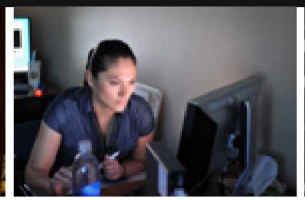
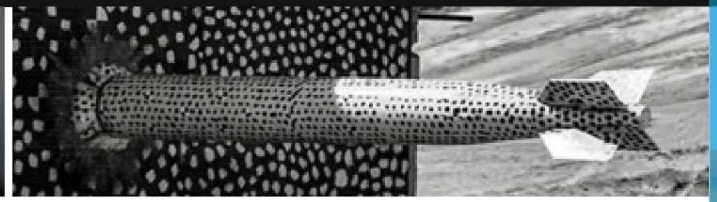
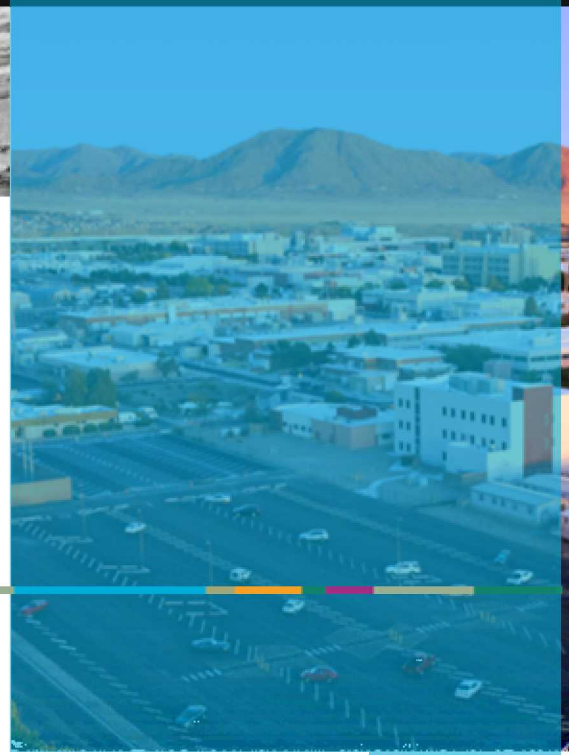
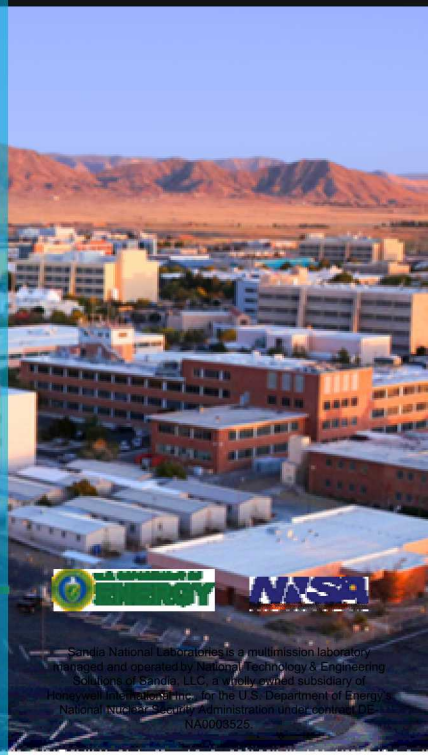
SAND2019-7275C

2019 IEEE Pulsed Power & Plasma Science Conference June 28th, 2019









PRESENTED BY

Eugene C. Ormond

Sandia National Laboratories is a multimission laboratory managed and operated by National Technology & Engineering Solutions of Sandia, LLC, a wholly owned subsidiary of Honeywell International Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Cygnus System Timing*

2019 IEEE Pulsed Power & Plasma Science Conference
June 28th, 2019
Orlando, Florida

Cygnus Team

Eugene C. Ormond, Michael R. Garcia, Martin F. Parrales
Sandia National Laboratories

John R. Smith
Los Alamos National Laboratory

Percy H. Amos, Keith W. Hogge, Michael K. Misch,
Mohammed Mohammed, Hoai-Tam V. Truong
Mission Support Test Services

