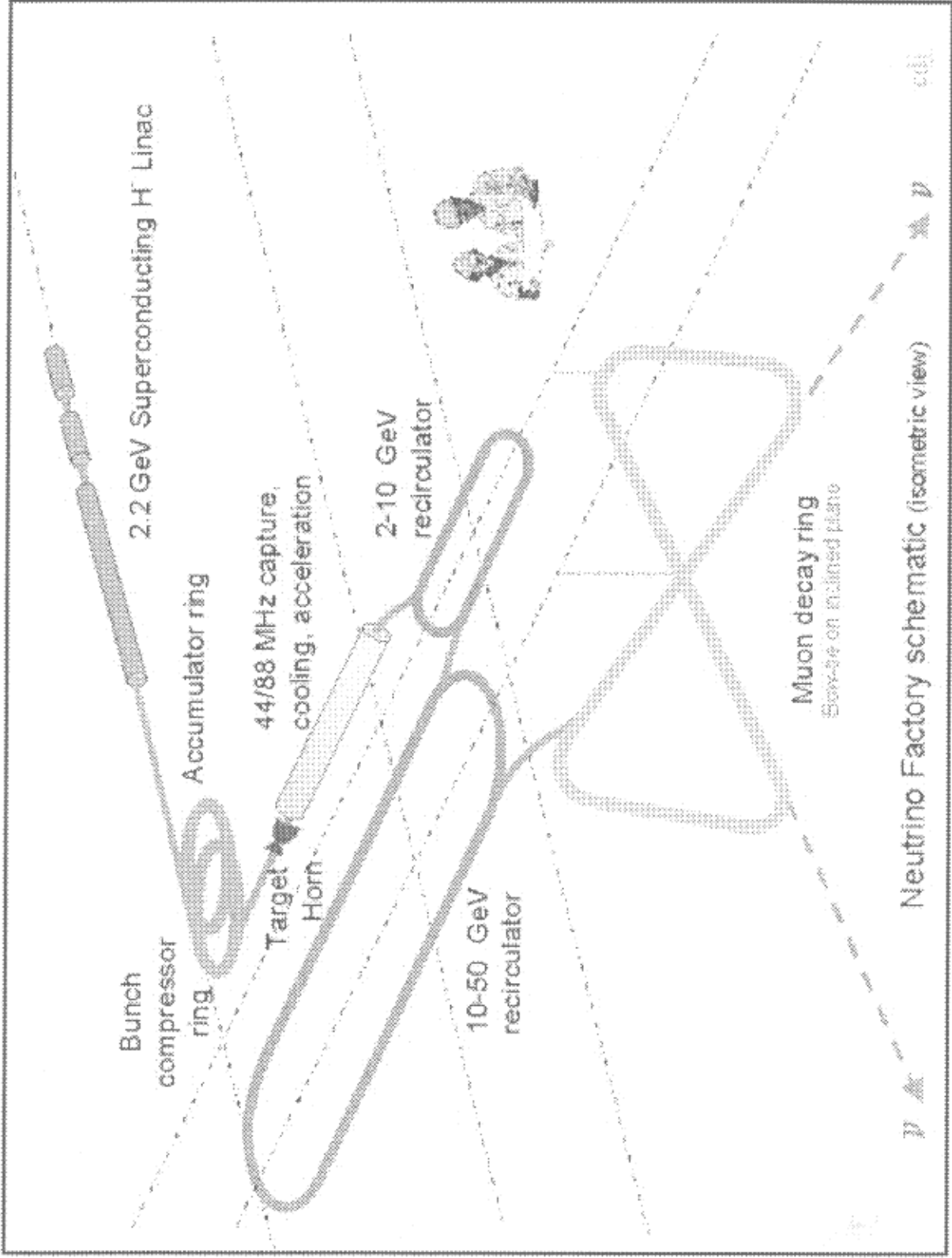
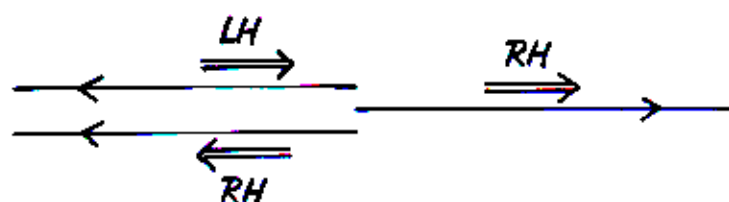
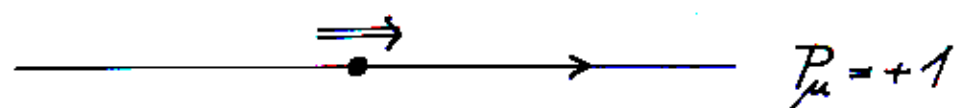
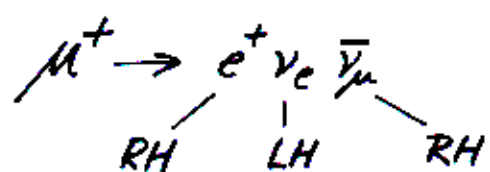


