14th Annual PQSynergy International Conference 2014

Chiang Mai, Thailand

An Innovative Voltage Conditioning System for Industrial Applications

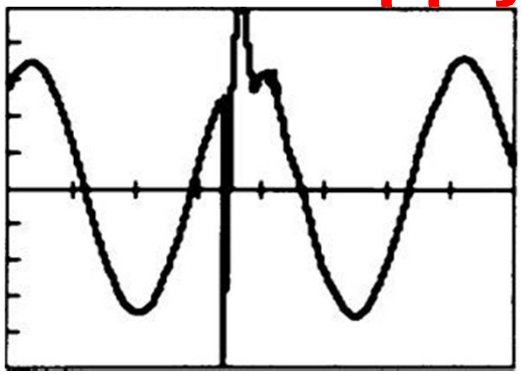
May 19, 2014

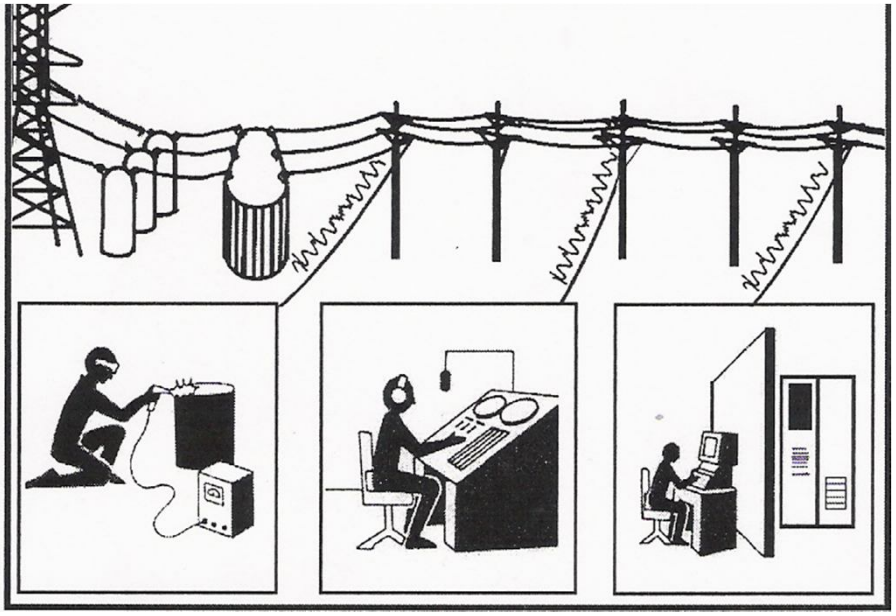
Presented by J. Ferrer
Zigor HK Ltd.

