Vacuum Challenges for Future Machines

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The major challenge

- The challenge remains
  - To produce a vacuum system where
    - the base pressure is (almost) zero
    - this pressure is reached in a few minutes
    - there is no space for pumps or gauges
    - the cost is very low
- But there are more realistic challenges!

The scene

New accelerators are being planned, both large and small, and these will introduce their own challenges to the vacuum scientist and engineer.

Some of these challenges will be ones of scale, and others will be rather more fundamental.

During this school, we have had pointers given to us as to where many of these challenges lie.

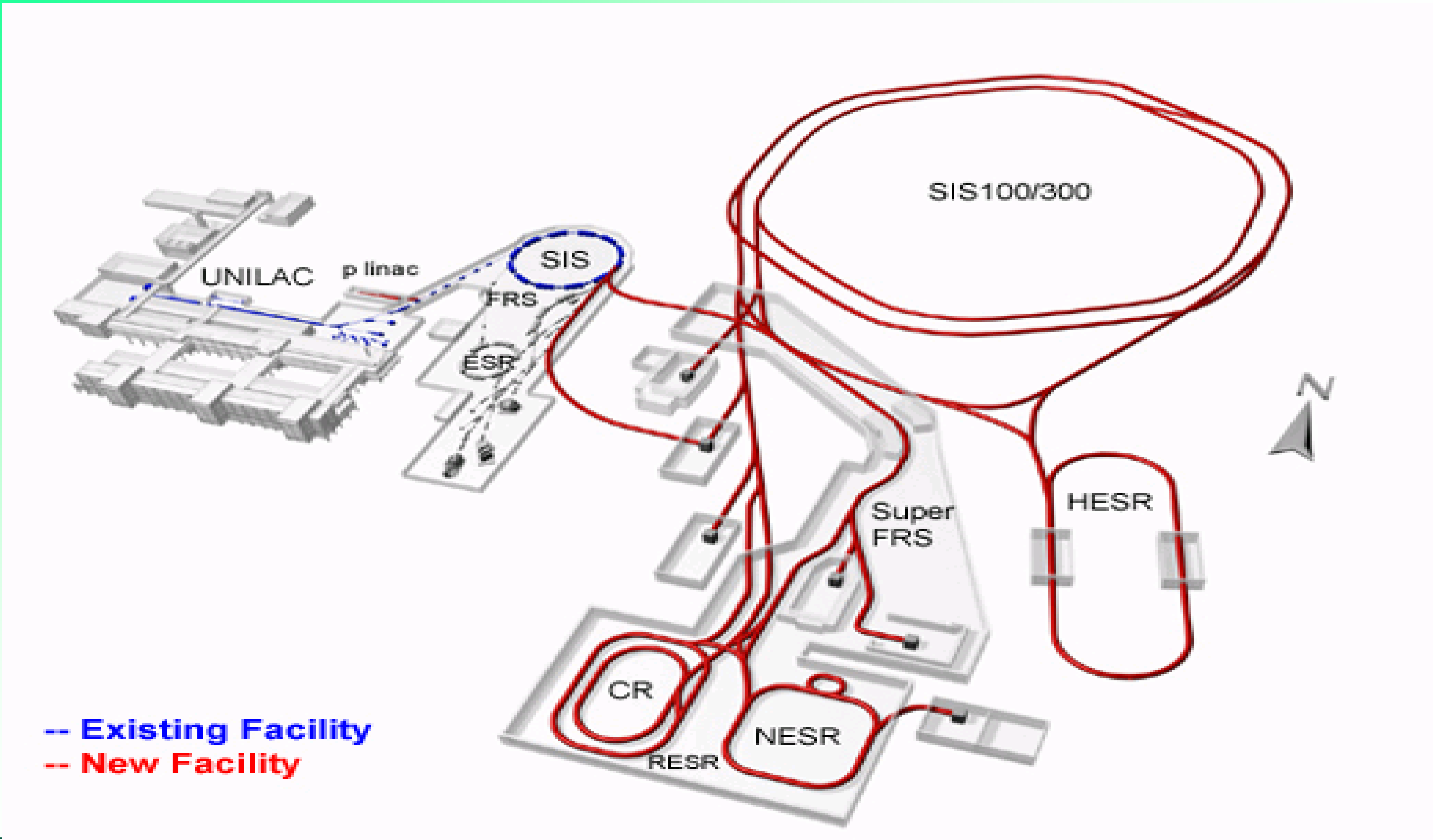
I will illustrate from three projects, then some more general things

- FAIR
- ILC
- Alpha-X

FAIR

- Facility for Antiproton Ion Research
- GSI, Darmstadt, Germany
- Upgrade to the present SIS heavy ion accelerator
- Large complex of rings and transport lines