**This work sponsored by the United States Department of Energy*

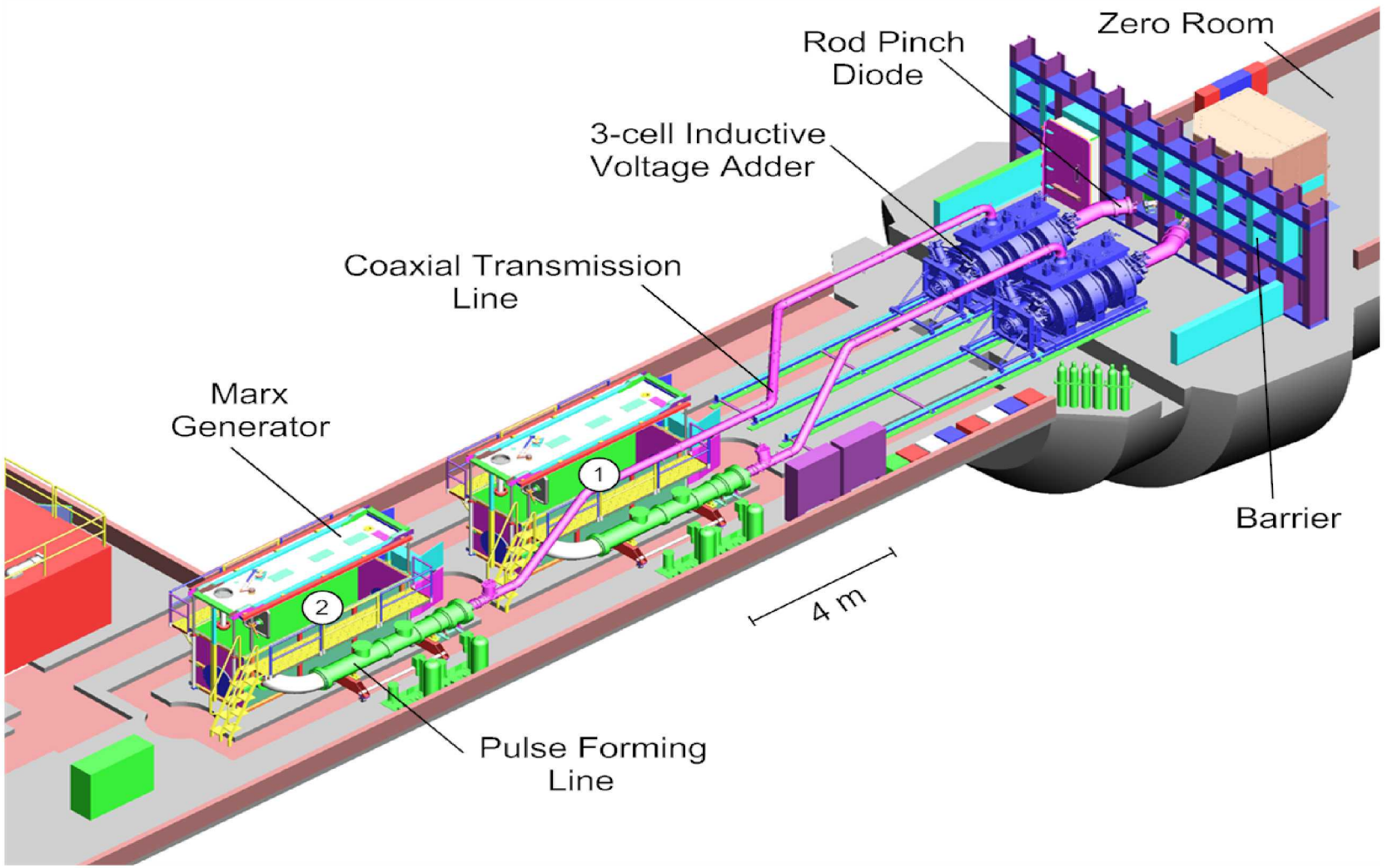
Outline

1) **Machine Configuration**
2) Trigger System Description
3) System Jitter Analysis
4) Spare Trigger Generator Analysis
5) Conclusion and Path Forward

U1a - Cygnus 1 & 2 Layout

***

TLD Dosimetry
is the Major Cygnus
Performance Diagnostic



Outline

1) Machine Configuration
2) **Trigger System Description**
3) Jitter Analysis
4) Spare Trigger Generator Analysis
5) Conclusion and Path Forward

Trigger System Description

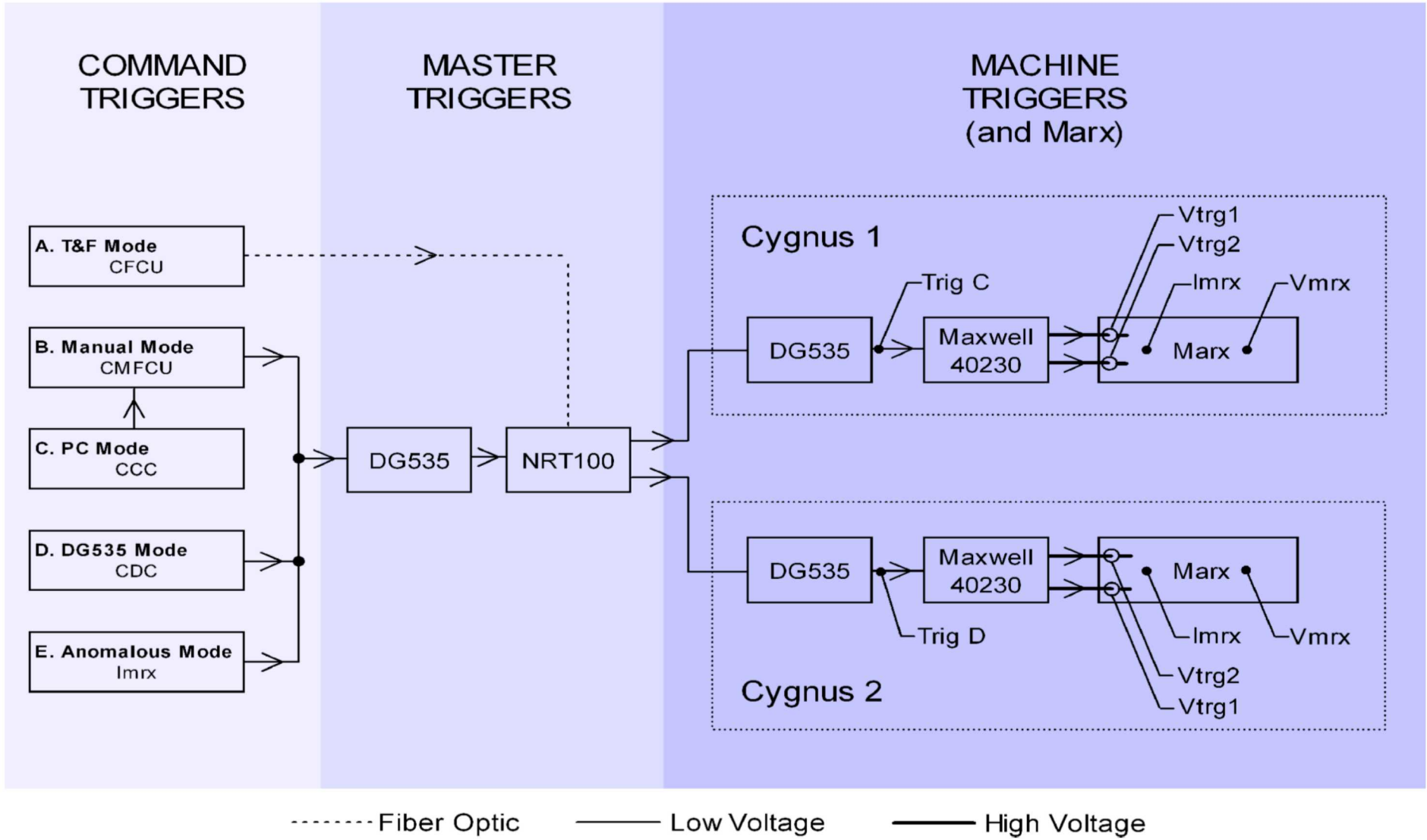
• The two Cygnus machines were installed in the 05 Drift in late 2003 for the 2004 Armando series. It is a fully developed diagnostic that has had engineering improvements over the 14 years of operation.

