LM Tape and PPB1 Production

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SCT Barrel PAR
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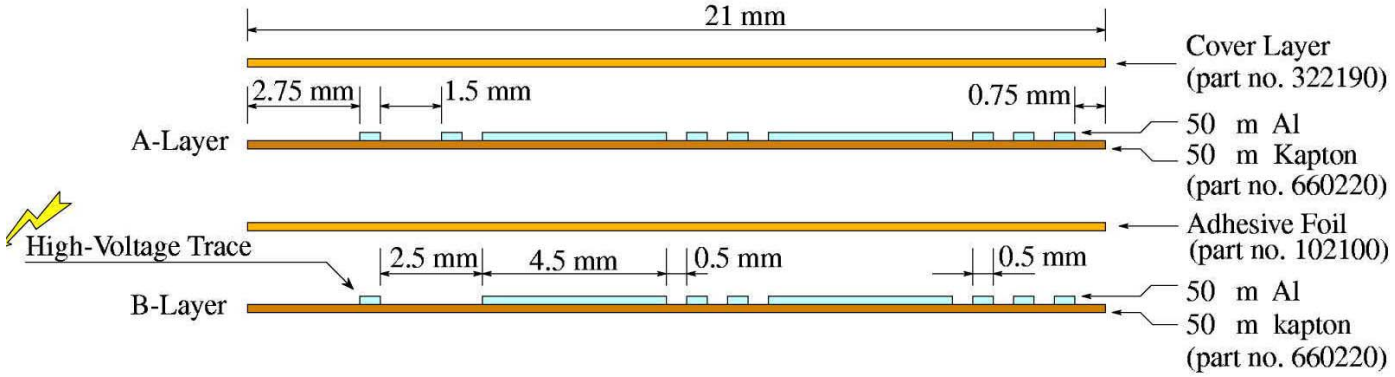
Low Mass Tapes

- Supply power, sensing and control signals to the read-out electronics and high voltage bias to the silicon strip detectors of the ATLAS SCT
- Due to stringent requirements on material and space, custom fabrication as large-scale flexible circuits on aluminium-Kapton™ laminates is requested



Low Mass Tapes – Technical Specifications

- Technical Specifications ATL-IS-CS-0014
  - 2640 barrel type tapes serve 2112 barrel modules and provide 25 % overhead to cover losses during harness production
  - Produced in 25 length bins from 860 to 2085 mm, combining tapes with lengths varying by 40 mm, max no in bin 160, min 40 tapes
  - Total length of barrel tapes ~ 4 km
  - Production order for ~ 410 kCHF (including 2470 end-cap tapes of ~ 7 km length) placed on Jan 9, 2003 from CERN to ELGO-LINE in Cerknica, Slovenia

Low Mass Tapes – Delivery

- Contractual delivery schedule – 6 batches
  - 1st batch of ~ 10 % in 6 weeks after order placement
  - 2nd batch of ~ 10 % in 2 weeks after 1st batch
  - 3rd to 6th batch of ~ 20 % in 4 week intervals
- Actual shipments
  - 1st batch (240 tapes) shipped Jan 14
  - 2nd batch (240 tapes) shipped Feb 12
  - 3rd batch (560 tapes) shipped Mar 31
  - 4th batch (460 tapes) shipped Apr 14
- Planned shipments
  - 5th batch (540 tapes) May 19
  - 6th batch (600 tapes) June 16
- ➔ Production complete in 22 weeks (2 weeks ahead)

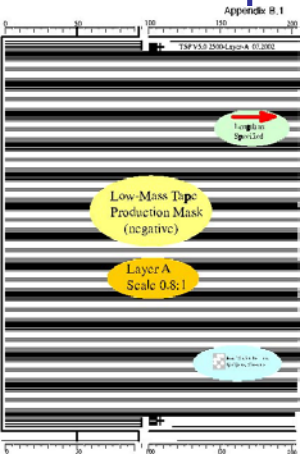
Low Mass Tapes – Production

- Large scale flexible circuitry on aluminium
  - Size (up to 4 m for end-cap) non-standard
  - No IPC standards exist for aluminium FC
- Tooling developed
  - Exposure table up to 7 m