AC POWER QUALITY PROBLEMS

Theoretical AC Supply

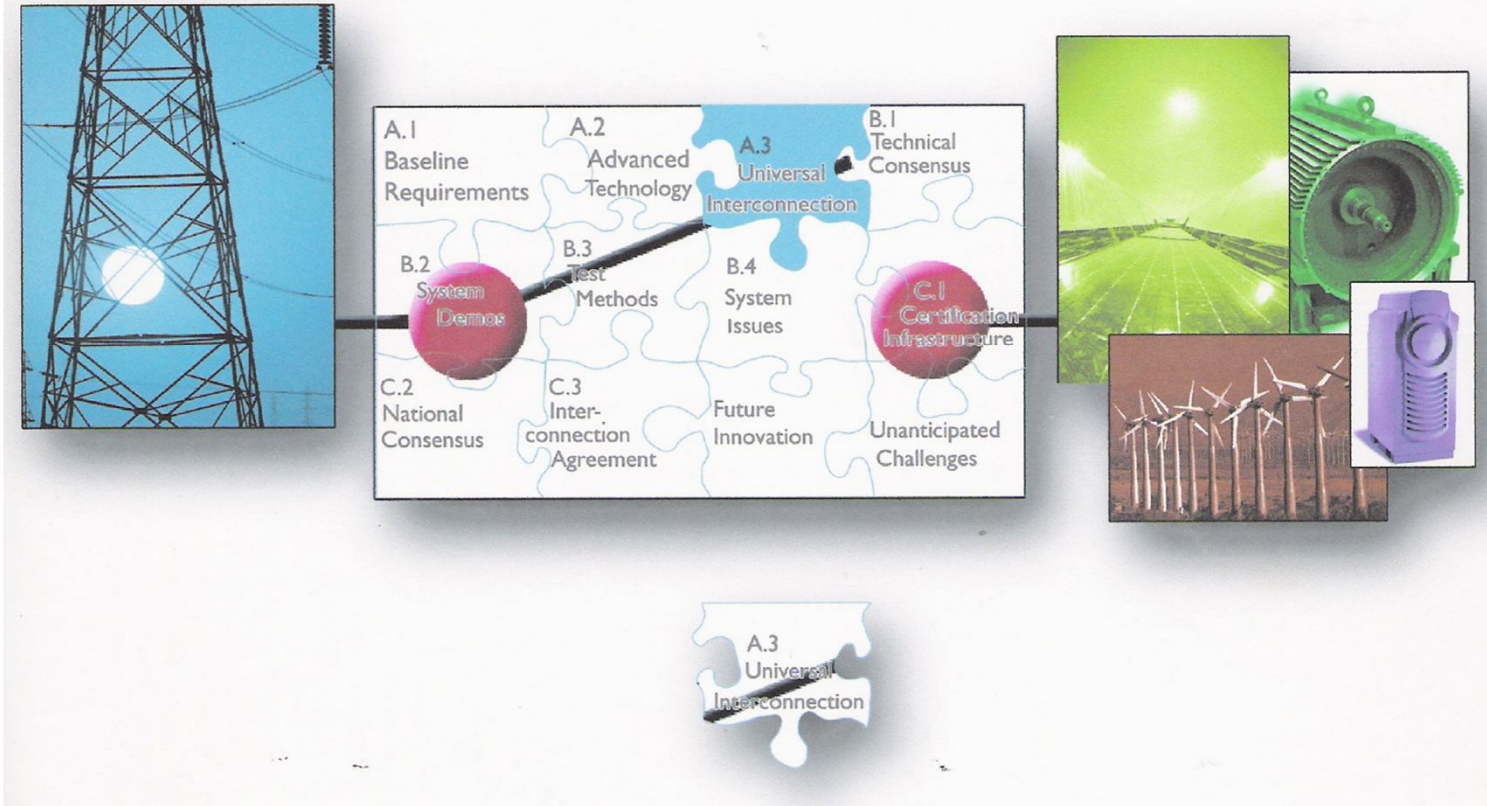
Real AC Supply



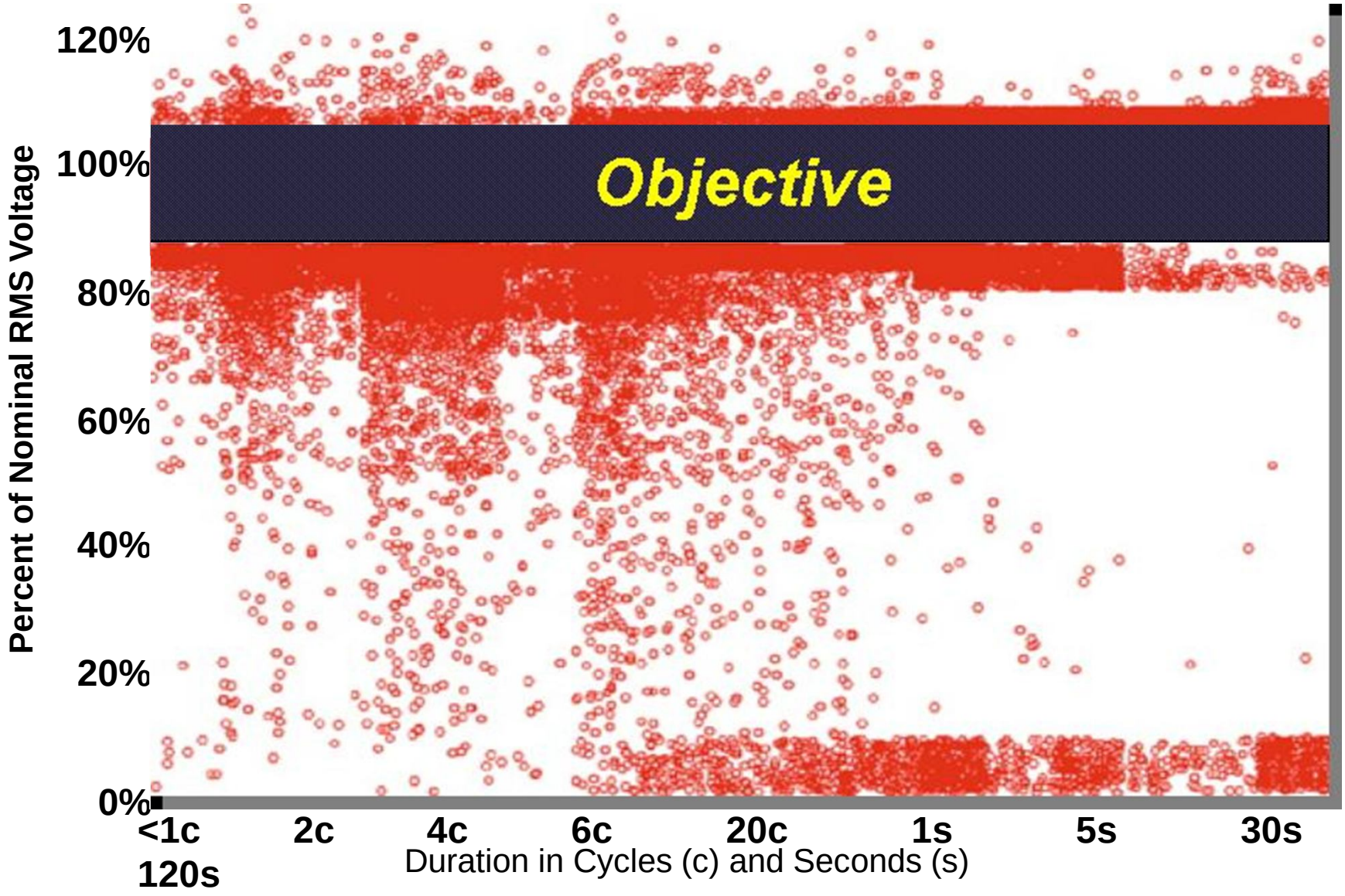


AC POWER QUALITY PROBLEMS

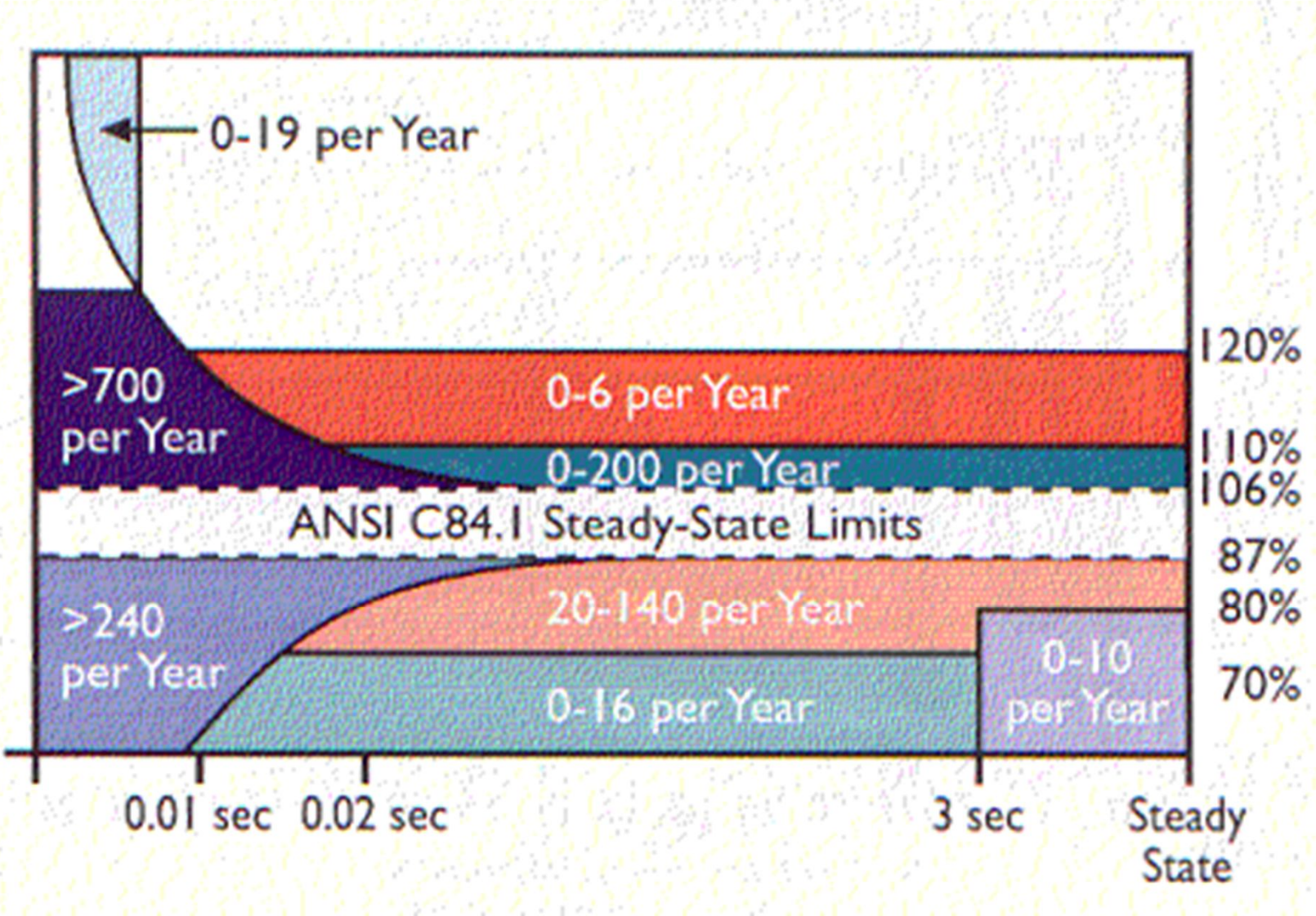
Reality of a complex AC Distribution



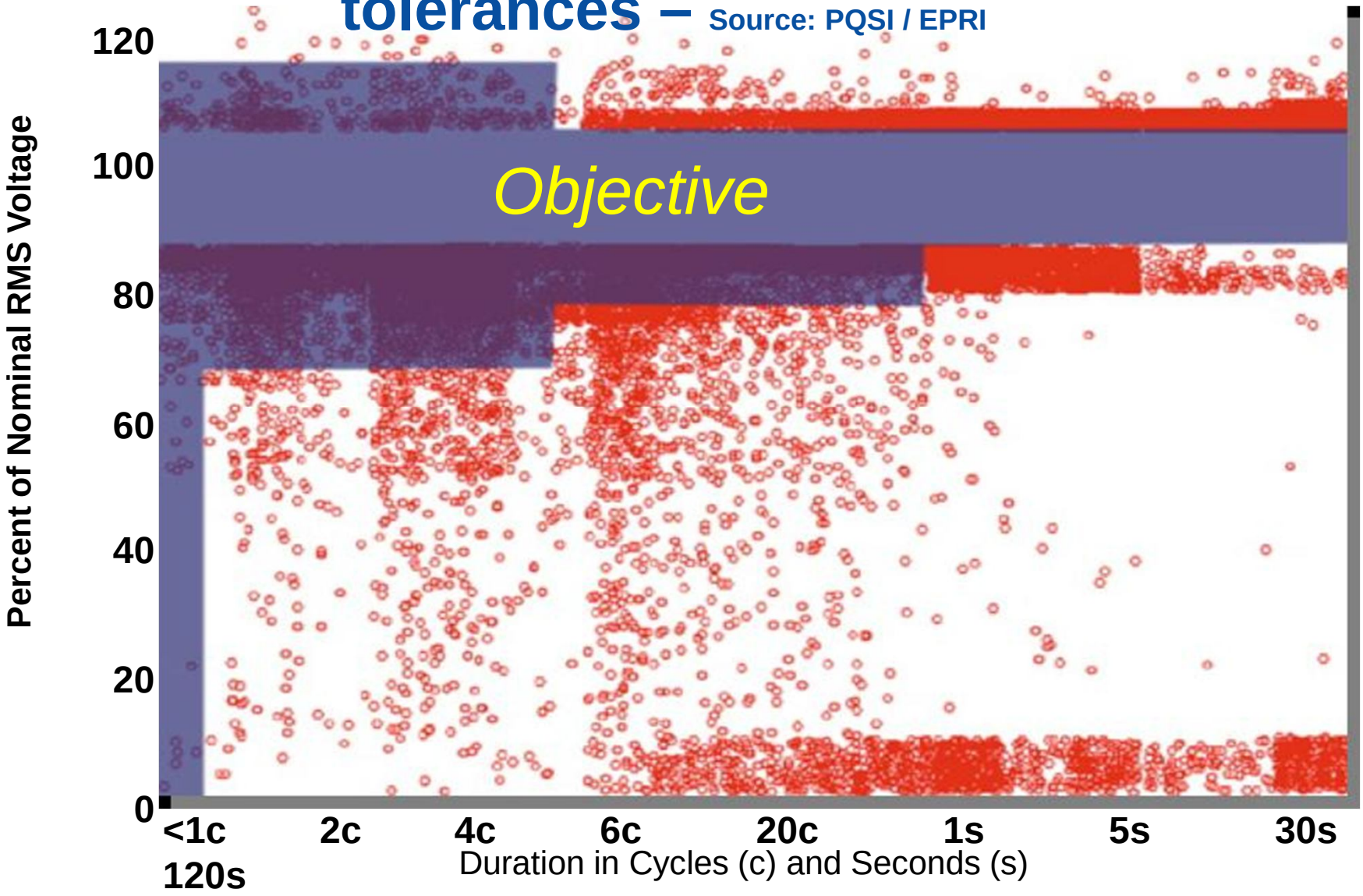
Industrial Survey Data – Source: PQSI / EPRI



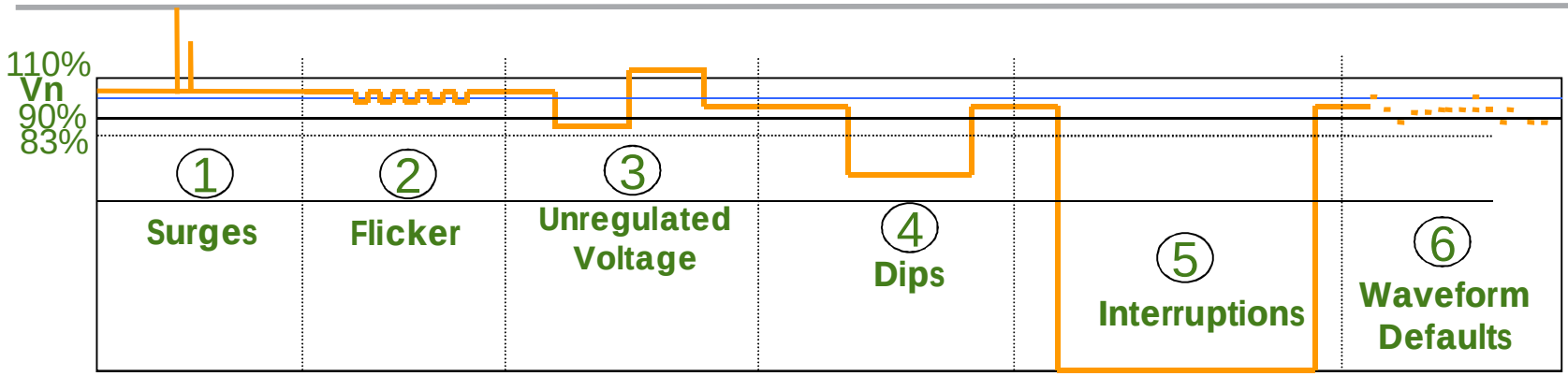
Typical Site Envelope – Source: PQSI / EPRI



International standards to improve load tolerances – Source: PQSI / EPRI



Power Quality: Most Common Problems



1 Surges: Transient Surges and Overvoltage (microseconds)
CAUSES: ATMOSPHERIC DISCHARGES, CAPACITOR BANKS

2 Flicker: Fluctuations, lighting disturbances
CAUSES: EXTERNAL DISTURBING LOADS (Arc ovens).

3 Unregulated Voltage: Vnom±7%
CAUSES: BIG LOAD CONNECTION OR COGENERATION SYSTEMS. CONSUMPTION OR GENERATION OF REACTIVE ENERGY.

Power Quality: Most Common Problems

4 DIPS - SAGS: Quick and Short Voltage Drops (>10%) & (<1seg) .

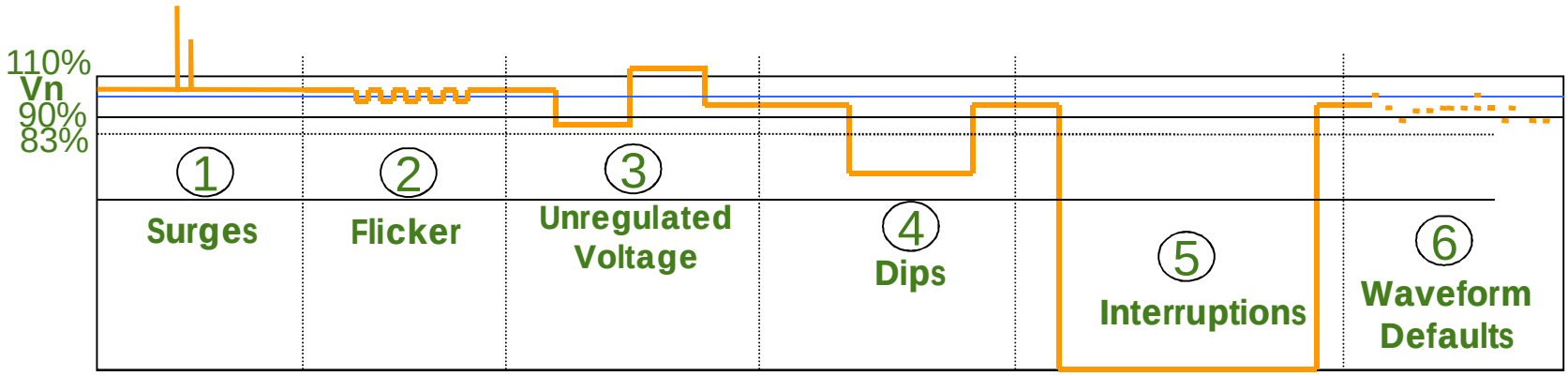
CAUSES: FAILURES / SHORT CIRCUITS IN TRANSMISSION OR DISTRIBUTION LINES

5 SHORT INTERRUPTIONS: (<3min)

CAUSES: FAILURES IN DISTRIBUTION LINES THAT ARE SOLVED THROUGH MV AUTOMATIC SWITCHES

6 Waveform Defaults: Distorted Waveform

CAUSES: DISTURBING LOADS (Power Electronics)

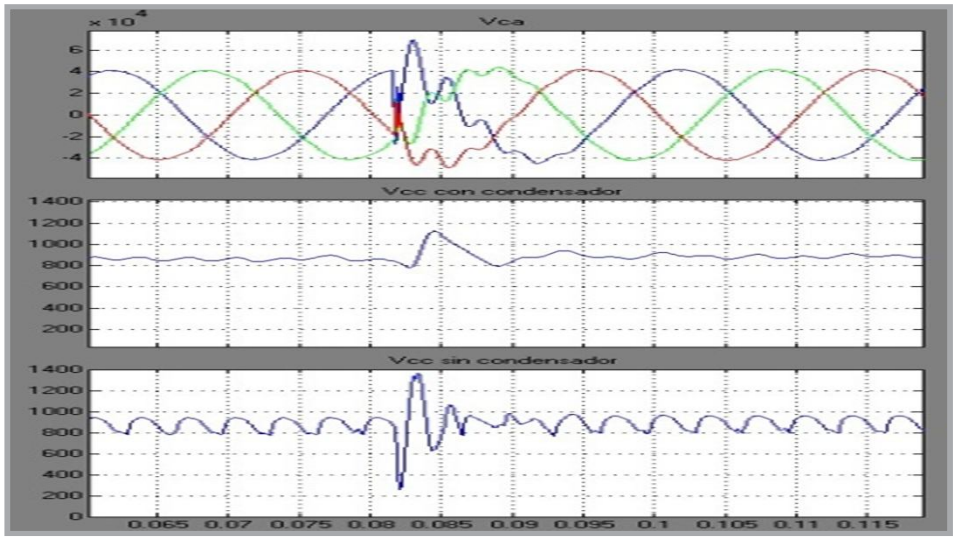


IMPORTANT: Need Prior Diagnosis

Phases of Engineering for the resolution of problems related to the Power Supply:

- **Measurement and Analysis of the Power Quality at site**
- **Technical Audit of the electrical installation.**
- **Determining sensitivity of equipment and processes.**
- **Proposal and implementation of solutions.**

Audits and Studies



Grade of Immunisation Definition

- **3 levels of protection can be raised according to the required degree of immunisation**.

