Adapting Muon Endcap UF/PNPI HV system for GEM
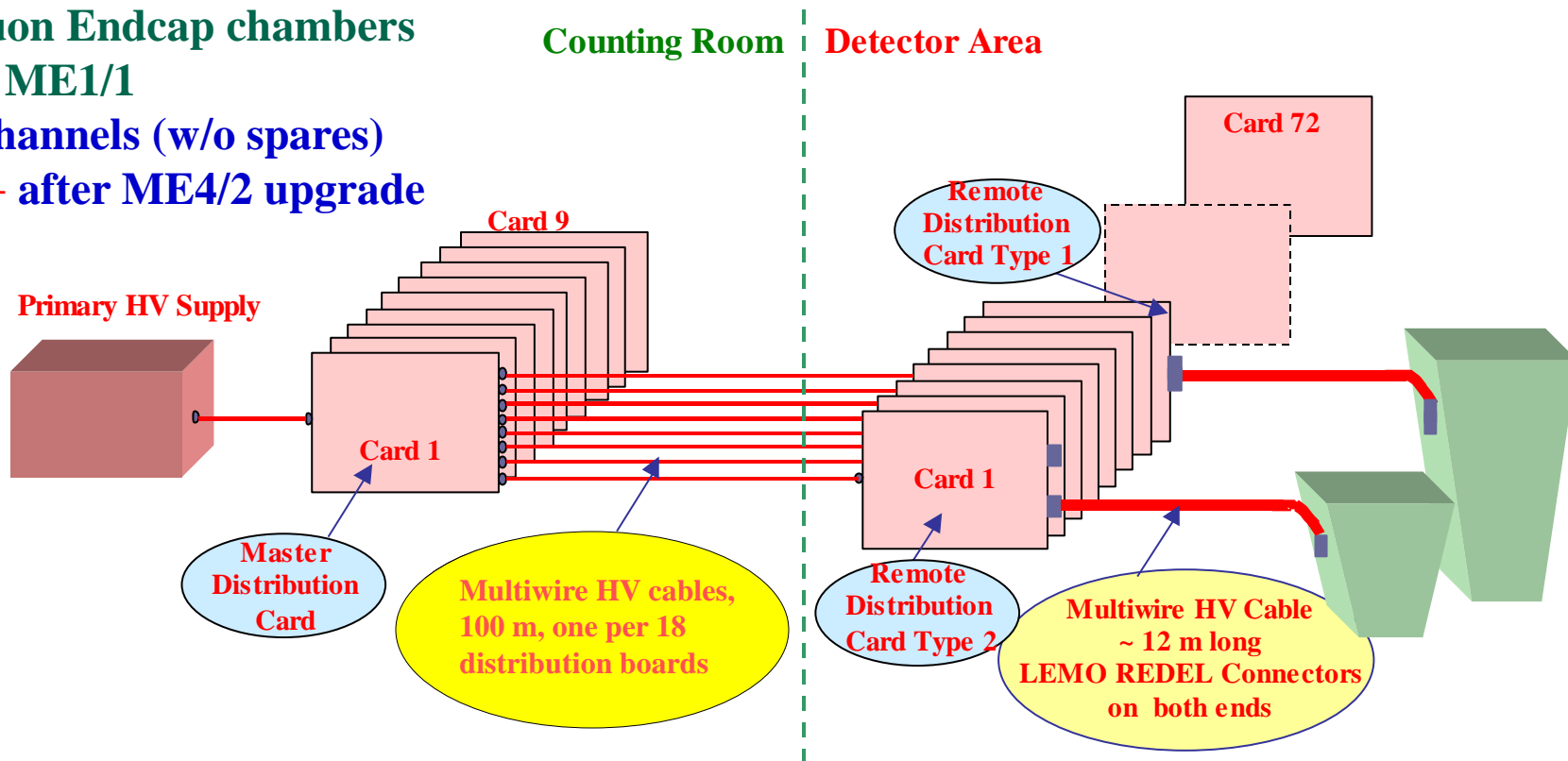
V. Barashko, A. Korytov, <u>A. Madorsky</u>, G. Mitselmakher

