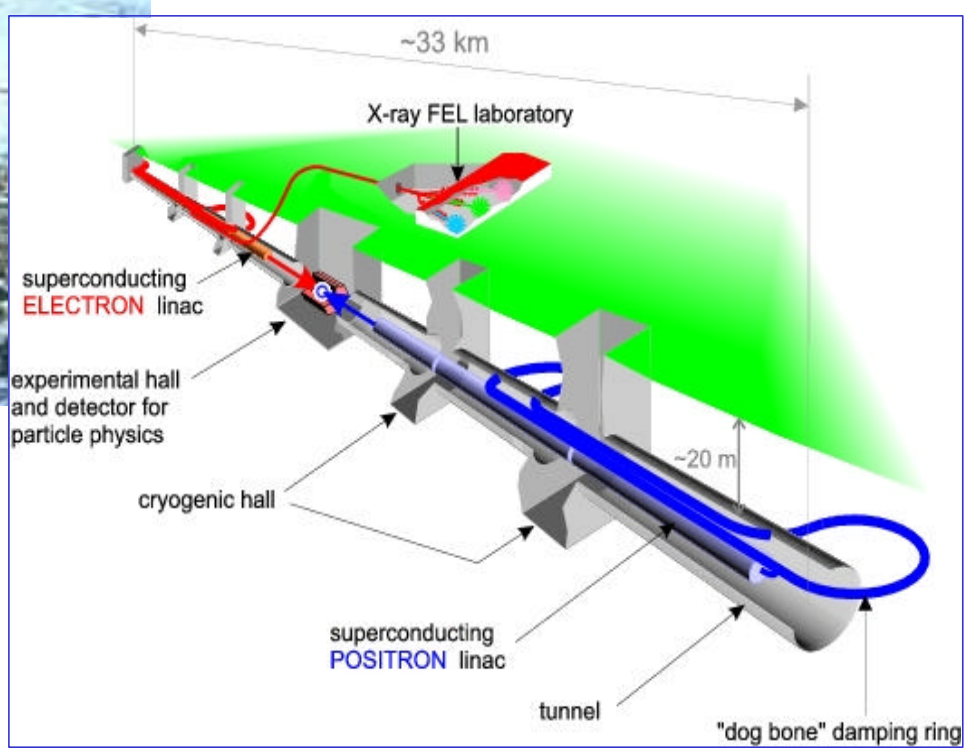
A Picture of HEP in the LHC Era

The Impact of a Linear Collider



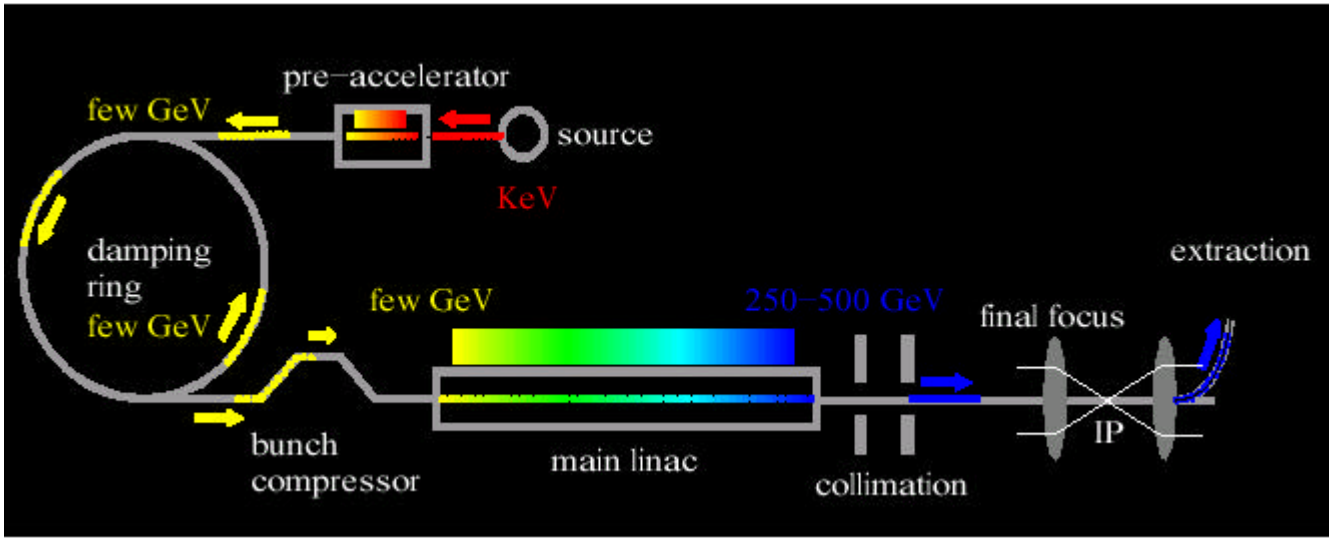
- Status
- Challenges & Solutions
- Impact on the Field
- Global Aspects

