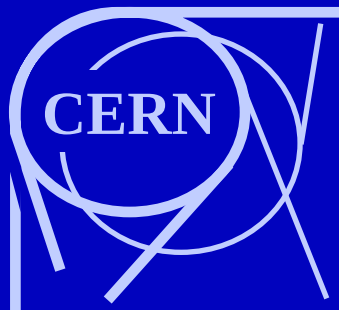


TS-DEM
Development of Electronic Modules

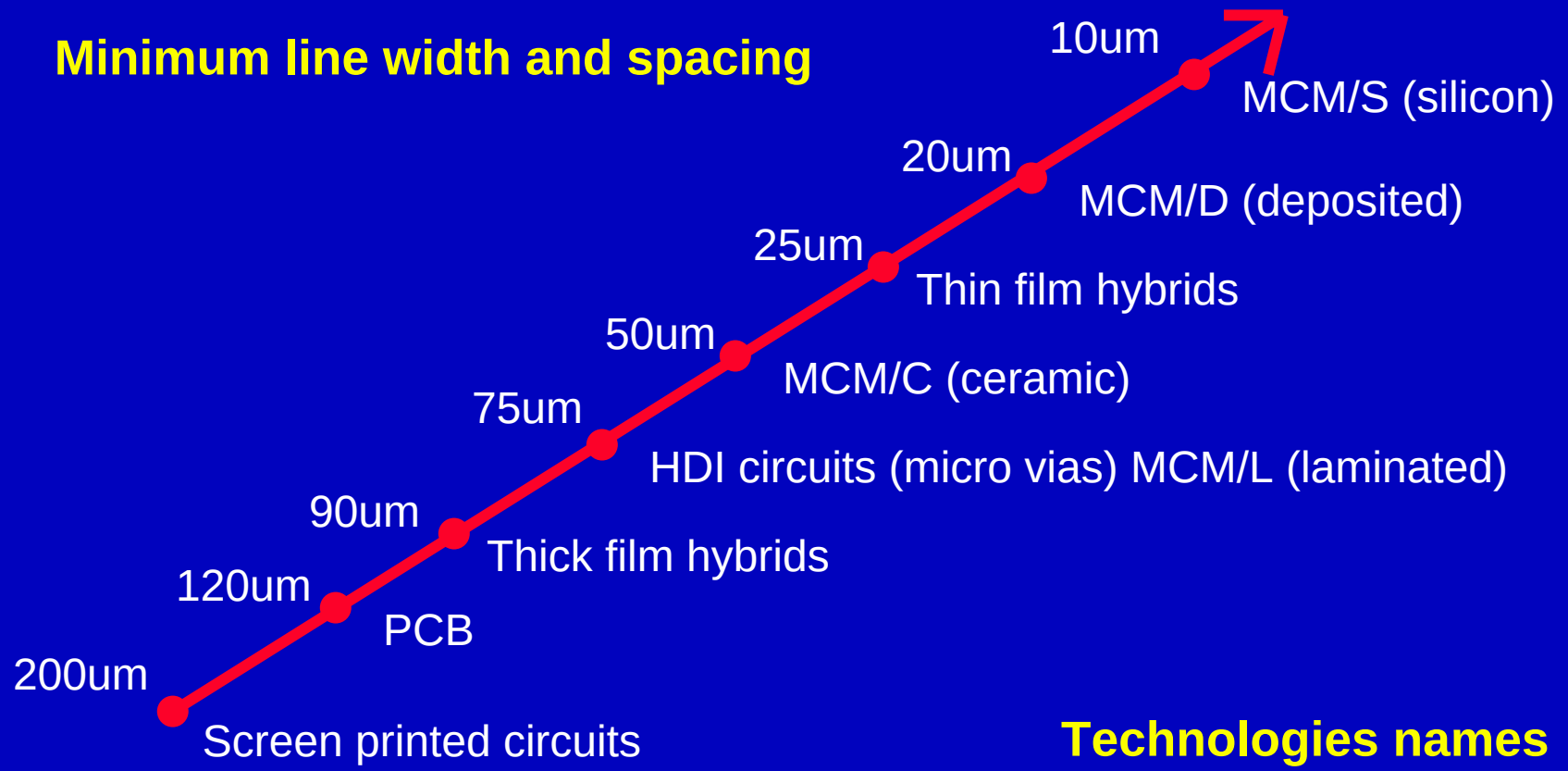
CERN hybrid production experience
(*or* how to stay out of trouble)