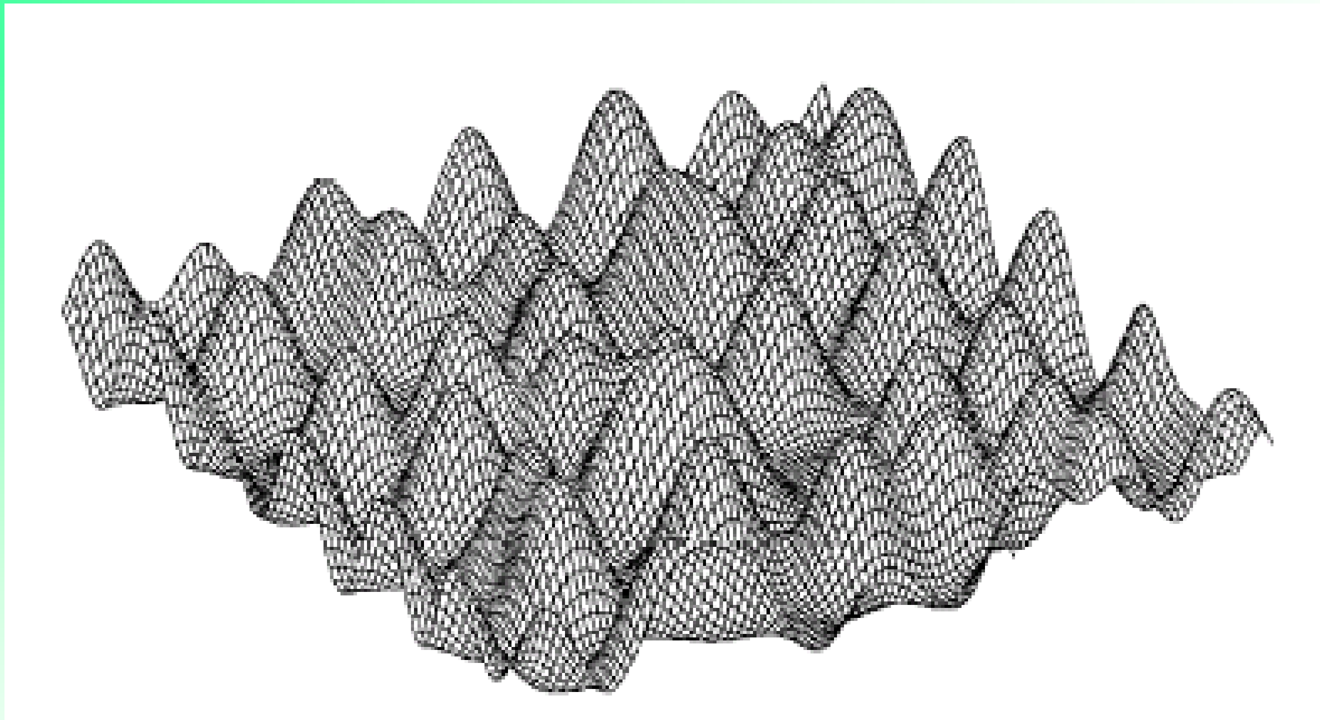
FAIR


SIS100/300
SIS
UNILAC
p linac
FRS
ESR
Super FRS
HESR
CR
NESR
RESR
N
-- Existing Facility
-- New Facility

FAIR

- A major challenge –
  - Electron cloud effects
  - Reduction in SEY
    - Active programme in coatings
    - ? Microtextured surfaces

