Development of μHV miniature HV supplies

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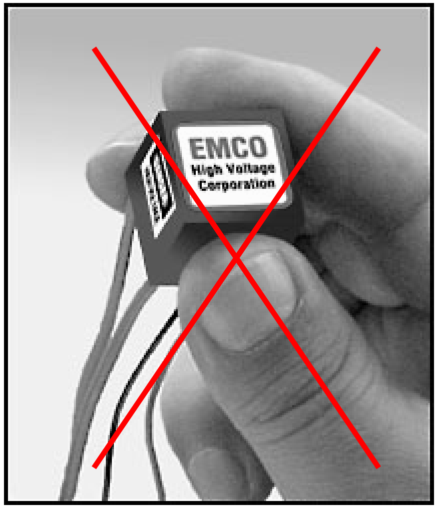
Why developing HV power supplies?



- Putting dedicated HV units in the vicinity of a detector
  - Avoiding long HV cabling
- Commercially available HV supplies are not suited for this
  - Often too bulky
  - May use iron based transformers
    - => do not operate in a magnetic field
  - Not radhard
  - Mostly designed to deliver substantial power (1 W or more) where powers in the mW region are needed
  - Mostly no trip level in the nA region
- Need for dedicated HV supplies for HEP detectors

Concept

- As small as possible
- Limited output power
- Small input power (< few mW idle mode)
- Very radhard (until 1000 Mrad, 10^7 Gy)
- Minimal noise emittance
- Output voltage stabilization, low ripple
- High resolution current measurement (< 1 nA resolution)
- Adjustable trip level in the nA region
- External communication like at CAN bus

Two designs for different applications

1. Larger unit, but easy to operate
   - Small scale physics experiments (lab, test beams)
   - In progress: lab version 50 – 500V
     - SHV out

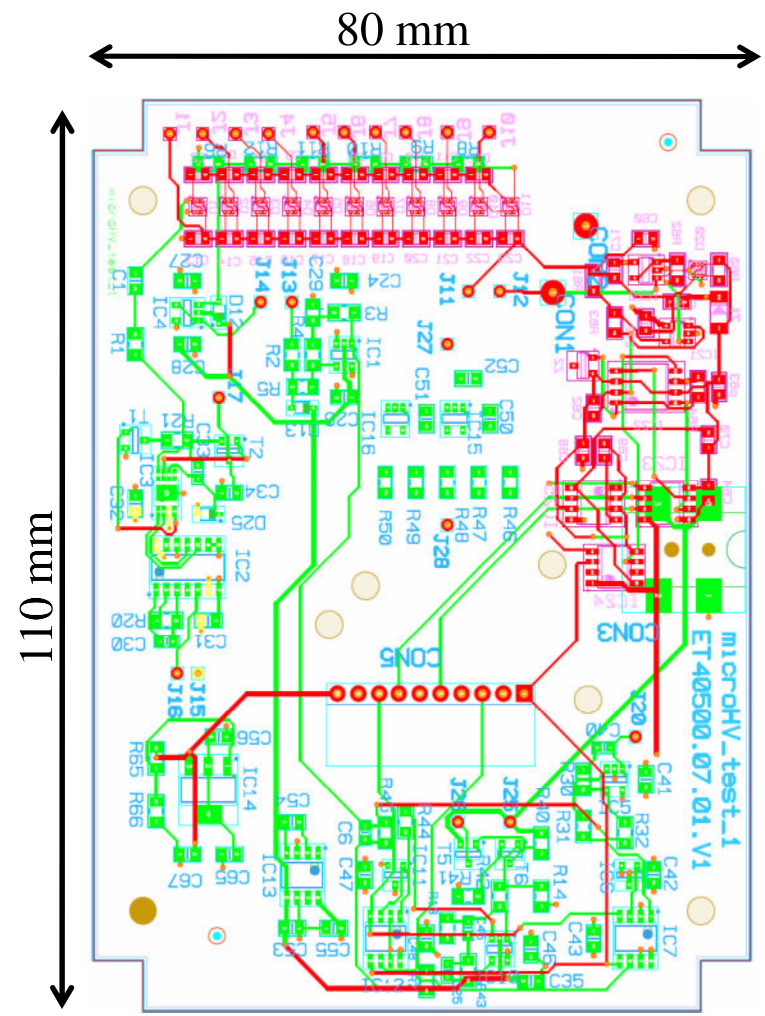
2. "As small as possible" unit for big scale HEP experiments (LHC)
   - Planned: Atlas upgrade: miniature and radhard version 50 – 1000V