  - Tape cutter
  - Optical inspection system

Low Mass Tapes – Production Steps

ask → photoresist lamination → exposure → etching →



→ Ni/SnPb plating → sheet lamination → cutting

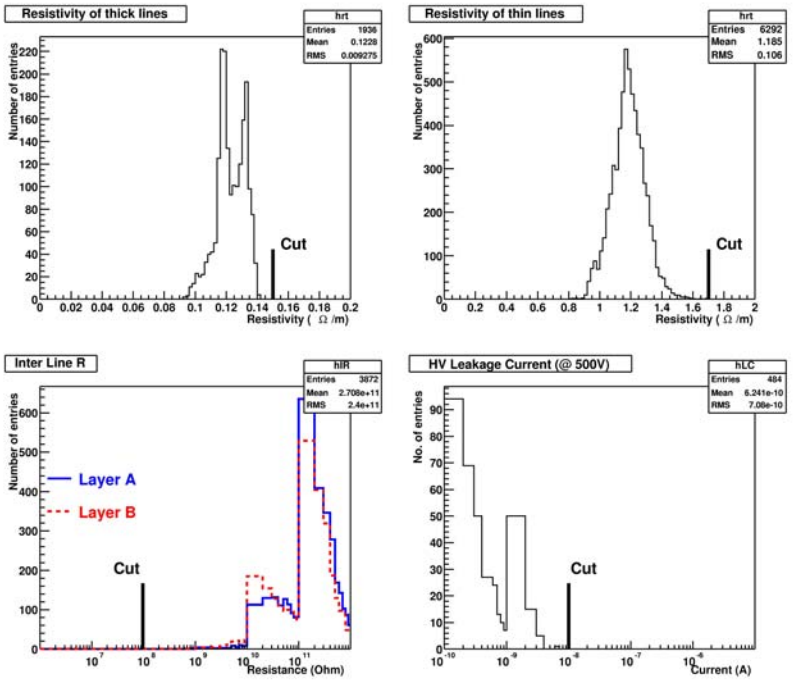
Low Mass Tapes – Quality Control

- Automated optical inspection
  - Acceptance criteria
    - conductor lines under-etching < 100 μm
    - conductor width reduction < 30 % of the nominal respective conductor width of 0.5 or 4.5 mm.
    - conductor spacing reduction < 0.15 mm due to conductor edge roughness, spikes, etc.

- Inspection performed on every sheet after etching
- Images reprocessed at JSI for each batch

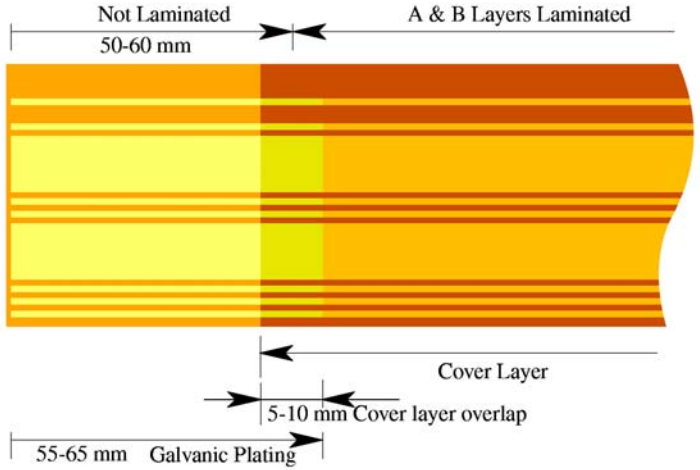
Low Mass Tapes – Quality Control (cont.)