Rui de Oliveira

CERN

Contents

A. Existing Technologies



B. Technologies used in HEP

- PCBs
  - all applications
- Flex, Flex rigid
  - cable replacement
- HDI
  - high-density front-end electronics
- Thick film Hybrids
  - vacuum applications, high power
- MCM/D
  - very high density electronics

C. Technology details PCBs

Base material

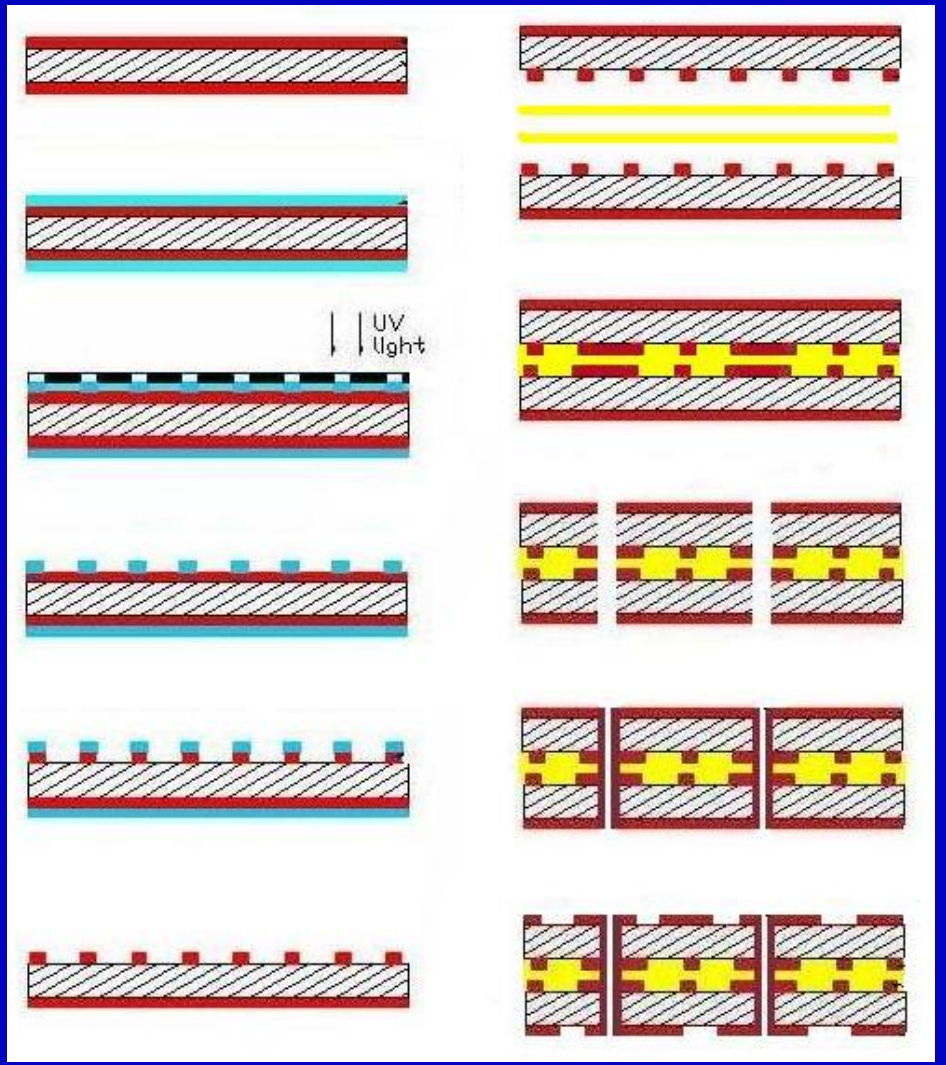
Lamination of photoresist

Image transfer (internal layers)

Development

Etching

Stripping



Pressing

Drilling

Metallization

Image transfer (external layers)