•In the normal operating mode, optical triggers are provided to the NRT-103 from the Central Fire Control Unit (CFCU). These redundant optical triggers are converted to electrical signals and trigger the Cygnus 1 and Cygnus 2 Stanford DG-535 (Digital Delay Generators).

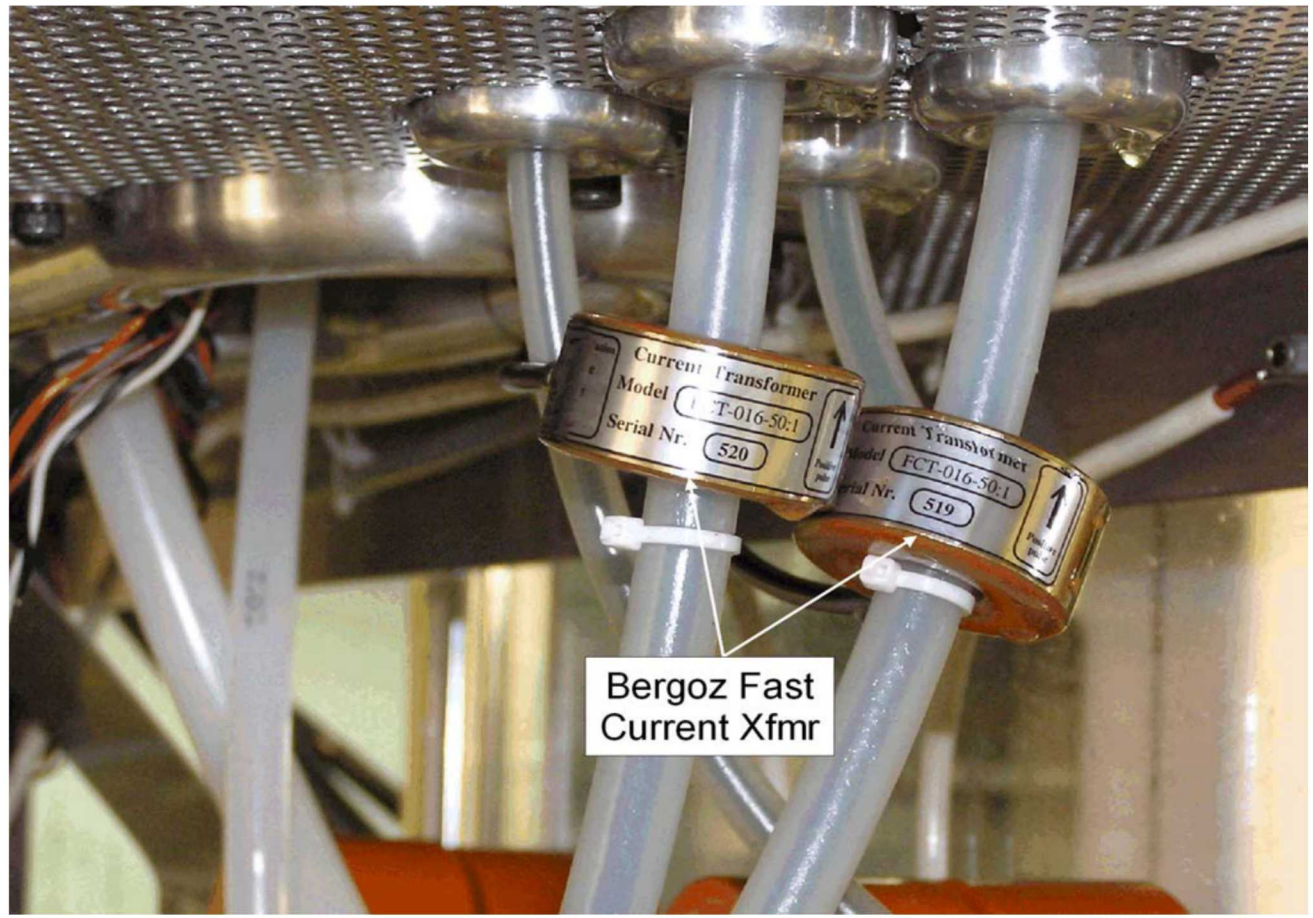
•The high voltage output of the DG-535 then triggers the Maxwell 40230 High Voltage Trigger Generators. (Maxwell is now Pulsed Sciences Division of L-3 Communications).

•Bergoz Fast Current Transformers are used to monitor the H.V. Trigger from the Maxwell 40230 High Voltage Trigger Generators.