- Electrical test
  - Acceptance criteria
    - Line resistance
      - < 0.15 Ω/m for 4.5 mm lines
      - < 1.7 Ω/m for 0.5 mm lines
    - Inter-line resistance > 20 MΩ
    - Leakage current on the HV line to grounded adjacent lines < 500 nA at 500 V DC voltage (resistance > 1 GΩ)
  - Test performed by Elgo-Line on every individual tape before shipment



Low Mass Tapes – Quality Control (cont.)

- Tests of conductor and tape processing
  - Acceptance criteria
    - Al thickness change < 10 % (test structures)
    - No lifted Al lands
    - Imperfections on edges (nicks and tears) < 0.5 mm
    - Adhesive flow on coverlayer edges < 2 mm
    - Misalignment of lines < 0.2 mm in the laminated area



  - Tests performed by Elgo-Line on a regular basis

Low Mass Tapes – Quality Control (cont.)

- Electroplating tests
  - Acceptance criteria
    - Electroplated surface solderable in accordance with IEC 68-2-20
    - Plating adhesion test according to IPC-TM-650, method 2.4.1. (pressure sensitive tape); no evidence of any portion of the plating or the conductor pattern foil being removed
    - Pull test of a soldered tape from PCB; no failure at F < 10 N due to poor nickel adhesion to aluminium
  - Tests performed by JSI and Academia Sinica on a sample of tapes and test structures

Low Mass Tapes – Quality Control (cont.)

- Dimensions tests
  - Acceptance criteria
    - Average thickness < 330 μm
    - Transition spots(tapes laminated twice): thickness < 400 μm
    - Tape width < 21.2 mm at any position along the tape
    - Tape length: nominal + < 10 mm; – 0 mm
  - Tests performed by Elgo-Line on a regular basis

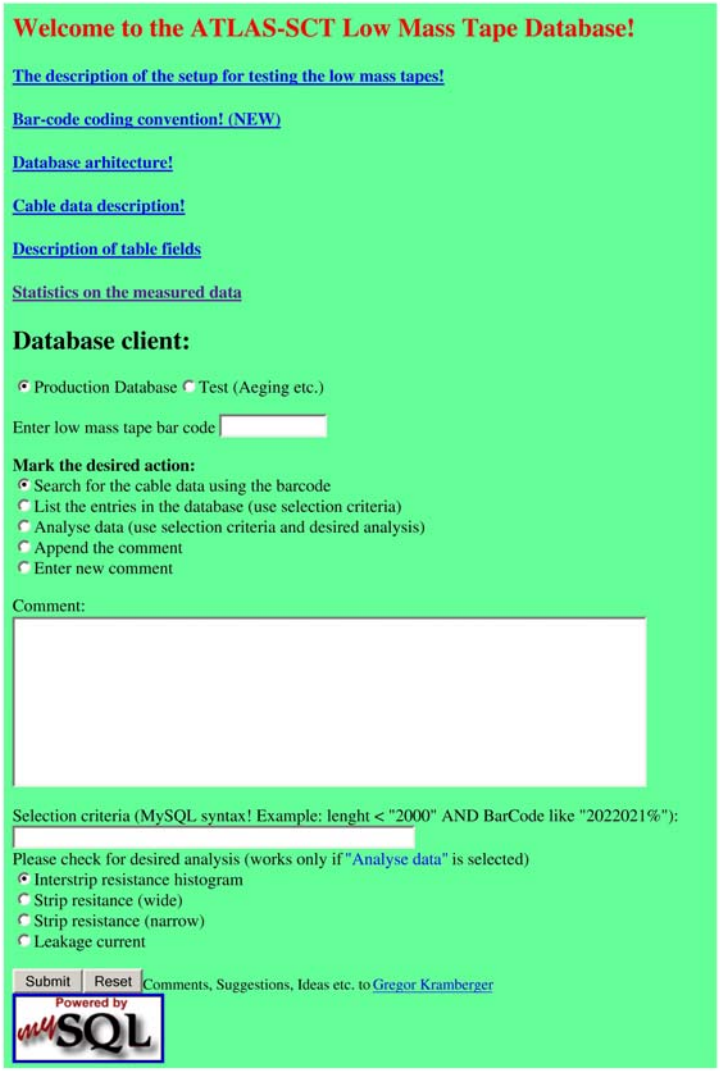
Low Mass Tapes - Yield

- Yield figures per batch

Batch	Opt. 1	Opt. 2	Opt. 1⇗2	Elect.	Total	Yield %
1	5				/240	
2					/240	
3					/560	
4					/460	