C. Technology details PCBs

Base material

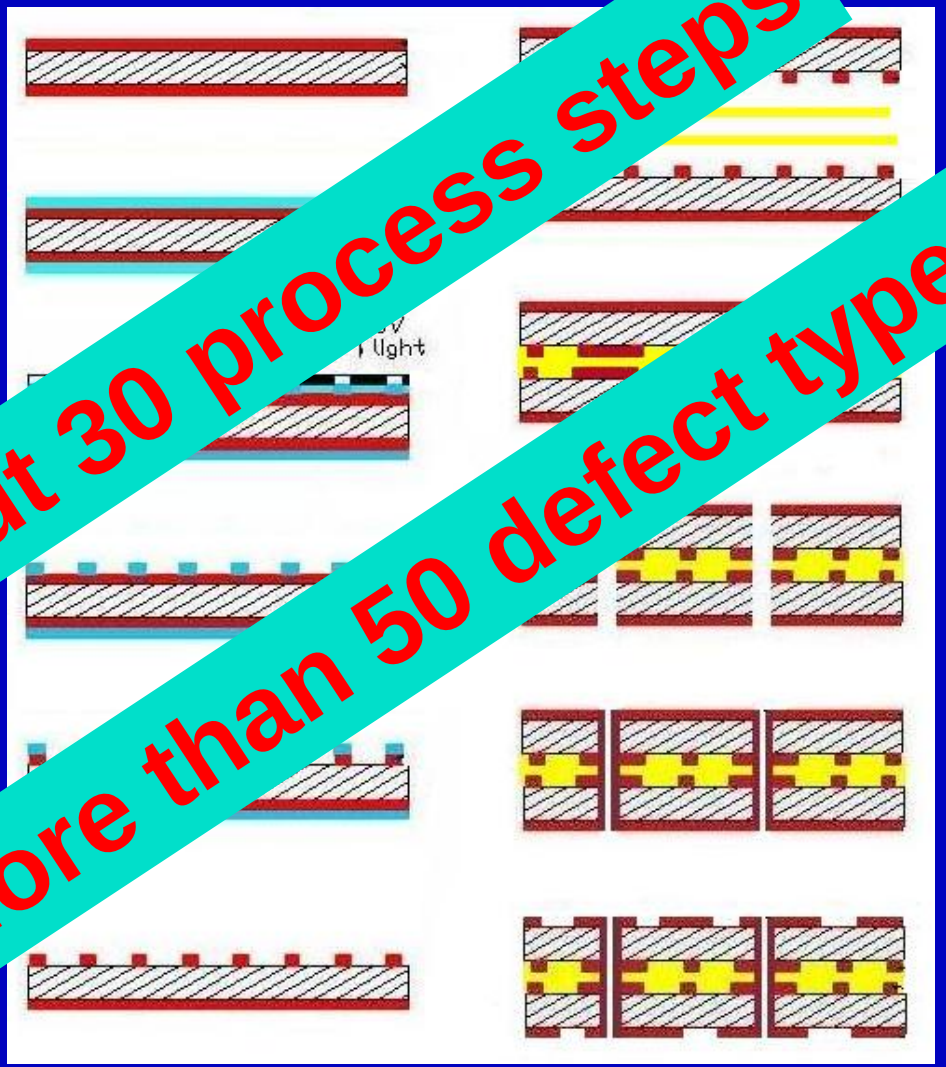
Lamination
of photoresist

Image transfer
(internal layers)

Deve

Etching

Stripping



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Drilling

Metallization

Image transfer
(external layers)

About 30 process steps

More than 50 defect types

D. Technology problems

- the number of problems that you can encounter is huge
- it is impossible to list them all in a small presentation
- but some standards like IPC-A-600 have listed many
  (Acceptability of Printed Wiring Boards)

IPC
ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

CERN TS-DEM is IPC member

Type of Problems

- **Minor problems**
  - Aspect
  - Sizes (board, tracks, etc.)
  - Most of these defects can be solved during the prototype run
- **Major problems**
  - Hidden defects
  - Evolution with time (short term or long term)
  - Stable, but can stop the process in the next steps of assembly

These defects should be under QA control during mass production

Visible defects

- partially etched lines
- over etchings
- defects in solder mask
- bowing
- metal finishing pollution
  - solder mask, legend ink pollution
- dust
- wrong thicknesses, sizes, etc.