Consensus

The scientific community world-wide has agreed (Europe, United States, Asia) that a Linear Collider

- has an excellent scientific potential in the energy range of 500 GeV and above (see many detailed studies)
- is complementary to LHC
- is the next step on the road map of particle physics, but not the last
- therefore requires a timely realisation

e+e- Colliders: The Challenges



For E > 200 GeV need to build linear colliders

Proof of principle:

SLC

The challenges:

Luminosity: high charge density (10^{10}), > 10,000 bunches/s

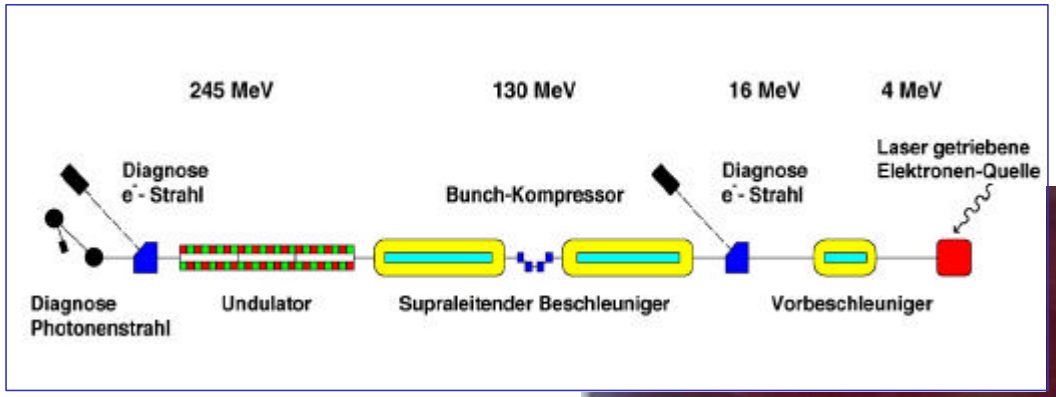
very small vertical emittance (damping rings, linac)

tiny beam size (5*500 nm) (final focus)

