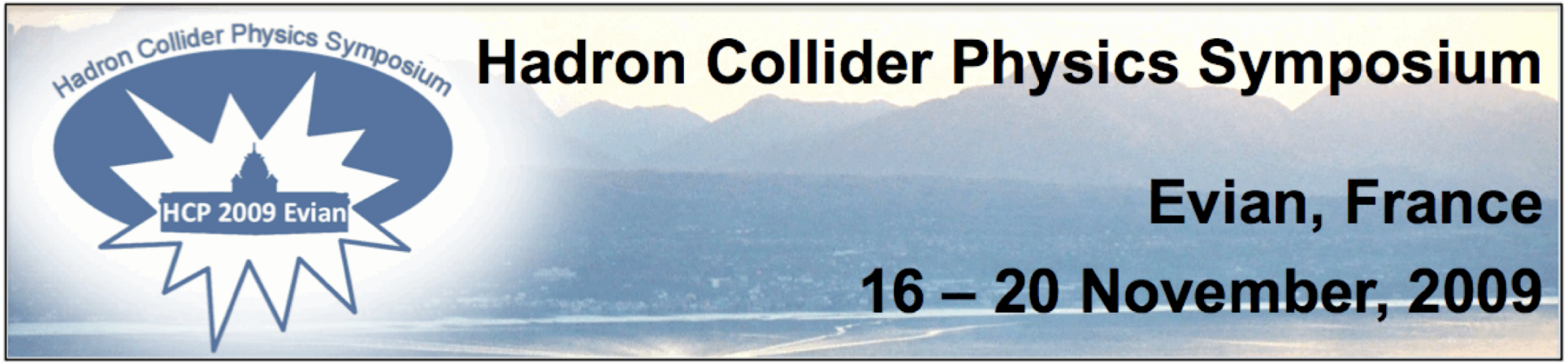
Roadmap for Particle Physics in Europe



T. Nakada

LPHE-EPFL

ECFA

CERN Council

Particle Physics?

Energy frontier direct search of new physics at high energy

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Flavour physics { quark sector
lepton sector { charged lepton
neutrino

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non-accelerator

European Strategy Document

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☝ The strategy document should be “regularly” updated (every ~5 years)

European Strategy for energy frontier

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- The LHC will be the energy frontier machine for the foreseeable future, maintaining European leadership in the field; *the highest priority is to fully exploit the physics potential of the LHC, resources for completion of the initial programme have to be secured such that machine and experiments can operate optimally at their design performance*.

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European Strategy for energy frontier

- In order to be in the position to push the energy and luminosity frontier even further it is vital to strengthen the advanced accelerator R&D programme; *a coordinated programme should be intensified, to develop the CLIC technology and high performance magnets for future accelerators, and to play a significant role in the study and development of a high-intensity neutrino facility.*