Neutrino Factory: experimental aspects

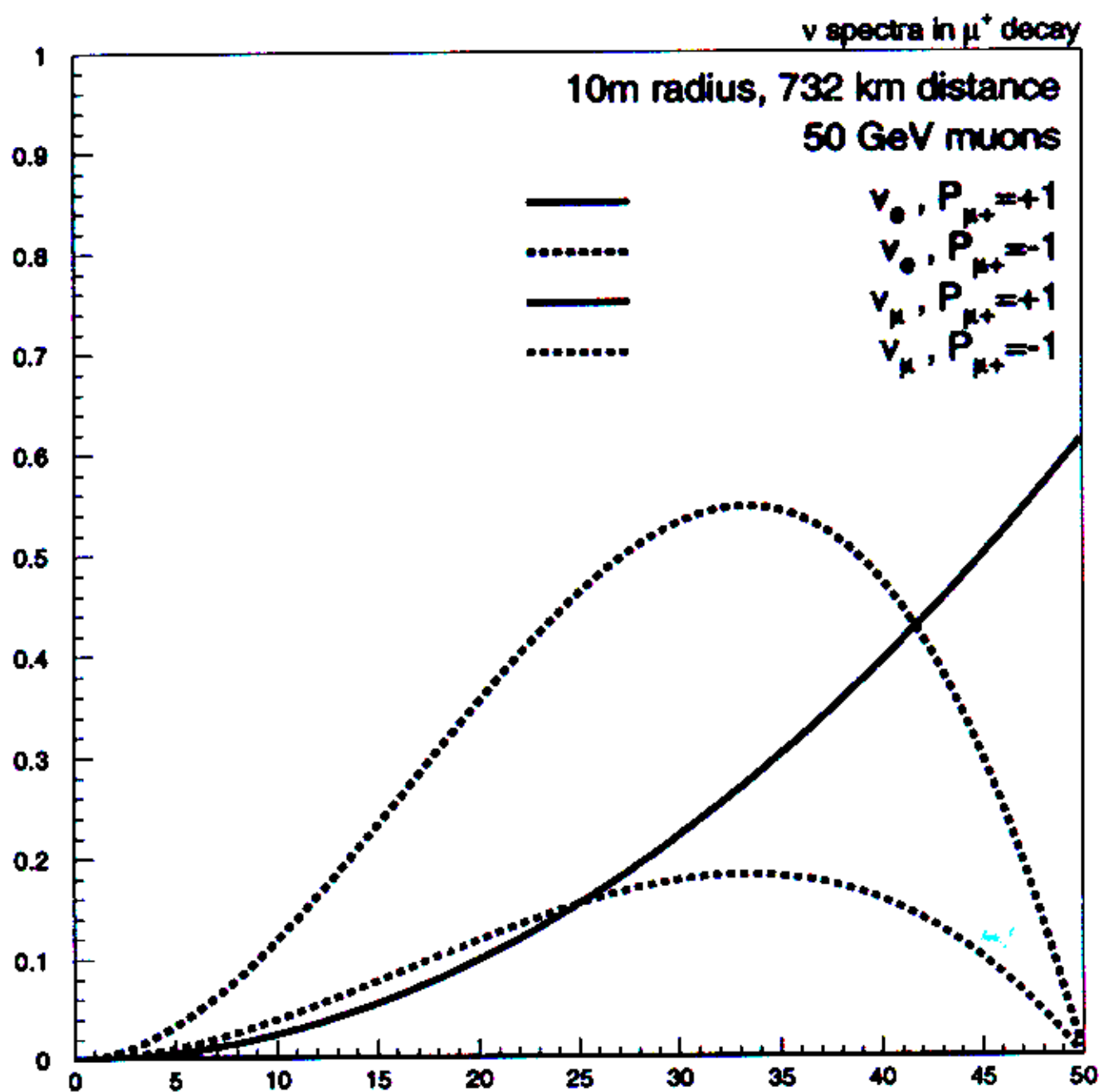
F. Dydak / CERN

Workshop on Neutrino Telescopes
Venice, 6 - 9 March, 2001





$\Rightarrow$ det.



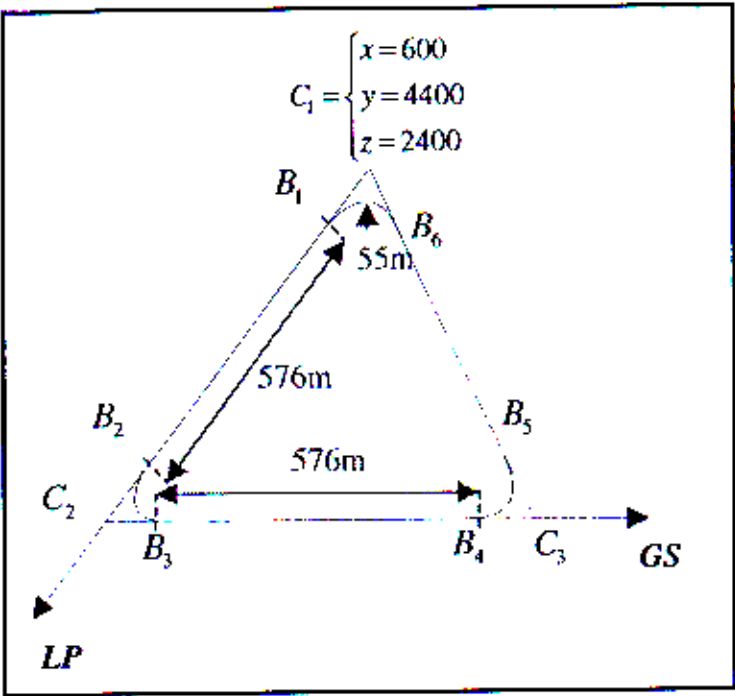
**The outstanding and unparalleled
feature of the neutrino factory is its**

