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International Science and Large Scale Facilities
-
The International Linear Collider:
The need for Global collaboration

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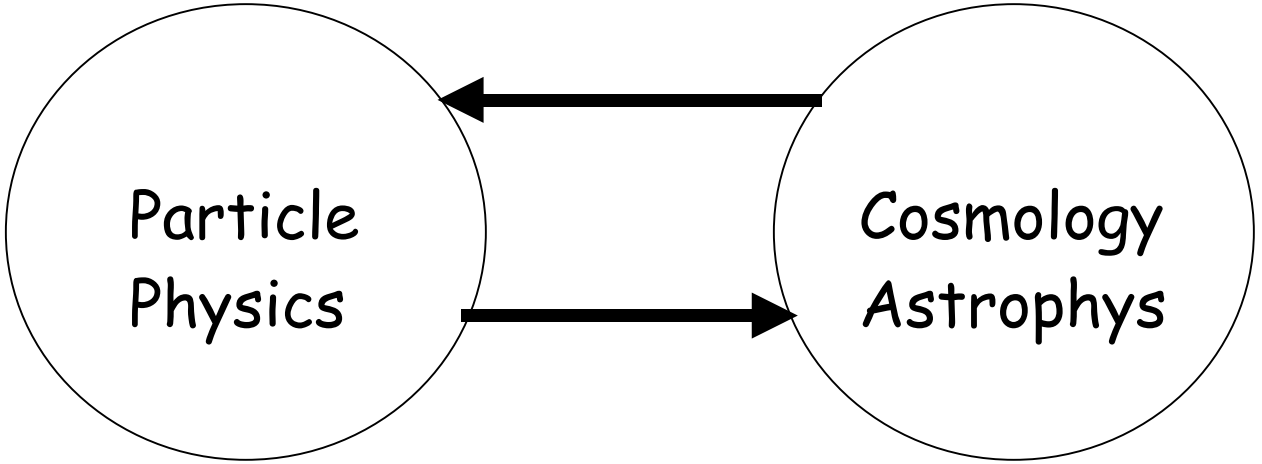
A. The scientific challenges of particle physics today
B. What is a linear collider?
C. Why must it be international?
D. History of collaboration in ILC
E. Status of the collaboration today/ future plans

A. Scientific Frontiers



- *Origin of mass*
- *Mechanism of electroweak symmetry breaking*
- *Is supersymmetry a feature of our universe*
- *What is dark matter; dark energy*
- *Can the universe be described with 4 dimensions…*

As the universe cooled after the big bang the nature of the interactions taking place changed in ways characteristic of the prevailing temperature . If we could recreate these conditions and study the elementary interactions in the lab, we should be able to find answers → *particle accelerators*

- Today, the frontier of Energy ("temperature") is at about 2 TeV, colliding protons against anti-protons at FNAL in the "Tevatron" a superconducting storage ring

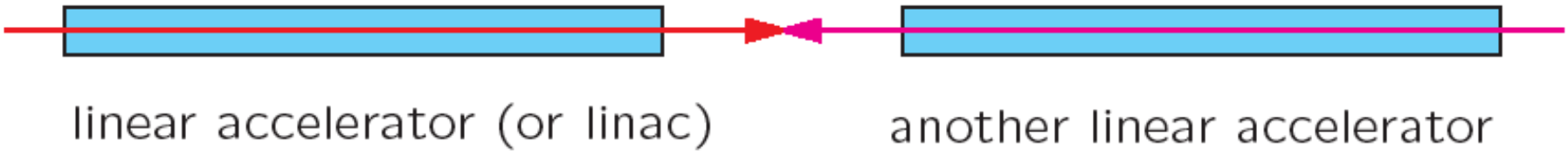
- In ~ 2007 the LHC (Large Hadron Collider) at CERN will come on with capability for ~14 TeV, colliding protons with protons. (*protons are composite particles sharing the energy so that the elementary collision energies are ~ 1/10 total)*

- Important parts of the questions listed above will be addressed by the LHC. It is now widely agreed† that obtaining the complete picture will require a machine colliding monochromatic elementary particles, in this case electrons and positrons. To avoid the enormous synchrotron radiation that would inhere in a storage ring for e+ and e- at TeV energies, one must accelerate in a straight line - hence a "Linear Collider"