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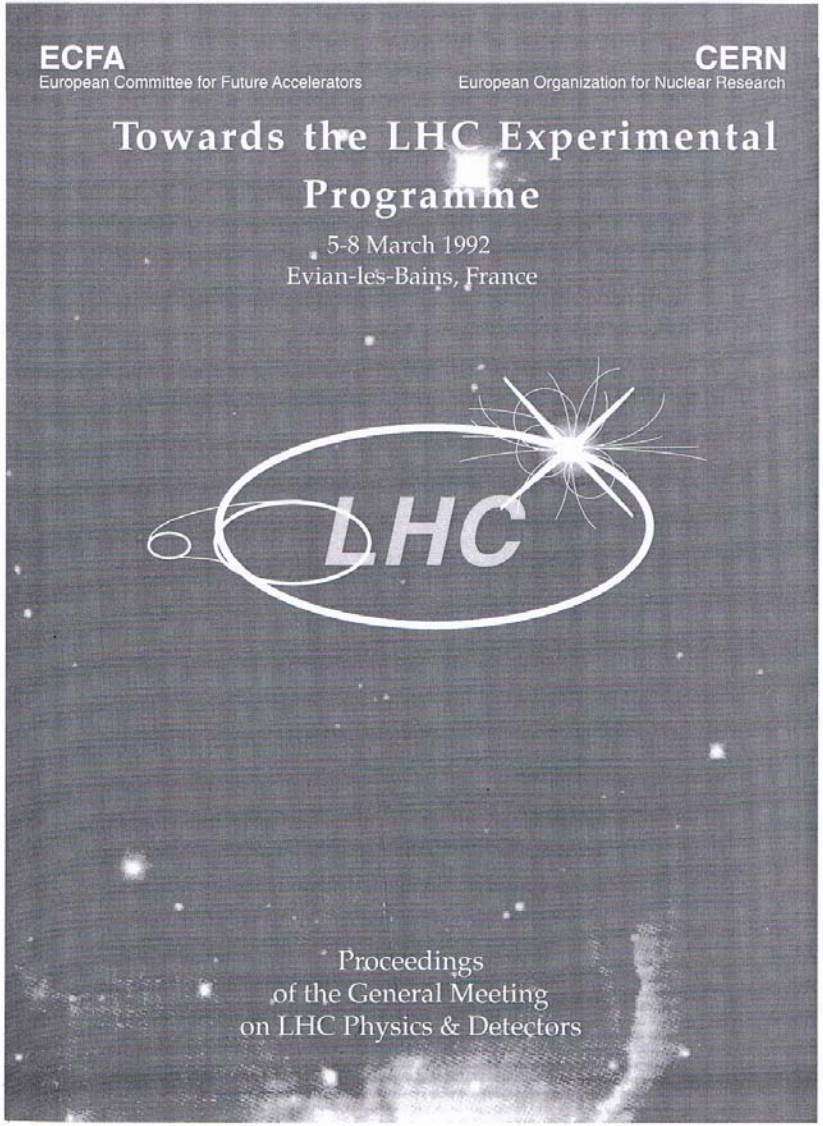
- In the energy range of 0.5 to 1 TeV, the ILC, based on superconducting technology, will provide a unique scientific opportunity at the precision frontier; *there should be a strong well-coordinated European activity, including CERN, through the Global Design Effort, for its design and technical preparation towards the construction decision, to be ready for a new assessment by Council around 2010*.

LHC has started from here…



Summary by E. Iarocci

SUMMARY OF EXPRESSIONS OF INTEREST

• **PP** : a) Main Detectors	- ASCOT	P. Norton
	- CMS	M. Della Negra J.C. Lottin
	- EAGLE	P. Jenni
	- L3+1	S.C.C. Ting
b) B Physics	- CP Violation in B (forward spectrometer in collider mode)	P. Schlein
	- CP Violation in B (extracted beam FT)	G. Carboni
	- CP violation in B (GAS JET FT)	T. Nakada
• **Heavy Ions** :	- Dedicated general purpose detector	J. Schukraft
	- DELPHI	G. Jarlskog
	- CMS	L. Ramello
• **Neutrinos** :		K. Winter L. Vannucci

Summary by E. Iarocci

- We operate under the initial assumption that the initial programme for the LHC consists of:
  - 1 or 2 general purpose detector(s) to study proton-proton collisions. In case of >1 detector ,"complementarity" must be ensured
  - 1 dedicated heavy-ion facility +parasitic use of the other detectors
  - 1 or 2 non-mainstream experiments (beauty, neutrino, ...)
- This guide-line has been endorsed by the SPC and constitutes:

  – a broad and competitive programme fully exploiting the diverse physics opportunities of the LHC, while