Trigger System Description

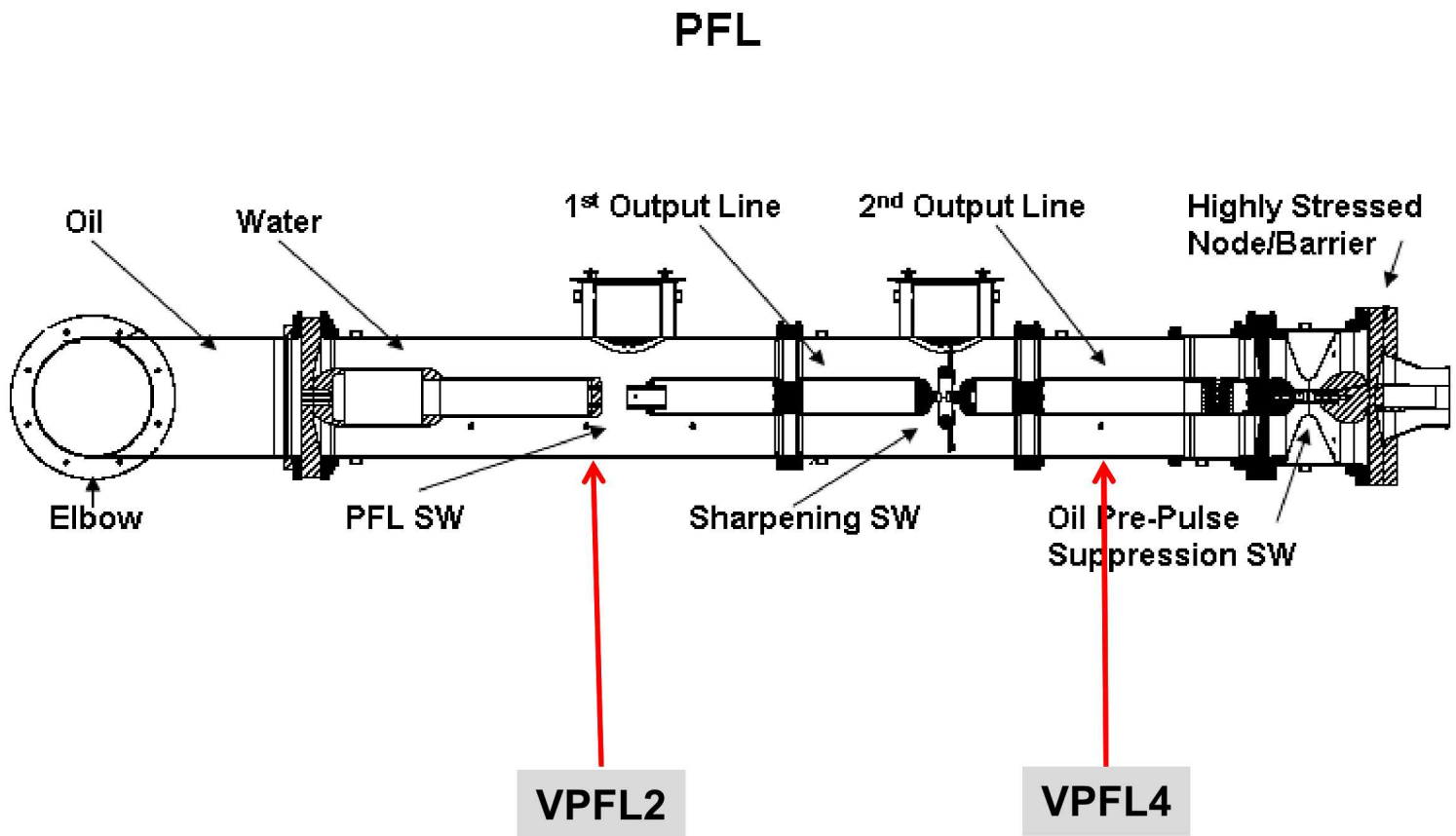


Trigger System Description



Bergoz fast current transformer (Diagnostic label VTRG1&2) located
beneath Marx lid on Maxwell 40230 HV trigger generator lines.