- high-intensity**
- background-free**
- well-determined**

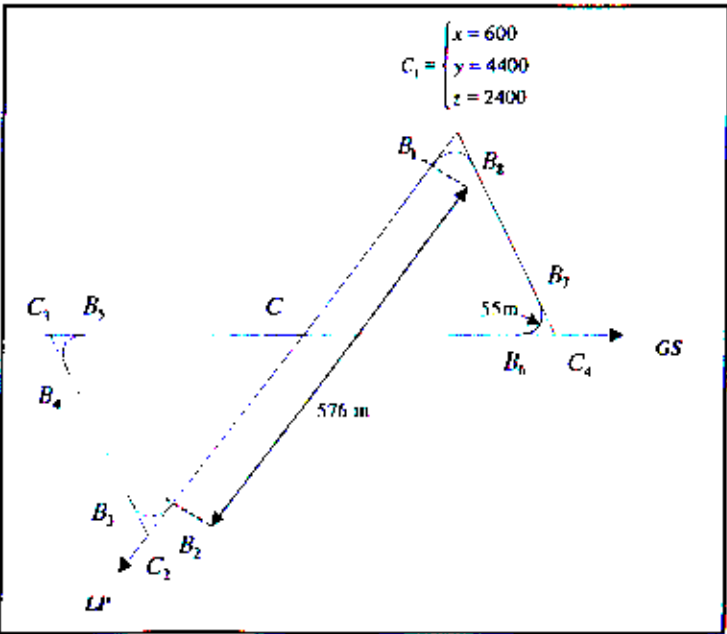
electron-neutrino beam

Machine parameters: the (European) experimentalist's desiderata

- *Energy of circulating muons*
The higher the better; default: 50 GeV/ c .
- *Charge sign of circulating muons*
Both signs needed; as far as possible the same intensity; no concurrence of both signs.
- *Injected muons per year*
Baseline 10^{21} ; upgradable to 10^{22} or more.
- *Fraction of 'useful' decays*
25% or larger.
- *Beam divergence in long straight sections*
Less than $0.1/(\beta\gamma) = 0.2$ mrad at 50 GeV/ c , known to better than 10%.
- *Geometric configuration of the storage ring*
'Triangle' or 'bow-tie'.