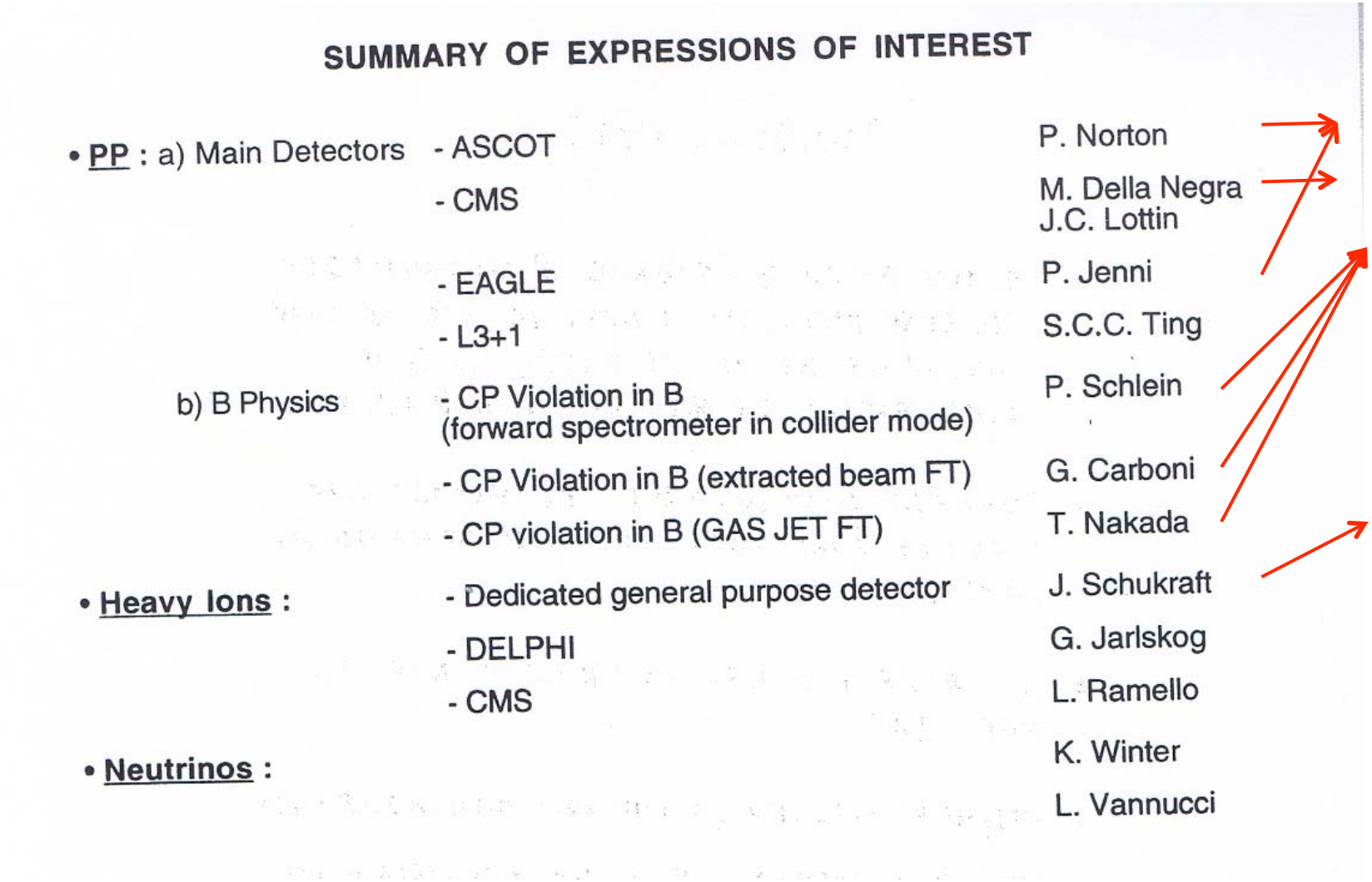
  – taking into account the inevitable limitations in manpower and financial resources, which exclude unnecessary duplication of experimental efforts.
- It is assumed that a possible electron-proton option will only be considered at a later stage and on the basis of the results of HERA.

Evian, March 8, 1992

P 4

Summary by E. Iarocci

It has been a long way for many of us…



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Now
ATLAS
CMS
LHCb

ALICS

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- We are soon going to have an extremely exciting period with LHC ✌ ✌ ✌
- However…
  start-up of the LHC has been more difficult than generally anticipated:
  - completion of the construction took longer than hoped for, ☟
  - will take, most probably, still appreciable time to reach the nominal luminosity (was expected) and energy (not really expected) ☟ ☟

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Without "positive" results from the LHC experiments, it would be very unlikely to fund a new energy frontier machine (even "any" big machine for particle physics?):

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⇒ILC-CLIC collaboration is becoming important!

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  - Consolidated injection complex is needed rather soon, not in 2020 for a reliable LHC operation.
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- In which scenario, ~10 times more statistics would really make a difference?

European Strategy for neutrino

- Studies of the scientific case for future neutrino facilities and the R&D into associated technologies are required to be in a position to define the optimal neutrino programme based on the information available in around 2012; *Council will play an active role in promoting a coordinated European participation in a global neutrino programme*.

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CERN Council has this year asked the CERN Science Policy Committee (advisory to the council):

- What is the view of the SPC on the importance of precise measurements of the neutrino oscillation parameters, in particular the CP violating phase and mass hierarchy?

European Strategy for neutrino

– One of the most promising techniques for such measurements is the neutrino factory and there is currently an International Design Study (IDS) to produce a conceptual design report for a neutrino factory by 2012. This is not site specific. What is the view of the SPC on the overall value of the IDS for the future of the subject? Should CERN take a more active role in enabling the study to reach its goals, irrespective of where such a facility would be sited?