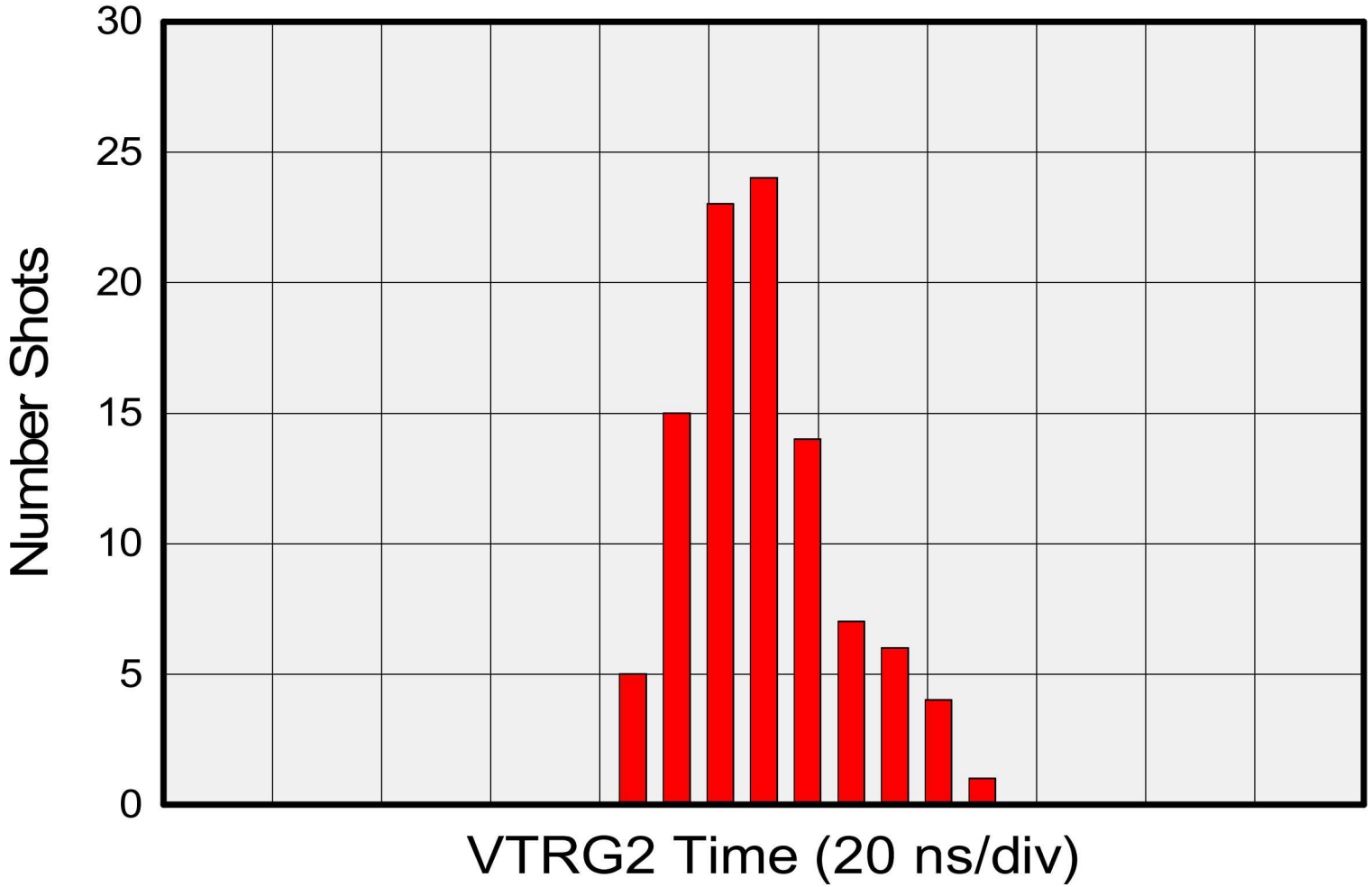
Diagnostic Locations



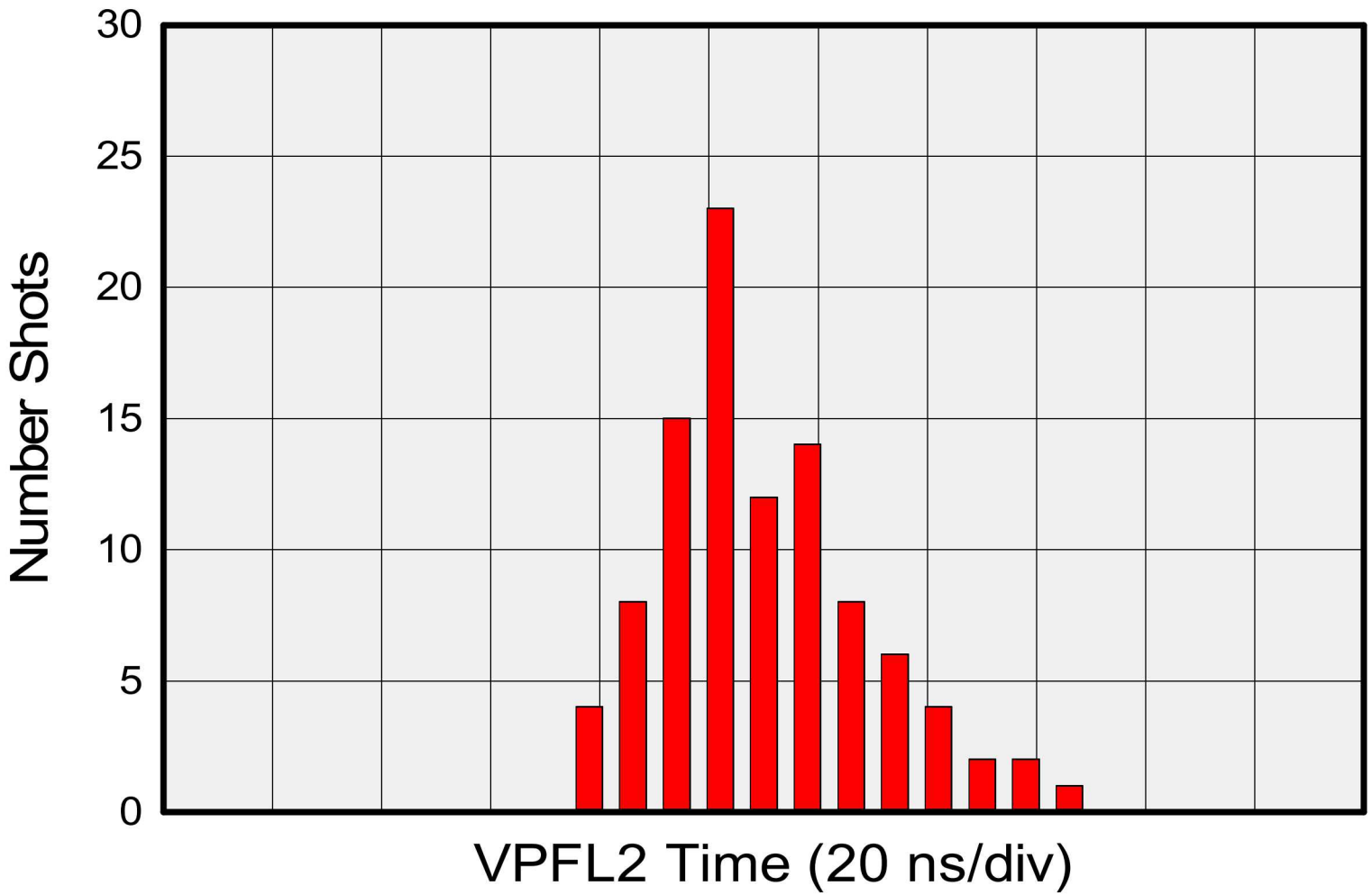
Outline

1) Machine Configuration
2) Trigger System Description
3) **System Jitter Analysis**
4) Spare Trigger Generator Analysis
5) Conclusions and Path Forward

