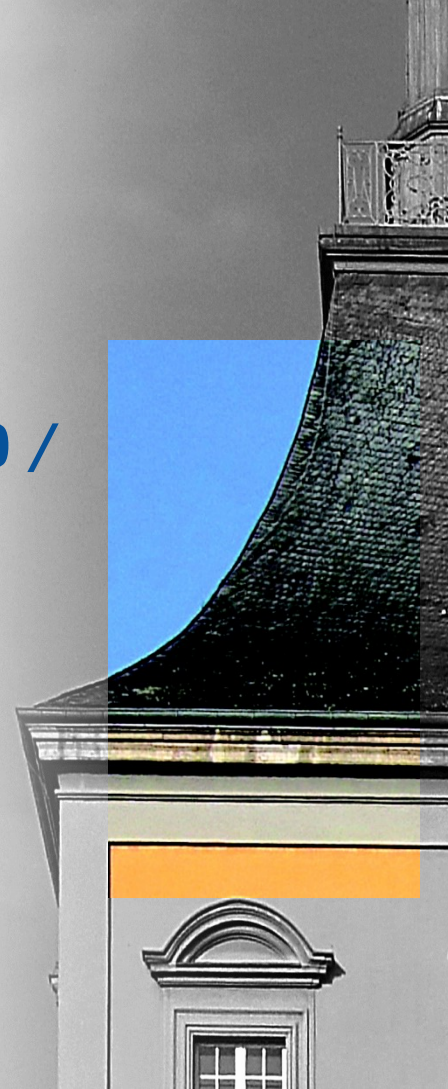


COMPASS FRONT-END, TRIGGER
AND DAQ WORKSHOP

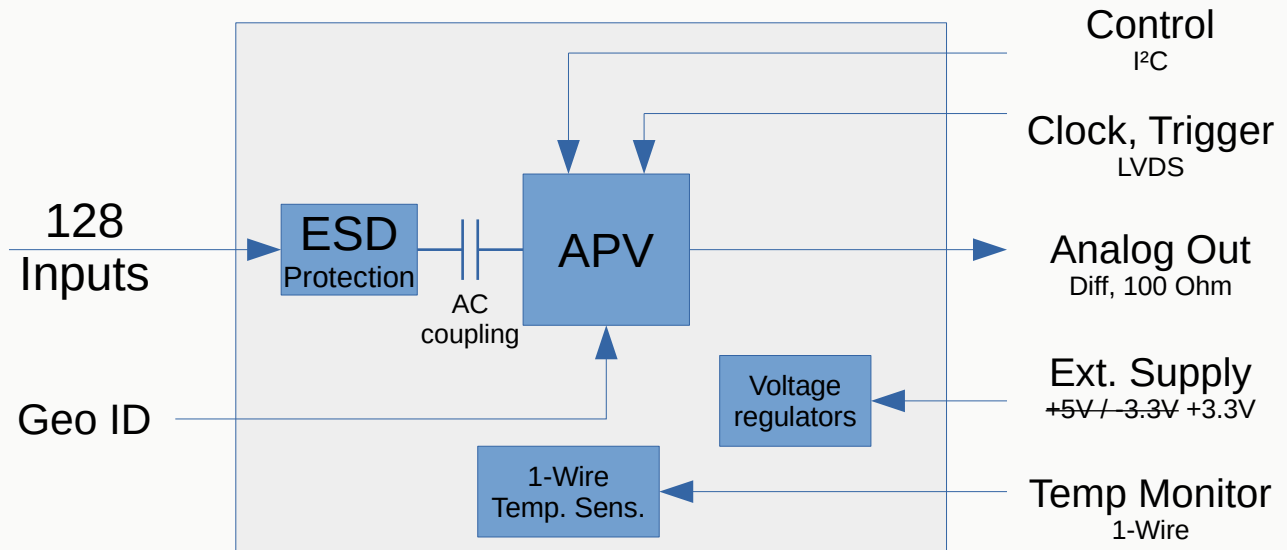
STATUS OF APV FRONT-END / GEM DETECTOR



- The new APV frontend card: features / requirements / changes
- Padplane, HV supply
- Current Status