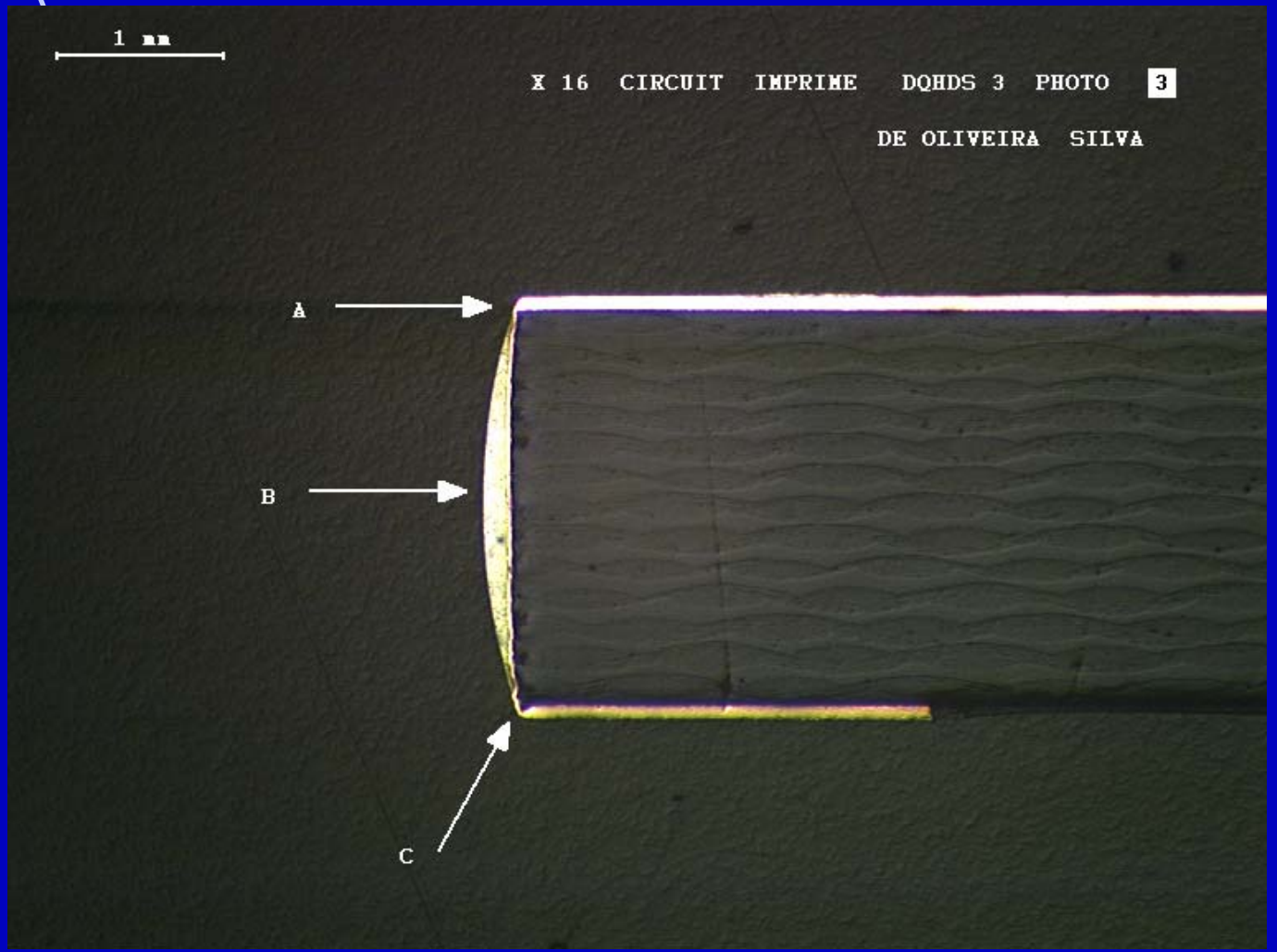
These test can be performed with simple equipment such as microscopes and measuring tools