- Also two power versions foreseen
  a) few mW for MPGDs and diamond

  b) Up to few 100 mW for silicon

Lab version under development

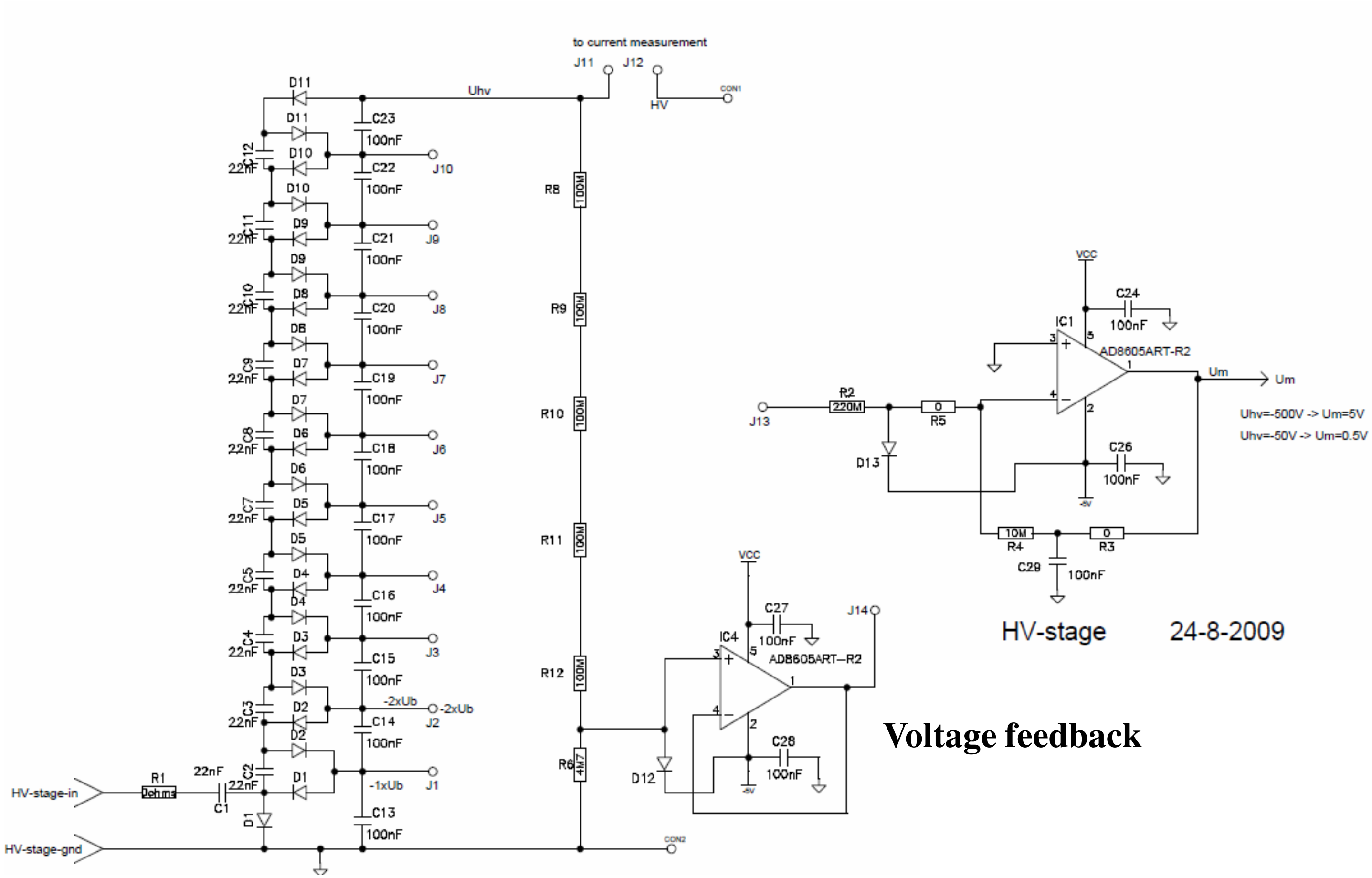
- Intended specs
  - 50 V < V_{out} < 500 V, SHV connector
  - $I_{max} \approx$ few µA
  - Voltage control by 14 bit DAC
  - SPI/CAN controller per board providing:
    - Adjustable software trip
    - Adjustable upward ramping speed
    - Rapid downward ramping
  - Current measurement with 1 nA resolution or better
    - 14 bit ADC