Low Mass Tapes - Documentation

- All tapes labelled with a bar-code sticker
- Information on electrical tests in local DataBase
- Local DataBase copied to SCT DataBase



Welcome to the ATLAS-SCT Low Mass Tape Database!

The description of the setup for testing the low mass tapes!

Bar-code coding convention! (NEW)

Database arhitecture!

Cable data description!

Description of table fields

Statistics on the measured data

Database client:

(•) Production Database ( ) Test (Aeging etc.)

Enter low mass tape bar code

Mark the desired action:
(•) Search for the cable data using the barcode
( ) List the entries in the database (use selection criteria)
( ) Analyse data (use selection criteria and desired analysis)
( ) Append the comment
( ) Enter new comment

Comment:

Selection criteria (MySQL syntax! Example: lenght < "2000" AND BarCode like "2022021%"):

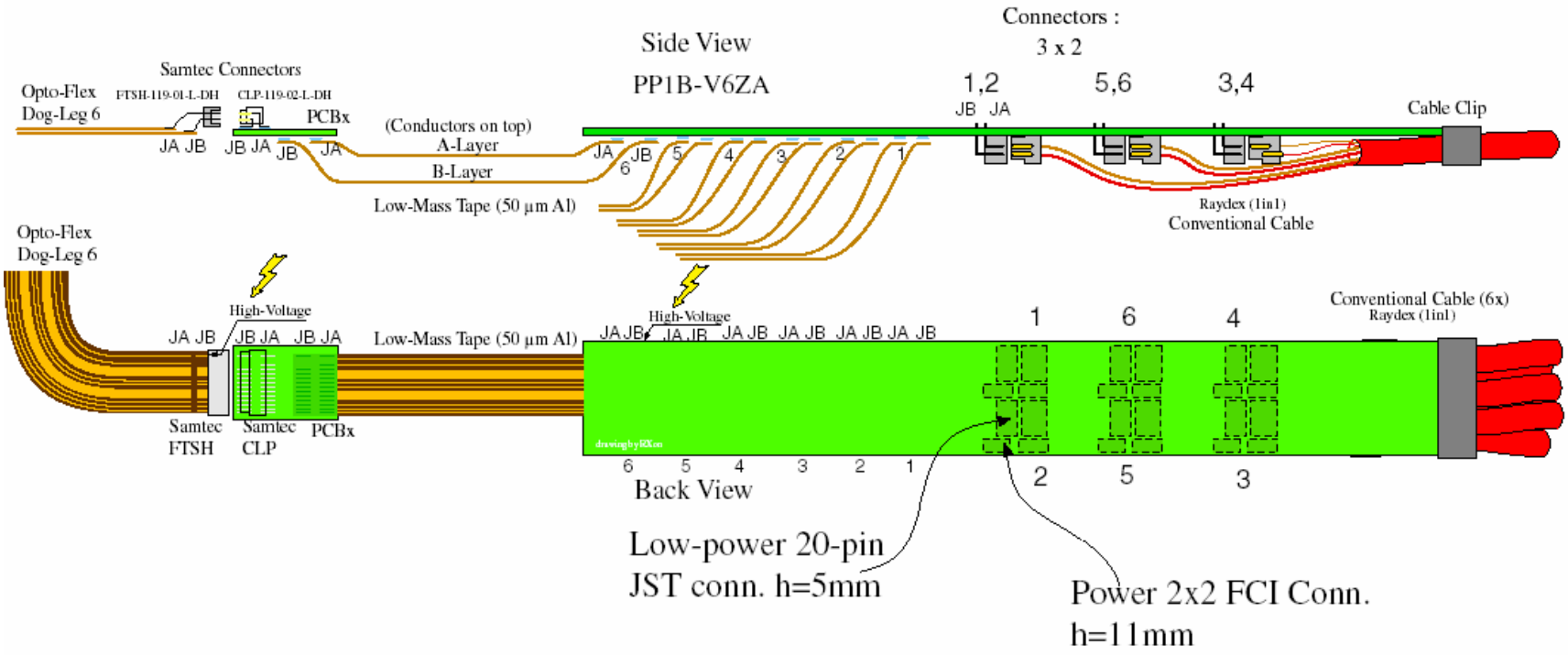
Please check for desired analysis (works only if "Analyse data" is selected)
(•) Interstrip resistance histogram
( ) Strip resitance (wide)
( ) Strip resistance (narrow)
( ) Leakage current