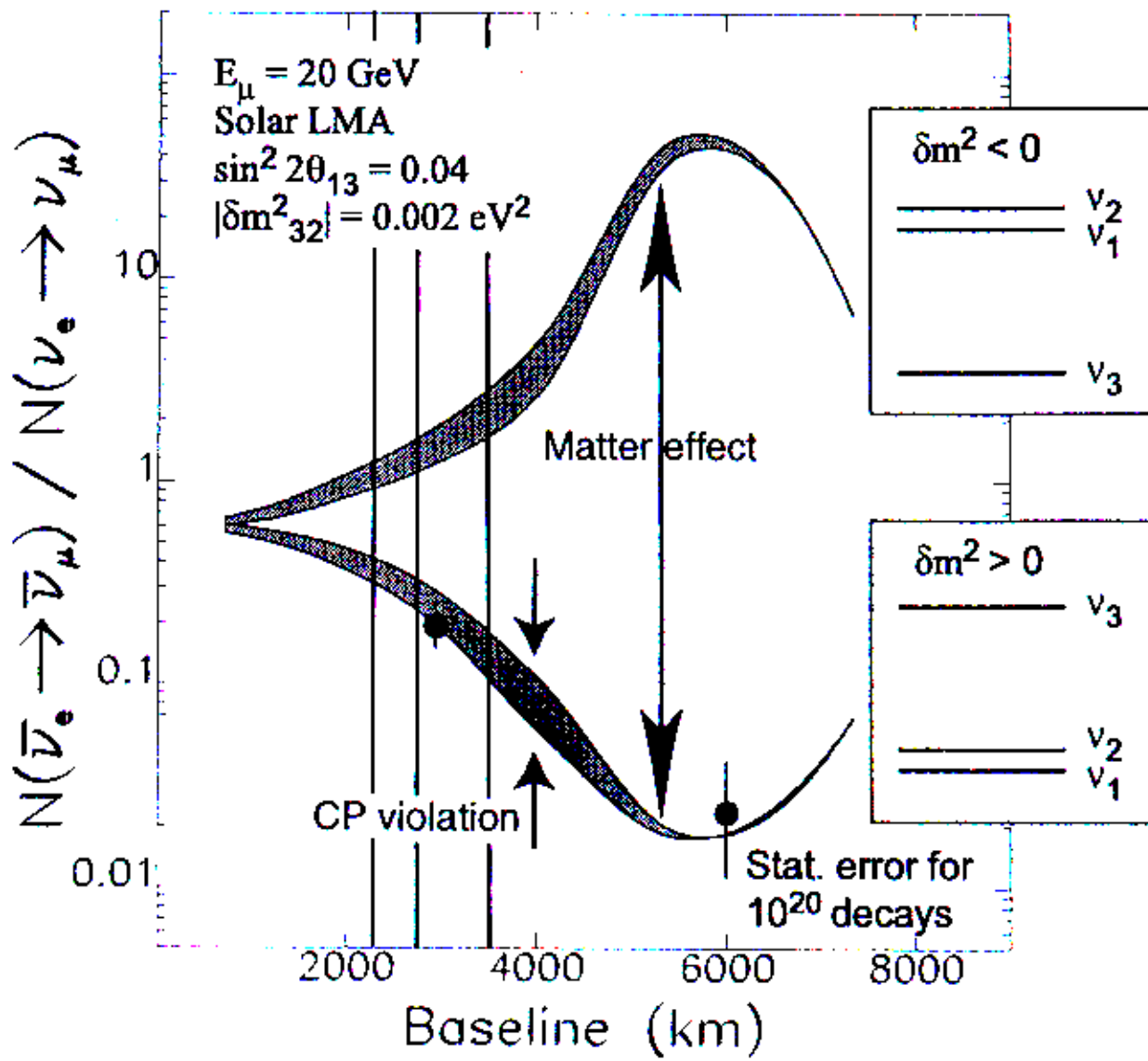


'Triangle' CERN - Gran Sasso - Canary islands



'Bowtie' CERN - Gran Sasso - Canary islands

Wrong-Sign Muon Measurements



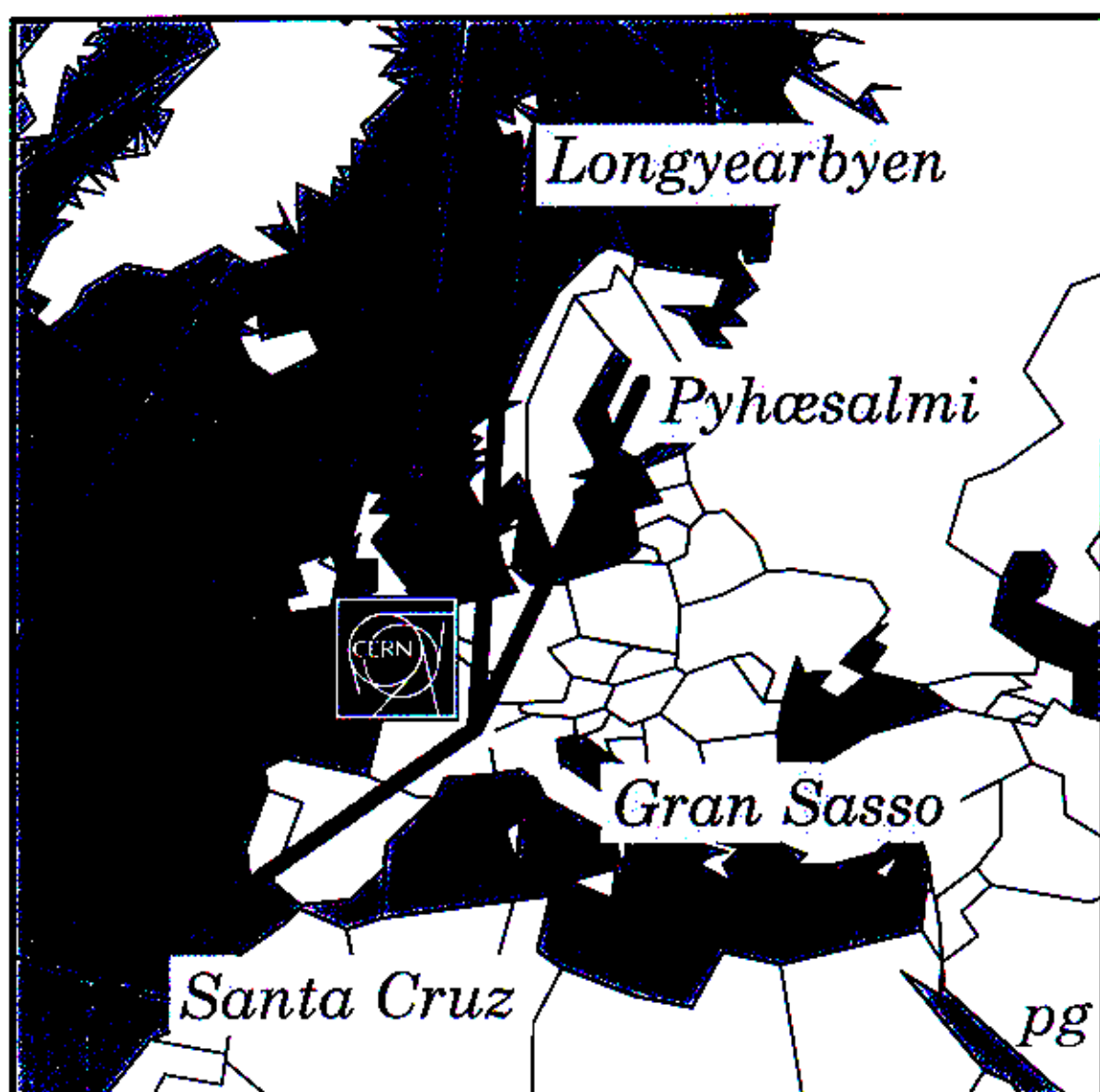


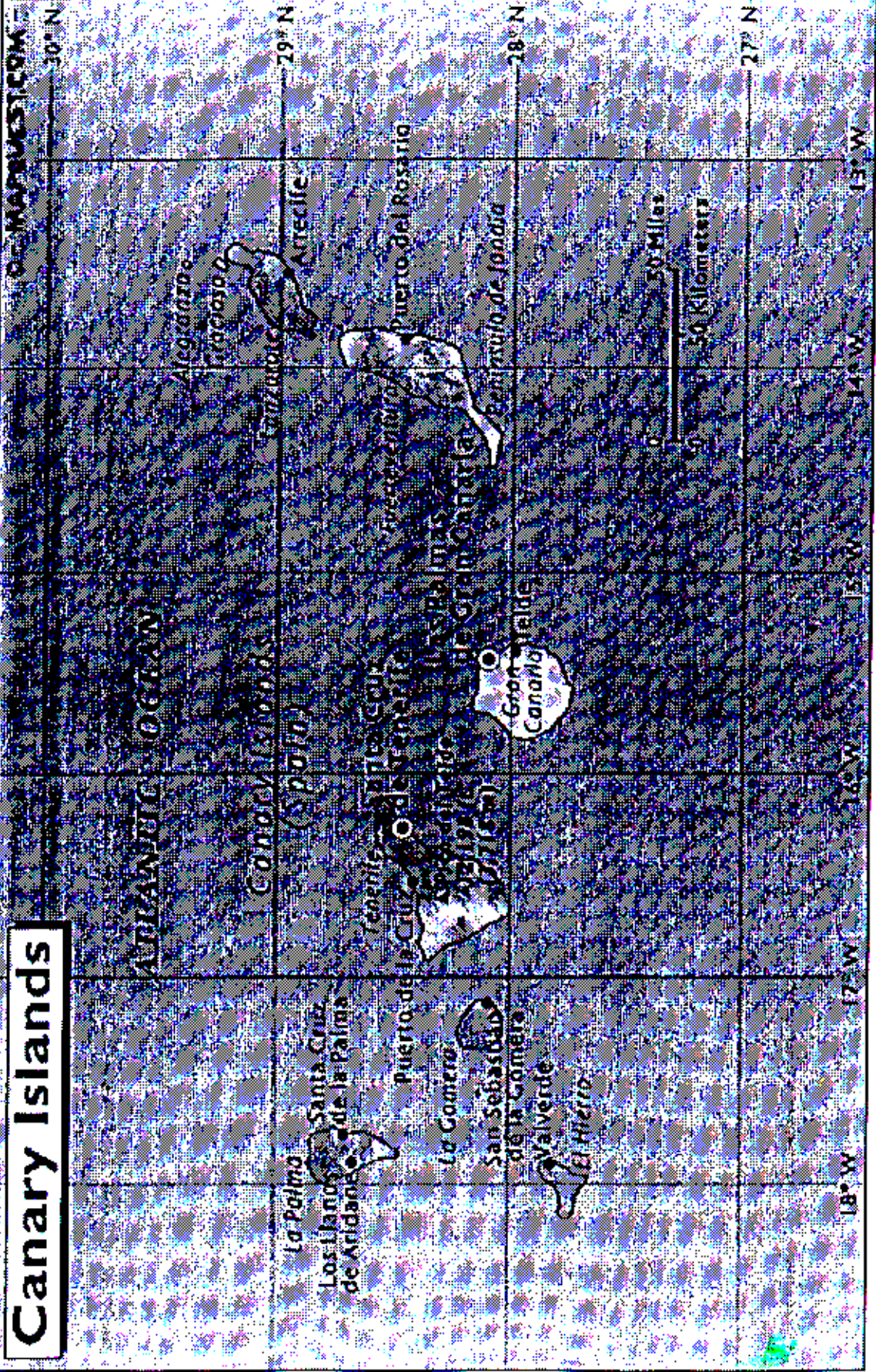
Figure 1: European long-baseline candidates

Detector sites

Criteria