New Front-end for GEM Detector

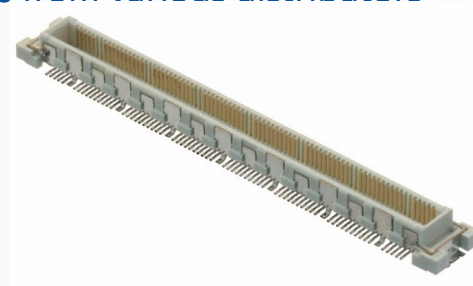
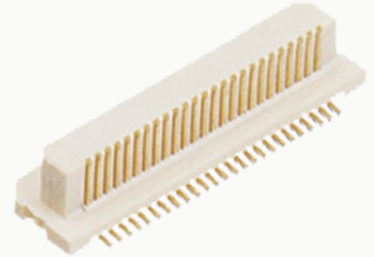
- Detector: 768 Strips in X and Y, split in middle → 24 APV chips required.
- **Maintain concept of previous front-end (mostly):**
 - Modules with one APV each, Regulator for internal supply rails, 1-Wire temperature sensor, Clock, Trigger: LVDS input, Analog APV Output: Differential, 100 Ohm Impedance, ESD Protection



Changes (I)

Connector to Detector

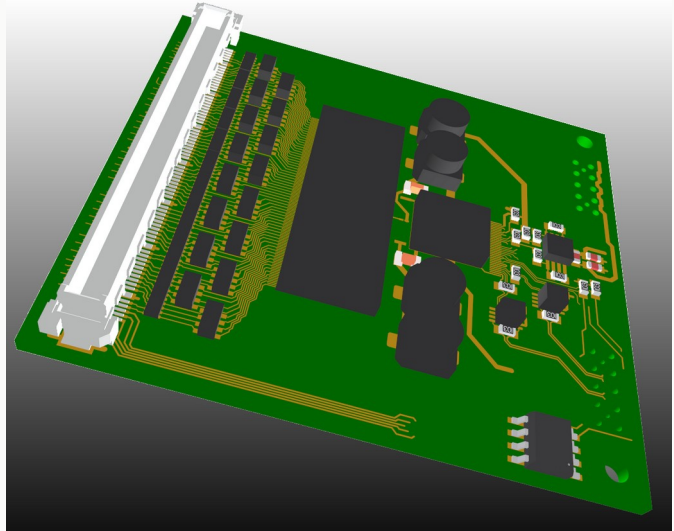
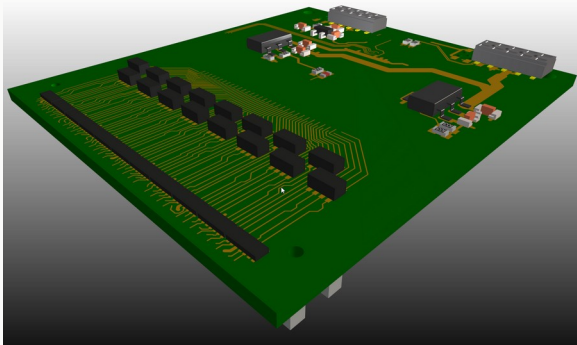
- Connector on existing front-end: **AXK6SA3675P**
 - Discontinued by manufacturer
- New Front-end: **FX10A-140P/14-SV1(71)**
 - Also used on VMM3x Hybrids
 - Use same pinout, GEO ID pins to assign APV address (?)
 - Easily available in small quantities from various distributors



- Differences FX10A / AXK6
 - Pitch: 0.5 mm / 0.5 mm
 - Mated height: 5 mm / 6.5 mm
 - Ground pins: 14 (by design) / 2 (by choice)
 - Additional pins: 12 / none
- In VMM3x Hybrids: 6 Pins used for GEO ID
 - Current idea: Use to assign APV-I2C address