1. Parameters and changes of Control Settings.

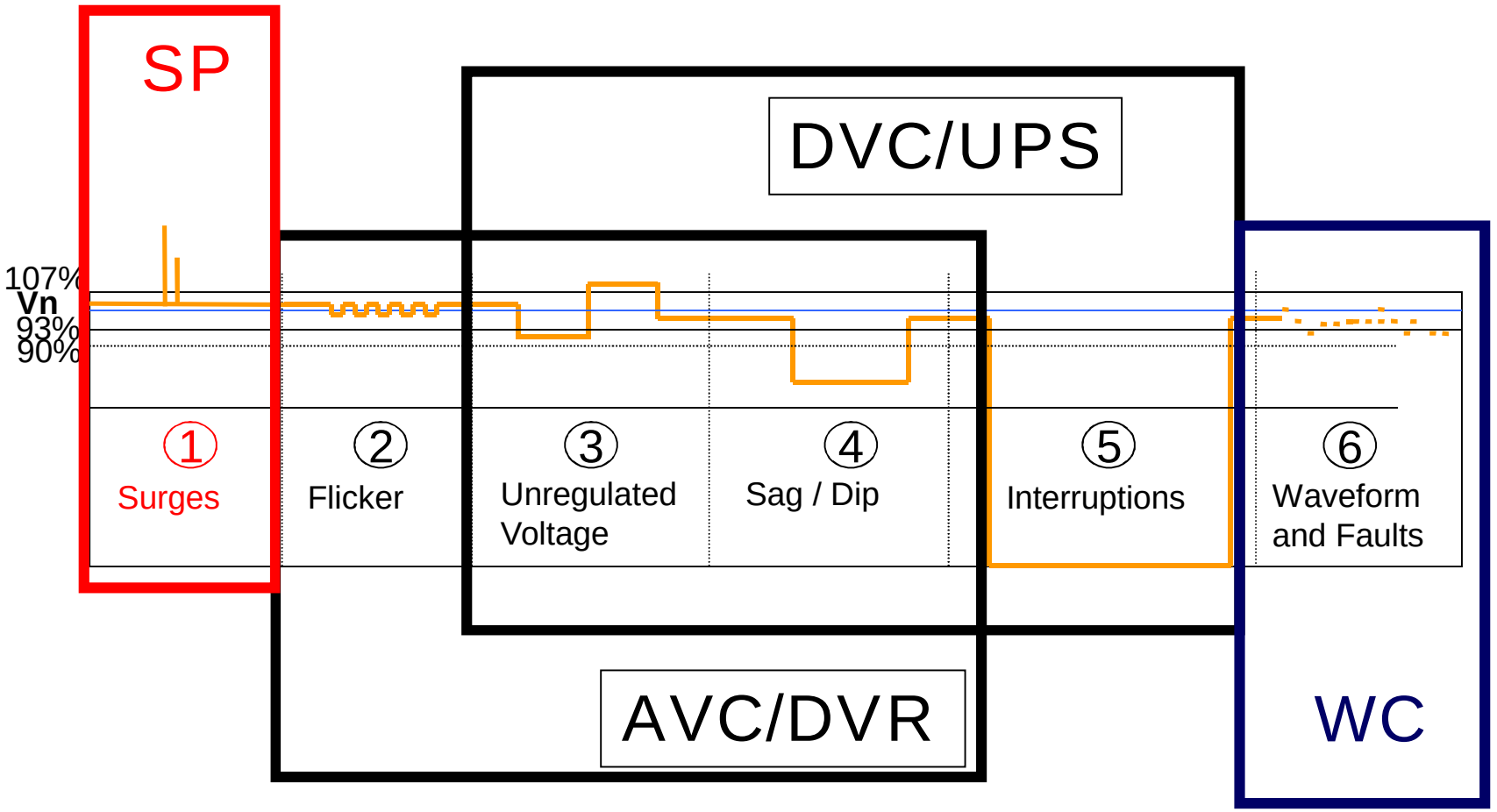
2. Protection and Back-up to Control Systems with Low Power Equipment.

3. Protection and Back-up to the whole process with High Power Equipment in both, Low Voltage and Medium Voltage.

Load Grade of Immunisation

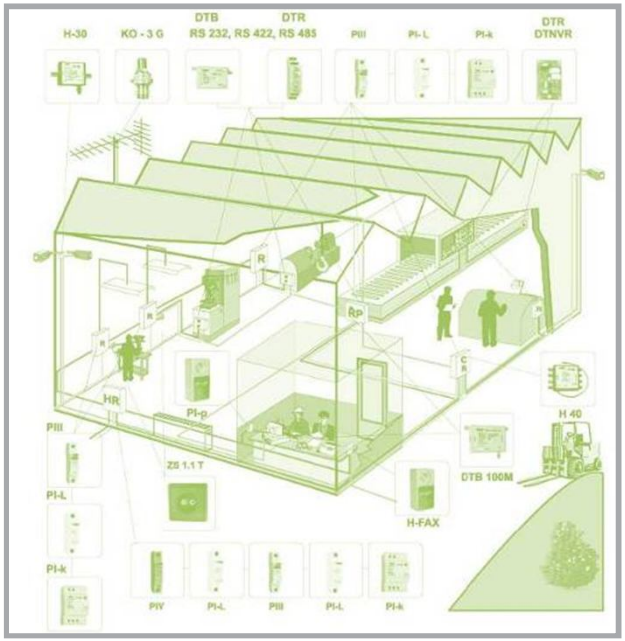
Load Distribution and Protection		
LOAD TYPE	**REQUIREMENT**	**RECOMMENDED EQUIPMENT**
Non Critical	Power Factor, Harmonics	PFC, Filter
Non Critical Sensitive	Overvoltage sensitive	TVSS
Low Power Critical	Regulation, Sag, Interruption	On-line UPS
High Power Critical I	Regulation, Sag	DVR: Dynamic Voltage Restorer
High Power Critical II	Regulation, Sag, Interruption	SEPEC, DVC : High Efficiency Industrial UPS

PQ SOLUTIONS FOR INDUSTRIAL APPLICATIONS

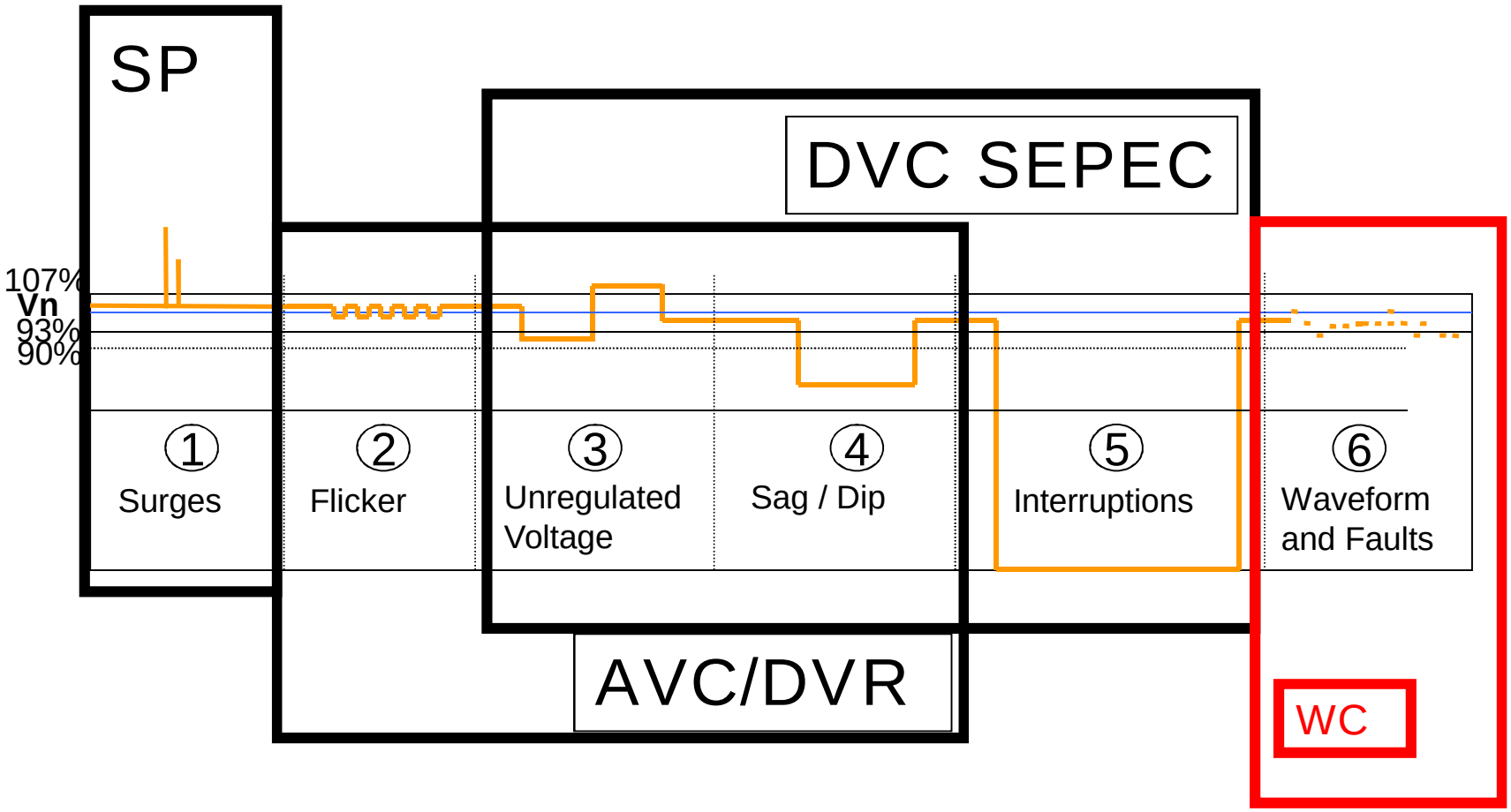


SOLUTION FOR SURGES

- ACTIVE NON DESTRUCTIVE SURGE PROTECTOR
- METAL OXIDE SUPRESSORS
- GAS DISCHARGE TUBES
- ISOLATING SPARK GAP

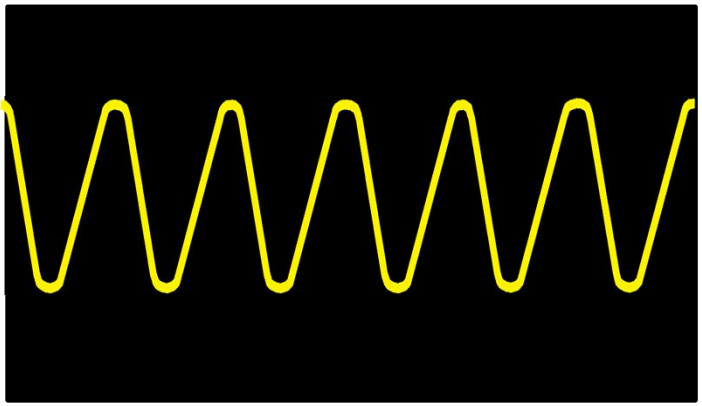


PQ SOLUTIONS FOR INDUSTRIAL APPLICATIONS

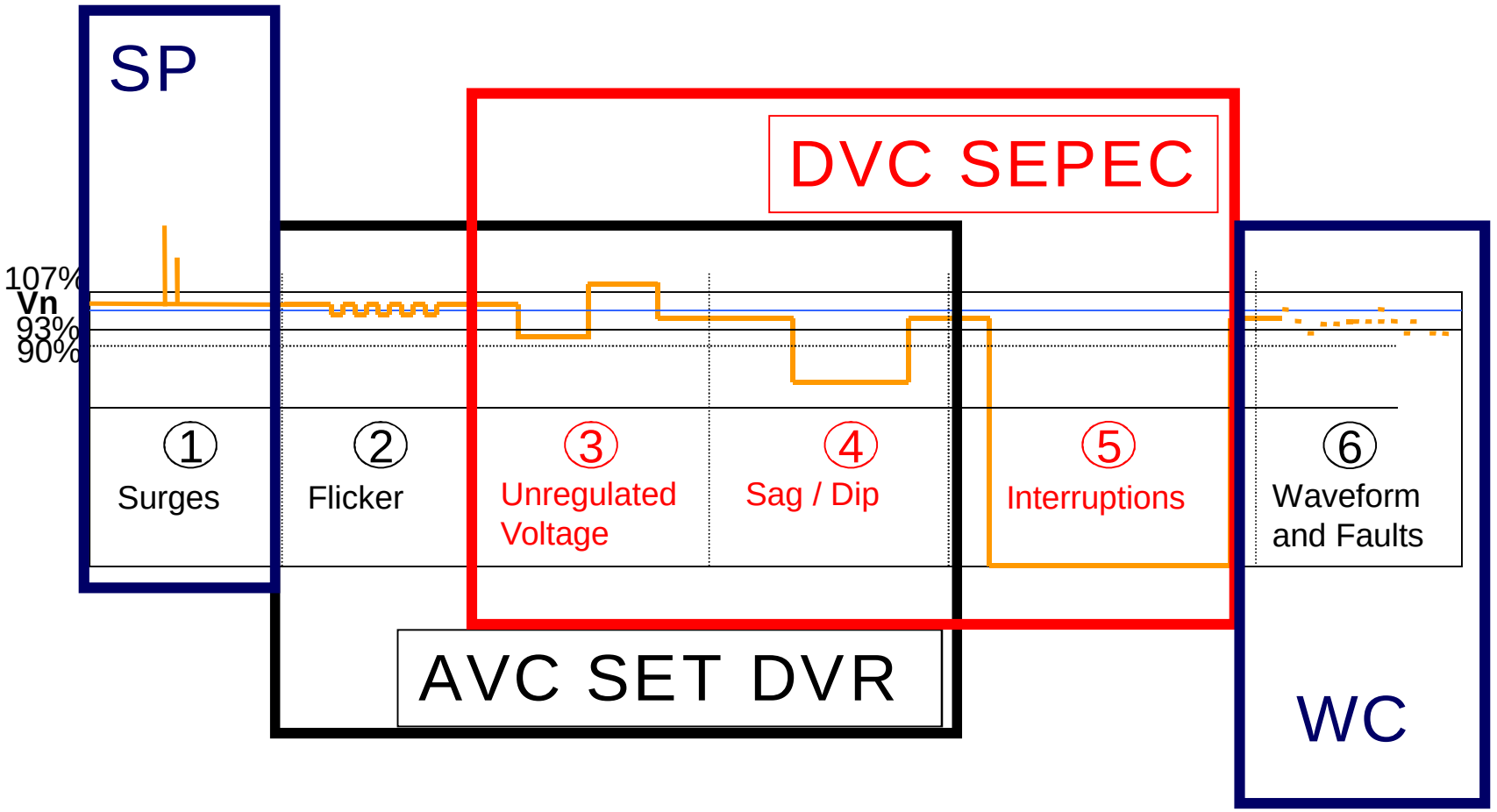


HARMONIC DISTORTION SOLUTIONS

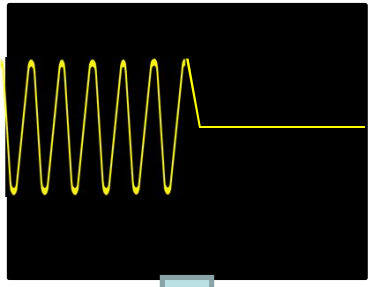
- VOLTAGE STABILIZER WITH INCREMENTAL FILTER
- ACTIVE, PASSIVE OR HYBRID FILTERS