- Distance / angle from CERN
- Underground depth
- Infrastructure
 - airport
 - transport of heavy equipment
- Support
 - local
 - national

Canary Islands



Santa Cruz de Tenerife

Underground tunnel

Location:

On Tenerife (the largest island of the Canary islands).

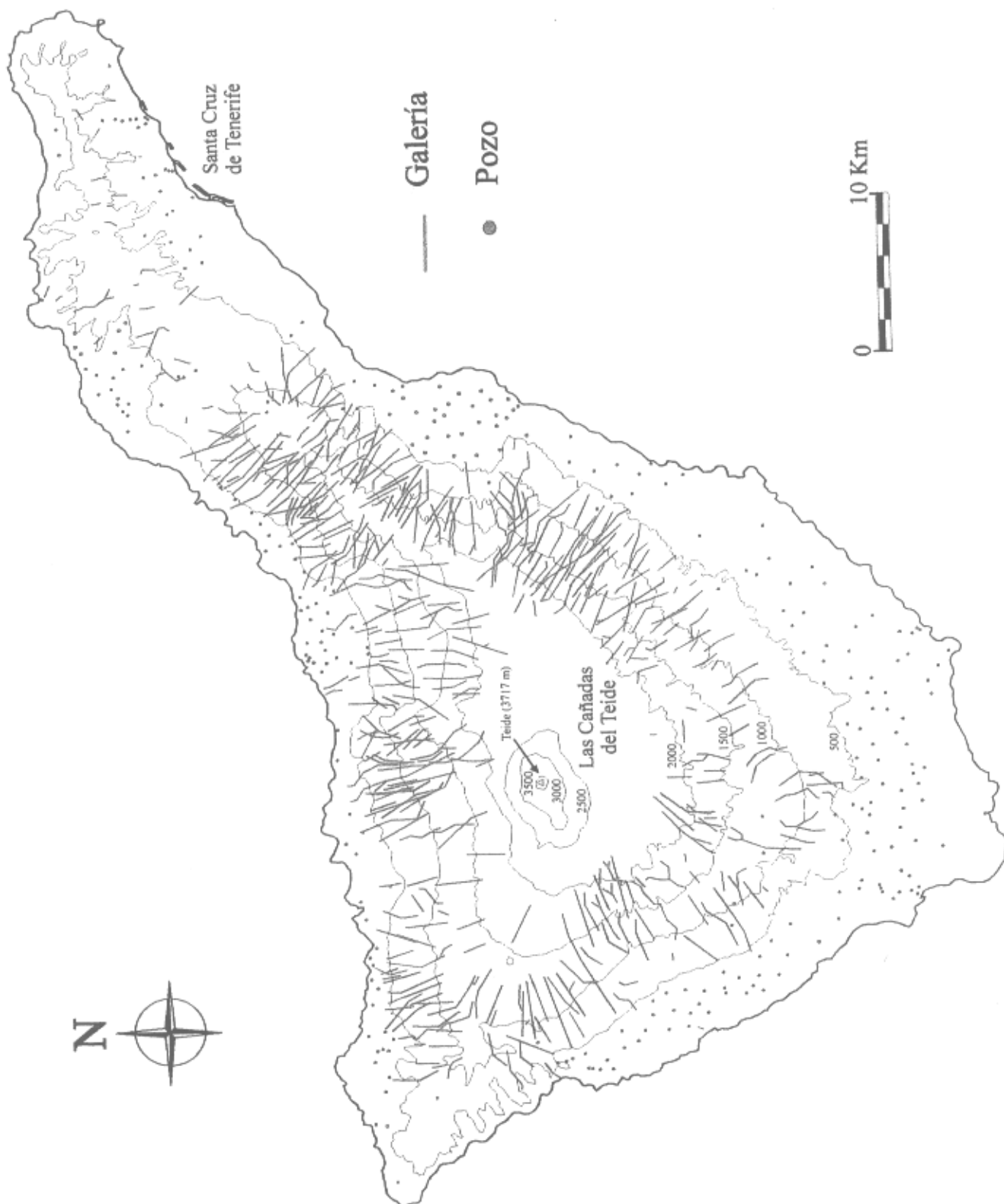
Excellent plane connections.