Microtexture



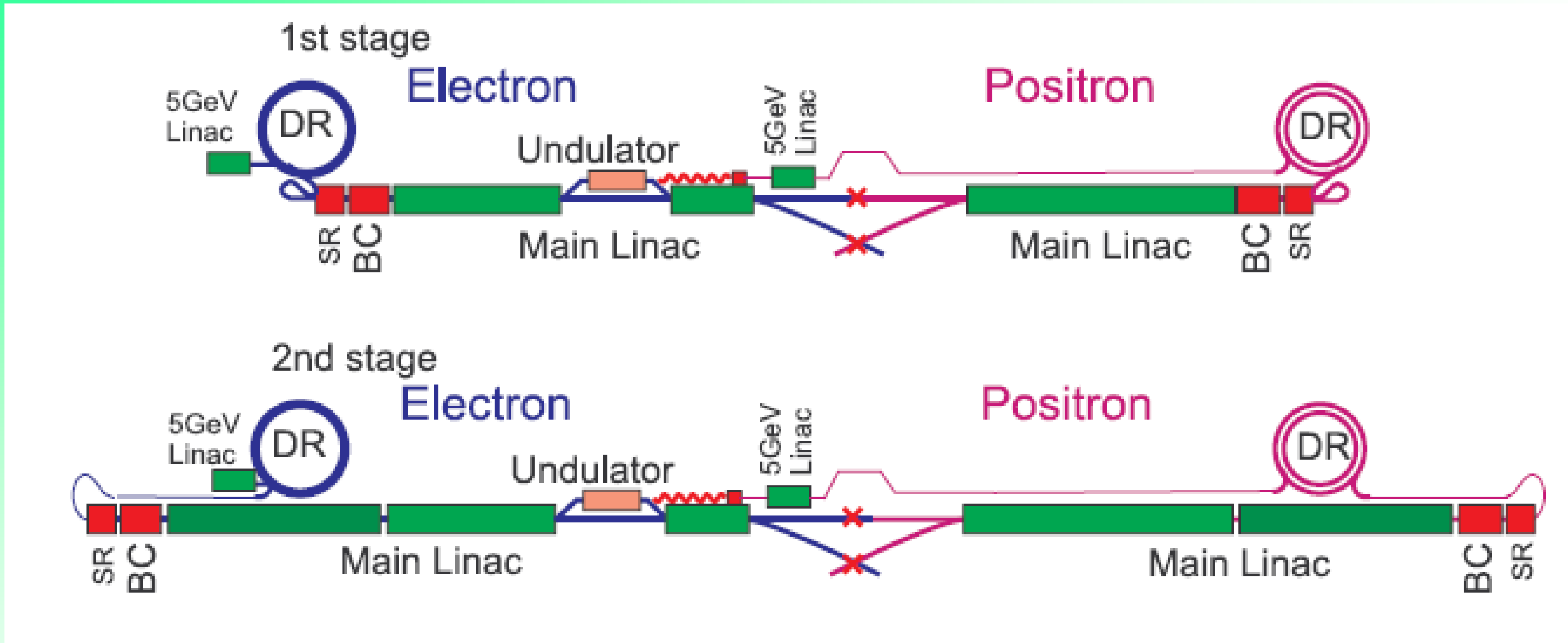
FAIR

- A major challenge –
  - Electron cloud effects
  - Reduction in SEY
    - Active programme in coatings
    - ? Microtextured surfaces
      - Would they work?
      - Can they be produced on the scale we require?
      - How long would they last?