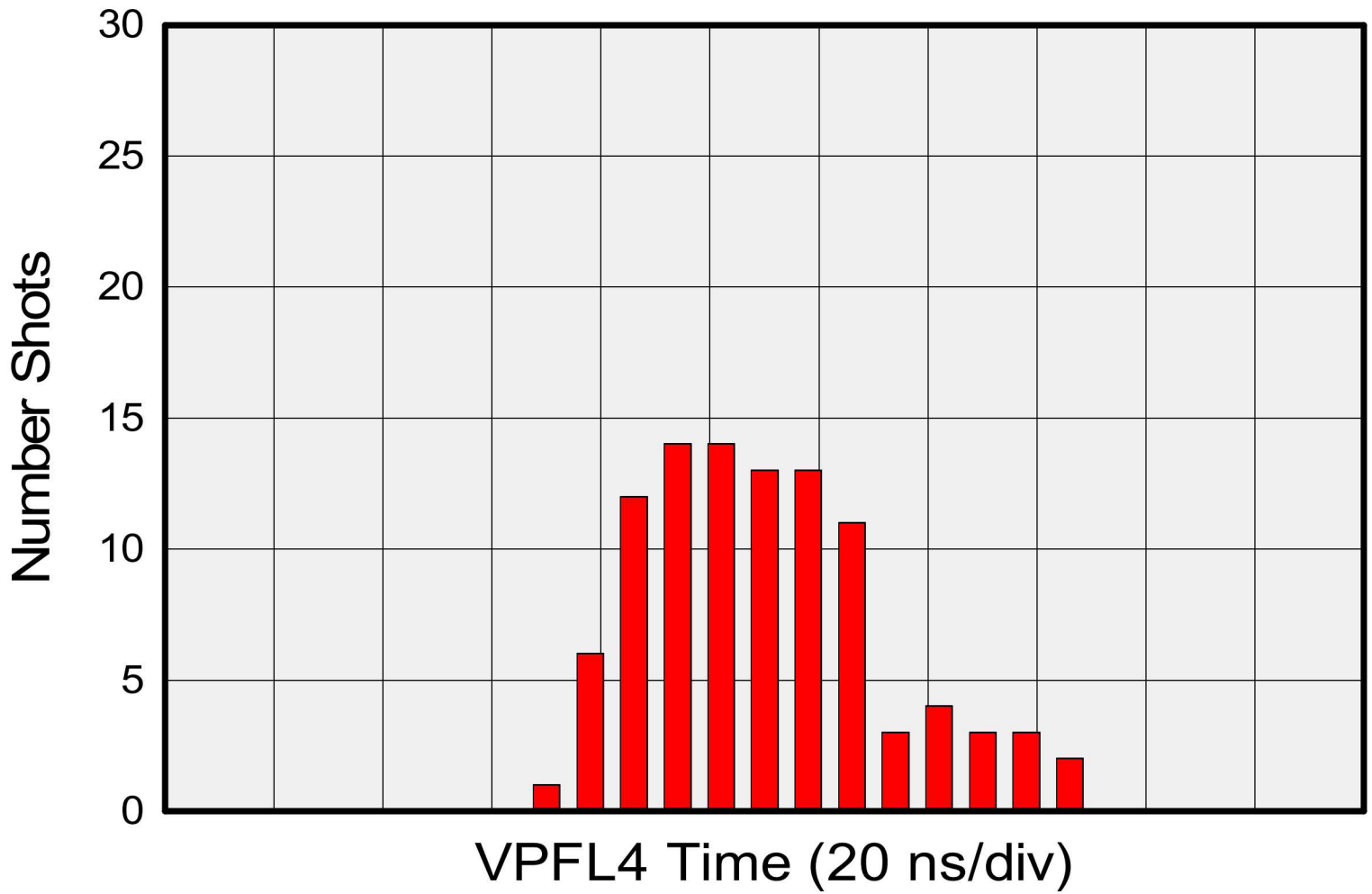
Jitter Analysis – Ediza VTRG2



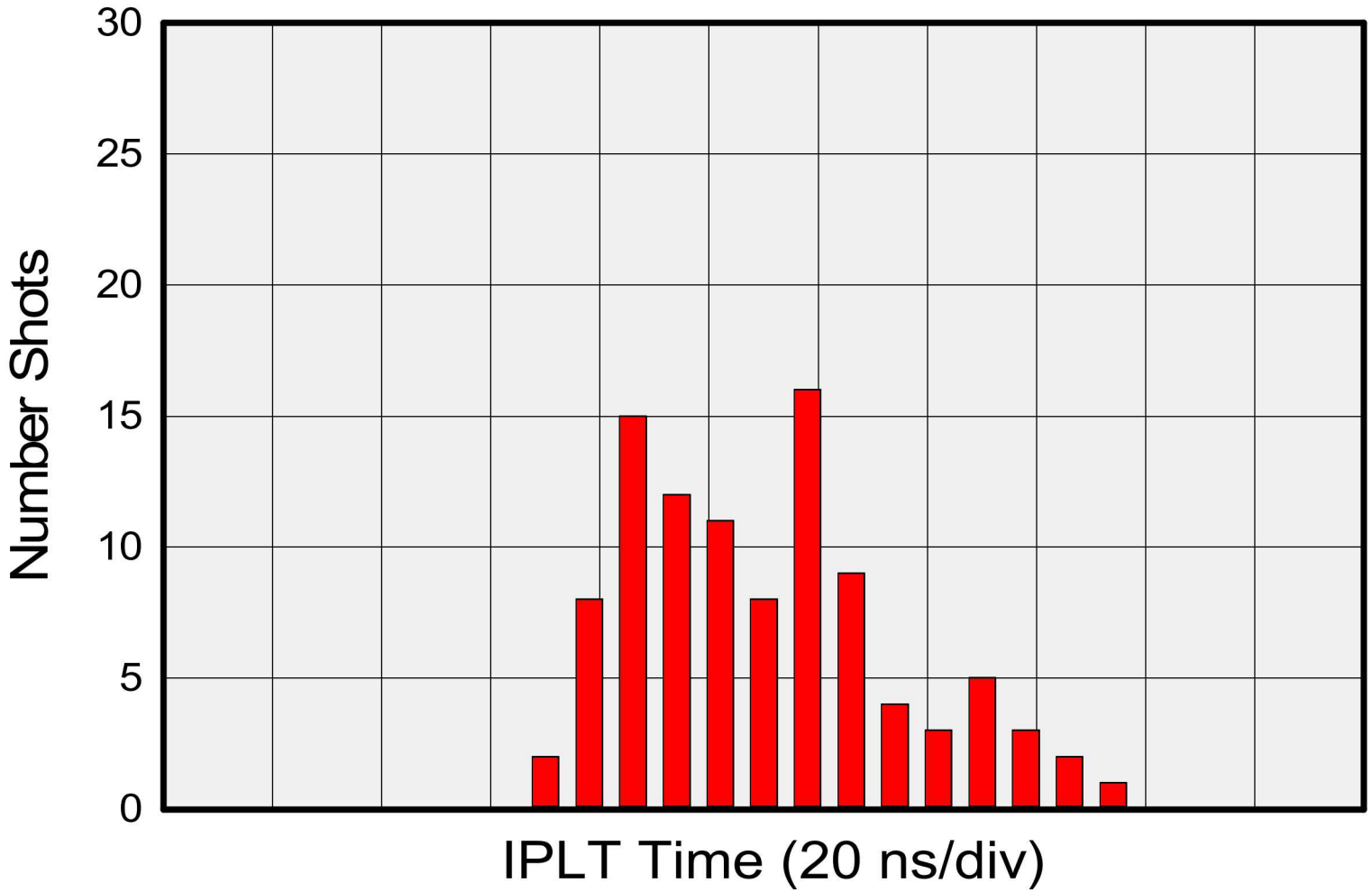
Jitter Analysis – Ediza VPFL2



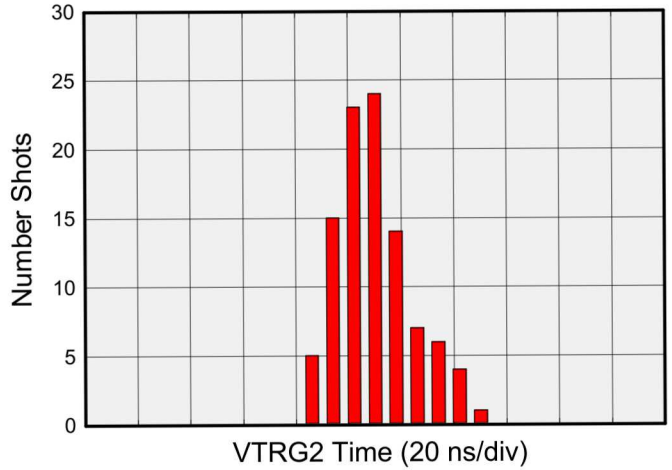
Jitter Analysis – Ediza VPFL4

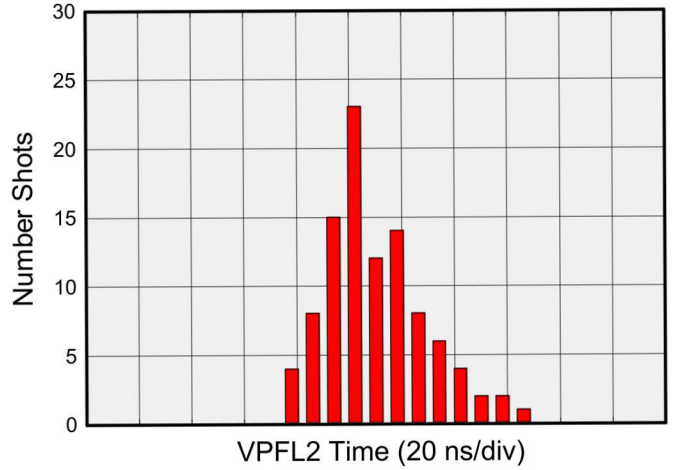


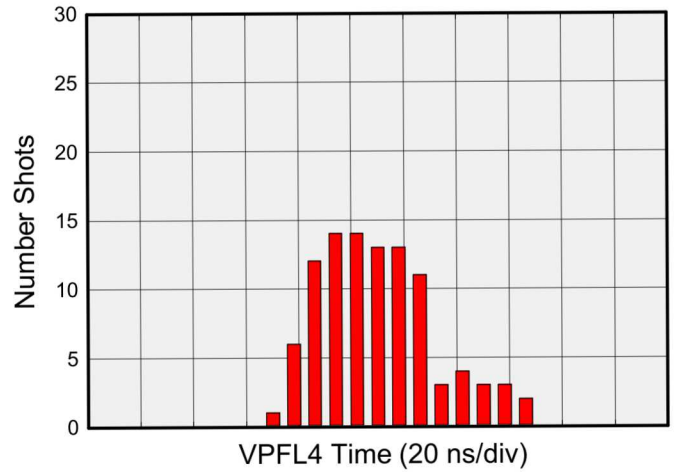
Jitter Analysis – Ediza IPLT

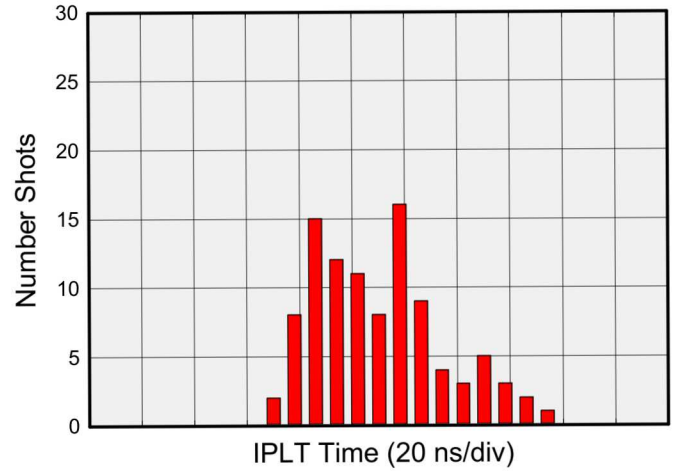


Jitter Analysis – Ediza





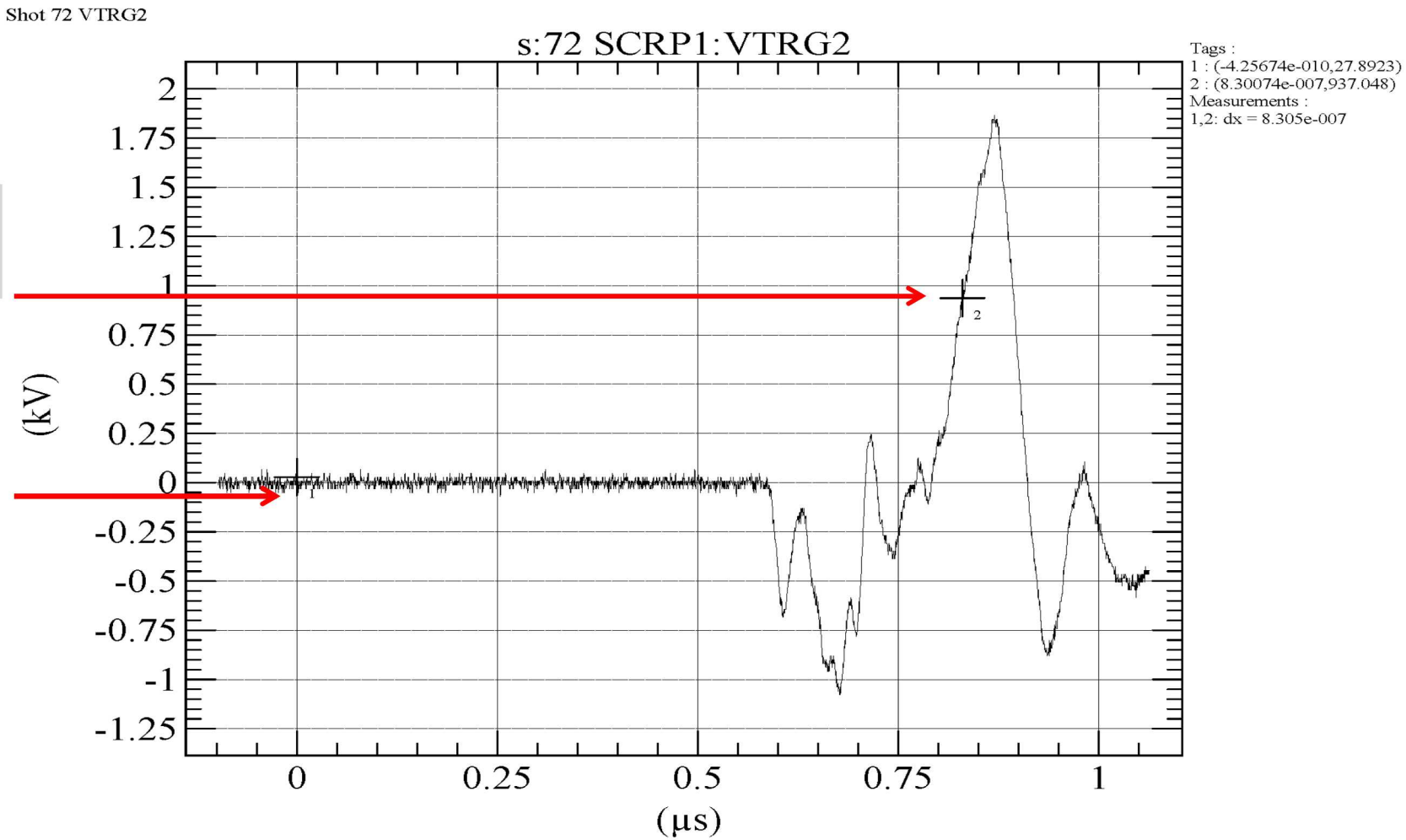




Jitter Analysis

50% of Positive Pulse

Start at Zero



Cumulative Jitter Analysis

Series Name	VTRG2 (Jitter in ns)	VPFL2 (Jitter in ns)	VPFL4 (Jitter in ns)	IPLT
Jitter due to:	Trigger Generator	Marx = TG	Marx + TG + PFL	Marx + TG + PFL + Diode
ARMANDO - 2004 (30 Shot Data Set)	10.6ns	15.9ns	20.6ns	19.9ns
POLLUX - 2012 (30 Shot Data Set)	3.5ns	4.4ns	10.4ns	10.4ns
EDIZA - 2019 (100 Shot Data Set)	14.1ns	19.1ns	21.8ns	23.9ns