† *Formal studies in Asia, Europe and US*

B. What is a linear collider?

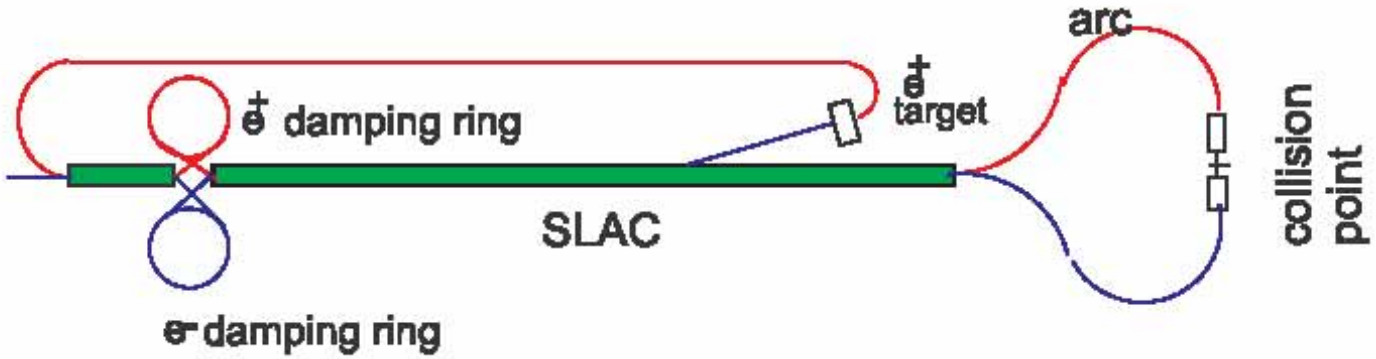
Electrons on positrons



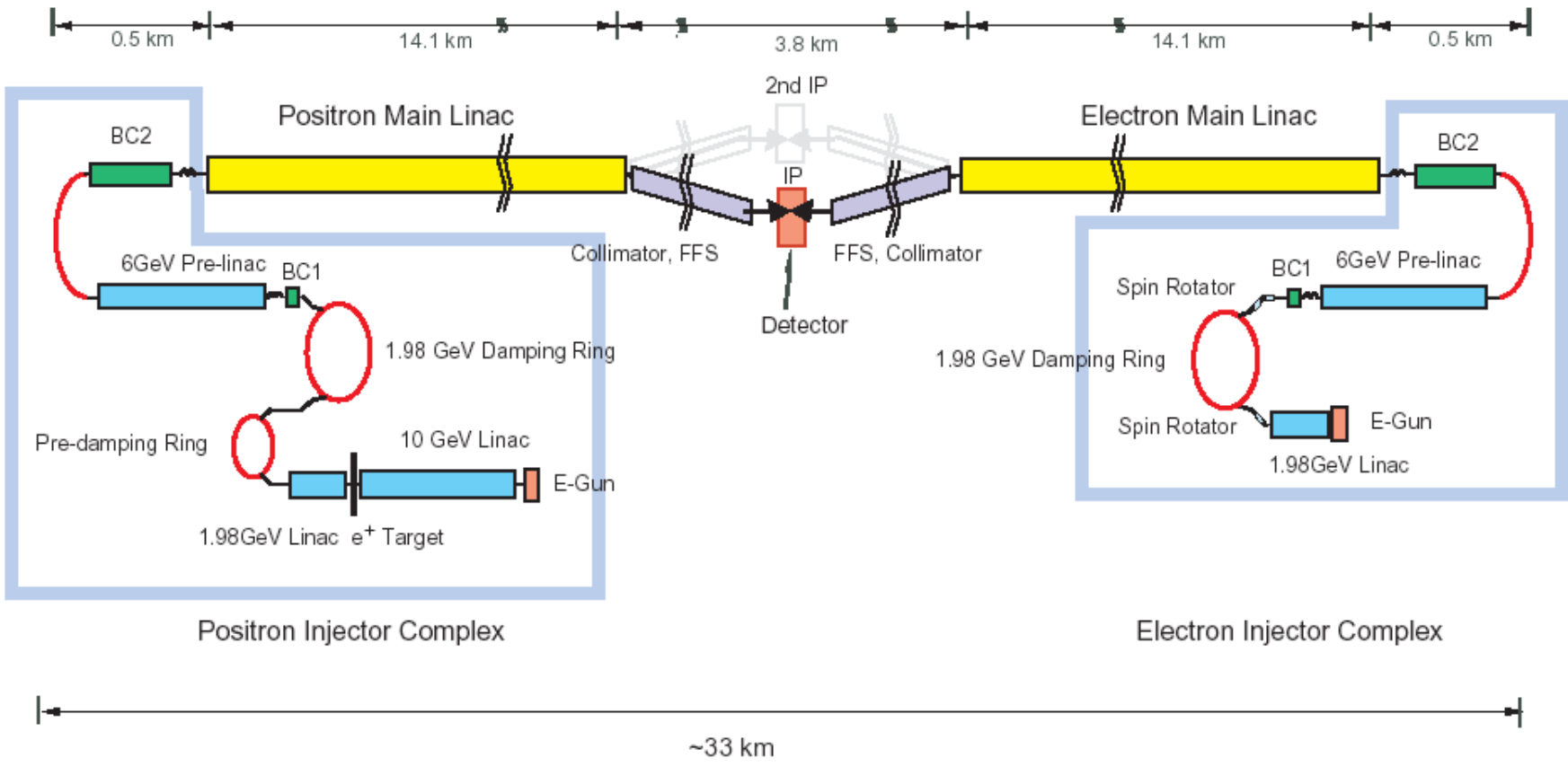
linear accelerator (or linac) another linear accelerator

