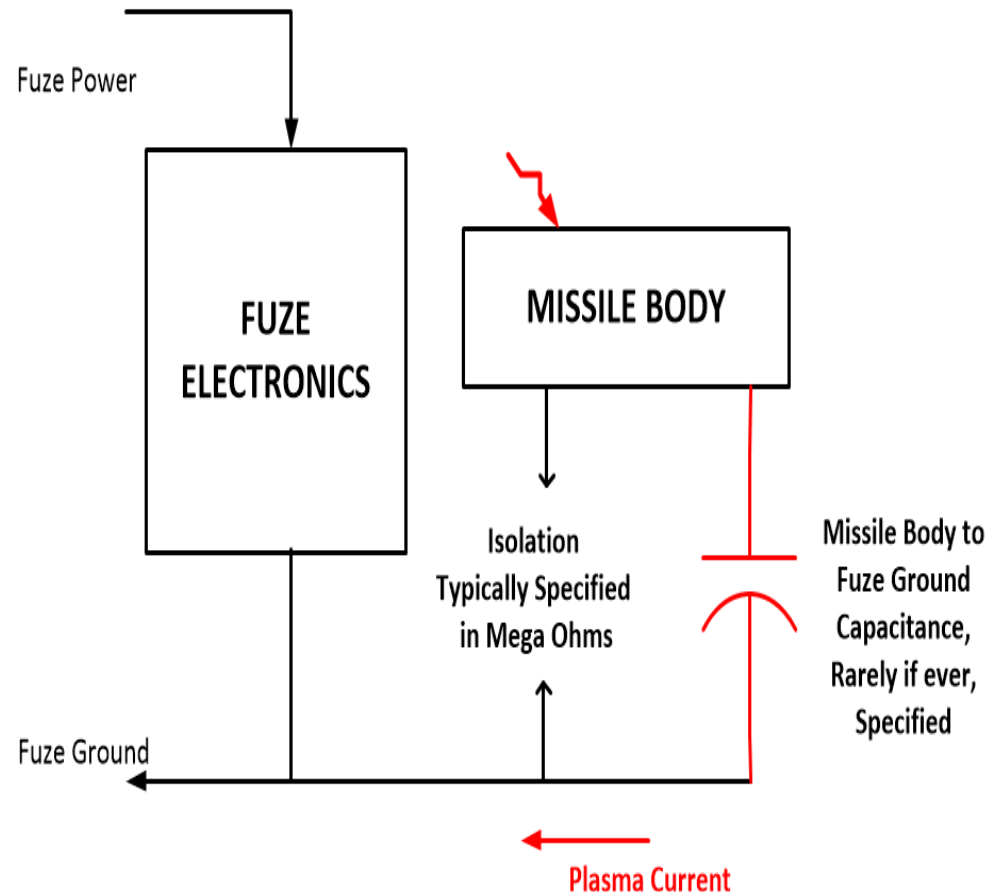
# “Undefined” Path

- **Undefined**
- **Means path That Causes Maximum Problem**
  - Resets Tandem Delay
  - Causes Sympathetic Firing
  - For ISDs, Possible Reset of the flight Computer
  - Anything Else Imaginable Including Damage to Electronic Circuits