Non visible defects

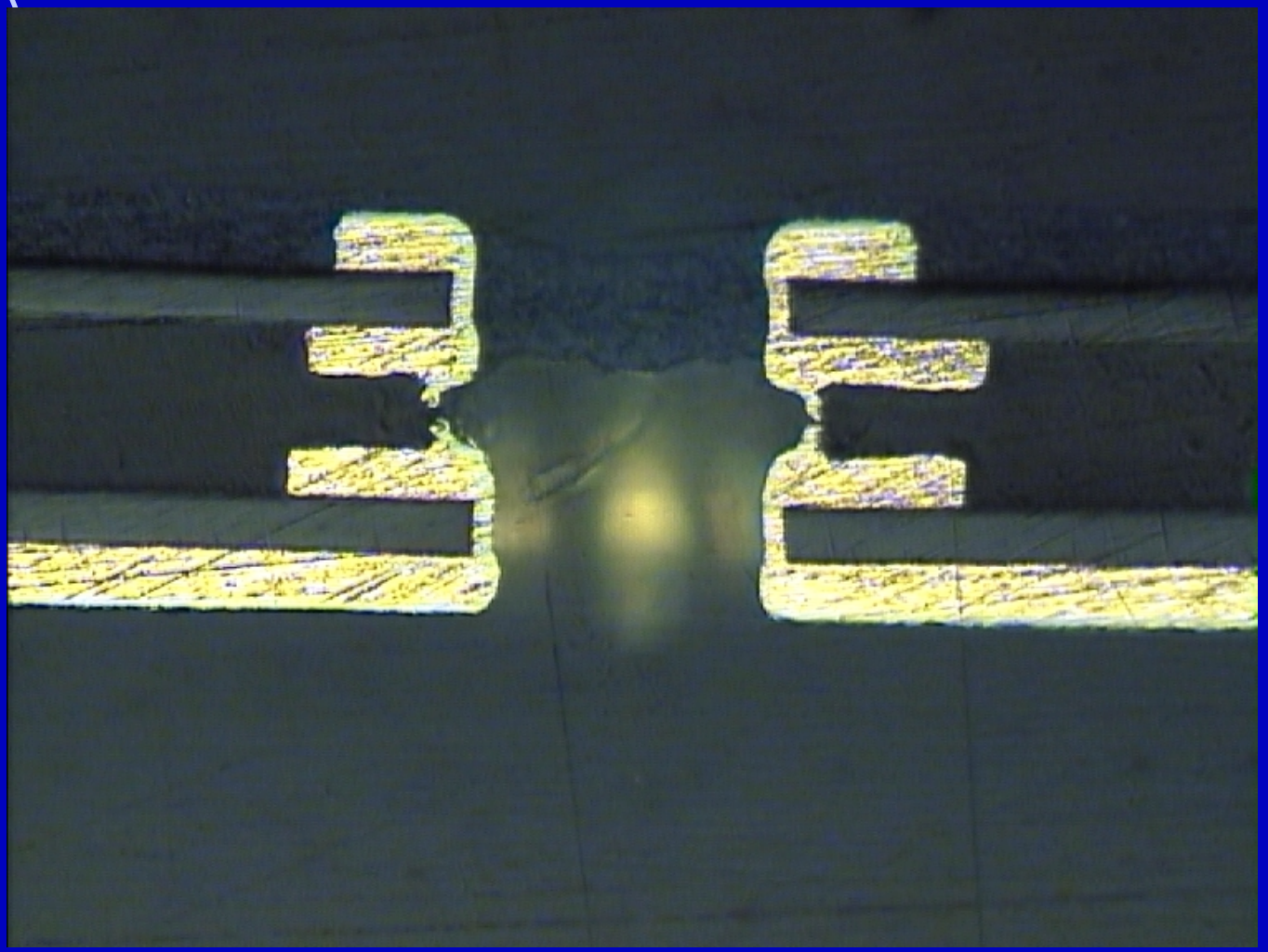
- bad plating (thickness of copper)
  - metallographic cuts or 4 probe low resistance measurement
- metalized hole integrity (cracks, non metalized, smear residues, etc.)
  - metallographic cuts
- bondability, solderability
  - X-ray fluorescence, bond test, leaching test
- delamination of inner layers (popcorn)
  - metallographic cuts, thermal shocks
- long term stability
  - thermal cycling, thermal shocks

These tests need destructive test and/or more sophisticated equipment

Bad plating of via



Crack in via



Time bomb...