SLC
: the first linear collider

- Built in 1988 at SLAC
- E_{CM}=92GeV
- Use one common linac for electron and positron
- Provided sufficient luminosity for Z^0 with beam size $\lesssim 1\mu$m
- Precious experience for future LC



JLC Complex


0.5 km
14.1 km
3.8 km
14.1 km
0.5 km
2nd IP
Positron Main Linac
Electron Main Linac
BC2
BC2
IP
Collimator, FFS
FFS, Collimator
Detector
6GeV Pre-linac
BC1
1.98 GeV Damping Ring
Pre-damping Ring
10 GeV Linac
E-Gun
1.98GeV Linac
e+ Target
Spin Rotator
BC1
6GeV Pre-linac
1.98 GeV Damping Ring
Spin Rotator
E-Gun
1.98GeV Linac
Positron Injector Complex
Electron Injector Complex
~33 km

C. Why international?

* If there is one to be – there will only be one to be shared by the world community ⟶ world community should share in the concept, realization and harvesting of science

* Pooling of resources – intellectual and economic – needed for realization of such a large project today

D. History of Collaboration - combination of grass roots and more formal activities

- Communities in Russia, Asia, Europe and US began work in early '90s – began formal exchanges soon thereafter in a series of workshops – first one LC1993 – reached

agreement on a common set of parameters to enable inter-comparison of the various schemes being developed. *Very beneficial and still going on.*

- In 1993 a collaboration of the principal actors from the various regions created a Collaboration Council to facilitate collaborations and technical developments. In 1994 they created a Technical Review Committee, TRC, ……*The TRC is to identify the accelerator physics and technological requirements for each approach to provide particle physics opportunities at the energy and luminosity goals agreed upon. The report of the TRC should contain a brief commentary of the status and expected progress toward understanding and achieving the most important of these requirements……*

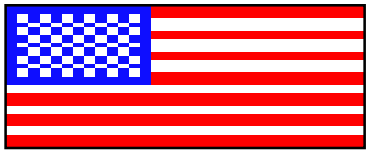
The TRC report was presented to a Collaboration Council meeting in Japan in 1995.

- The work in the several regions was collaborative from the beginning as well as shown by these illustrative mastheads adopted by the various groups (see Fig 1 & 2)

E. Status of the collaboration today/ future plans

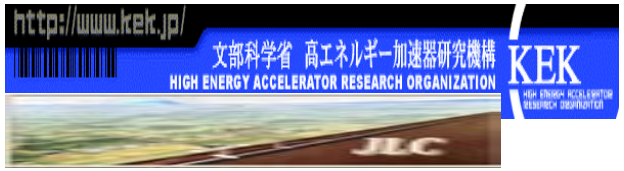
- In the intervening years, the number of approaches has reduced to ~ 2 owing to economic and other factors. The involved scientific community is now driving towards selecting one of those approaches and coalescing into one global collaboration.

World-Wide Collaboration on X-Band



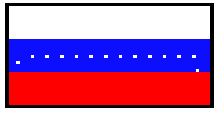
• Stanford • UC Davis

Fermilab



• British Columbia

• Oxford



• BINP

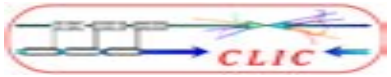


Fig. 1 Masthead for "Warm Technology" Collaboration

Fig. 2 Masthead for "cold technology" collaboration

Important steps in this process:

1. Each of the regions has formed a steering committee to coordinate LC development activities within its region, and to prepare for the eventual global collaboration. Thus we have a ELCSC, ALCSC and USLCSC (Canada and Mexico included)
2. Formal international scientific organizations have become involved. ICFA (International Committee on Future Accelerators), a child of IUPAP (46 countries), has reconvened the TRC to examine the current situation in preparation for selection of one approach. Report now just published (show). It defines R&D accomplishments that must be completed to verify feasibility of a

particular approach. ICFA has also created an ILCSC to facilitate formation of the global collaboration (see Fig. 3) *Prevailing opinion is that we will be able to decide on the one global approach before mid '04 and to have the beginnings of a global design group in place then.* Time will tell!