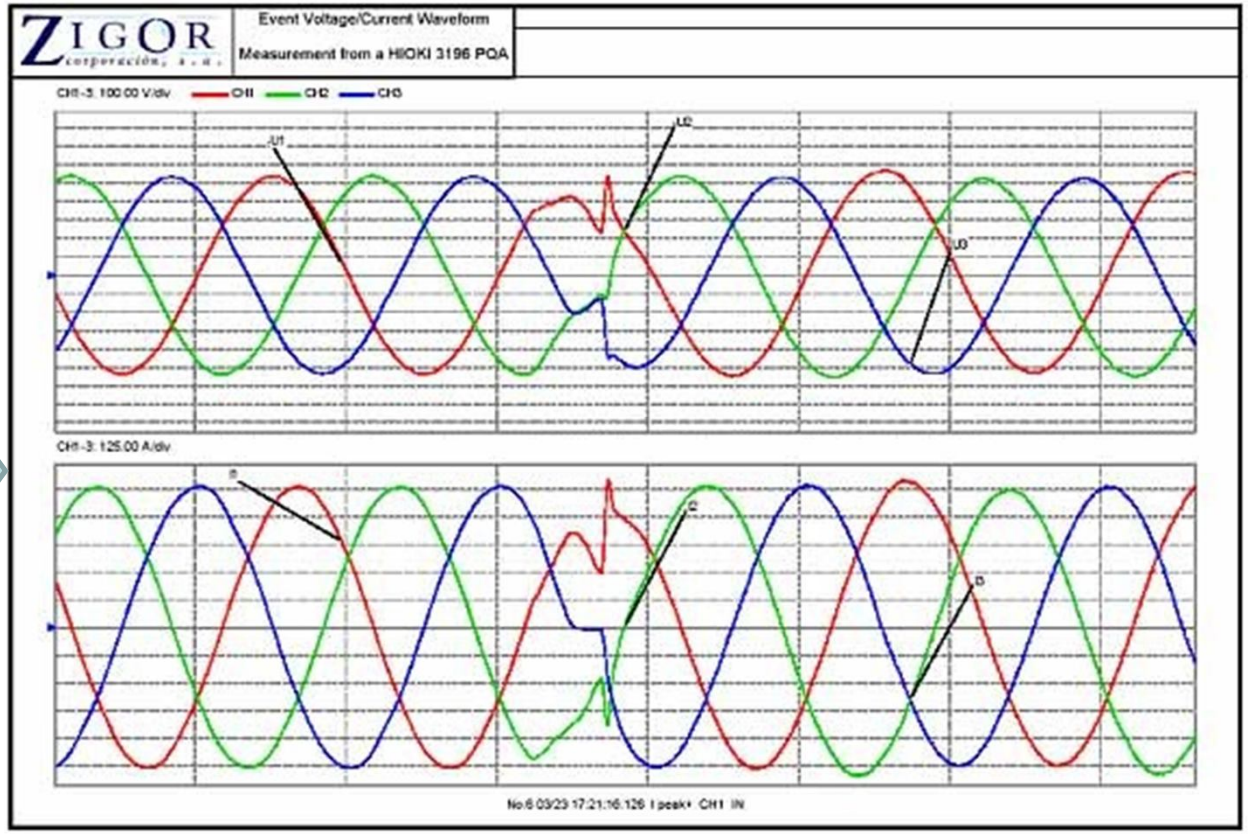
INNOVATIVE PQ SOLUTIONS FOR INDUSTRIAL APPLICATIONS



BLACK-OUT SOLUTION: DVC SEPEC



Performance for a black-out with regenerative load, return of energy and a control board equipped with a PLC and network (hubs) communication system.

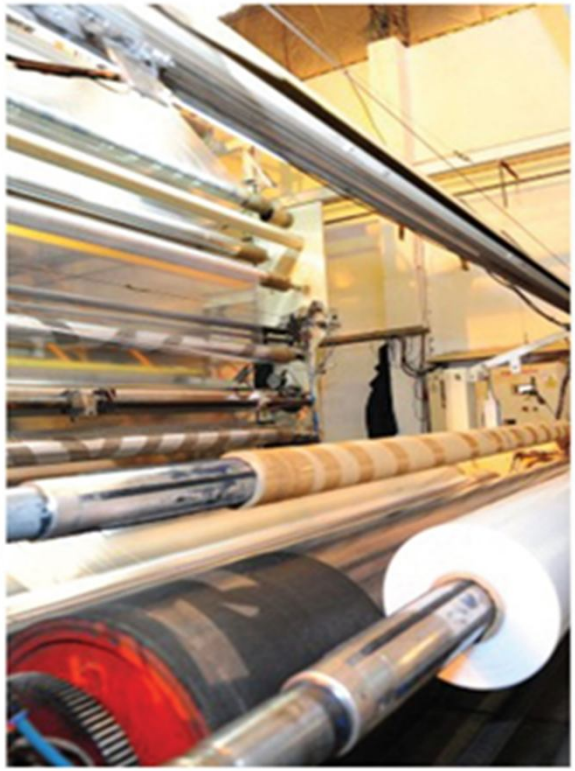


DVC SEPEC - *SPECS*

Characteristics:

- ✓ **Off-line (Stand-by) static power electronic system**
- ✓ **Very fast response: typical less than 1/4 cycle**
- ✓ **High System Efficiency over 99%**
- ✓ **Solve Short interruptions (up to 5 minutes).**
- ✓ **Relatively small Battery is required**
- ✓ **Compatible with already existing Protection Systems.**
- ✓ **Compatible with Diesel Generation System (Genset).**
- ✓ **Compatible with Regenerative Loads (Industrial Motors).**
- ✓ **Very Low Harmonic Distortion.**
- ✓ **Minimum running cost (extremely low losses, low maintenance, etc.)**
- ✓ **Advanced System for Management, Control and Diagnosis of batteries.**

SILVALAC – PLASTIC INJECTION COMPANY



SILVALAC – PLASTIC INJECTION COMPANY

SILVALAC (Barcelona) DVC SEPEC = 10.6 MVA

Process Description:

✓ Polyethylene film reel continuous production line

✓A plastic balloon is formed before the film folding process

Problem in case of black-out:

✓Production defects due to voltage fluctuation and interruption

✓Production losses due to plastic clogging in the ejector nozzle

✓Non-productive hours at cleaning

SILVALAC – PLASTIC INJECTION COMPANY

The solution:

- ✓ **Firstly, test DVC SEPEC 400KW at its old factory facilities.**
- ✓ **After checking the successful outcome, then installation in a new factory of:**

  10x DVC SEPEC 600kW and 1x DVC SEPEC 400kW.
- ✓ **Installation Year: 2006-2007**

SEPEC - Sistema de continuidad de suministro para procesos industriales en grandes potencias

FORVASA – FOOD AND BAKERY

FORVASA (Valencia) – DVC SEPEC 7.6MVA

Process Description:

- ✓Bread and pastries continuous production line
- ✓Several stages: mixing, kneading, resting and packing
- ✓Freezing process for some pastries before transportation

Problems in case of black-out:

- ✓Production defects due to voltage fluctuation and interruption
- ✓Discarded dough due to bacteria growth if frozen cycle stops
- ✓Non-productive hours at cleaning affected equipment

FORVASA – FOOD AND BAKERY

The solution:

- ✓ **Installation of 12x DVC SEPEC 600 KVA and 1x DVC SEPEC 400kVA = 7.6 MVA.**
- ✓ **Combined with Diesel Gen-set for long interruptions**
- ✓ **Installation Year: 2005-2012**

MERCADONA: SUPERMARKETS & DISTRIBUTION

MERCADONA (Valencia) DVC SEPEC <= 40MVA

Process Description:

- ✓ Fully automated logistic centre with stacker cranes, robots and conveyor belts.
- ✓Synchronization and timely movements are key factors

Problem solved in case of black-out:

- ✓Interruptions until diesel Gen-set starts
- ✓Lack of daily stock at supermarkets

MERCADONA: SUPERMARKETS & DISTRIBUTION

The solution:

- ✓ **Installation of almost 40MVA of different DVC systems.**
- ✓ **Combined with Gen-set for long interruptions**
- ✓ **Installation Year: 2006-2012**

MERCADONA: SUPERMARKETS & DISTRIBUTION

1x DVC 800kVA / 54x DVC 600kVA / 12x DVC 400kVA / 4 x DVC 200 kVA

XIAMEN YINLU: DAIRY PRODUCTS AND DRINKS

Xiamen Yinlu Foods (Nestle Group) – Fujian, China

Process Description:

- ✓ Milk / dairy products continuous production line

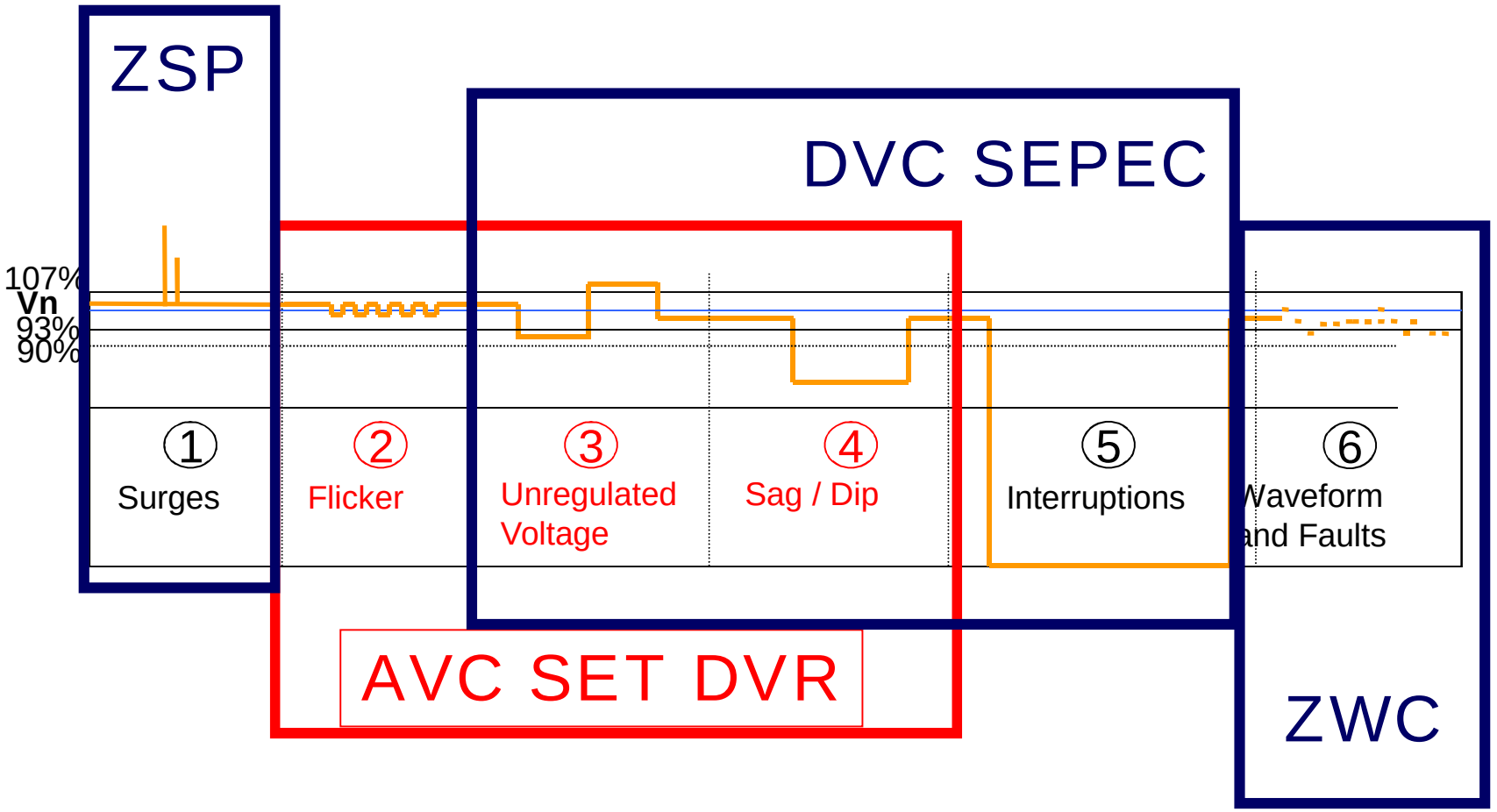
Problem solved in case of black-out:

- ✓Bacteria growth
- ✓Cleaning of production line
- ✓Re-start production cost

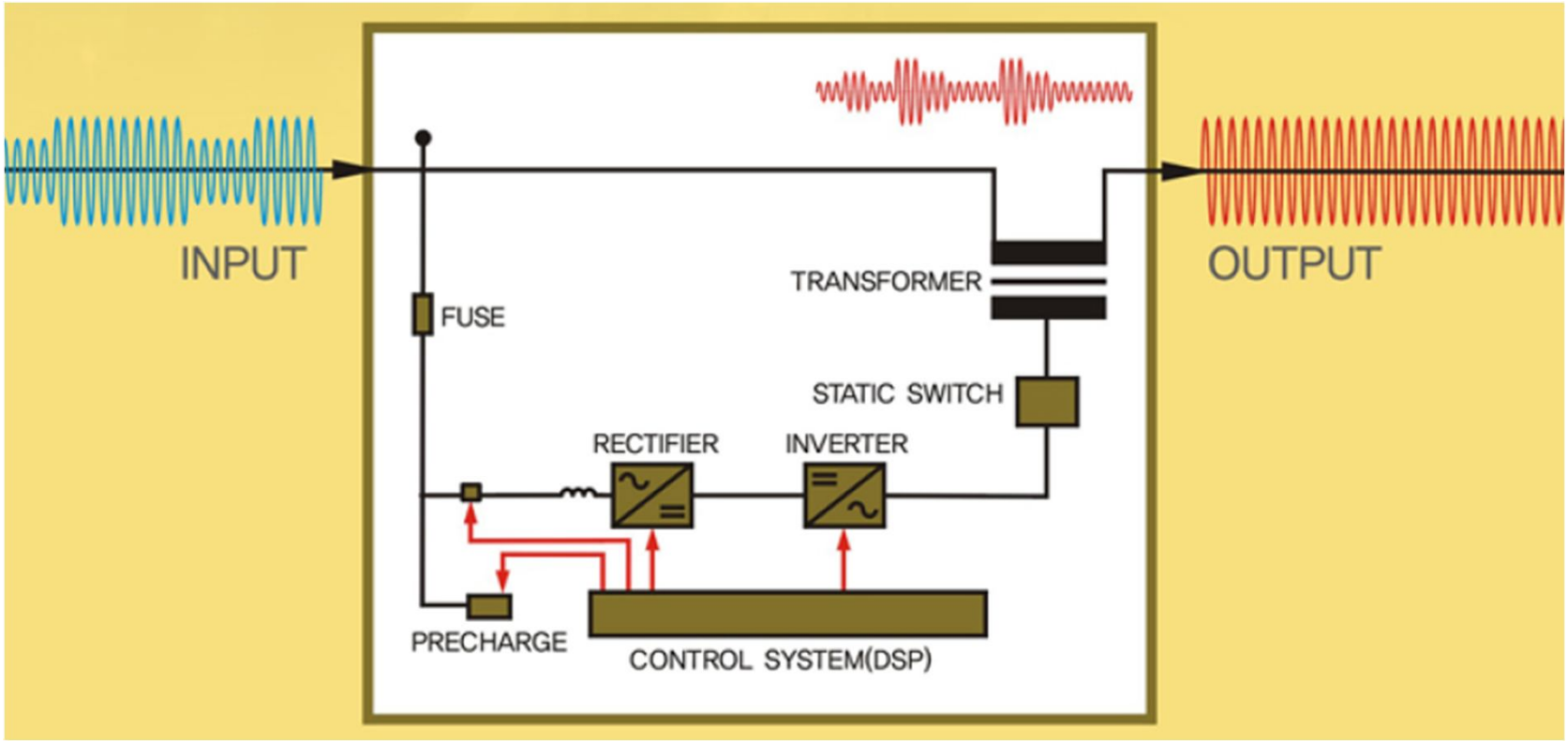
The solution:

- ✓2x DVC SEPEC 400kW
- ✓ Installation Year: 2007

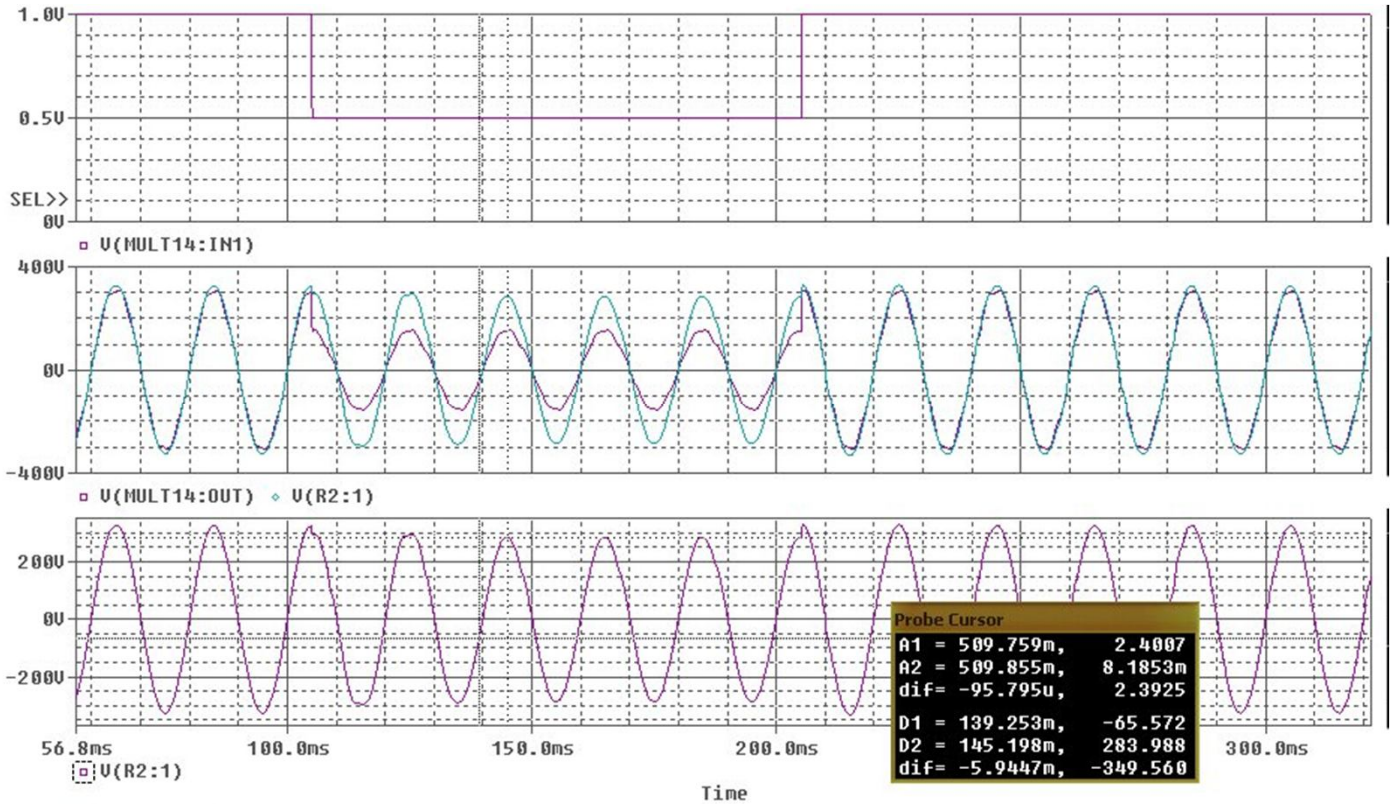
INNOVATIVE PQ SOLUTIONS FOR INDUSTRIAL APPLICATIONS



AVC SET DVR - BLOCK DIAGRAM



AVC SET DVR - DYNAMIC RESPONSE

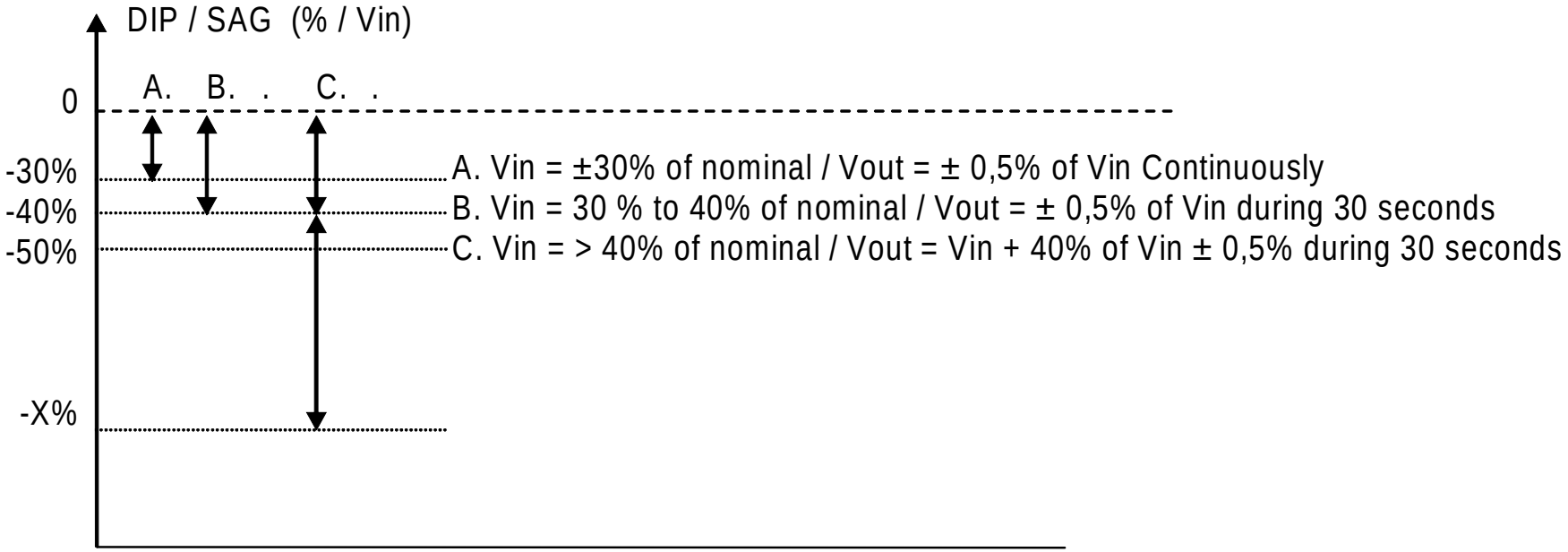


AVC SET DVR - *SPECS*

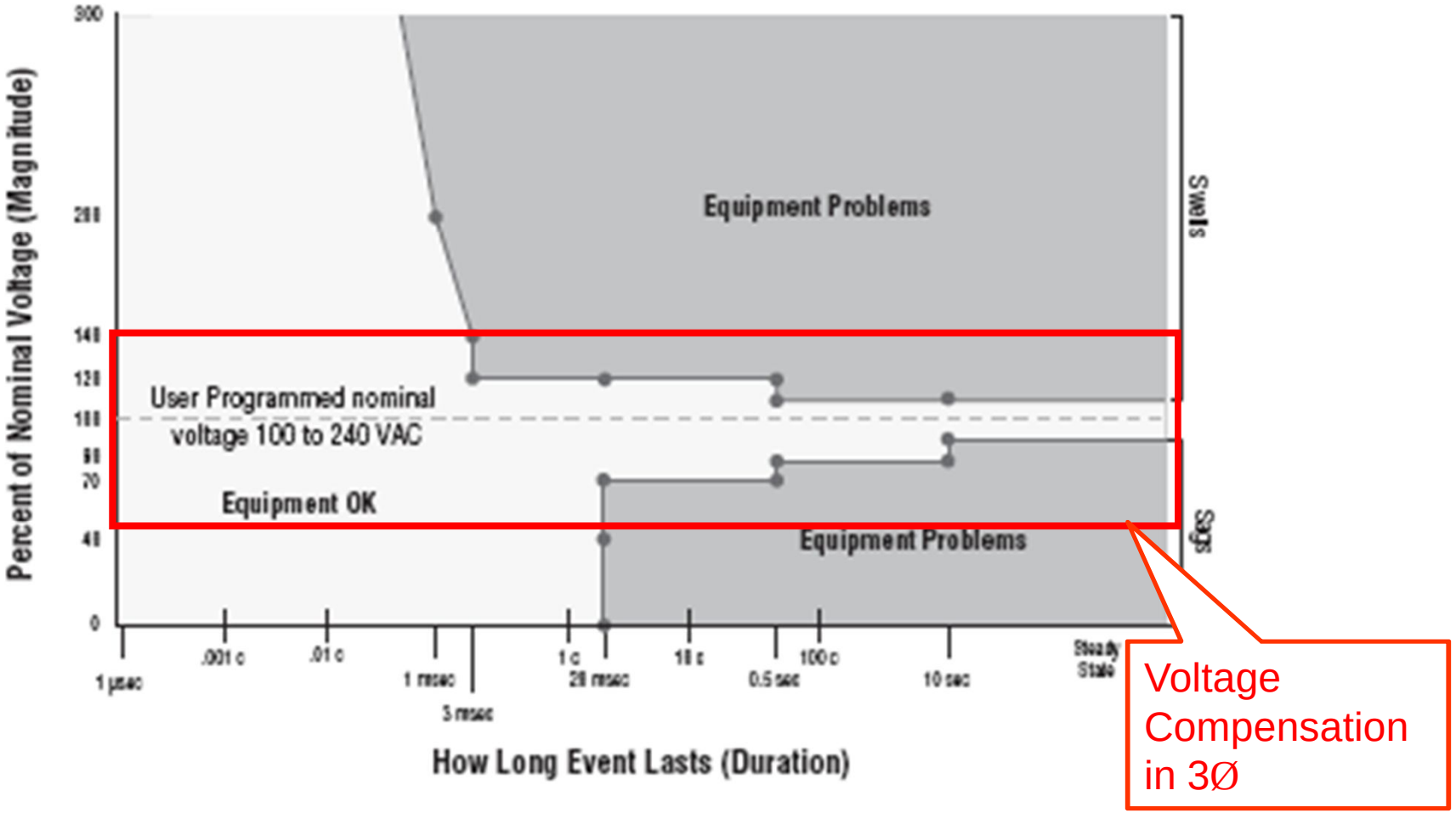
Characteristics:

- ✓ On-line static power electronic system
- ✓ Very fast response: typical less than 1/4 cycle
- ✓ Efficiency approx. 98%.
- ✓ Capable to compensate long lasting DIPS (up to 50%)
- ✓ Precise Voltage regulation : typical +/- 0.5%
- ✓ No battery required.
- ✓ Independent Phase Compensation.
- ✓ Voltage balancing capability.
- ✓ Automatic Bypass.
- ✓ Capable to operate with Industrial Regenerative Loads (four quadrant converters)

AVC SET DVR - COMPENSATION RANGE



AVC SET DVR COMPENSATION RANGE



Voltage Compensation in 3Ø

703EN00

DESALINATION PLANT

DESALINATION PLANT (Alicante) – AVC SET DVR 600KVA

Process Description:

- ✓ Reverse osmosis process
- ✓Submersible pump extraction of sea water from 18 seabed wells

Problem in case of voltage sag:

- ✓Starts and stops of the well pumps
- ✓Turbulences in the wells that make some sand to be sucked by the pumps due to voltage variations
- ✓Sand clogs that spoils the reverse osmosis membranes

DESALINATION PLANT

SET DVR 600 kVA

Desalination plant

SET DVR construction detail

The solution:

- ✓ **1x AVC SET DVR 600kVA**
- ✓ **Installed in 2006**

AIR PRODUCTS GROUP

AIR PRODUCTS GROUP (Tarragona, Spain) – AVC 2,4MW 6,6kV

Process Description:

- ✓ Liquid hydrogen continuous production for an oil refinery
- ✓ Intermediate material for oil refinery

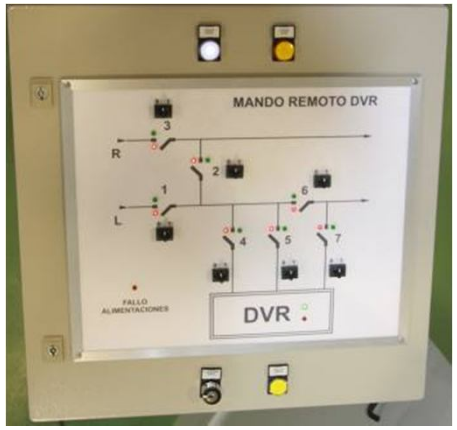
Problem in case of voltage sag:

- ✓ Emergency stop of hydrogen production due to voltage sag >12% at 6.6kV line, produced by heavy machinery in the oil refinery or summer storms
- ✓ Oil refinery stops as a consequence and takes 3 days to restart production
- ✓ Extremely high non-productive losses in refinery

AIR PRODUCTS GROUP

The solution:

- ✓ 1x AVC SET DVR 2.4MW 6.6kV
- ✓Prepared to be supplied from any of 2 different MV distribution feeders
- ✓Sag protection at MV level for all loads excepts non-critical services and outdoor lighting
- ✓Installed in March 2009
- ✓With saved production losses, investment paid back in less than 2 years



CARBUROS METALICOS

AIR PRODUCTS GROUP

Medium Voltage SET DVR

Medium-Voltage Cells

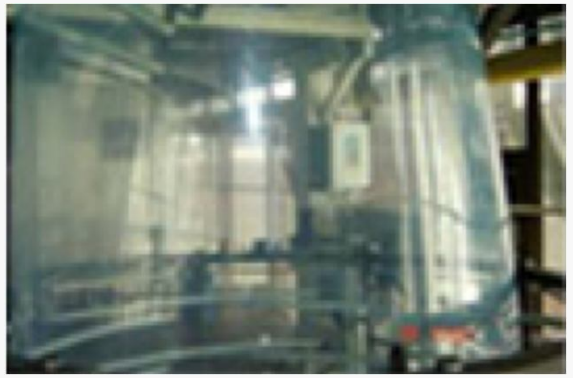
Concrete buildings

The system description:

- ✓ 1x AVC SET DVR 2.4MW 6.6kV + 1x concrete building to host the unit
- ✓1x MV switchgear + 1x concrete building to host the switchgears
- ✓MV transformer 6.6kV/400V + Booster of MV transformer 6.6kV + 1x concrete building

SOTRAFA – PLASTIC INJECTION

SOTRAFA (Almeria) – AVC SET DVR 3.6MW 20KV



Process Description:

✓ Polyethylene film reel continuous production line

Application:

Plastics for agriculture (greenhouse), livestock and construction

Problem in case of voltage sag :

✓Production defects due to voltage fluctuation

✓Production losses due to clogging of ejector nozzle

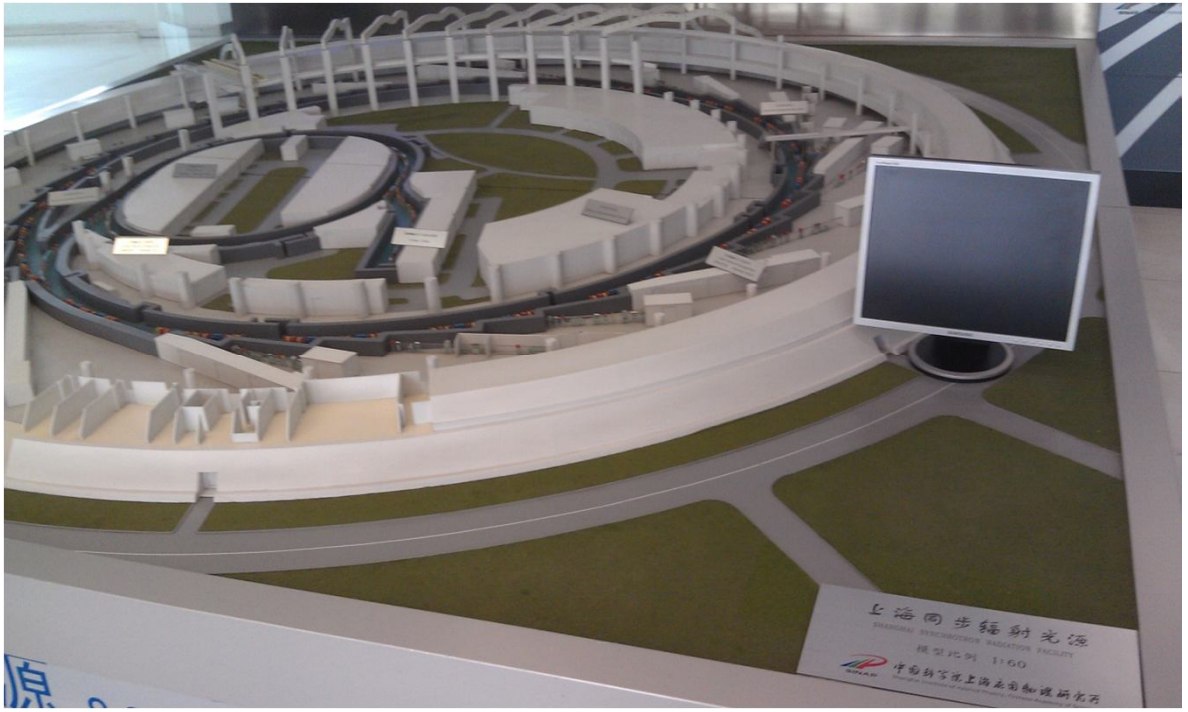
✓Non-productive hours at cleaning

SOTRAFA – PLASTIC INJECTION

The solution:

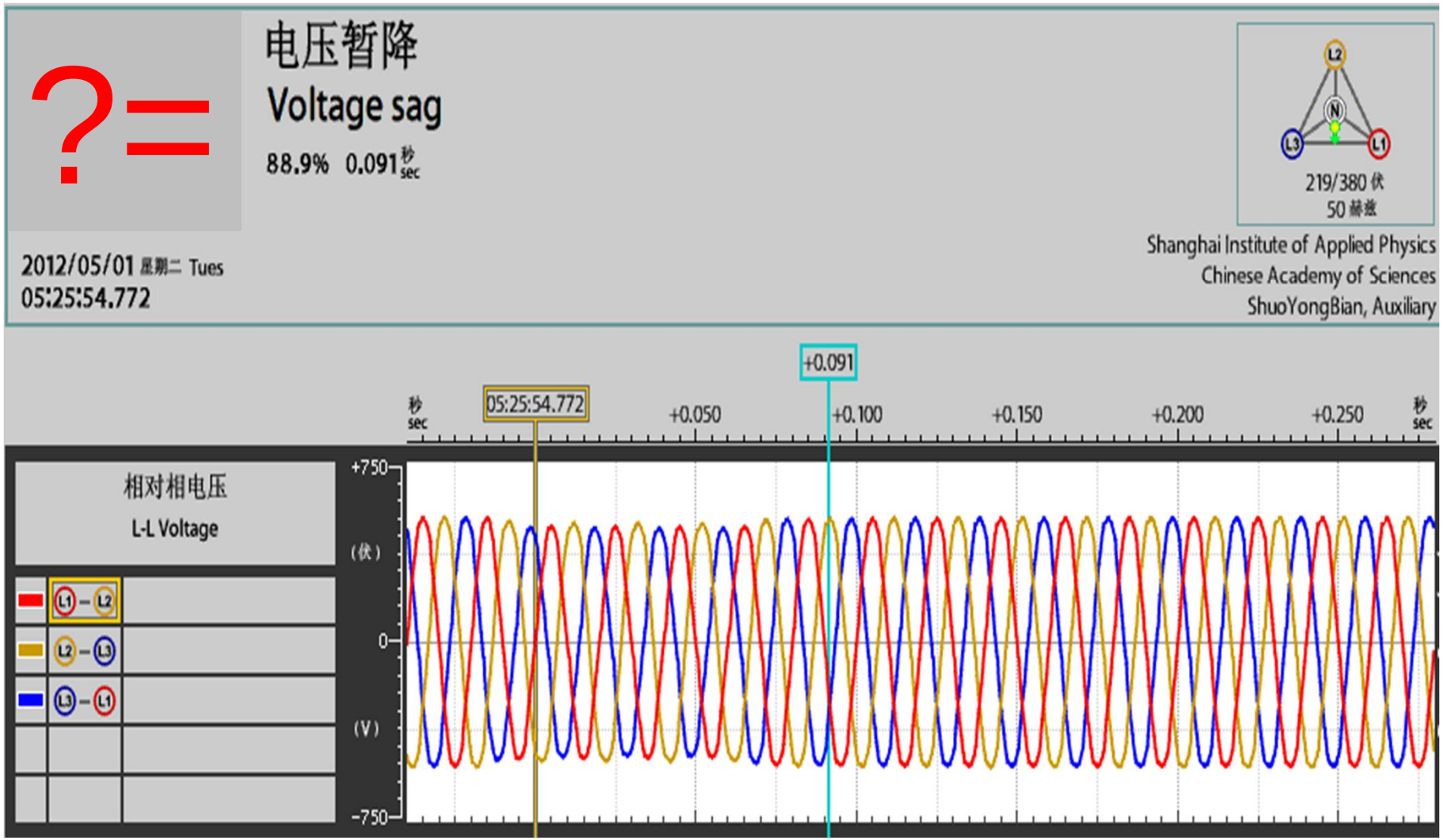
- ✓ 1x AVC 3.6MW 20kV + MV transformer + MV Switchgear
- ✓ at the 20KV substation protecting the whole factory
- ✓ Installed in December 2012

WHERE ELSE SAG PROTECTION IS NEEDED ?