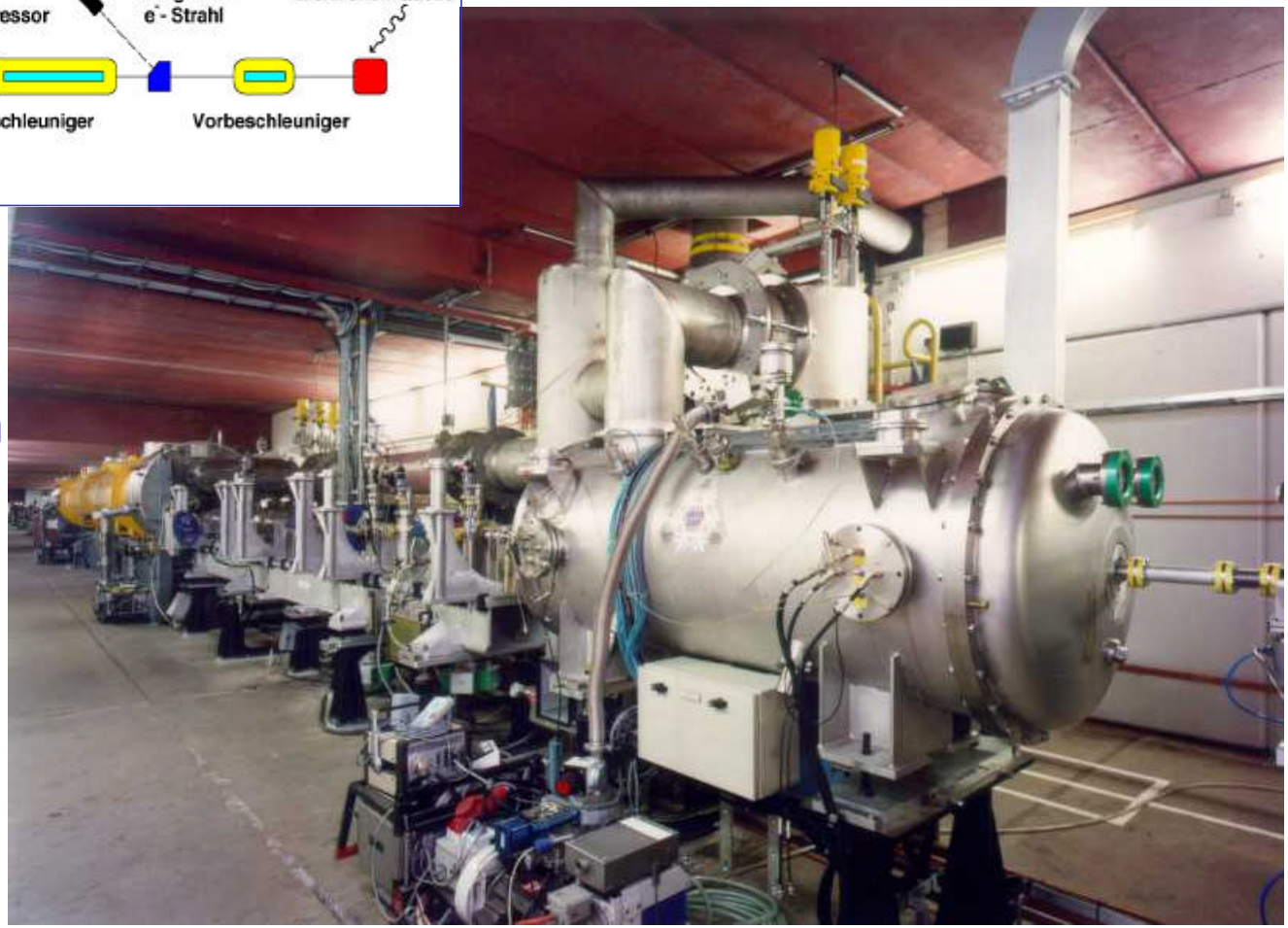
Energy: high accelerating gradient (> 25 MV/m, 500 - 1000 GeV)

To meet these challenges: A lot of R&D on LC's world-wide

The TESLA Test Facility



Construction of a prototype accelerator:



Tasks:

Test of all components

Operation for > 10 000 h

Base for costing

Conclusion:

The technical readiness has been demonstrated

Global Accelerator Network

How to Realise Big Accelerator Projects?

What is it?

Collaboration of interested accelerator laboratories and institutes world-wide with the goal to build, operate and utilise large new accelerators

Follows example of major detector collaboration in particle physics

- Partners contribute through components or subsystems
- Facility would be the common property of the participating countries, these would also share the responsibility, remote operation and cost
- Project of limited duration (25 years)

Workshops in March and September 2002 (Cornell, BNL)

Evaluation by German Science Council

Context: Large Scientific infrastructure proposals

Working Groups have been established, started to work:

- TESLA Linear Collider
- Free Electron Lasers
- etc.