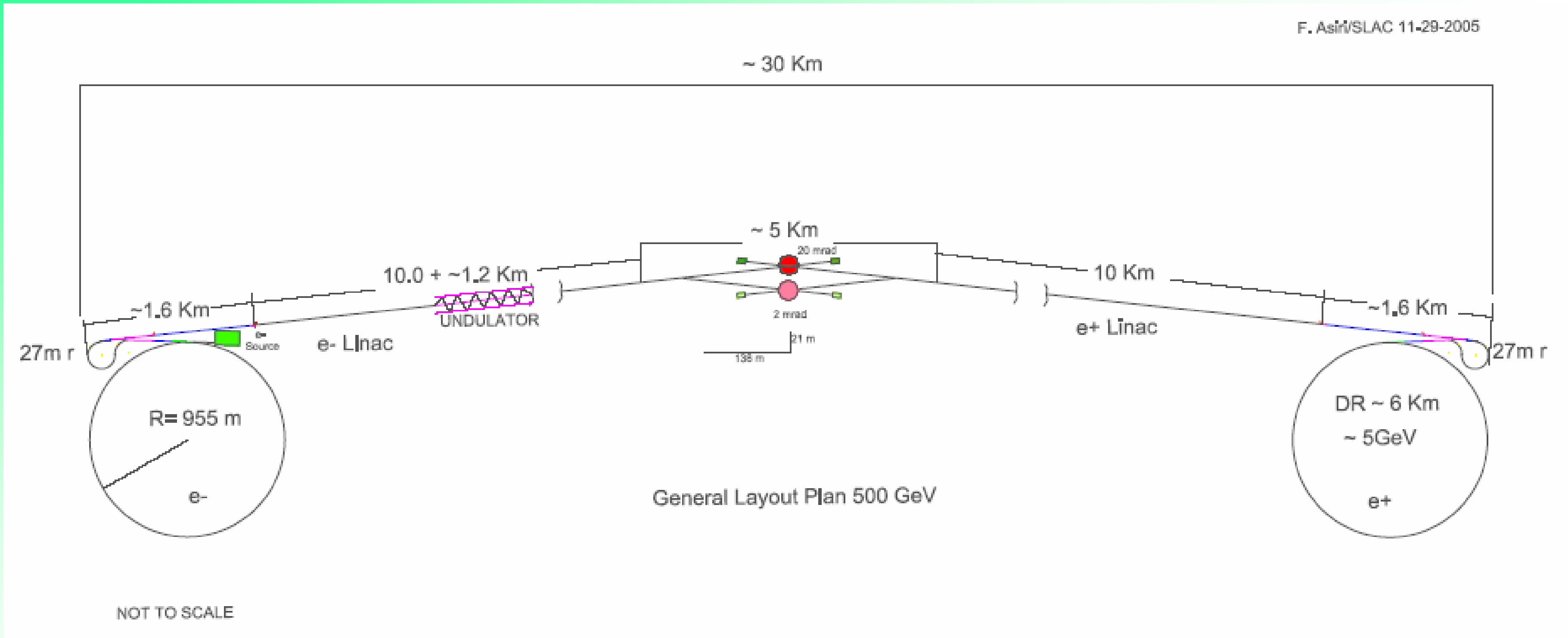
ILC

- International Linear Collider
  - World collaboration for the next big machine
  - Electron positron collider
  - 200-500 GeV (1 TeV)

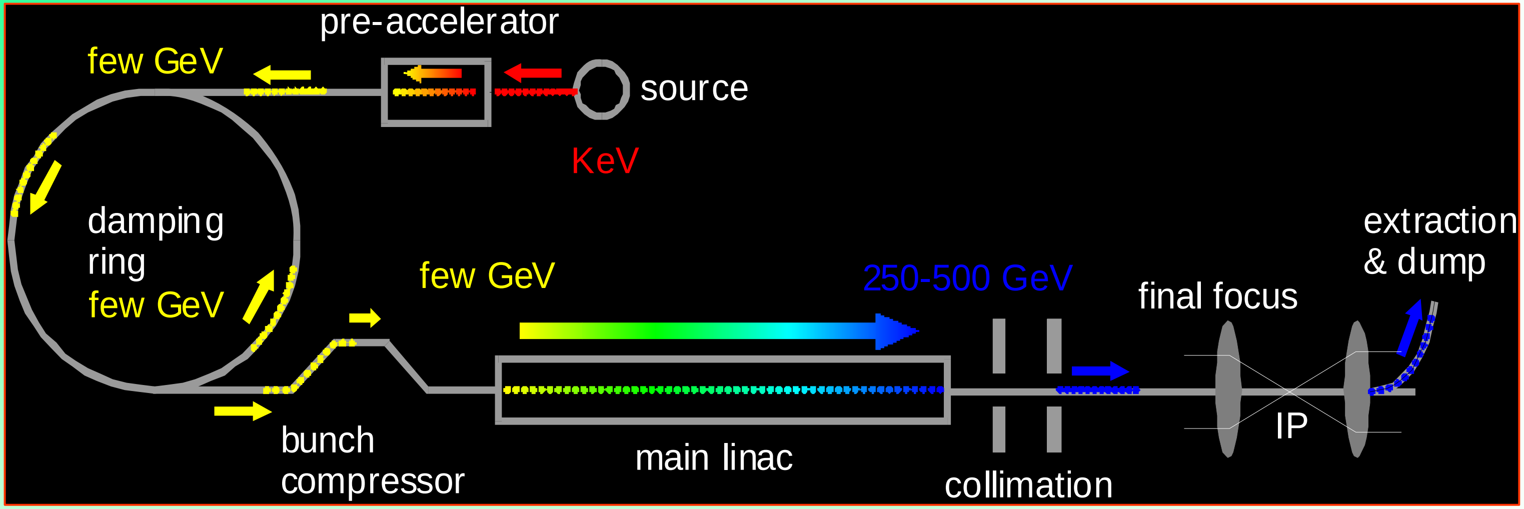
ILC

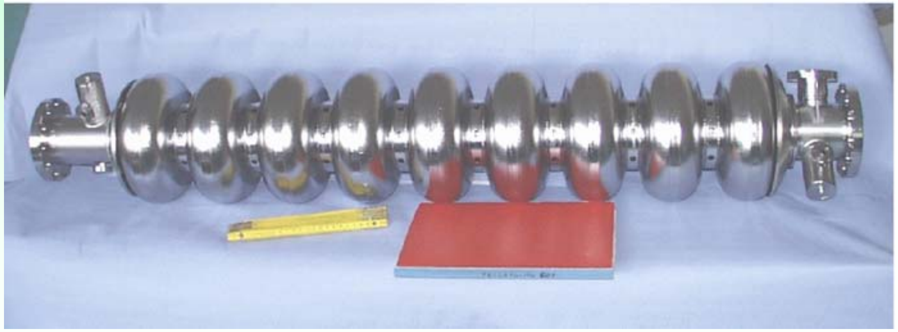

1st stage
Electron
Positron
5GeV
Linac
DR
Undulator
5GeV
Linac
DR
SR
BC
Main Linac
Main Linac
BC
SR
2nd stage
Electron
Positron
5GeV
Linac
DR
Undulator
5GeV
Linac
DR
SR
BC
Main Linac
Main Linac
BC
SR