University of Florida/Physics

N. Bondar, V. Golovtsov, P. Levchenko, L. Uvarov,

S. Vavilov, S. Volkov

St. Petersburg Nuclear Physics Institute (PNPI)

All Muon Endcap chambers except ME1/1

9006 channels (w/o spares)

11000+ after ME4/2 upgrade

Counting Room | **Detector Area**

Primary HV Supply

Card 9

Card 72

Remote Distribution Card Type 1

Card 1

Master Distribution Card

Multiwire HV cables, 100 m, one per 18 distribution boards

Card 1

Remote Distribution Card Type 2

Multiwire HV Cable ~ 12 m long LEMO REDEL Connectors on both ends

- Primary HV power supplies: off the shelf

- Master board: One output per distribution board. Regulates voltage 0-4KV (VMAX), measures current on each output.

- Remote Distribution board: powers one large or two small chambers (36 outputs max). Regulates voltage 1KV down from VMAX, measures current on each output. Each output can be disconnected from HV if necessary.
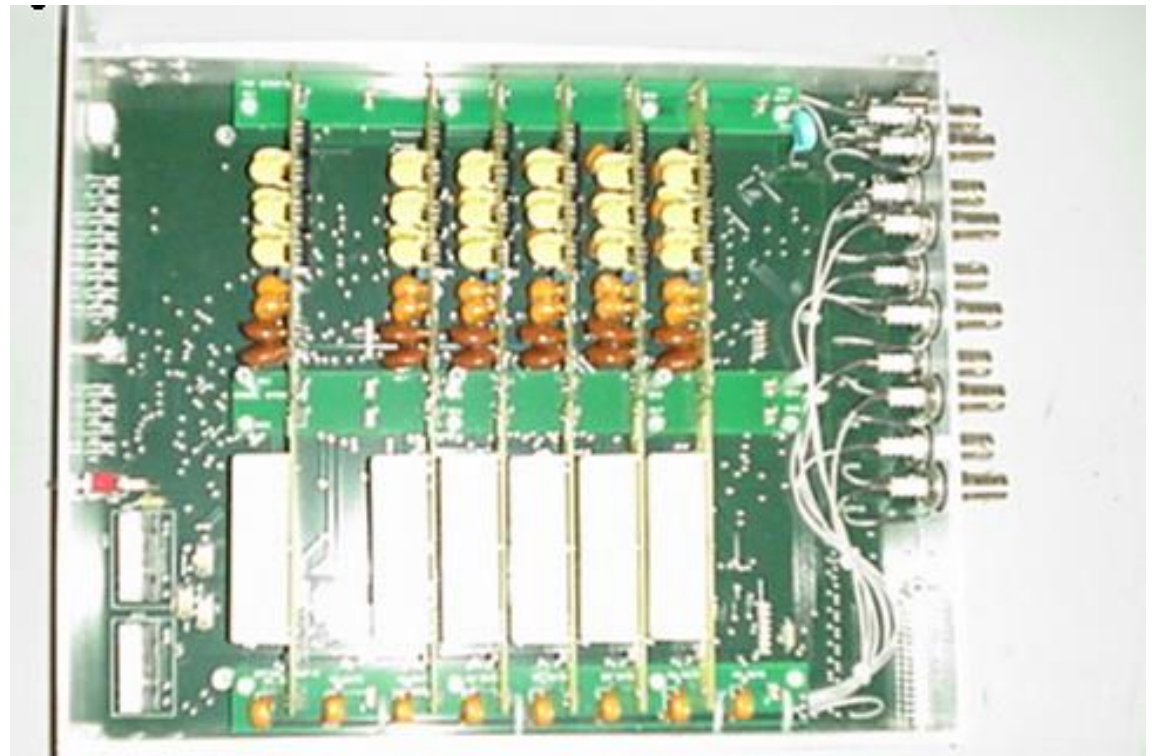
Primary HV Power supply