Involvement of governments:

1. To date, primary involvement of regional governments has been in support of their own laboratory's efforts with little communication to other governments in a global context.
2. OECD has made some effort to get the ball rolling through its Global Science Forum which created a

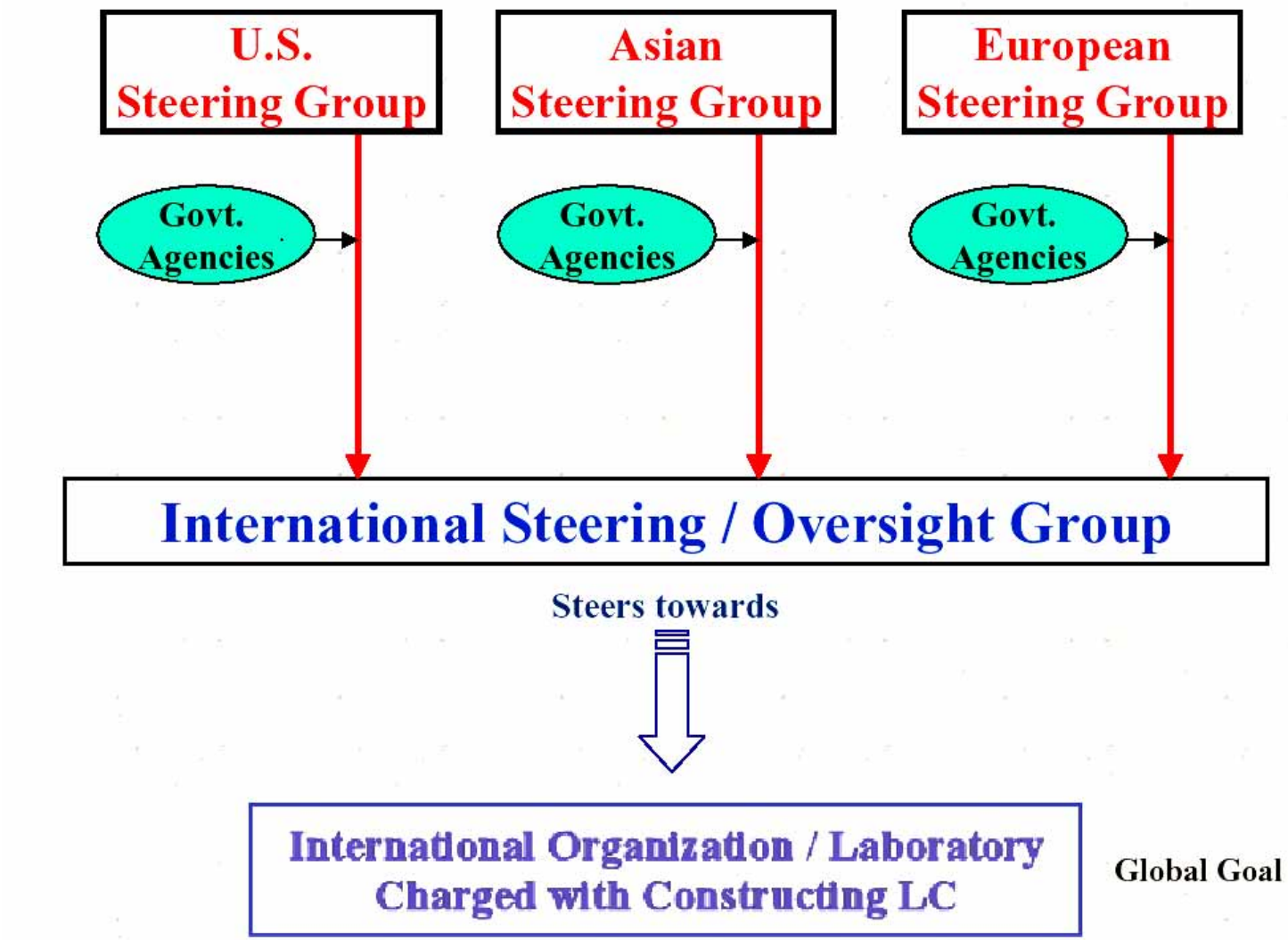


Fig. 3 ICFA endorsed, grass roots linear collider coordination arrangement

"Consultative Group on High Energy Physics", a mixed group of scientists and government agency people. Their report was submitted last year and contains discussion of the science and of the possible paths to forming a global collaboration with appropriate participation by, and accountability to, governments which will participate in the hoped for project.