ILC


F. Asiri/SLAC 11-29-2005
~ 30 Km
~ 5 Km
20 mrad
2 mrad
10.0 + ~1.2 Km
10 Km
~1.6 Km
~1.6 Km
UNDULATOR
e- Linac
e+ Linac
Source
21 m
138 m
27m r
27m r
R= 955 m
e-
DR ~ 6 Km
~ 5GeV
e+
General Layout Plan 500 GeV
NOT TO SCALE

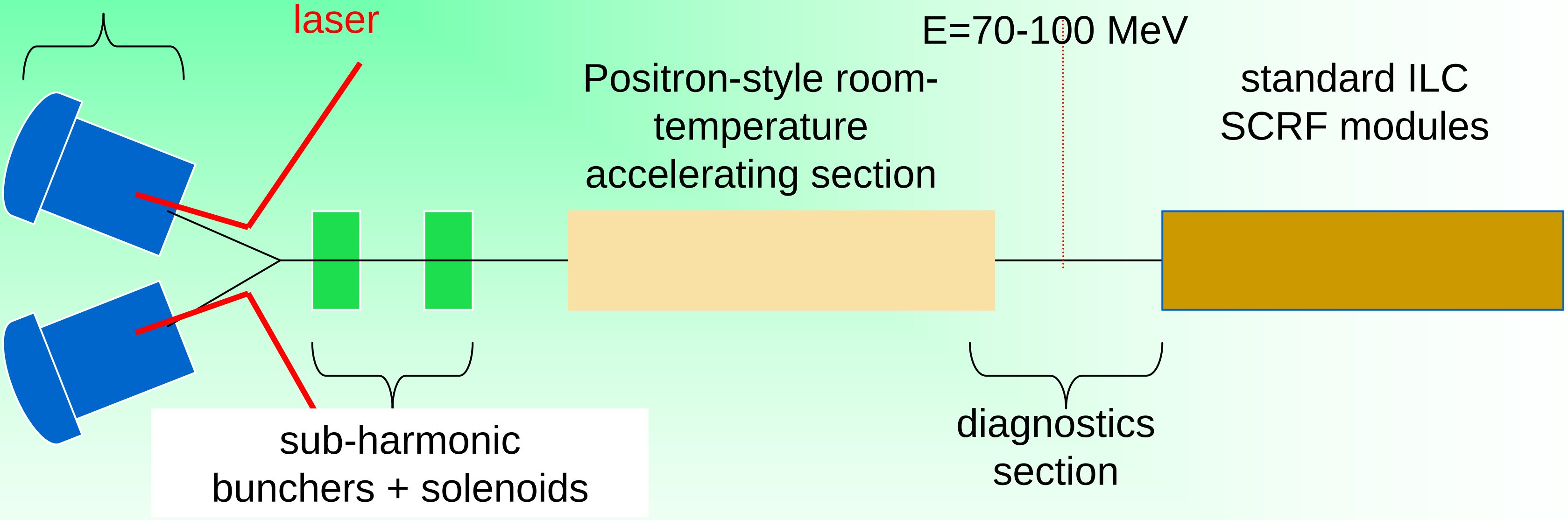
ILC


pre-accelerator
few GeV
source
KeV
damping
ring
few GeV
few GeV
250-500 GeV
extraction
& dump
final focus
IP
bunch
compressor
main linac
collimation