Final result of evaluation by summer/fall 2002

Government decision expected in 2003

Impact of a LC on the Field

Study for US by HEPAP:

Case 1: Linear Collider in the US lead to the following priorities

- An electron-positron linear collider in the United States, with the U.S. contributing about 2/3 of the total project cost;
- Participation in the LHC and its possible upgrades;
- Significant US participation in the world-wide neutrino program
- Significant participation in effort to address key cosmological questions
- Continued program of flavour physics using exisiting facilites in the US and possible new or upgraded facilities abroad
- Participation in particle astrophysics by selective pursuit of new opportunities
- Continued accelerator R&D

.....

This scenario requires a net increase of about 30% in total funding to the field over twenty years.

Impact of a LC on the Field

Study for US by HEPAP:

Case 2: Linear Collider in Europe or Asia lead to the following priorities

- An electron-positron linear collider in Europe or Asia,with the U.S.contributing a significant share of the total project cost;
- Participation in the LHC and its possible upgrades;
- A major new neutrino facility in the US, with sigificant international participation, as part of a world-wide neutrino program
- A focused accelerator R&D program (VLHC, multi TeV LC)
- Significant participation in effort to address key cosmological questions
- Continued program of flavour physics
- Participation in particle astrophysics by selective pursuit of new opportunities

.....

This scenario requires a net increase of about 10% in total funding to the field over twenty years.