3. It is generally agreed that this activity should continue but that some "government only" forum needs to exist to start hammering out the many difficult challenges. Beginning initiatives are underway but path to the future not yet clear. Stay tuned.

What might a construction phase organization look like:
(see draft in Fig. 4)

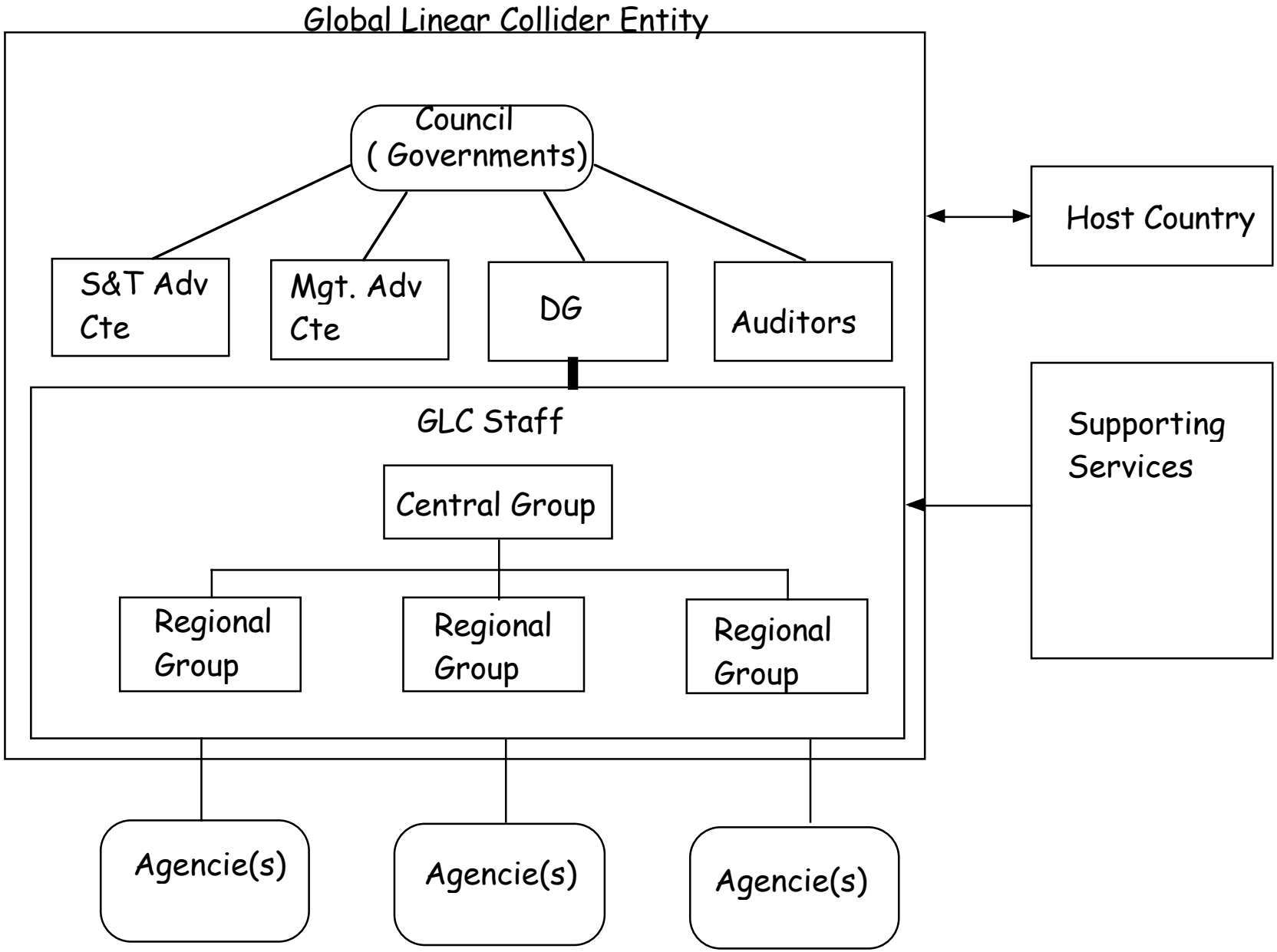


Fig. 4 Possible international organization for carrying out construction of a linear collider

In the mean time – lots of technical progress in the regions.

The experts predict that we'll be able to make a technology choice within a year. With this in view, the process for creating a Global Design Group to turn the technology choice into an engineering design is now underway.

There is still a long way to go but the spirit is there for making a great advance in global scientific culture and the culture of human cooperation.

Let's make it work!