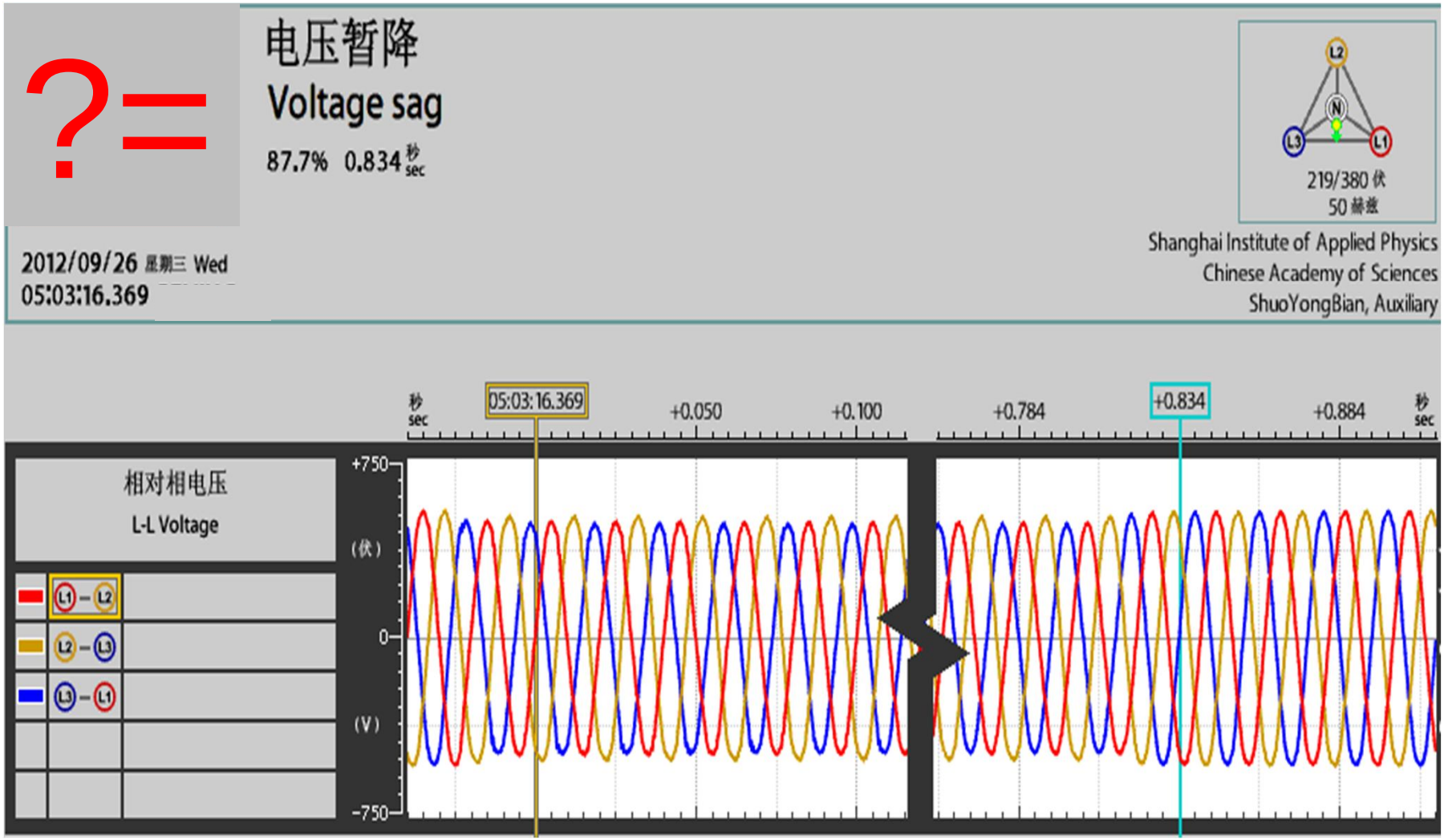


EVEN IN A PARTICLE ACCELERATION FACILITY

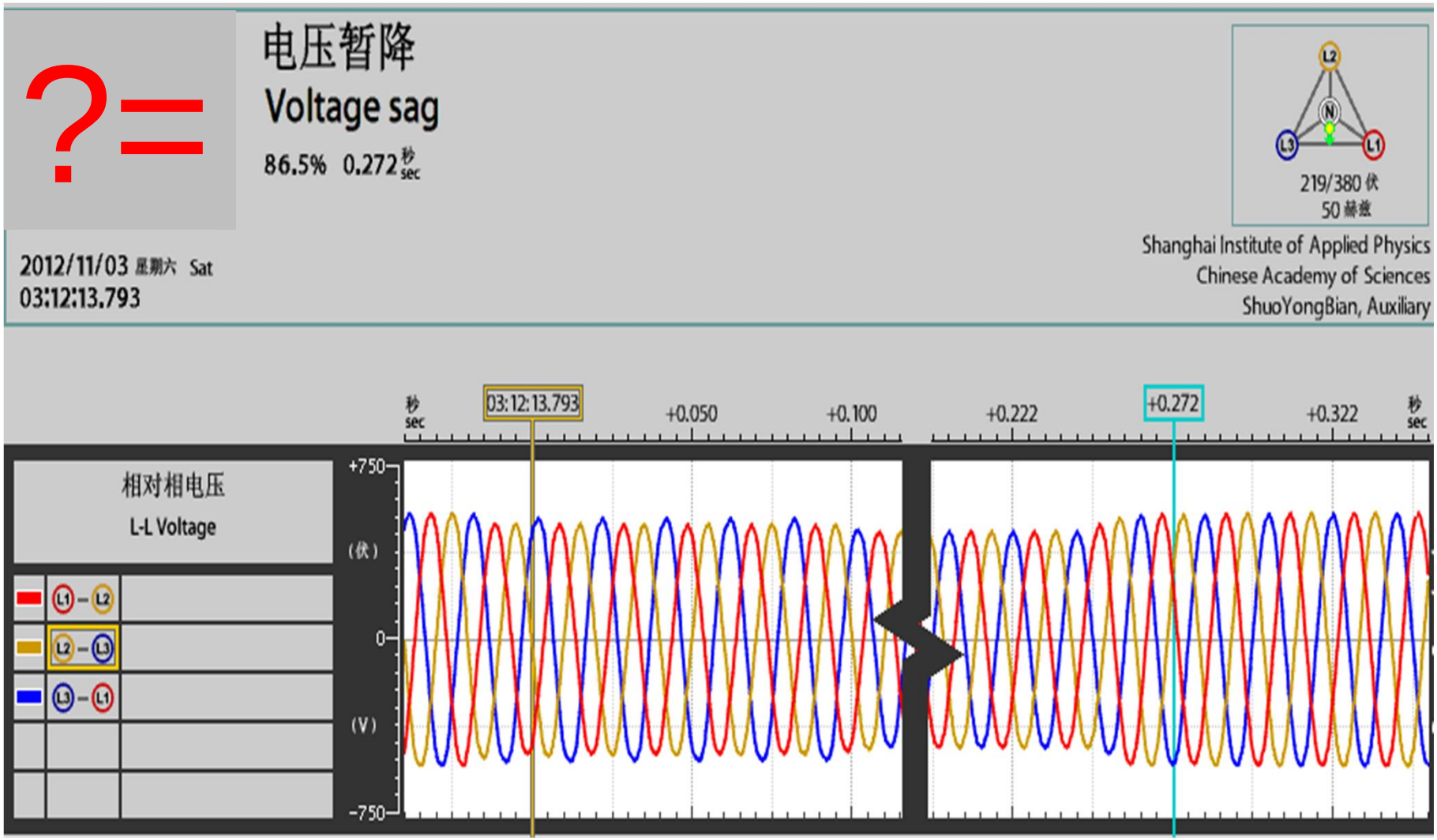
SAG IN A PARTICLE ACCELERATION FACILITIES (1)



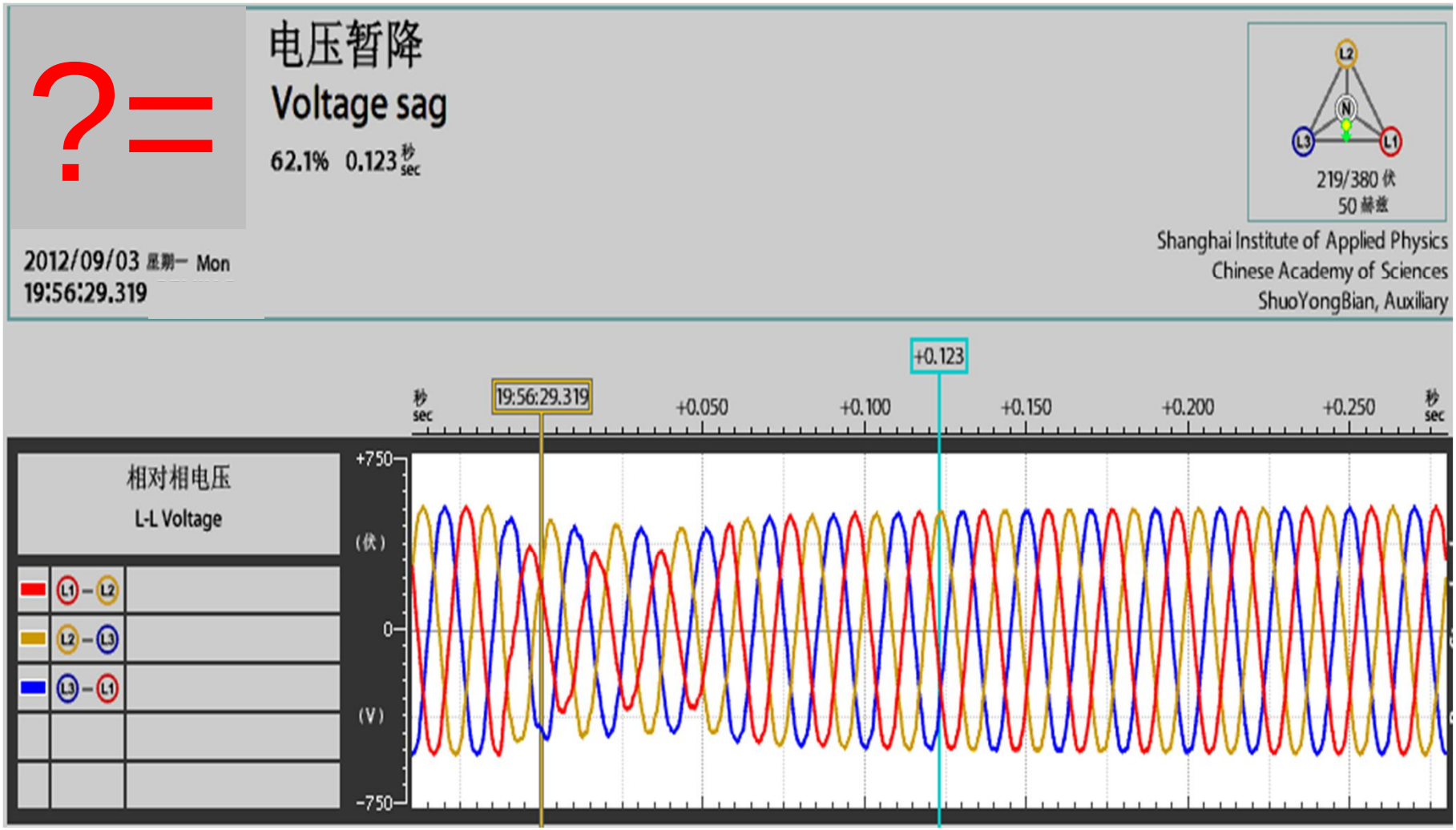
SAG IN A PARTICLE ACCELERATION FACILITIES (2)



SAG IN A PARTICLE ACCELERATION FACILITIES (3)