Jitter sources not present after PFL. IPLT measurements shown demonstrating digitizer sample rate as limiting factor and validating lack of jitter sources after PFL Self-Break water switch.

Component Jitter Analysis (Ediza Series)

Using Quadrature $a^2 + b^2 + c^2$

	Trigger Generator	Marx	PFL
Ediza Series	14ns	12ns	11ns

Outline

1) Machine Configuration
2) Trigger System Description
3) System Jitter Analysis
4) **Spare Trigger Generator Analysis**
5) Conclusions and Path Forward

Spare Trigger Generators Analysis

HV Trigger Generator	Jitter in ns
Cygnus-1 Installed (A)	14.1ns
Cygnus-1 Spare (C)	22.3ns

Two spare generators were installed. One unit had erratic operation in computer controlled mode and was not repaired before this presentation. The second unit shows higher deviation and will have spark gaps refurbished.

Outline

1) Machine Configuration
2) Trigger System Description
3) System Jitter Analysis
4) Spare Trigger Generator Analysis
5) **Conclusions and Path Forward**

Conclusions and Path Forward

• The data analysis indicates Cygnus jitter is relatively close in the Trigger Generator, Marx and Pulse Forming Line in the Ediza Series.

• Maintenance logs will be reviewed to determine if the lower jitter during the Pollux Series was shortly after one of the two major refurbishments (Refurbished Marx Spark Gaps and/or different Trigger Generator.

• **Spare Trigger Generators:** The spare Trigger Generators were evaluated and one unit has erratic computer controlled operation. The second unit has higher deviation/jitter and the spark gaps will be refurbished.

• **Path Forward:** 1) Cygnus 2 data will be evaluated and compared to the Cygnus 1 data presented for the same series of shots.

Questions?