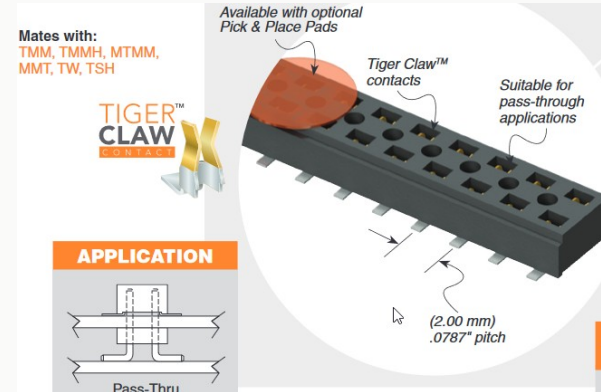
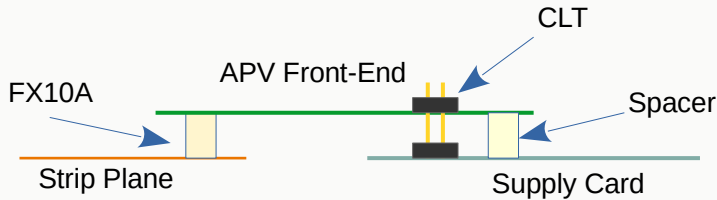
CAD rendering of new APV Front-End

- New Front-end



New Supply Connector

- FX10A has a lower stacking height (5mm) than previous connector (6.5mm)
- Supply connector: 8mm
 - Replace connector to avoid mounting tilt
- Solution: Back Entry Connector (Samtec CLT)
 - Allows adjustment
- Fixation via spacer on PCB



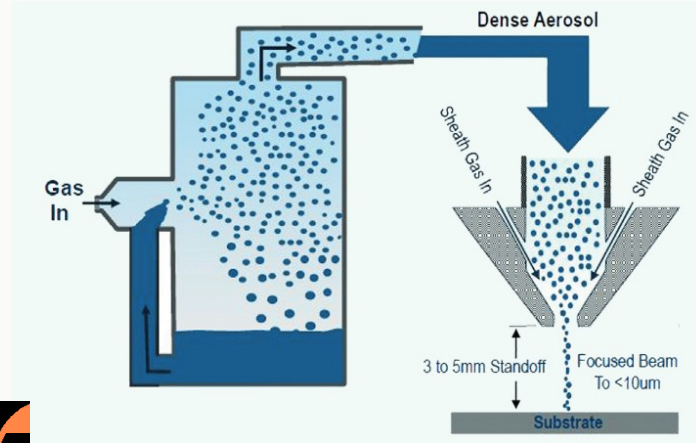
Pitch Adapter

- Pitch Adapter:
 - Spread out APV inputs (44 μm pitch) to dimensions for ordinary PCBs ($\geq 200\mu\text{m}$)
- Manufacturer Hightech.ch
- Alternate solution: aerosol jet printing (?)

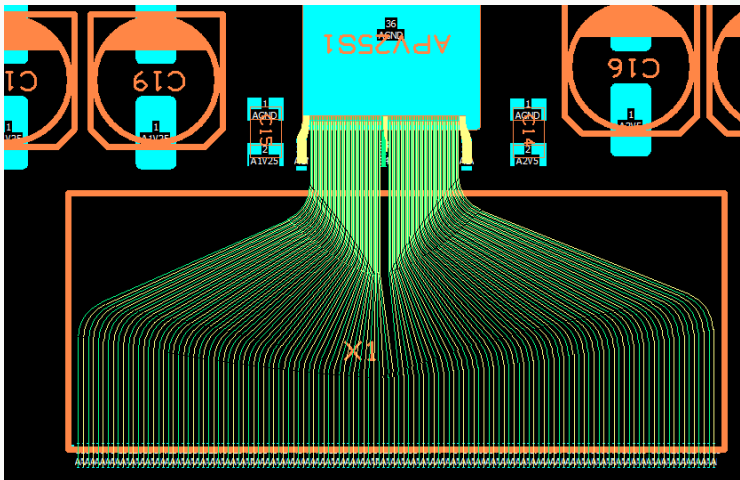


Aerosol Jet Print

- Printed conductor
- Structures down to 10µm achievable
- If prototype works properly:
 - Can replace pitch adapter and wire bonding