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– What other high intensity neutrino facilities are technically possible and how would they address the measurements above? What should be the involvement of CERN in studies of these facilities, in particular with regard to the planned LHC upgrades?

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- What other high intensity neutrino facilities are technically possible and how would they address the measurements above? What should be the involvement of CERN in studies of these facilities, in particular with regard to the planned LHC upgrades?
- What is the view of the SPC on the merit of a European strategy in this phase of neutrino experimentation and whether it should have a place on the future CERN road map?

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- 2012~2013 a new set of measurements on θ_{13} from the current round of experiments -accelerator (US and Asia) and reactor (EU and Asia) to a level of ~0.01, will provide an indication for the future steps…

Personal Observation (mumbling)

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– Asia and US: plan to make the Super ν beam
– R&D activities on a ν factory in EU and US
– R&D activity on β beam in EU
– US: neutrino factory (on its way to a muon collider)?

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- Other special R&D needed for the neutrino factory (e.g. cooling) and β beam (e.g. source)
- Europe should stay at forefront for those R&D activities, however, answers to:
  - Should we try to build a Super ν beam in Europe?
  - Should the consolidation of the LHC injection complex take into account the needs for a possible neutrino facility at CERN? (win-win☺ or loss-loss☹)

  would be needed "soon". (LHC cannot wait too long)

European Strategy for astroparticle

- A range of very important non-accelerator experiments take place at the overlap between particle and astroparticle physics exploring otherwise inaccessible phenomena; *Council will seek to work with ApPEC to develop a coordinated strategy in these areas of mutual interest*.

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☞Council discussion on CERN Scientific enlargement.
Council recognition as a European Strategy project.

Personal Observation (mumbling)

- Purely particle physics experiments, e.g. neutrino-less 2β decays, proton decay, etc. are also under ApPEC
  - ☞infrastructure (underground laboratory)
  - ☞exploring other funding opportunities

GARDA and CUORE under construction

Personal Observation (mumbling)

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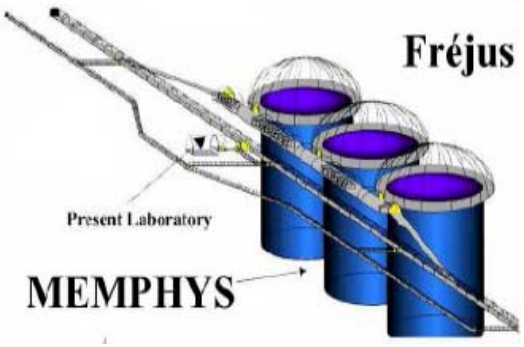
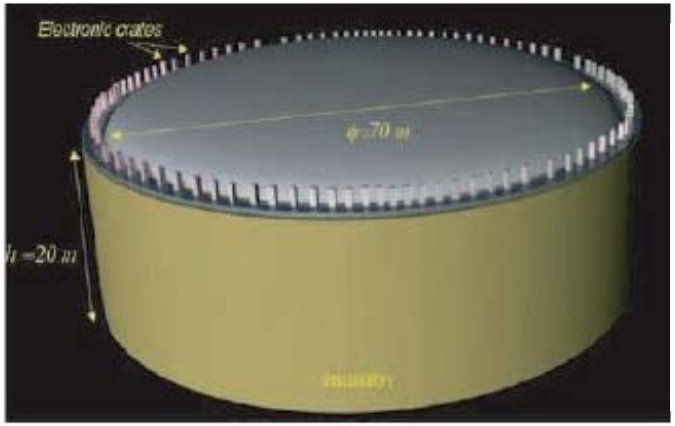
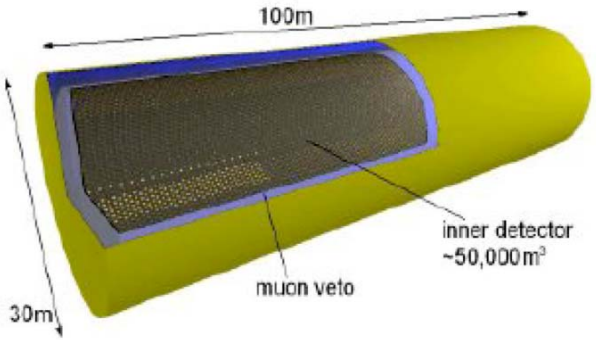
- Some neutrino detectors are at the border line between particle and astroparticle…







European Strategy for flavour

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☞ In Europe, there are still some accelerator based particle physics experiments other than at CERN:
e.g. PSI (MEG), Frascati (KLOE), …

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- INFN is proposing a Super B Factory (L>10^{36}cm^{-2}s^{-1}) based on a novel scheme of colliding two nano-beams using a "crab waist" crossing. Machine construction and operation mainly by Italy: not really inexpensive, but still more or less affordable (~500 MCHF).