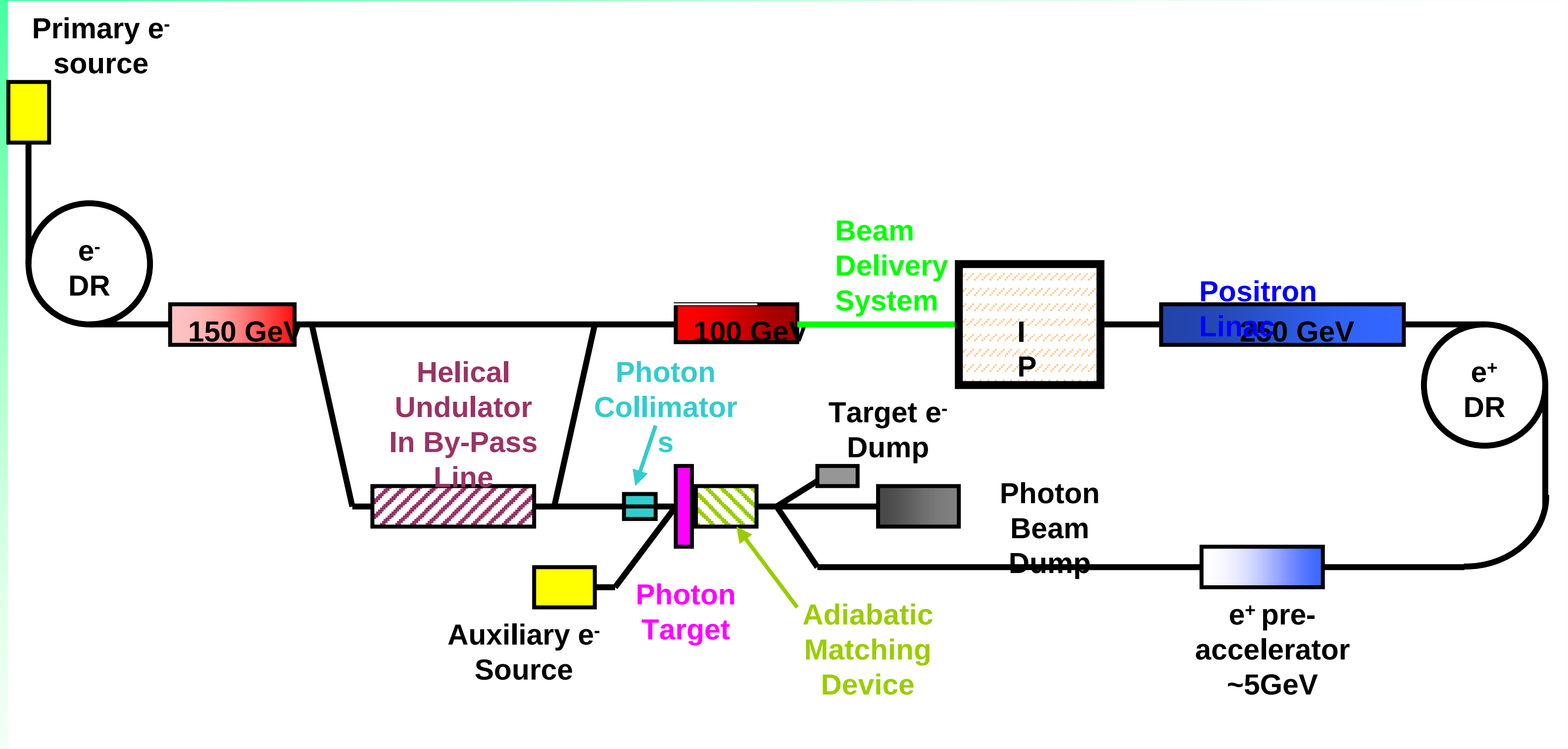
ILC

Electron Source



ILC

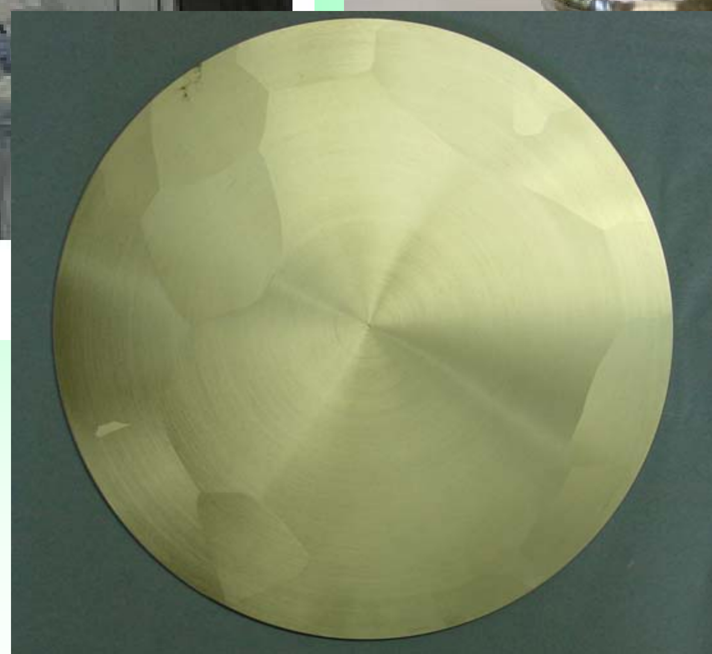
Positron Source



ILC

- Scale!
  - Industrialisation
- Superconducting cavities
  - Surface conditioning
  - Electropolishing
  - Surface characterisation