[https://www.enas.fraunhofer.de/content/dam/enas/de/documents/Downloads/datenblaetter/AerosolJetPrinting_DE_web.pdf]

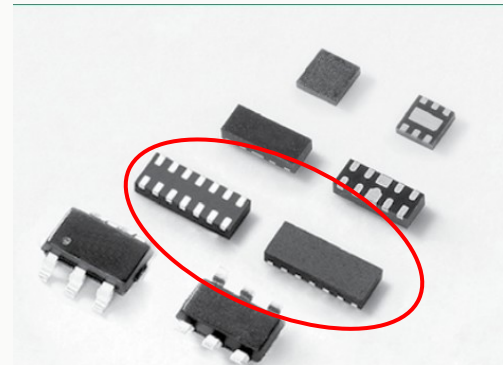


- Old Solution: BAV99
 - ~2 pF parasitic capacitance
 - Total: 45x26mm² on PCB
 - Specified up to 300 mA

- New Solution: SP3012-06UTG
 - USB3.0 ESD protection array
 - ~0.5 pF parasitic capacitance
 - Total: 40x4mm² on PCB
 - Specified for 4 A surge



[<https://www.diodes.com/assets/Datasheets/ds12007.pdf>]

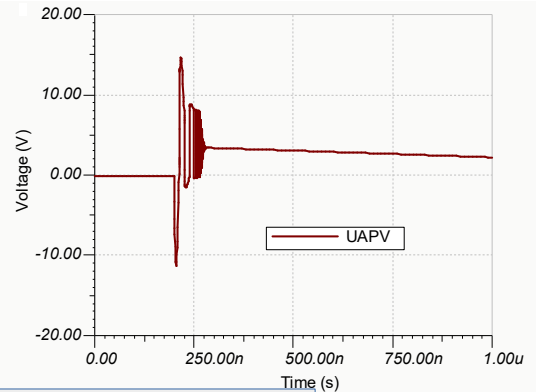
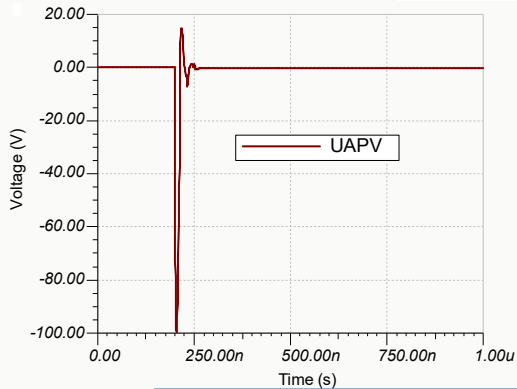
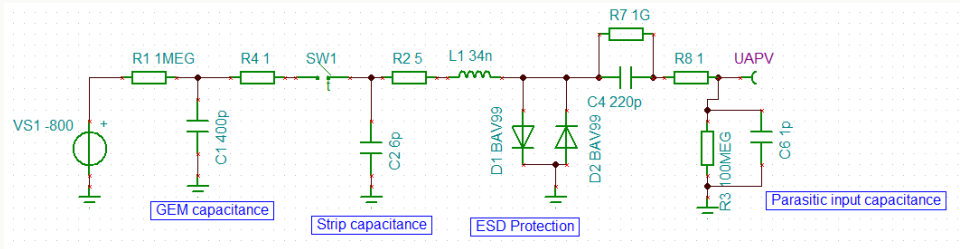


[https://www.littelfuse.com/~media/electronics/datasheets/tvs_diode_arrays/littelfuse_tvs_diode_array_sp3012_datasheet.pdf]

Changes (II)

ESD Protection

- Simplistic Model:

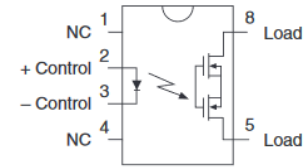


Caution!