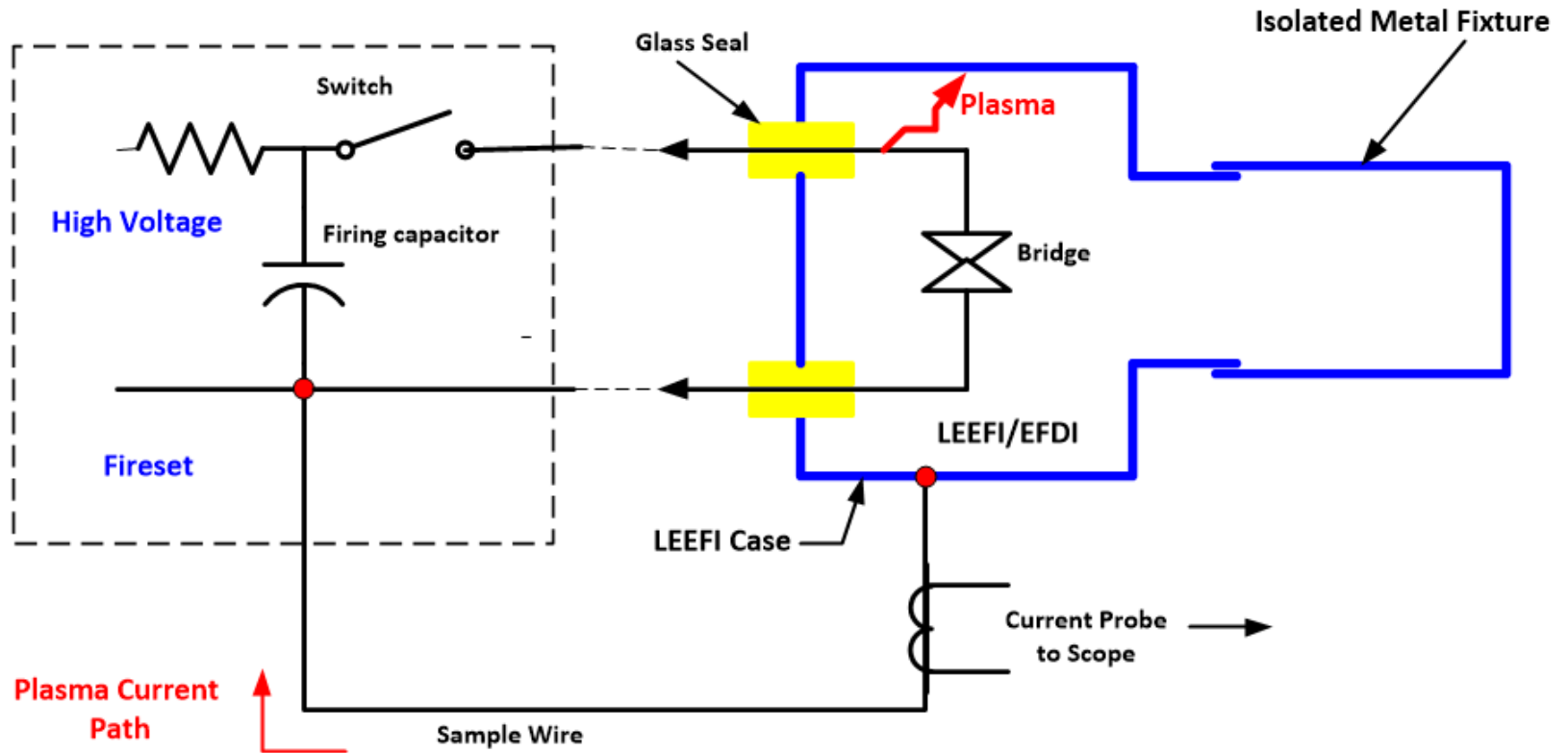


# Not So Undefined

- **Fuze Electronics to Missile Body Res. Specified in Fuze Spec.**
- **Cap not Specified**
- **Cap is a very low Z path for Fast, HV Transient.**