- ➢ **Off the shelf unit**
- ➢ **Matsusada AU type**
- ➢ **Up to 5KV output**
- ➢ **60 mA**
- ➢ **Control : RS-232**
- ➢ **Overcurrent protection**
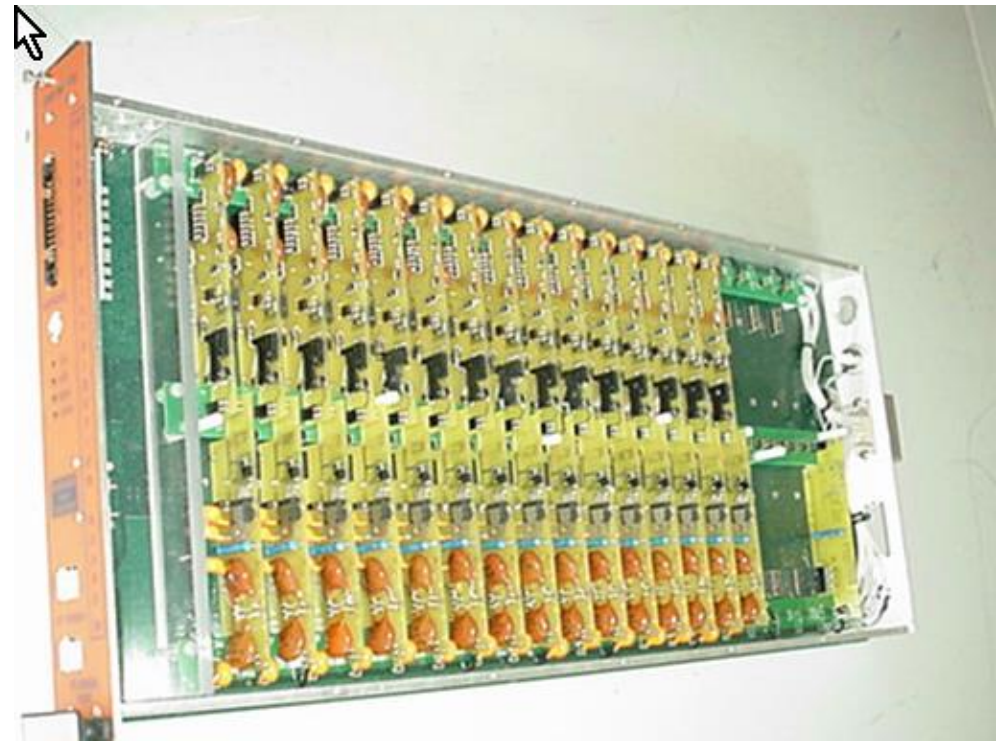- ➢ **Door switch**
- ➢ **Floating output**

Master board

- 8 channels
- Full range regulators 0-4KV
- Up to 1.5 mA per channel
- NOT rad-hard
- Located in S1 (control room)
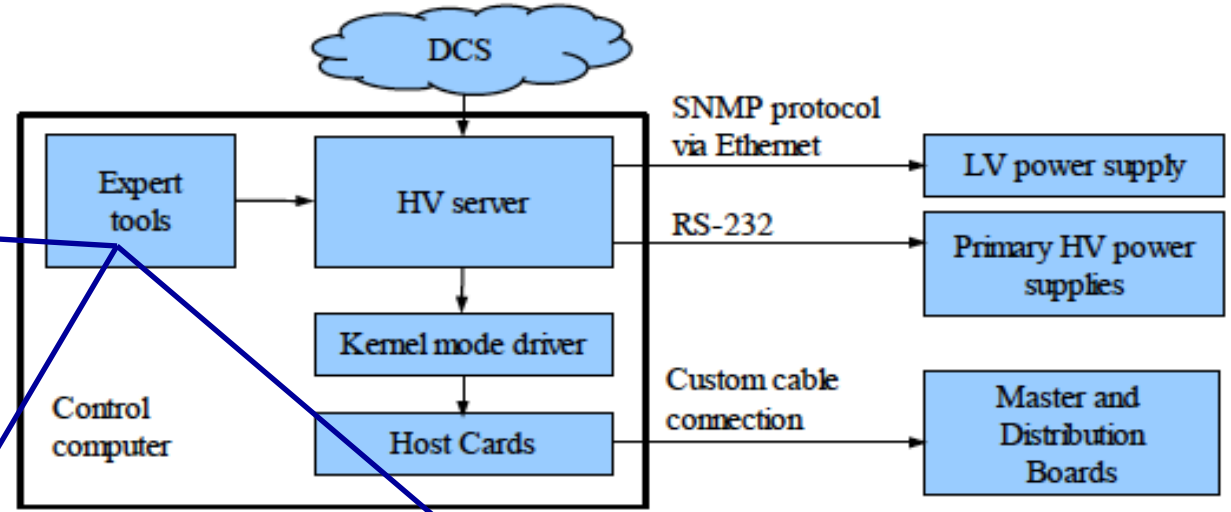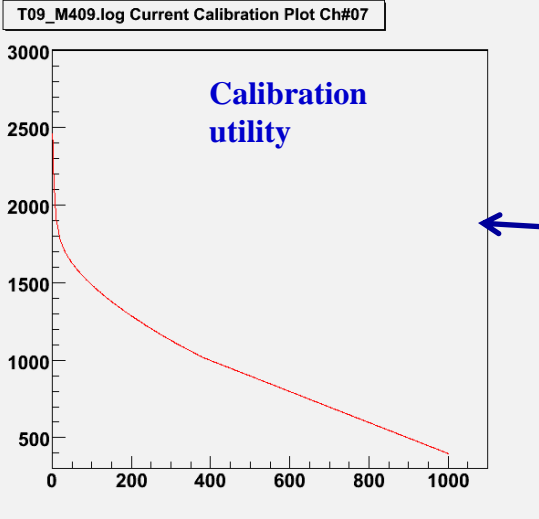- Voltage and current measurement on each channel