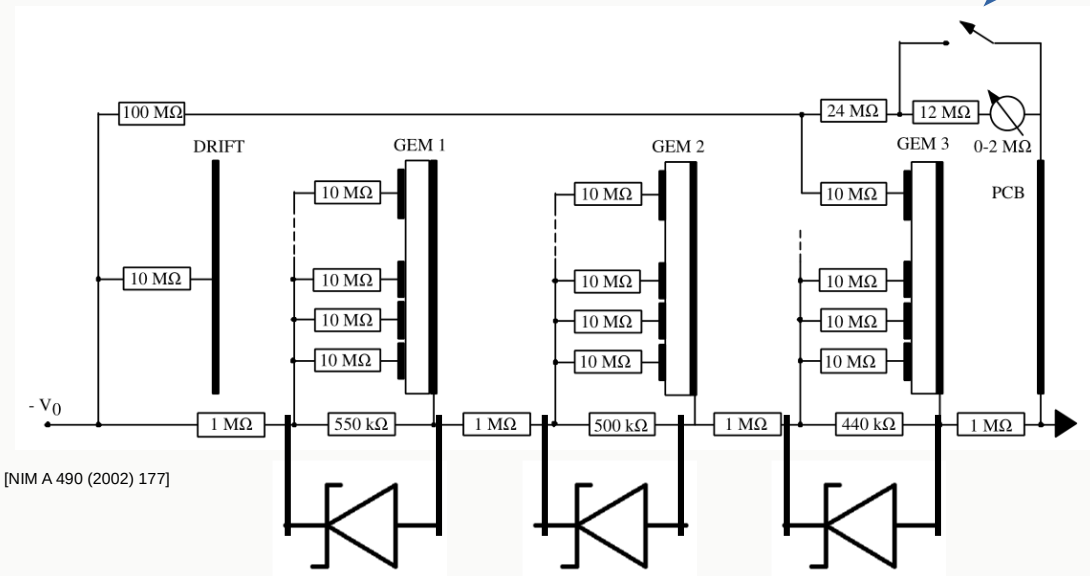
- Limits of Simulation (Discharge as short circuit, validity of diode spice models not certain, ...)
- ESD protection inside APV: here neglected
- Still, SP3012 seems to achieve better performance

Additional Changes on Detector: HV Supply

- Disable GEM HV at beam spot: OPTOMOS PLB171
- GEM overvoltage protection: Zener type voltage suppressor, e. g. P6SMB



[[http://www.ixysic.com/home/pdfs.nsf/www/PLB171.pdf/\\$file/PLB171.pdf](http://www.ixysic.com/home/pdfs.nsf/www/PLB171.pdf/$file/PLB171.pdf)]



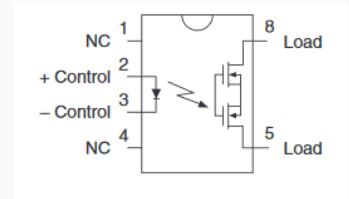
[NIM A 490 (2002) 177]

Additional Changes on Detector

- **Disable GEM HV at beam spot: OPTOMOS PLB171**

- Important features:

- Low leakage current
 - Sufficient output load voltage



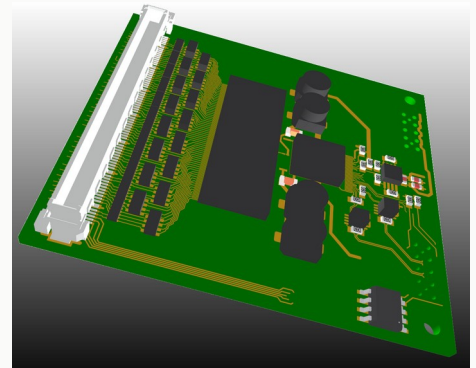
[[http://www.ixysic.com/home/pdfs.nsf/www/PLB171.pdf/\\$file/PLB171.pdf](http://www.ixysic.com/home/pdfs.nsf/www/PLB171.pdf/$file/PLB171.pdf)]

- **GEM overvoltage protection: Zener type voltage suppressor, e. g. P6SMB**

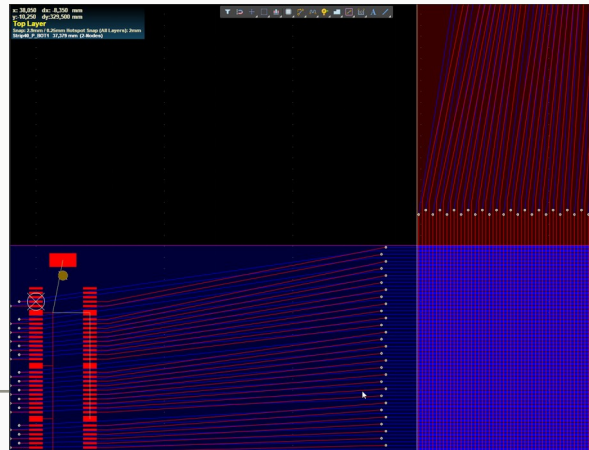
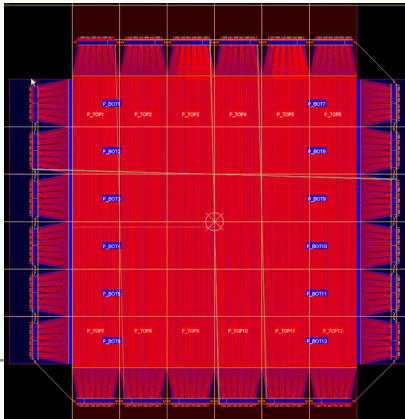
- Important features

- Low leakage current at operating voltage ($< 1\mu\text{A}$)
 - Quickly increasing current above break down voltage limits V_{GEM}

Current Status

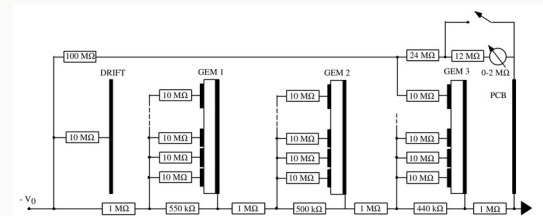
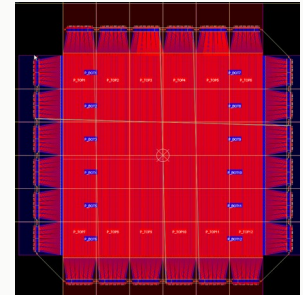
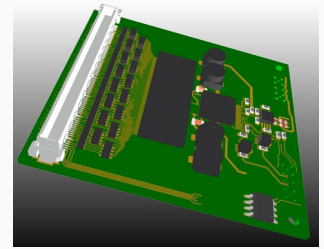


- Frontend PCB
 - Design: 80% done
 - Next: Build prototype / wire bond / jet print
- Supply Card
 - Design PCB
- Readout Plane: Active Area $307.2 \times 307.2 \text{mm}^2$, $400 \mu\text{m}$ pitch, split readout
 - Design: mainly done



Summary

- New GEM detector needs 24 APV front-end cards
 - Design: Close to finished
 - Small changes to previous version (new connector, ...)
 - Evaluate aerosol jet print to connect APV
- Padplane:
 - Design almost done
- HV supply / voltage divider
 - Use optomos instead of relay
 - Implement GEM overvoltage protection



Thank you for your attention!