ILC



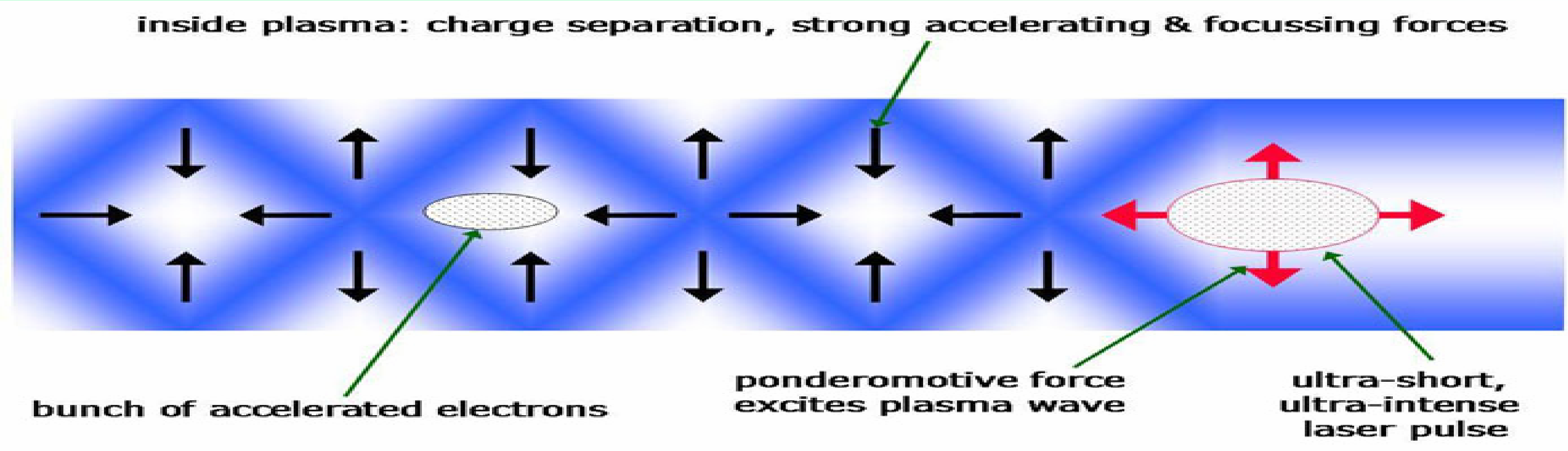
Slice from a large grain ingot

Single Crystal Vessels?

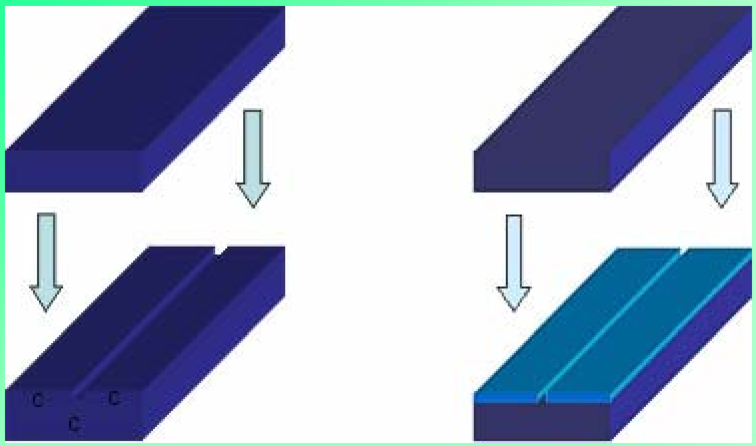
If it can be done for niobium, what about other metals?

Alpha-X

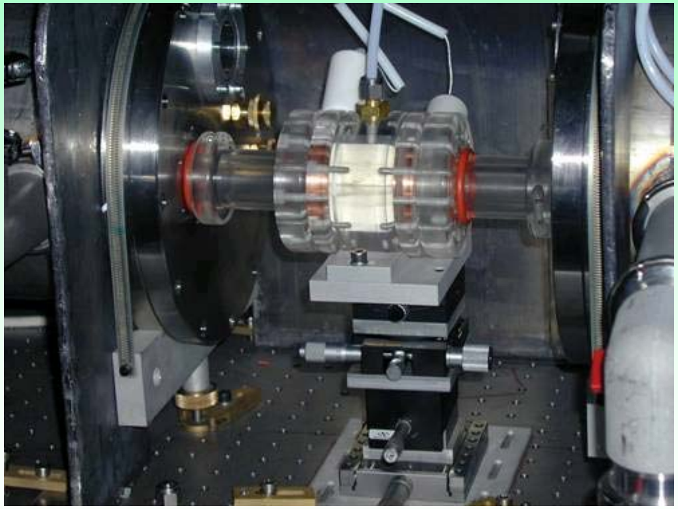
- Different concept
- ***A**dvanced **L**aser-**P**lasma **H**igh-energy **A**ccelerators towards **X**-rays*
- Wakefield accelerator