Creating HV with Cockroft-Walton circuit

- 50 V block pulses in (**duty cycle modulation**)
- No transformer
- Voltage divider feedback for stabilisation

We cannot regulate down to 0V

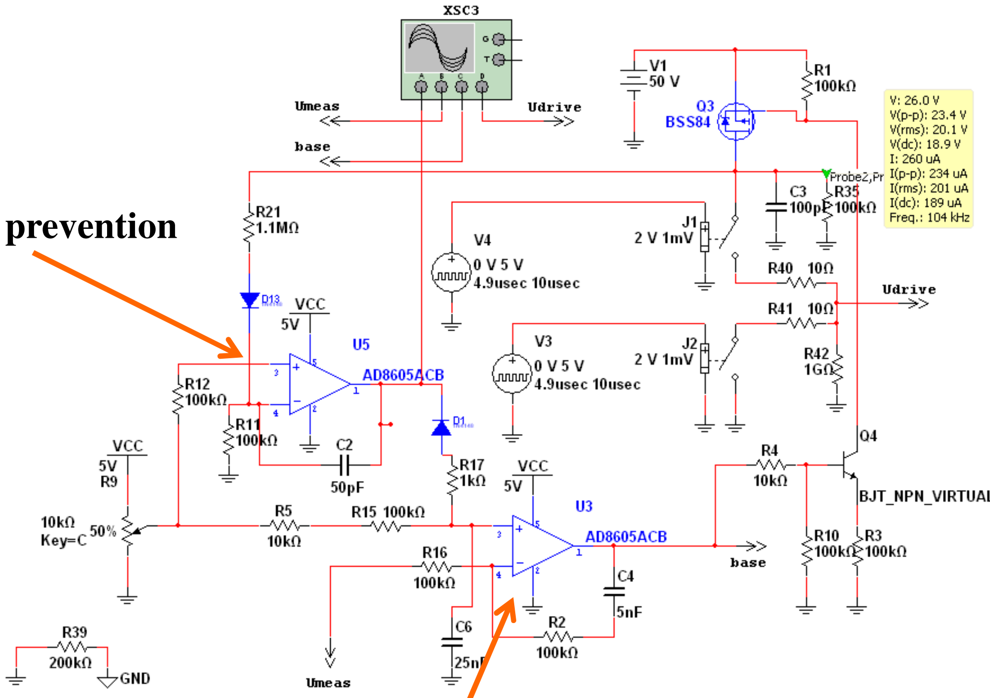


Voltage feedback

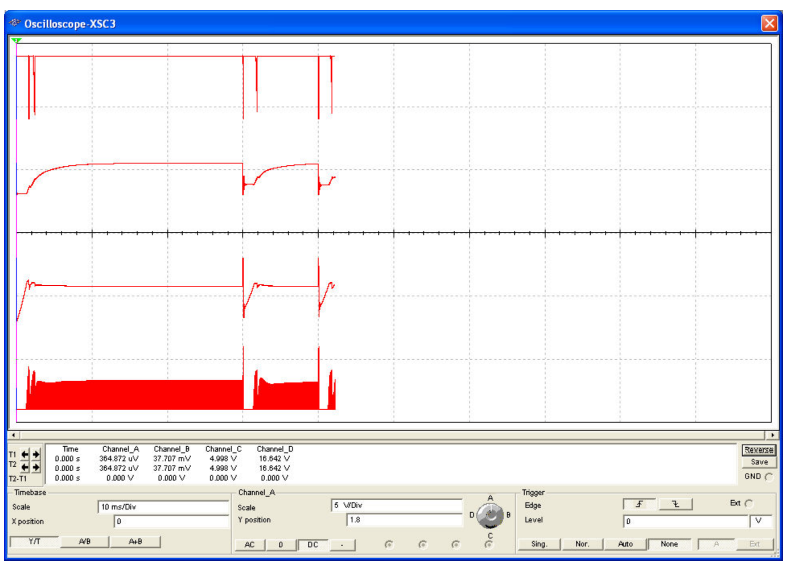