Strong local scientific activities (astronomy, astrophysics).

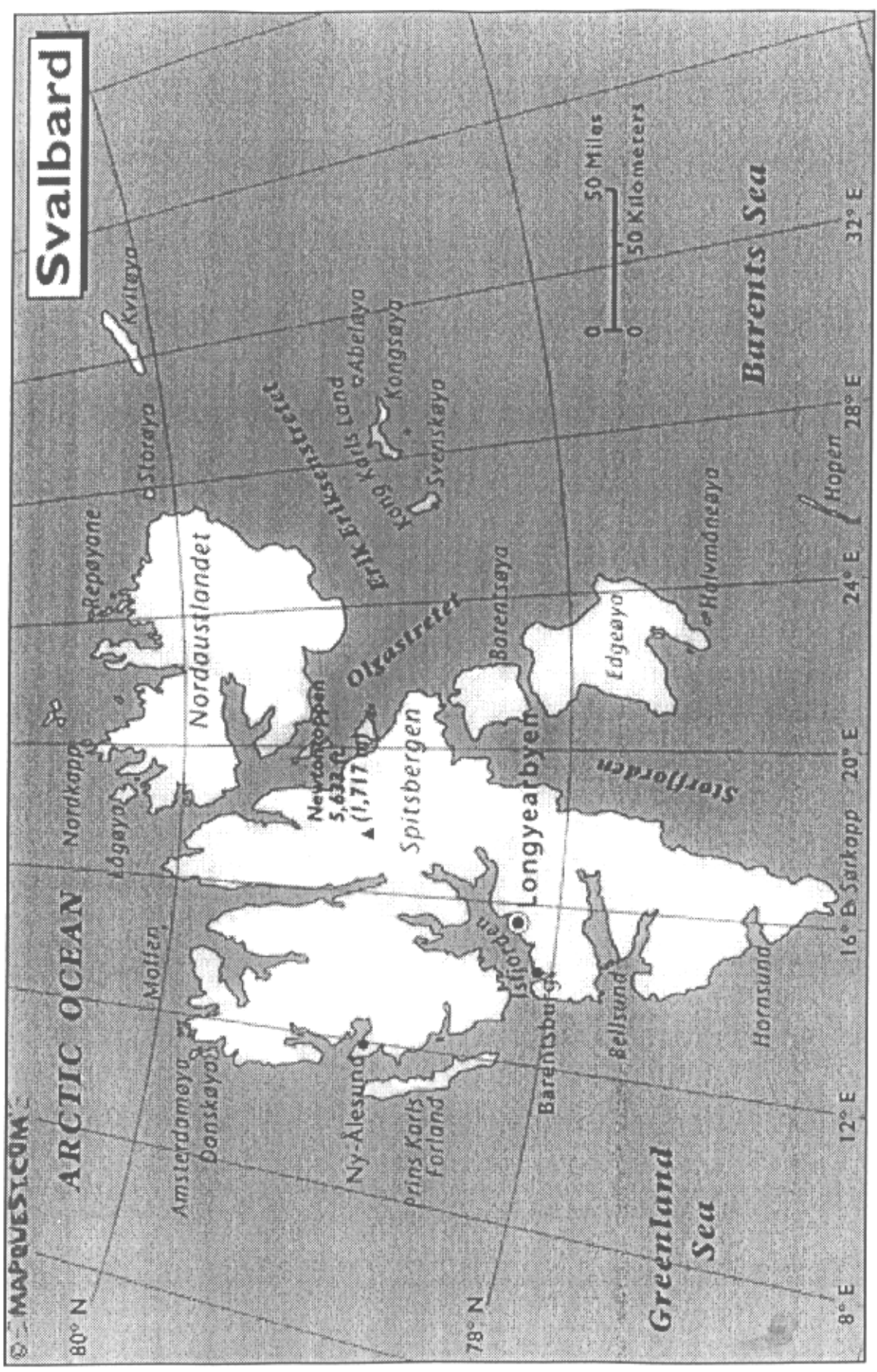
Some characteristics:

Underground hall to be constructed, either from one of the very many water tunnels, or from a road tunnel which is being planned.

