Low Voltage Power Supply Schemes
Experiences with the HADES-Upgrade

• Short Overview: HADES + Upgrade + Motivation
• DC/DC converters used at the FEE
• LDO based system
• Summary
High Acceptance DiElectron Spectrometer
HADES Upgrade: DAQ

- 100,000 front-end channels
- 100 kHz event rate
- 400 MByte/s data rate

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DC/DC-Converters and Analog Electronics

- Paul Horowitz, Winfield Hill: The Art of Electronics (The Bible) + all experts
  - Don't use DC/DC converters for analog electronics!

- This really motivates to try it out!
Switcher vs. Linear Regulation

DC/DC vs LDO:

- Pro:
  - More efficient for large $\Delta V$ and high currents
  - Galvanic isolation is possible

- Cons:
  - Produces noise: conduced and radiated
  - Larger footprint depending on current
  - More expensive
DC/DC Market

• Point-of-Load Alliance: POLA
  • multisourcing of pin-compatible, nonisolated, point-of-load power modules

  30A output current
  2.95-3.65V input voltage range
  Output voltages from 0.8V up to 2.5V
  Industry standard POLA™ compatible
  34.8 x 28.5 x 9.00 mm
  High efficiency, up to 93%
  Auto Track™ sequencing pin
  More than 2.1 million hours MTBF

• Proprietary solutions: e.g.: μModules
• 48V standard power distribution over larger distances
• 5V bus voltages on PCB
• Second DC/DC regulation at the point of load
• Filtering at the load
First Application: 128 channel TDC

- DC/DC supplies and filters
- Down to 20ps time resolution
- FPGA-TDC: 10ps RMS time resolution (no tails)
• Pi-Filters: Low ESR Caps, Ferrite beads
• Second order: Common-Mode-Filters
TOF

- TOF: 128 channel PMT discriminator and charge measurement

- Completely based on switchers on the same board
- No channels fire down to a sub 1mV threshold
- No change in performance if linear lab supplies are used as a reference!
- Conclusion: small common and differential noise on the PCB doesn't matter!

- PSRR value of modern OpAmps: 60-80dB (DC)
RPC

- amplification (factor 100) + discrimination + charge measurement
  - Distributed system with DC/DC separated and filtered
  - **No** difference in performance between linear lab power supply and custom DC/DC solution could be measured
Shower

- 96 channel ADC measurement
- Differential signal input
- DC/DC directly on board
- **No** noise floor on the ADC measurement
RICH

- 30k channels pad-plane
- 700e noise
- DC/DC on FEE didn't work
- 50cm distance solved the issue completely
Multiwire Drift Chamber

- 40k antennas
- Very sensitive to radiative noise => no DC/DC directly at the detector
- Huge effort to deal with linear regulators: heat, high currents, etc.
MDC power-supply

- 8 times 180A power supplies, 1500W each
Conclusion

- Horowitz, Hill: Are right and wrong at the same time!
  - Conductive noise seems to be under control with “simple” filtering
    - Most of the FEE-electronics can be built with switchers
  - Radiative noise is seen, if DC/DC is close to very sensitive detectors (like drift chamber antennas)
    - Distance (50cm) helps a lot (no noise measurable, on the 700e level)
- Your mileage may vary but it is worth a try
  - New low noise devices on the market every week
  - Hot topic