PID circuit

- Simulated operation
  - FETs represented by switches

Overshoot prevention

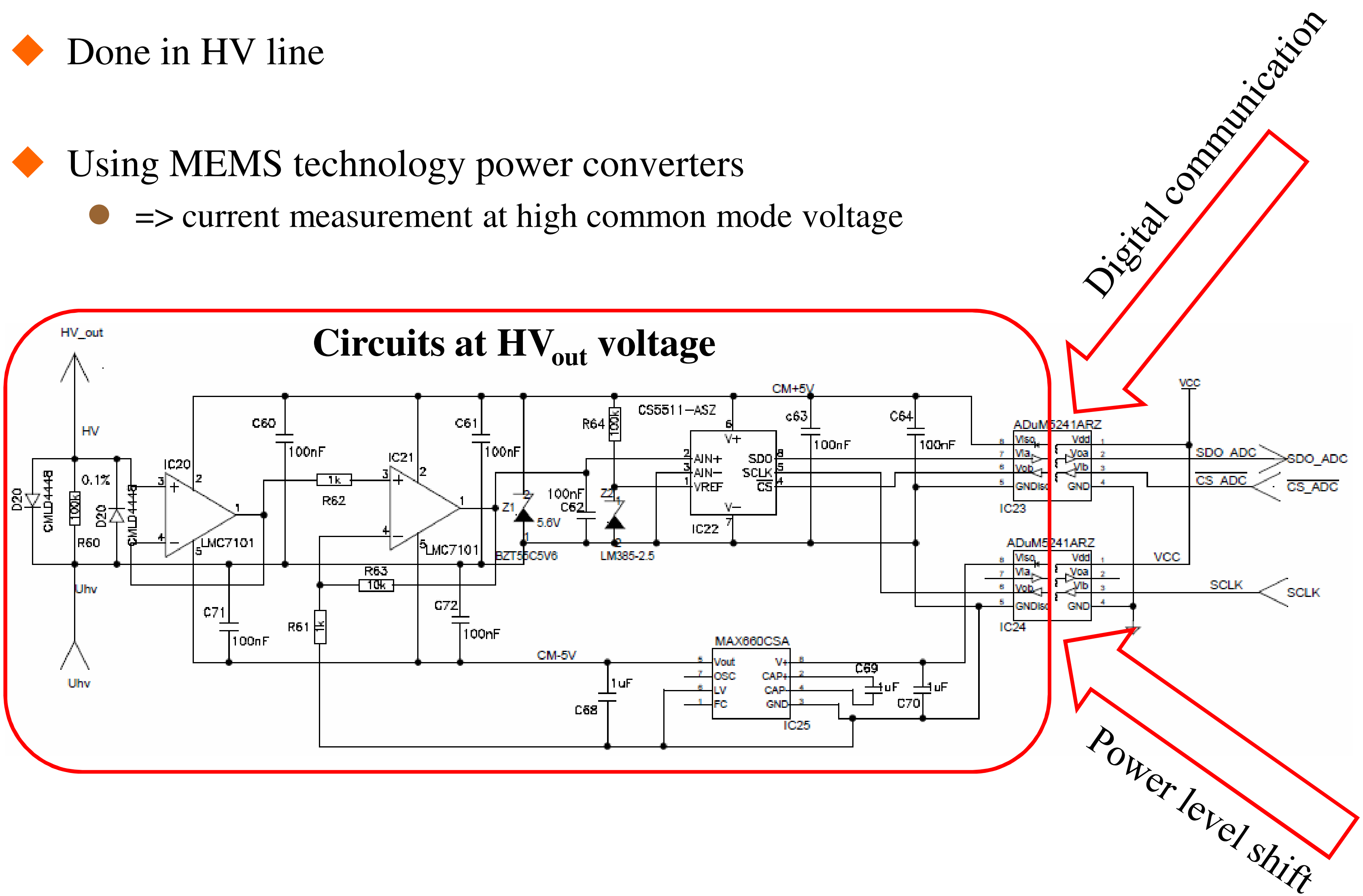


Voltage feedback



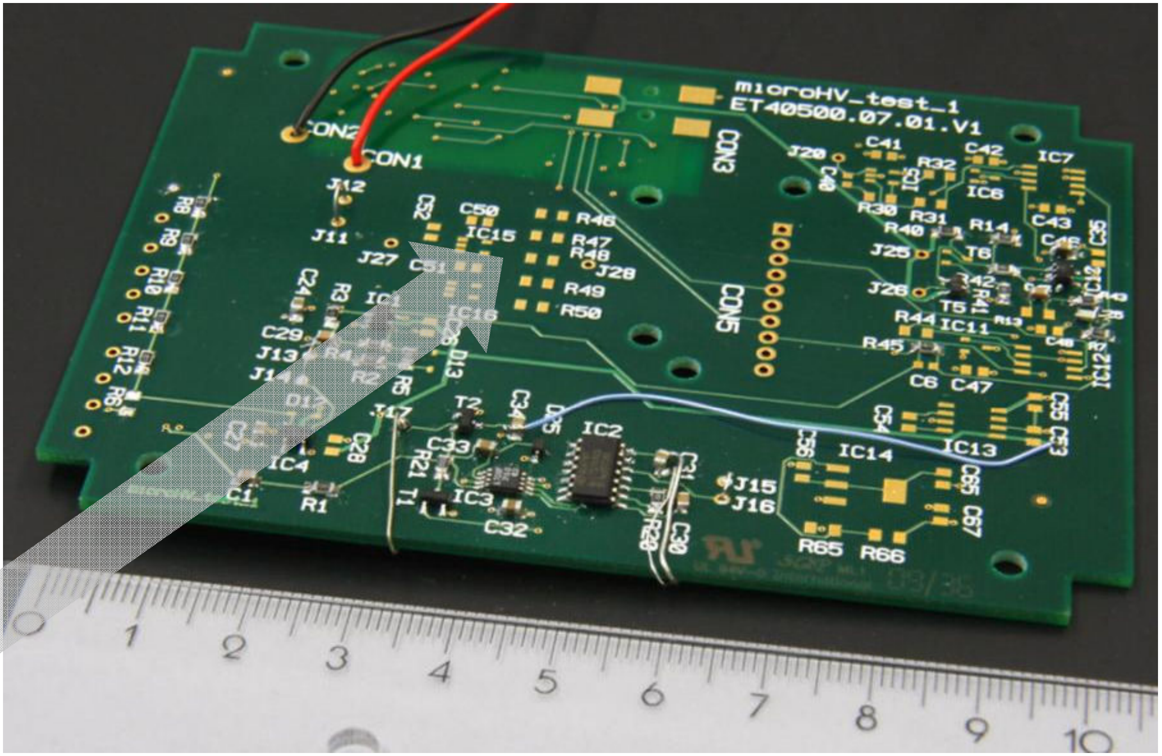
Current measurement

- Done in HV line
- Using MEMS technology power converters
  - => current measurement at high common mode voltage

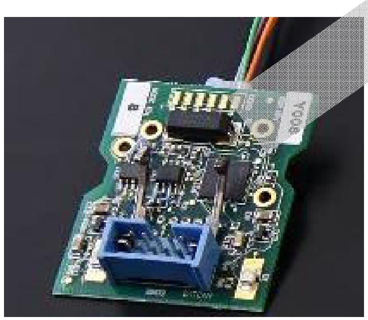


Present prototype PCB

- 110 x 80 mm



SPI/ CAN controller



Finally intended geometry of lab version

- Practical and rugged mechanical box
- 136 x 82 x 40 mm^3
- for future PCB