- **Up to 38 channels**
- **Partial range regulators (~1KV down from input V)**
- **Each channel can be disconnected from load**
  - ❖ **Remote-blow fuse**
- **Up to 100 uA per channel**
- **Rad-hard, magnetic field-tolerant**
- **Located in UXC (CMS cavern), near disks**
- **On each channel:**
  - ❖ **Voltage and** current limit programmable
  - ❖ **Voltage and current measurement**
- **Voltage resolution:**
  - ❖ **~1V**
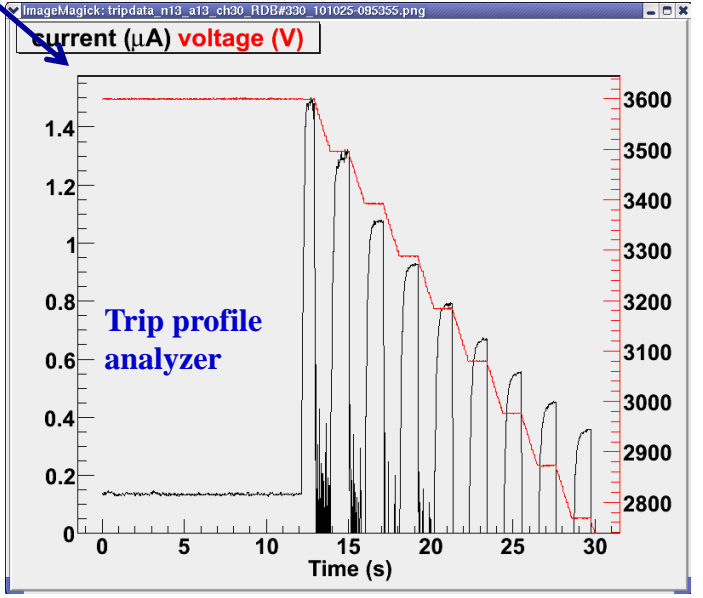- **Current measurement resolution:**
  - ❖ **100 nA**

UF UNIVERSITY of FLORIDA

T09_M409.log Current Calibration Plot Ch#07

Calibration utility

DCS

SNMP protocol via Ethernet → LV power supply

RS-232 → Primary HV power supplies

Custom cable connection → Master and Distribution Boards

Control computer: Expert tools, HV server, Kernel mode driver, Host Cards

Expert GUI (Java)
Shows V and I on each segment in each chamber
Lets you control all parameters independently of DCS

current (μA) voltage (V)

Trip profile analyzer

UNIVERSITY of FLORIDA

Purposes

- ➢ **Safety of the personnel**
- ➢ **Protection of the end-loads**
- ➢ **Protection of system components**

Fail-safe devices:

- ➢ **Interlocks**
  - ❖ **All long cables**
- ➢ **Primary HV PS overvoltage protection**
  - ❖ **Remove PHVPS AC power in case of overvoltage**
- ➢ **Hardware watchdog**
  - ❖ **Monitors main control software loop activity**
  - ❖ **Turns PHVPS off if activity is missing for ~10 sec**
  - ❖ **Protects against:**
    - ❑ **software bugs**
    - ❑ **computer hardware failure**
    - ❑ **computer power cut-off**
- ➢ **Overvoltage and overcurrent protection on each output channel**
  - ❖ **All thresholds programmable**
- ➢ **Dead or disconnected board detection**

UF | UNIVERSITY of FLORIDA

What can we do for GEM

- **Each voltage input should be powered from its own regulator**
  - ❖ **Voltages are individually adjustable**
  - ❖ **Currents are measured on each channel**
- **GEM segment ganging will be needed**
  - ❖ **Table shows one possible option →**
- **CMS Distribution board can have up to 38 outputs**
  - ❖ **Two GEM chambers, 19 outputs each**
- **Other ganging options possible**

GEM chamber voltages		
Voltage (V)	Segments (unganged)	Segments (ganged x7)
-3760	1	1
-2860	35	5
-2410	1	1
-2060	35	5
-1620	1	1
-920	35	5
-500	1	1
Per chamber	109	19
In system	15696 ☹	2736 ☺

- **Polarity reversal**
  - ❖ **CMS CSC HV boards are designed for positive output**
  - ❖ **Provisions for polarity reversal made**
  - ❖ **This has not been tested**
  - ❖ **Regulators need significant rework**
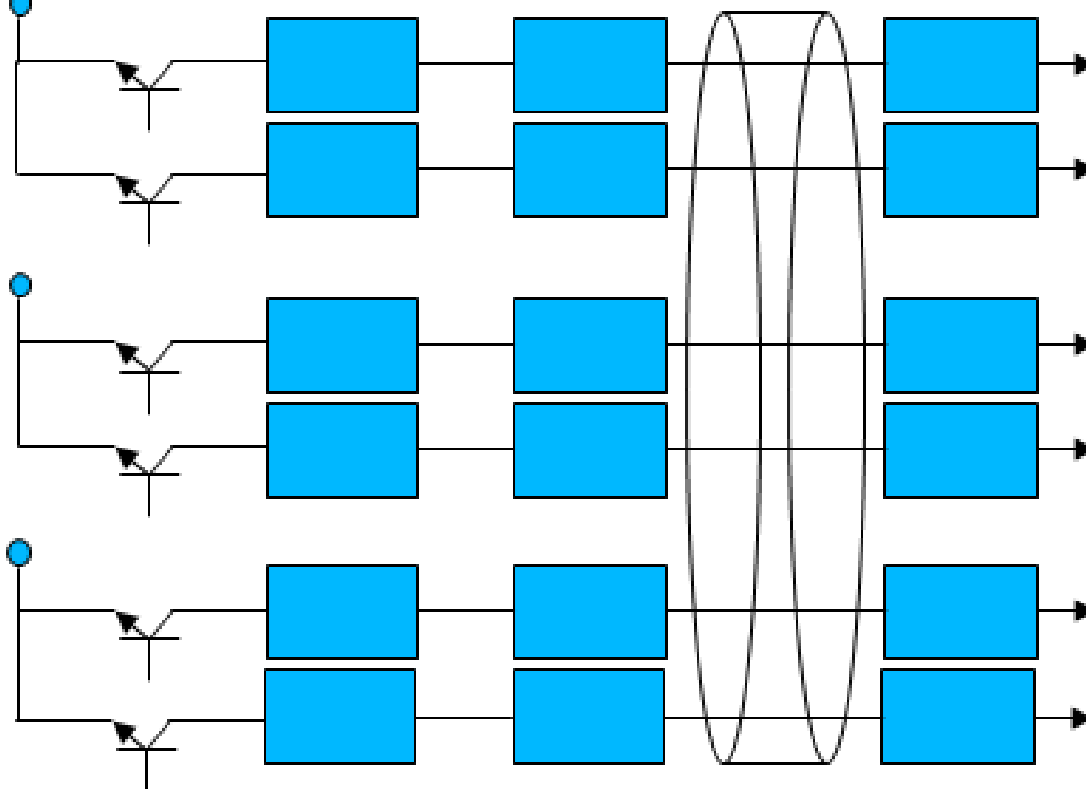
- **Multiple output voltages**
  - ❖ **Distribution boards (DB) have a single HV input.**
  - ❖ **All output voltages are regulated down from input voltage.**
  - ❖ **Maximum regulating range is ~1KV**
  - ❖ **Need multiple inputs on DB**