HEPAP Road Map

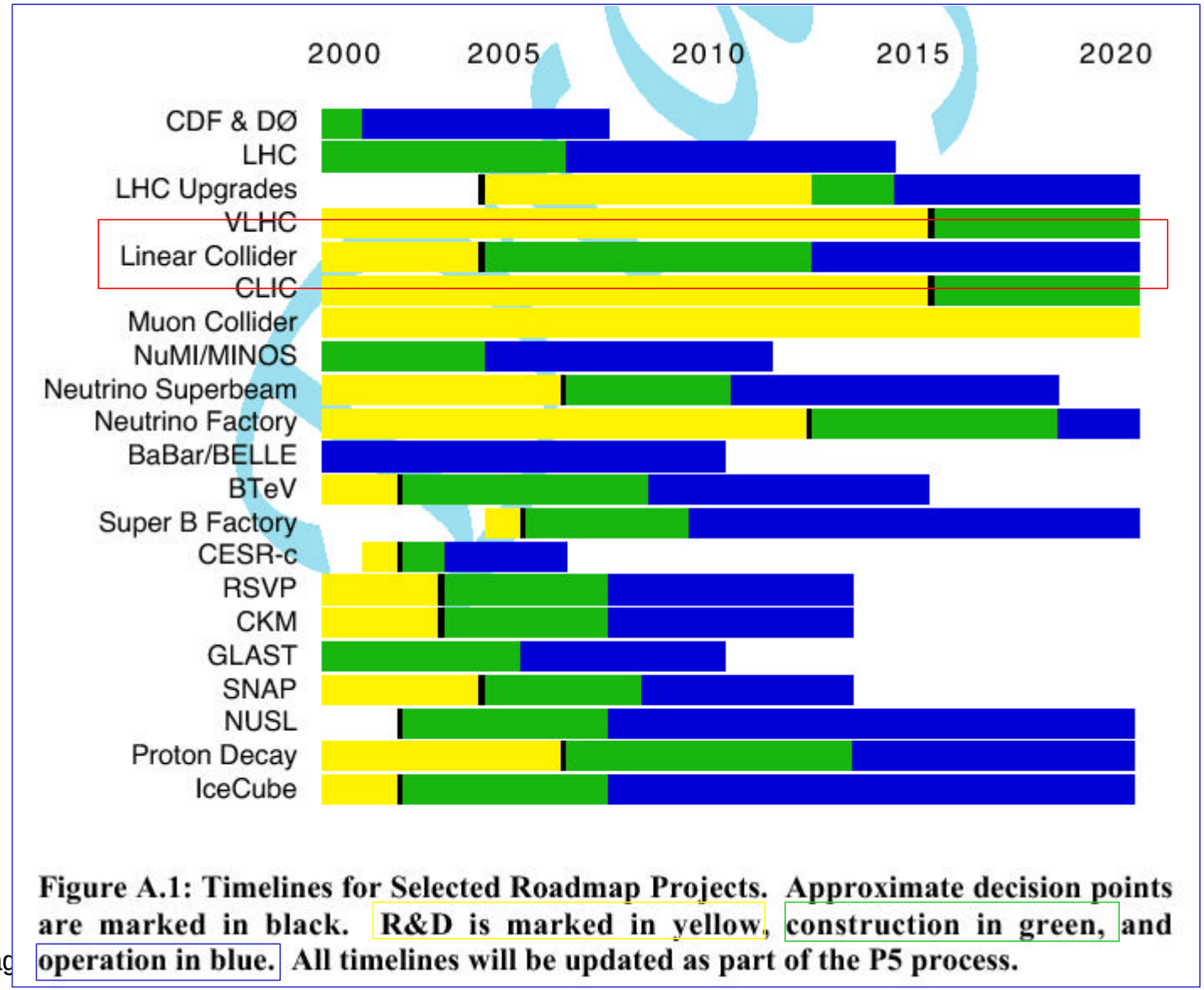


Figure A.1: Timelines for Selected Roadmap Projects. Approximate decision points are marked in black. R&D is marked in yellow, construction in green, and operation in blue. All timelines will be updated as part of the P5 process.

Impact of Linac Development on other Fields of Science

High quality, low emittance electron beams will provide the basis for a new type of light source:

Synchrotron light sources have become key tools for many fields of science

Their performance approaches the limits given by physics

SC-Linac driven light sources open new possibilities:
XFELs, Energy Recovery Linacs

The development of new accelerators for particle physics has paved the way for other fields of science

How to Proceed towards LC

HEPAP report: “We recommend that the highest priority of the U.S.program be a high-energy, high-luminosity, electron-positron linear collider, wherever it is built in the world. This facility is the next major step in the field and should be designed, built and operated as a fully international effort.”

Convince all interested governments to invest in a joint international project, e.g. through the mechanism of a Global Accelerator Network or alike.

The choice of site will be primarily a political decision, determined by which country/region is willing to host the facility. The host has to make a major investment and a long term commitment. → Spontaneous symmetry breaking needed

J. Marburger on U.S. S&T Priorities

"Today the frontiers of the large and the small – of astronomy and particle physics - remain unconquered. But they have receded so far from the world of human action that the details of their phenomena are no longer very relevant to practical affairs.

Not by accident, the instrumentation required to explore them has become expensive. Because we can no longer expect that society will benefit materially from the phenomena we discover in these remote hinterlands, the justification for funding these fields rests entirely on the usefulness of the technology needed for the quest, and on the joy we experience in simply knowing how nature works. (A joy, I am afraid, that is shared fully by a rapidly declining fraction of the population.)

I believe society will continue to support the exploration of the traditional frontiers of large and small, but it will do so with increasing insistence on careful planning, careful management, and the widest possible sharing of costs for the necessarily expensive equipment. Fortunately, these fields today do possess excellent planning processes, and for the most part the great accelerators and telescopes have been well built and well managed.

But the greatest opportunities in science today are not to be found at these remote frontiers. "

The American Institute of Physics Bulletin on Science Policy, #23, 21 February 2002

Conclusion

The world community is starting to identify priorities

Consensus on unique capabilities of LC and complementary to LHC, excitement in community

A LC might generate new resources

Need to maintain spectrum of first class instruments, big and small, but don't duplicate

Need to aim at more global coordination and complementarity of programs

Need to establish new forms of international networking, making all future large projects in particle physics international but at the same time part of the national research programmes

"Spin-offs" such as X-FEL help in making the case, as many fields of science will greatly benefit