Submit Reset Comments, Suggestions, Ideas etc. to Gregor Kramberger

Powered by mySQL

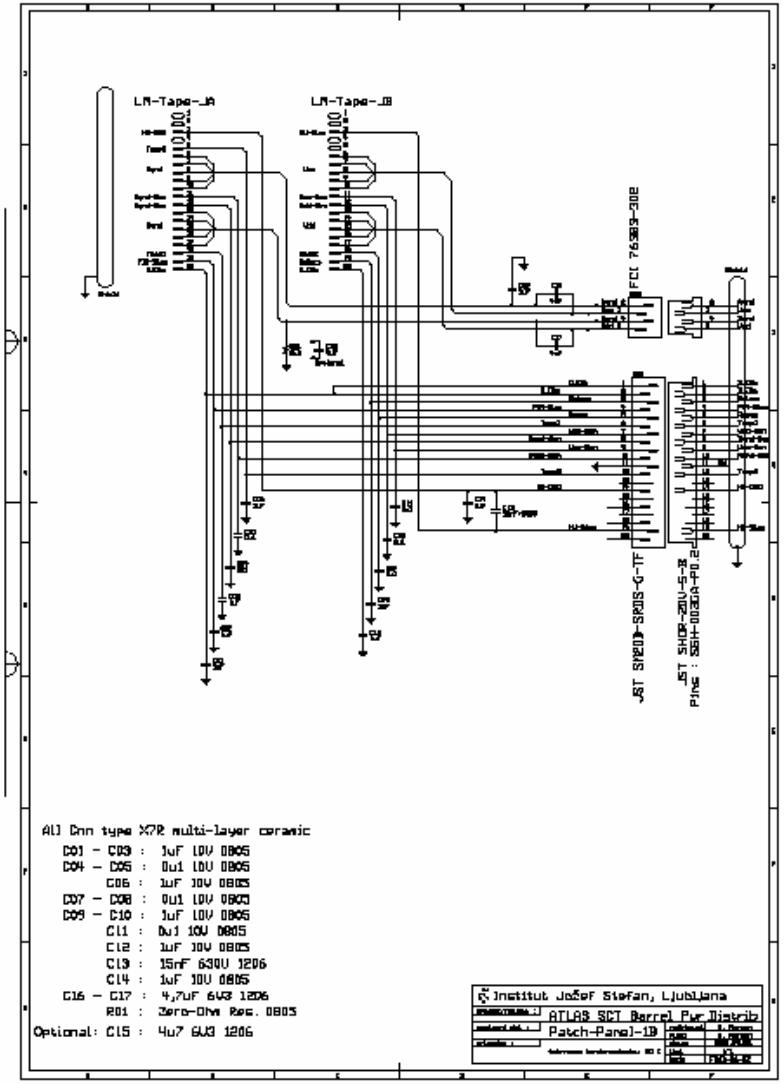
PPB1

- PCB serving 6 modules (half-stave)
  - Transition from LM tapes to Type II cables
  - Filtering of all lines, grounding of DGND