O(800) m rock overburden.



Svalbard



Longyearbyen

Active coal mines

Location:

On Spitsbergen (the largest island of the Svalbard archipelago).

Longyearbyen is the administrative centre of the Norwegian authority. 1400 inhabitants. Seat of Svalbard University Courses.

Regular plane connection to Tromsø, Norway (7 - 9 times per week, 90 min flying time).

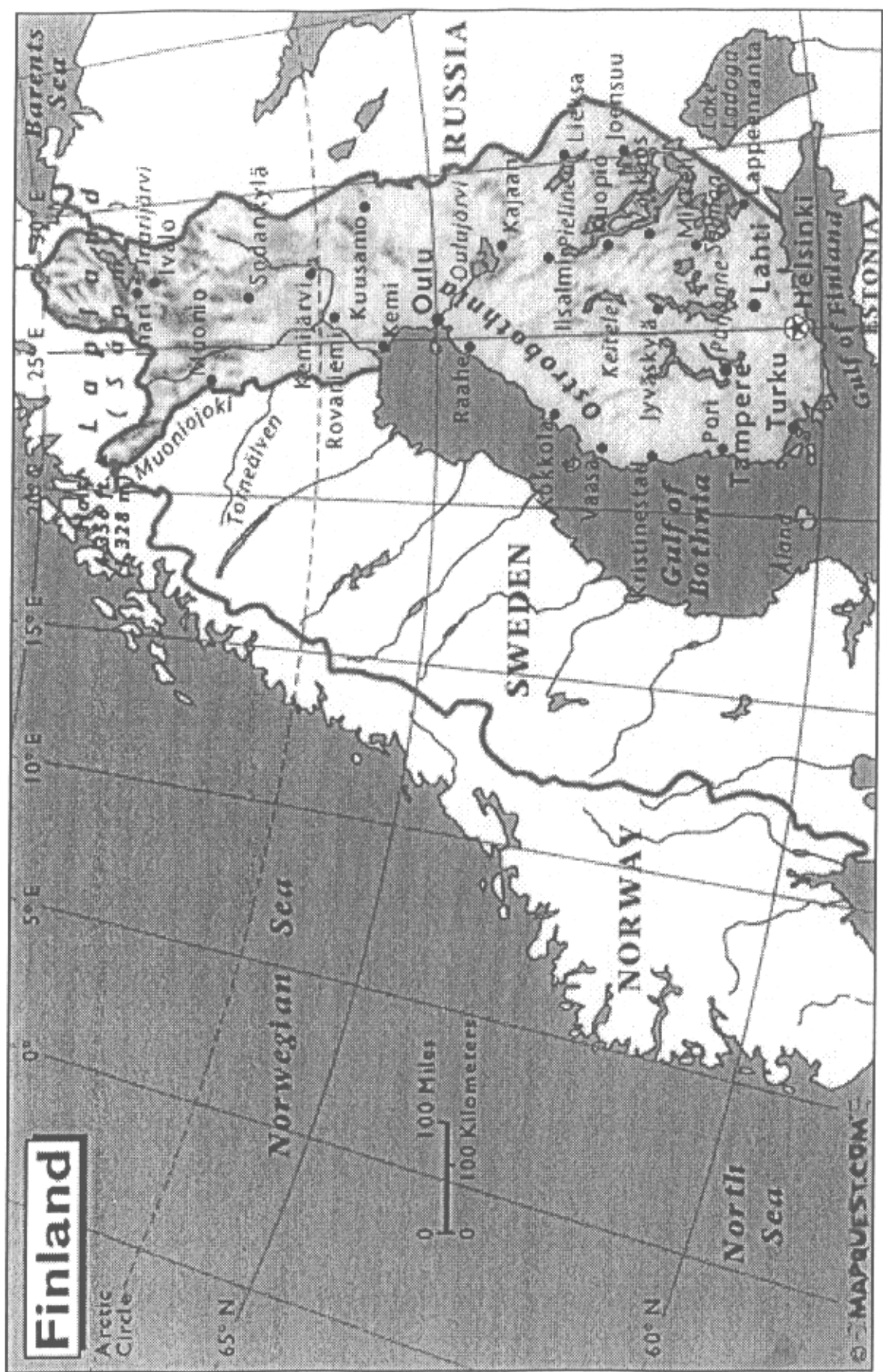
No roads between settlements. 45 km of roads in and around Longyearbyen.

Temperature -14 to +6 degrees. 4 months of midnight sun, 4 months arctic night.

Some characteristics:

Several candidate mines.

O(300) m rock overburden, maybe up to 500 m.



Finland

Pyhäsalmi

Active zinc and copper mine

Location:

**160 km south of Oulu, Finland
(Oulu has an international airport, good connections
to Stockholm and Helsinki).**

Highway connections to Oulu and Helsinki.

Pyhäjärvi (7000 inhabitants) at 5 km distance.

Some characteristics:

Depth 1440 m (4050 m water equivalent).