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There were two B Factories, SLAC and KEK.
There will be also two Super B Factories, or
only one, which accommodates the world interests in the field?

European Strategy for other topics

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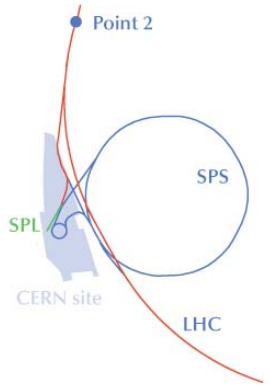
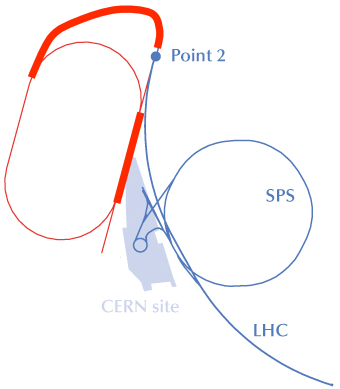
  e.g. ECFA sponsored LHeC (ep collider) working group.
  two workshops have been organized:
  p in the LHC vs e^- in a ring or from a linac
  CDR: by the end of 2010





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- European theoretical physics has played a crucial role in shaping and consolidating the Standard Model and in formulating possible scenarios for future discoveries. Strong theoretical research and close collaboration with experimentalists are essential to the advancement of particle physics and to take full advantage of experimental progress; *the forthcoming LHC results will open new opportunities for theoretical developments, and create new needs for theoretical calculations, which should be widely supported.*

European Strategy for organization

- There is a fundamental need for an ongoing process to define and update the European strategy for particle physics; *Council, under Article II-2(b) of the CERN Convention, shall assume this responsibility, acting as a council for European particle physics, holding a special session at least once each year for this purpose. Council will define and update the strategy based on proposals and observations from a dedicated scientific body that it shall establish for this purpose.*

☞Strategy secretariat with a dedicated scientific secretary
+ ECFA and SPC

European Strategy for organization

- Future major facilities in Europe and elsewhere require collaborations on a global scale; *Council, drawing on the European experience in the successful construction and operation of large-scale facilities, will prepare a framework for Europe to engage with the other regions of the world with the goal of optimizing the particle physics output through the best shared use of resources while maintaining European capabilities.*
- Particle physicists in the non-Member States benefit from, and add to, the research programme funded by the CERN Member States; *Council will establish how the non-Member States should be involved in defining the strategy.*

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☞CERN council geographical enlargement discussion.

Final Thoughts

- With LHC, Europe will be at the forefront of the energy frontier for coming years, providing a unique opportunity to the world particle physics community.
- Exploitation of LHC, will be the highest priority
  -hopefully with a realistic and effective upgrade path-
- R&D for high energy frontier (ILC/CLIC) and intensity frontier (neutrino programme), will/should be pursued.

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- Answers for where to built will be unclear at the moment. Do not know how to share responsibilities in the worldwide scale, i.e. America-Europe-Asia. Strong world regional activities are vital.

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Of course One does not need to be very clever nor visionary for making those observations…

Final Thoughts

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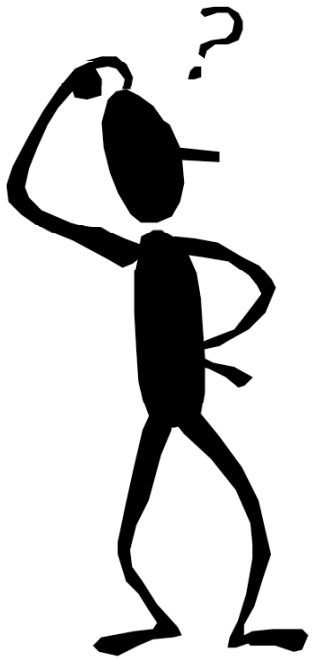
- Can we maintain the bottom-up approach? How can we exchange opinions between the different world regions?
- Will real break-though come from a roadmap and strategy? i.e. No expected unexpected?
  There should be some room for new ideas…