100 µm
X 100 QUENCH HEATERS POWER SUPPLY BOARD
DE OLIVEIRA PHOTO 4
33 um
33 um
FISSURE
90 um

E. Qualification, QA & QC

- **Qualification Tests**
  - Should be done before starting production and should verify that the circuit can perform the function in the foreseen environment
- **Quality Control**
  - All the test and controls needed during production to guarantee that the technical parameters of the circuits are within the specification
    The goal is to find the problems early in production
- **Quality Assurance**
  - Set up a system that guarantees the production stability
    The goal is to avoid problems

Qualification test

- Verify that the technology fulfills your requirements
- Define the condition of use (thermal, environment, etc)
- Choose the technology
- Build a prototype, assemble it
- Thermal cycle or Thermal shock (simulate life cycle)
- Tests (cut views, inspection, etc)
- Electrical measurement
- Long term stability (bonding and soldering)
- Long term storage

In this phase you have to define the QC parameters and the frequency of these tests in production

QC: Quality Control

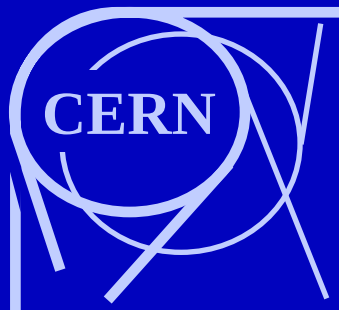
- **All the tests, during production that give the guarantee that one step is done perfectly**

alignments, local defects	microscopes
thickness of metal	precise ohm-meter
thickness of metal, defect in holes, delamination	metallographic cuts
defects in tracks	Automatic Optical Inspection
electrical integrity	electrical tester

- **The IPC-A-600 standard gives most of the rules**

With these tests we know how to verify a board,

- but you still don't know <u>when and how often</u> these test should be done,
- you cannot know if they are <u>really done,</u>
- and you don't know if they are going to be done always in the <u>same way</u>!



QA: Quality Assurance

- All persons know the processes?
- Every person who works on your circuit knows all its details?
- The circuit is made always in the same way?
- The equipment used is running perfectly?
- If a problem arises, is it detected rapidly?
- Is somebody permanently looking after your circuits in the company?
- Every comment from your side will be implemented in production?
- And when you receive the pieces, how can you trust them?

Minimum QA is

- Processes are written (under version control)
- The ***Process Flow*** exists and contains all technical details
  - under version control
- Equipment is under control (revisions and repairs traced)
- Raw material is under control (tracking)
- Quality manager is involved from the beginning of the project
- Project leaders are defined (both parties)
- Level of traceability should be agreed
- QC standards should be agreed

The *Process Flow* is the main document,
reading it you must be able to give an answer to all questions.
It is best to use the Process Flow as the specification, because it is the document that will be used in production.
Your own spec will be lost rapidly!

QA always needed?

- **When do you need QA?**
  - Large volume production
  - High value added to the circuit in the next processes
  - Long life time
  - Circuits used in modules were person security is involved (military, aeronautic, medical, accelerator safety)
- **When can you reduce or avoid QA?**
  - Prototypes
  - Simple toys

How to choose a company?

- Find a QA certified company
- Audit it before placing any order
- Read their Quality plan (before placing the order)
- Ask for production yields
- Find an expert
  - great help to define optimum technology, qualification test and QC parameters
- You need knowledge of QA processes

Don't forget the QA cost:
it may be 10% of the overall project cost,
mainly personnel who have followed training on quality assurance

F. Conclusions

- Qualify the chosen technology for your application
- Qualify the production company (audit)
- Define QC to verify quality during the production
- Define QA to guarantee your production stability

CERN has in-house experience with almost all technologies (fabrication, qualification, subcontracting)

A big problem is always a small technical problem that nobody had seen!

CERN TS-DEM can help: www.cern.ch/dem