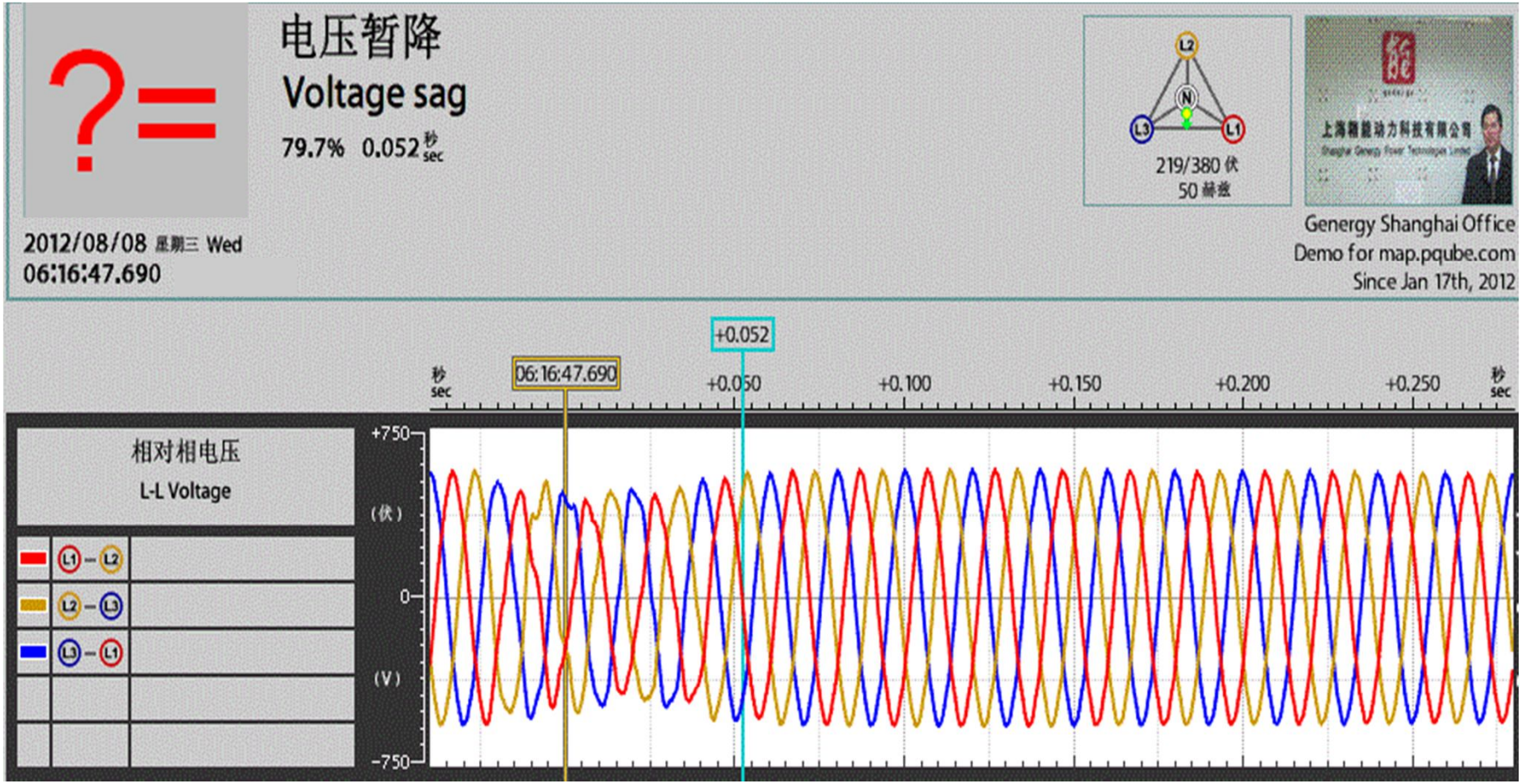
SAG IN A PARTICLE ACCELERATION FACILITY (4)



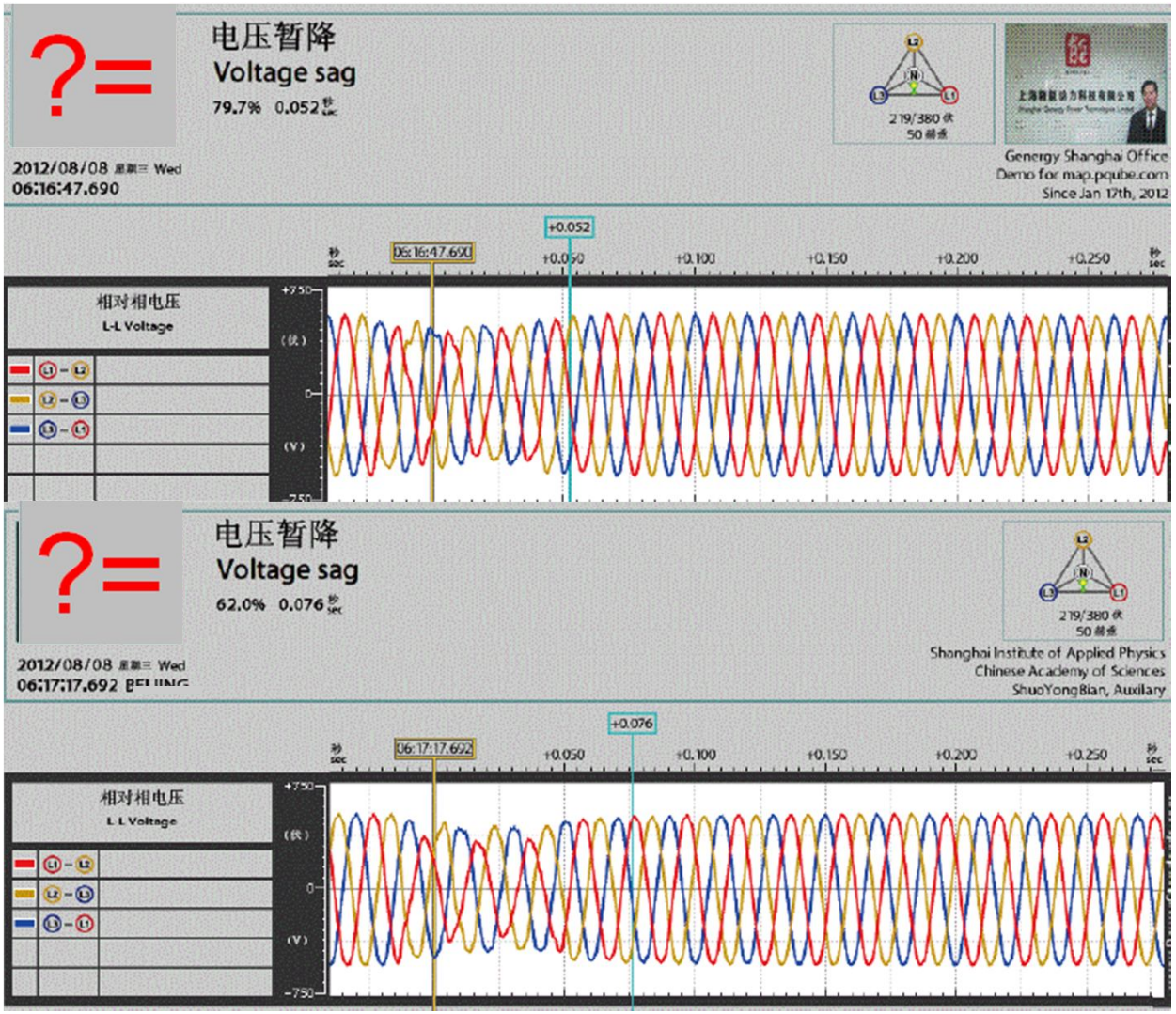
SAG IN PARTICLE ACCELERATION FACILITY (5)

WHAT IS HAPPENING 26 KILOMETERS AWAY?

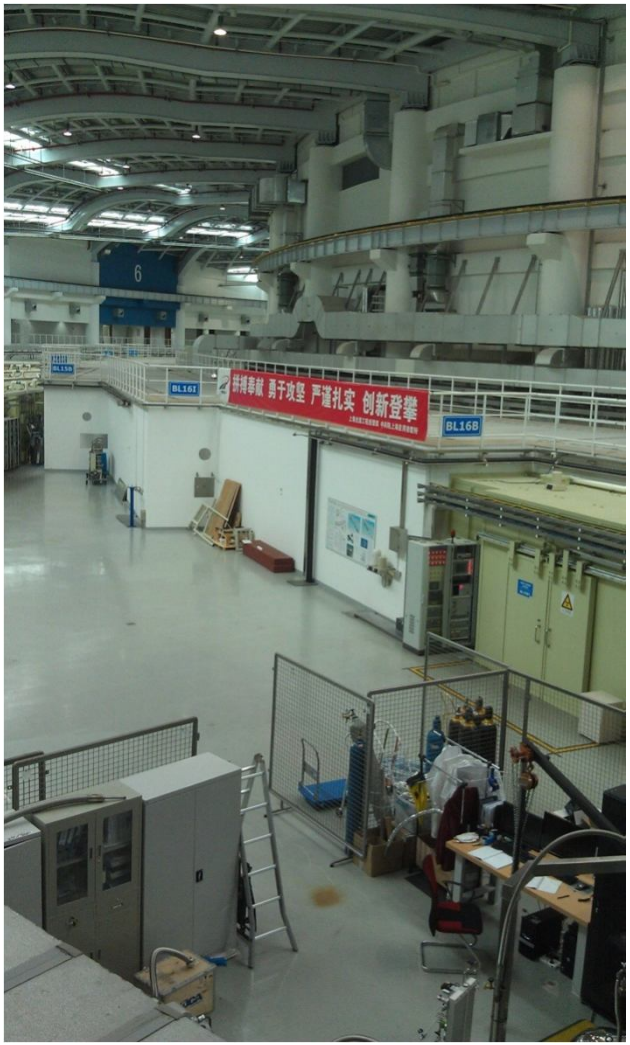
SAG IN PARTICLE ACCELERATION FACILITIES ? (6)

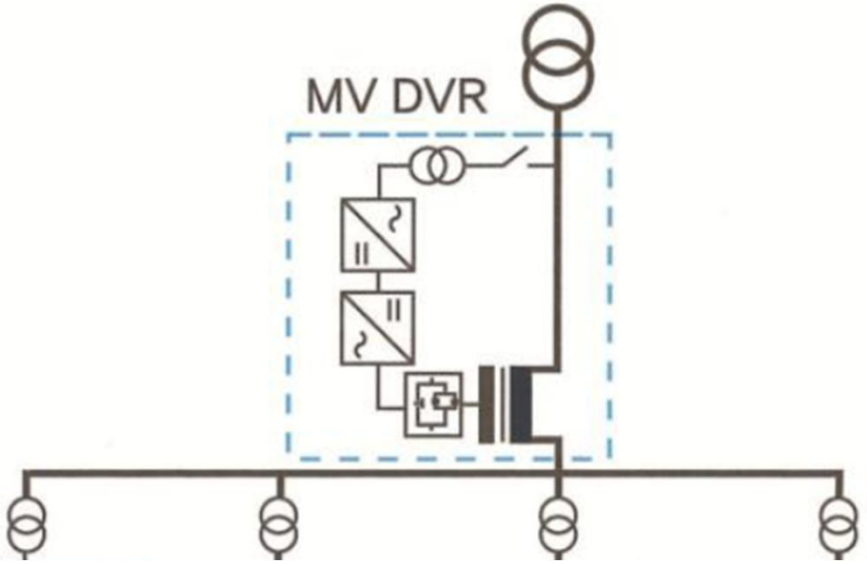


SAG IN PARTICLE ACCELERATION FACILITIES ? (7)

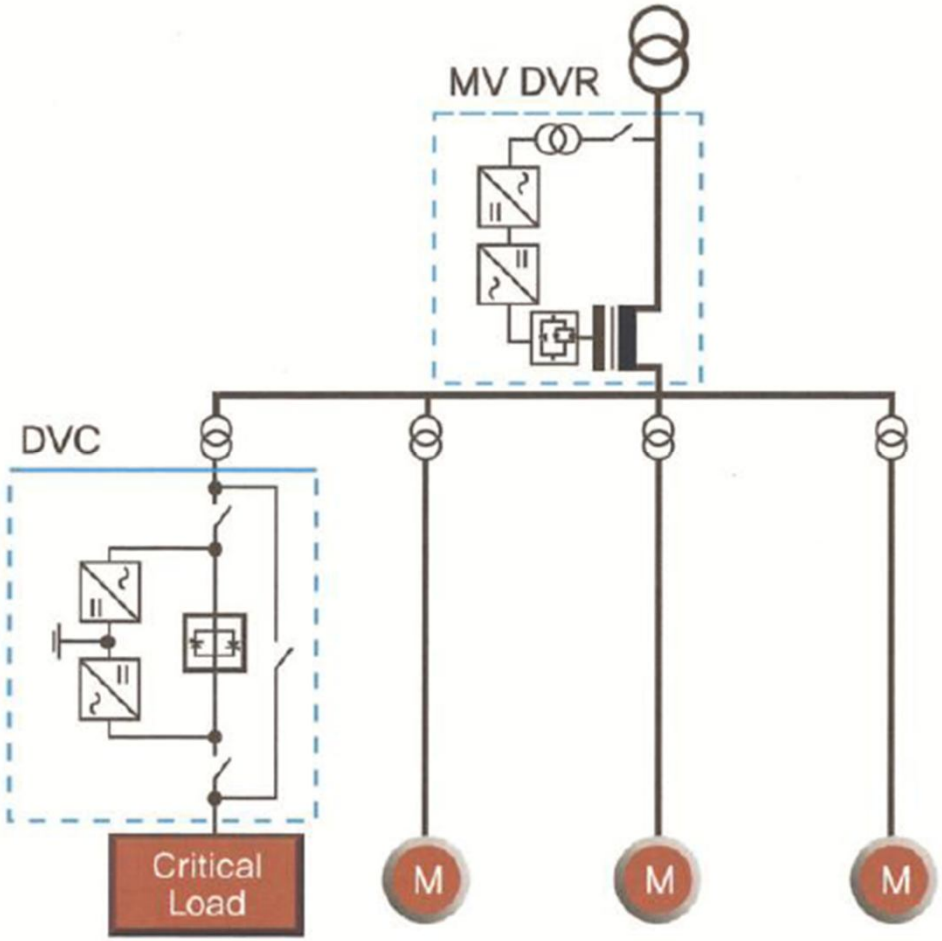


SOLUTION (1) IN PARTICLE ACCELERATION FACILITY





SOLUTION (2) IN A PARTICLE ACCELERATION FACILITY



THANKS

FOR YOUR KIND ATTENTION

Zigor HK Ltd.