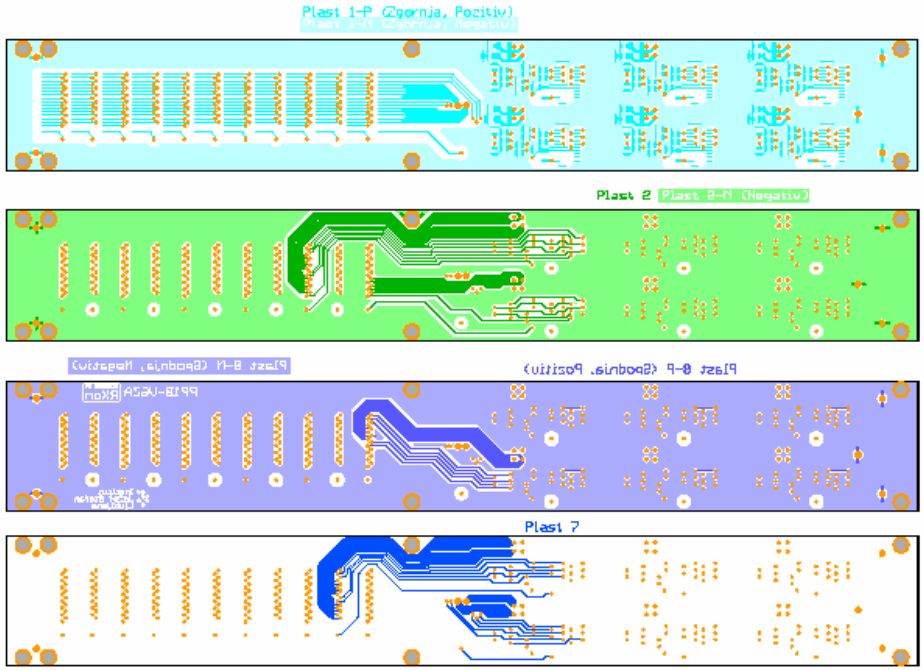
PPB1 - Schematics and Parts

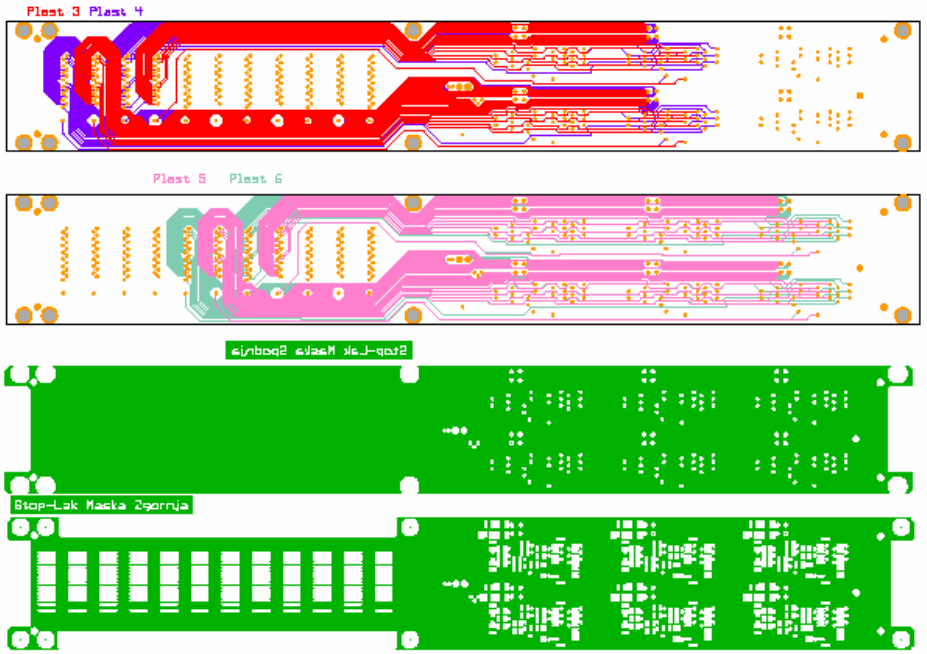
- Capacitors
  - 4.7 uF D&A supply – return
  - 0.1 uF sense to ground
  - 15 nF HV to HV_return
  - 1.0 uF all other to ground
- Connectors
  - 4-pin FCI 2.54 mm pitch for D&A supply & return
  - 20-pin JST 1 mm pitch for sense, control and HV



