

# Reliable High-Power Ignition

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# Topics

- The problem
- The Gila Monster
- R<sup>2</sup> (redundant/reliable) igniters
- The Gates front-closure design
- Questions

# The Problem

***The ignition of high-power rocket motors is problematic, around a 10-15% failure rate. While on the pad failures are a simply inconvenience for single motors, they can be catastrophic for clustered or staged design. To avoid these problem, you need at least a 95% probability of success.***

- Remember, the probability of failure of a multi-igniter system is:

$$P_{fail\_system} = P_{fail\_ignite}^n, \text{ where } n \text{ is the number of igniters}$$

# The Gila Monster

- 21 feet tall, 16.5 inches in diameter
- Center motor M1939W or N with 4-6 M1315Ws around the main
- Two 30' cargo chutes and one 9' drogue
- Empty weight 200 pounds
- The actual cost was classified due to fear of divorce
- Amazingly robust



# Goodyear AZ Launch

- Normal launch
- Failure of the M1939W rear closure at 30 feet
- Became a giant roman candle shooting burning grains out the back
- The Gila Monster shook-it-off and flew perfectly



# Lessons Learned



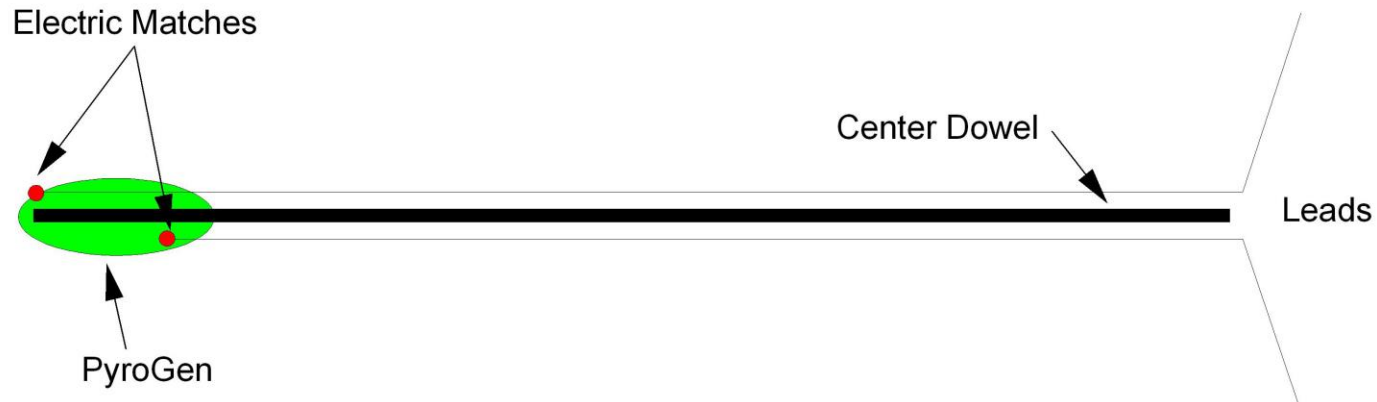
- Don't try to out run a grass fire
- We were lucky to have a road a mile away

# Two-Stage Gila Monster



- The Gila Monster never experienced a failed start
- Upper stage was a M1315W

# R<sup>2</sup> Igniters

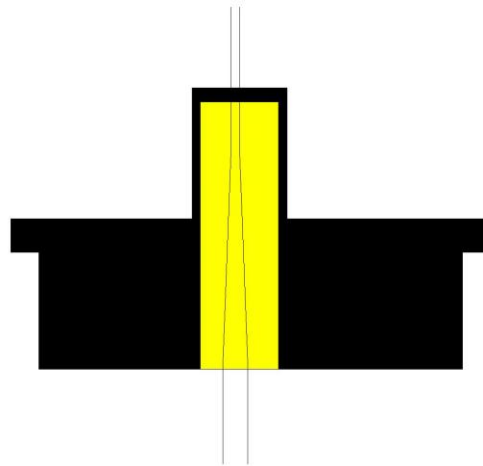


- Center dowel holds the igniter in place and prevents back-out from second stage motors
- Independent ignition sources

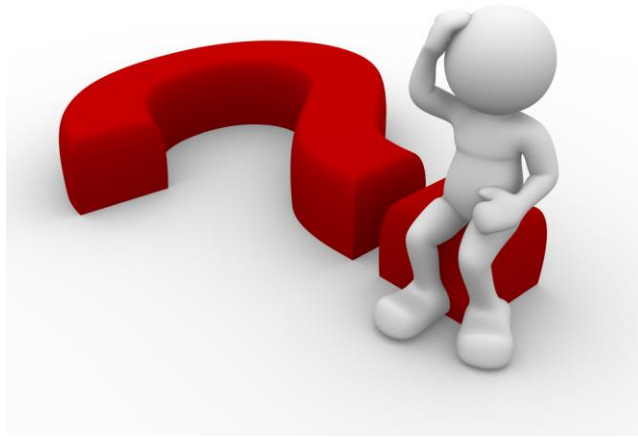


# Front-Closure Design

## M Front Closure



- The yellow plug is epoxy lost wax cast to the size of the tracking grain
- *It imperative to strip the internal wires to avoid failure*



# QUESTIONS