UNIVERSITY *of* FLORIDA

HV power inputs

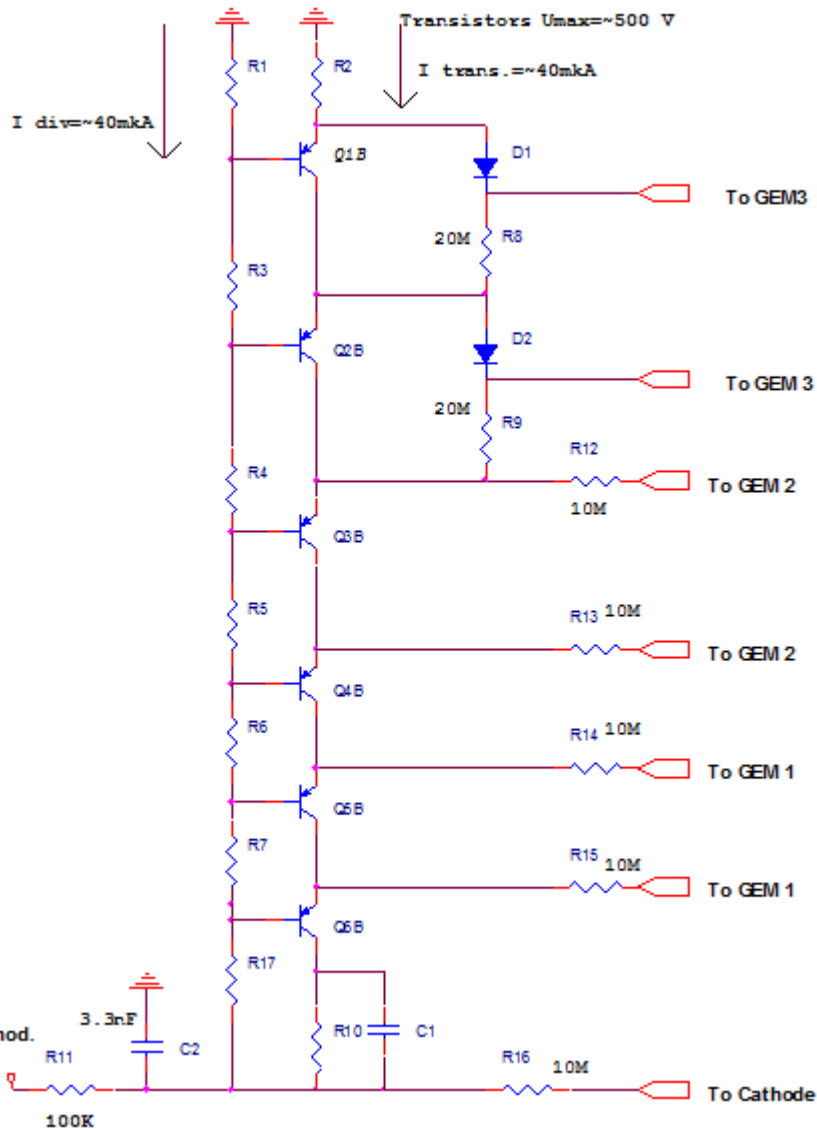-3800V

-2600V

-1400V

Regulating transistors   Filters   Current sensors   Long cable   Filters In GEM

- **Low-current active divider**
- **Voltages are fixed - no adjustment**
- **All foils on the same layer ganged together**
- **Not based on current DB**
- **New development required**

- ➢ **Two options are proposed**
- ➢ **Currently under discussion with PNPI colleagues**
- ➢ **Will have a meeting with A. Marinov, PNPI colleagues and me this week, for detailed discussion**