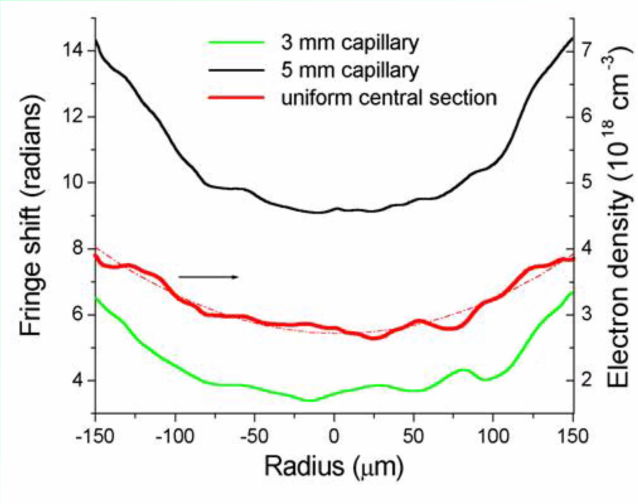


Alpha-X

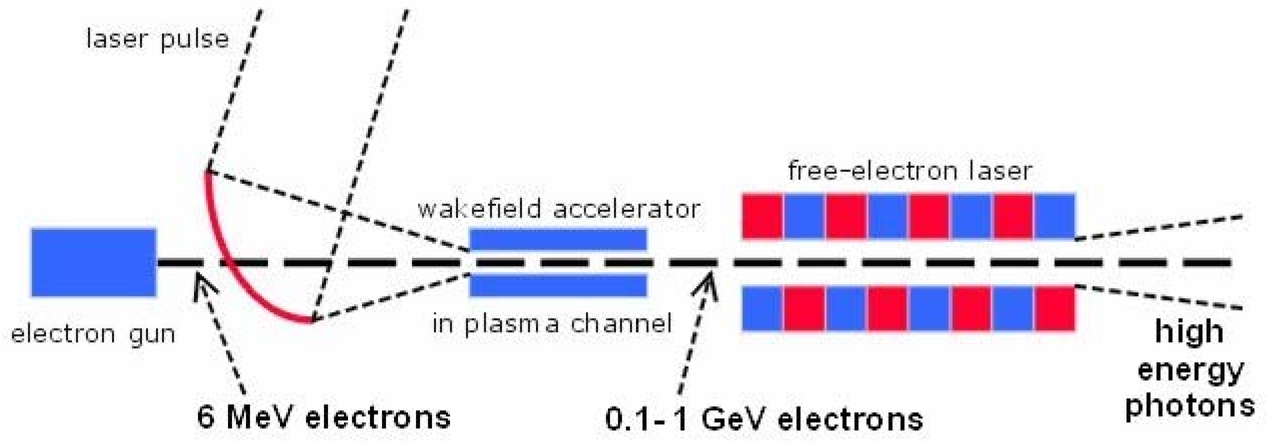


Capillary machined from sapphire – 2 methods





Alpha-X



Schematic overview of the ALPHA-X set-up

Alpha-X

- Gas is at low vacuum in the tube, but needs to be coupled to the much lower pressures in the rest of the system
- Gas flow may be molecular
- MEMS

Some more general challenges

- Large systems are large
  - Sophisticated tracking of items
  - Minimise numbers of pumps
  - Minimise vacuum diagnostics
    - How much is enough to give the information we need?
- Quality Control
  - Not just materials and manufacturing
  - Vacuum processing and acceptance tests
    - Leak testing
    - Cleanliness

Just a thought ….

- Leak testing long systems is difficult as we have seen
- Fred Dylla mentioned Pat Looney's work on laser interferometry
- Could we use such a technique to detect the plume of helium as it enters the system?
- Could we use TDR to locate the point of maximum density?
- Remember ….

….. You heard it here!

The final challenge …..

- You have learned a lot about vacuum during these past seven days
- The challenge is to go back, use this knowledge, and have fun with vacuum in the future so that you will be teaching on the next CAS Vacuum School

Thanks for sticking with it to the end!

Further information

FAIR

http://www.gsi.de/zukunftsprojekt/index_e.html

ILC

http://www.linearcollider.org/cms/

Single crystal Niobium

http://srf.jlab.org/

Alpha-X

http://phys.strath.ac.uk/alpha-x/index.html