PPB1 - Layout

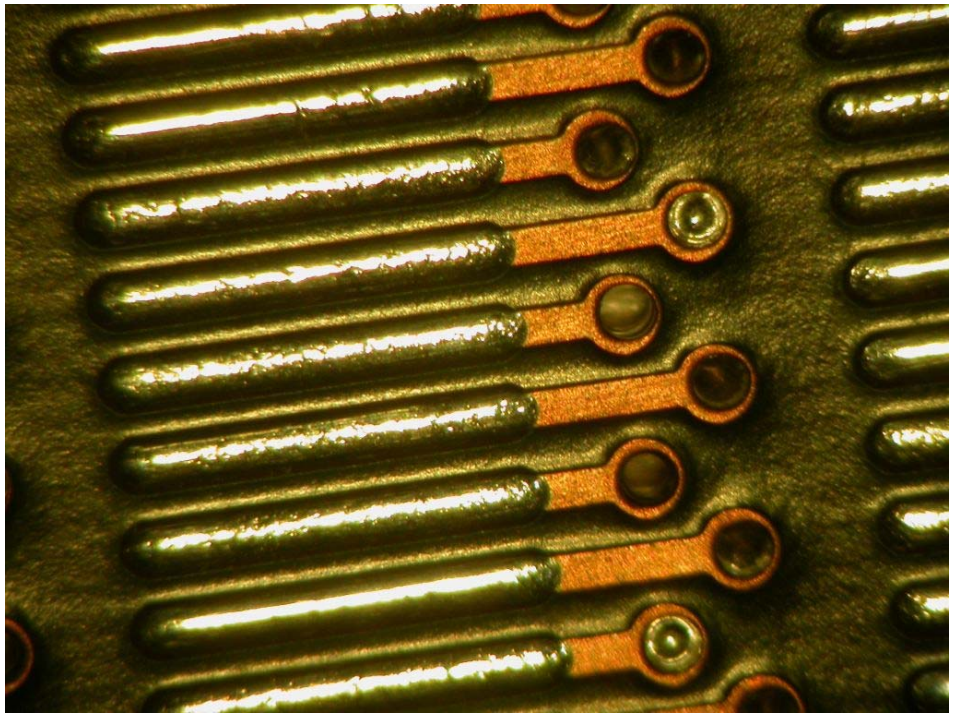
- 8-layer PCB
  - Routing of tapes to connectors – unfavourable topology
  - Outer planes "continuous" ground plane solidly connected to SCT master ground (thermal screen)





PPB1 - Production

- Standard multi-layer PCB process and SMT component mounting
- Solder deposition on LM tape solder pads for thermode soldering – HASL & rework



PPB1 – Quality Control

- PCB's are tested after production for trace continuity – standard automated test
- Assembled PCB's are tested for component and connector functionality
  - Capacitors < 30 % off nominal
  - Interline R > 2 MΩ
  - Power lines R < 0.1 Ω
  - Control/Sense lines R < 0.5 Ω
  - HV leakage to all lines grounded < 15 nA

PPB1 - Delivery

- 440 PPB1 ordered
- Delivered/Planned batches

Batch	# of PPB1	Delivery
1	80	13-Feb-03
2	120	08-Apr-03
3	120	07-May-03
4	120	16-Jun-03

Low Mass Tapes & PPB1 - Summary

- 1500/2640 LM tapes delivered
- 320/440 PPB1 delivered
- Delivery matches harness production schedule
- Rather smooth production with acceptable yield