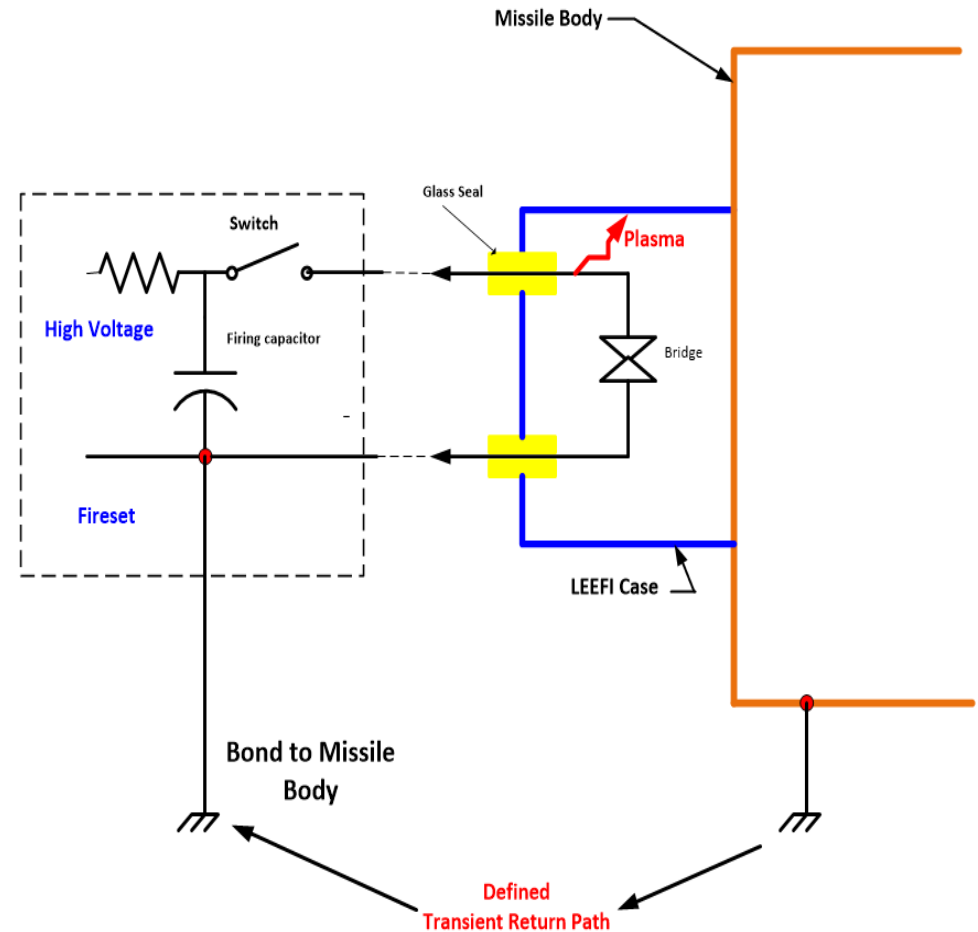


# Problem Detection



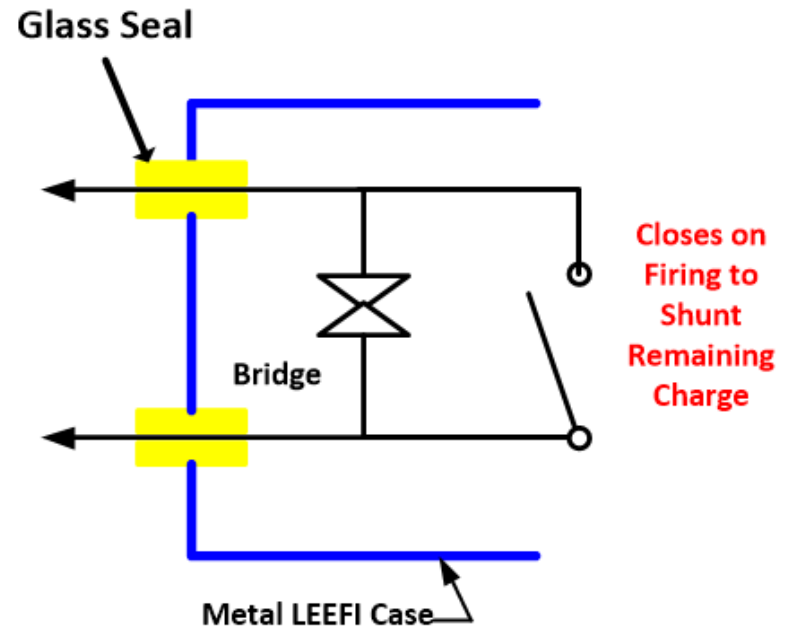
# Possible Remedies

- **Create Low Resistance Bond, Firing Cap to Missile Body. Cures problem but may raise other issues.**
  - Ground Insertion Into Firing Circuit
  - Violation of Isolation Specification for Grounds



# Possible Remedies (cont)

- Utilize Reynolds System LEEFI with Internal Plasma Suppression Switch
  - US Patent 8485097
  - Contact :
    - Chris Nance, VP Engineering
    - 707-928-5244
  - Possible Drop in fix



# Other Plasma Worries

- **Warhead Detonations Create Conductive Plasma, Not just the LEEFI**
- **Within the Chaos of the Plasma Cloud Every Element Becomes Instantaneously Cross Connected to Every Other Element**
- **This Event is Chaotic and Unpredictable**
- **The Fuze Designer Must Be Aware of the Possible Consequences of Such an Event**

# Summary

- **This Paper Has covered Only Two Possible Scenarios for Damage Created by Plasma Conduction.**
  - Residual Firing Energy Conducted to the Weapon Body
  - Chaotic Cross Connection of Multipoint Fuze Elements
- **Not Discussed is the Plasma Discharge of Energy Contained in Parasitic Capacitances.**
  - Cable Shields Being One Example
  - ***There is Always Next Year!***