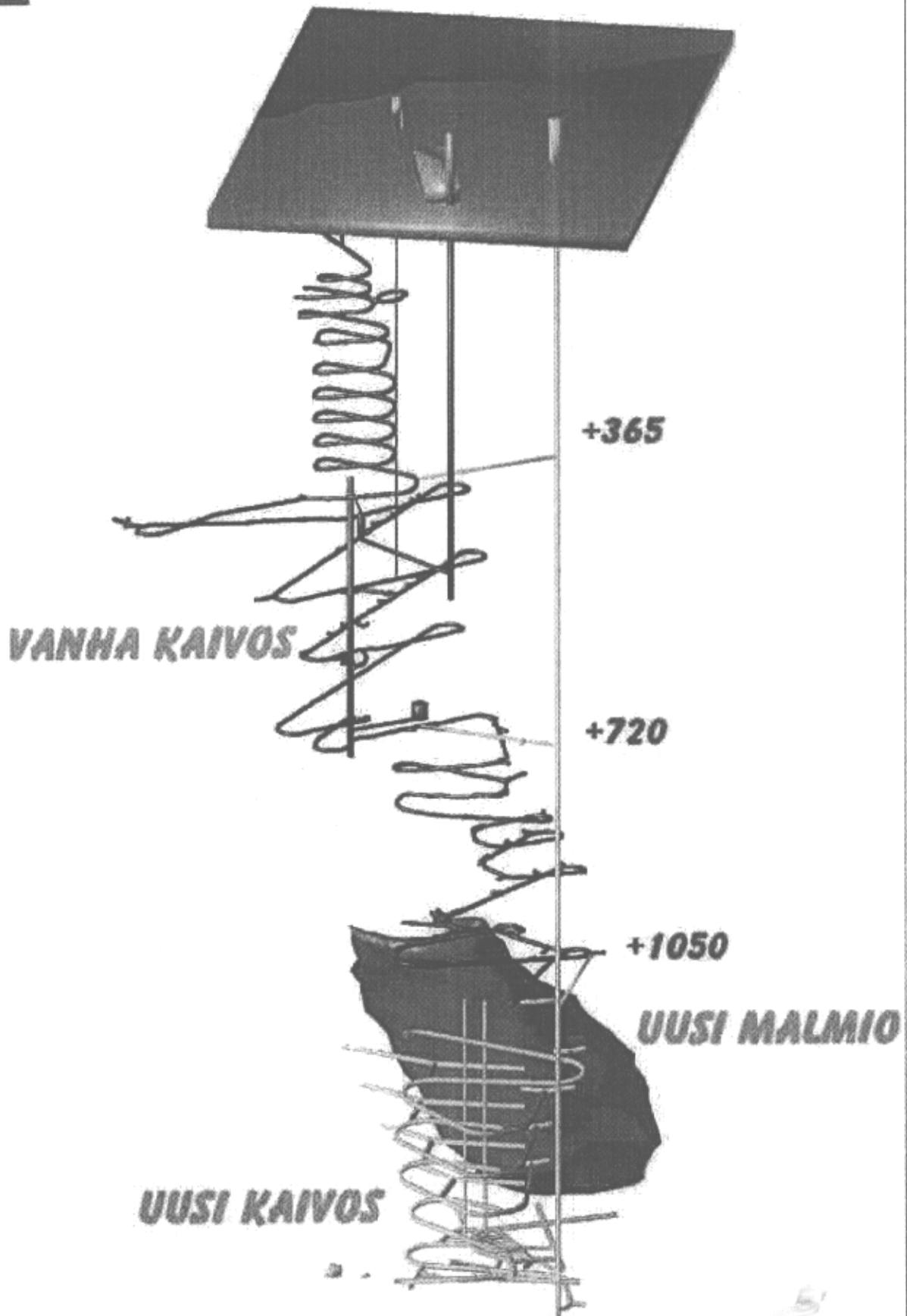
**Accessible by truck (container size 2.6 m x 2.8 m x
8 m).**

A new lift down to 1440 m under construction.

**Large caverns can be built after 2001, at a cost of
60 - 80 Euro/m³ (= 10 MioEuro for a large-size
cavern).**



AXONOMETRINEN KUVA



Outokumpu Mining oy

Pyhäsalmi mine

Base Metals

Candidate medium- and long-baseline detector sites at the CERN Neutrino Factory						
	Latitude	Longitude	Depth (km)	Distance (km)	Angle (deg.)	
CERN	46N 15' 22.93"	06E 03' 01.10"	0.4506			
Gran Sasso	42N 27' 11.31"	13E 34' 31.24"	1.014	733	-3.25	
Santa Cruz de Tenerife	28N 27' 00.00"	16W 14' 00.00"	0.1	2753	-12.47	
Longyearbyen	78N 00' 00.00"	16E 00' 00.00"	-0.1	3518	-16.01	
Pyhäsalmi	63N 39' 34.74"	26E 02' 29.94"	-1.345	2288	-10.38	
Modane	45N 08' 32.00"	06E 41' 21.00"	1.2	133	-0.28	

F. Dydak / 04.03.2001

European (ECFA-sponsored) programme towards a neutrino factory

- **Neutrino oscillation working group**
- **Other physics studies** (high-intensity stopped muons, deep inelastic neutrino scattering, radioactive beams, ...)
- **Machine physics working group**
- **Ongoing R & D programme:**

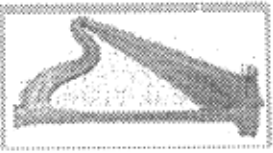
HARP (study of pion production for the neutrino factory and for the atmospheric neutrino flux)

MUSCAT (muon scattering in hydrogen at large angles)

Liquid Hg targets

RF cavities in high radiation fields

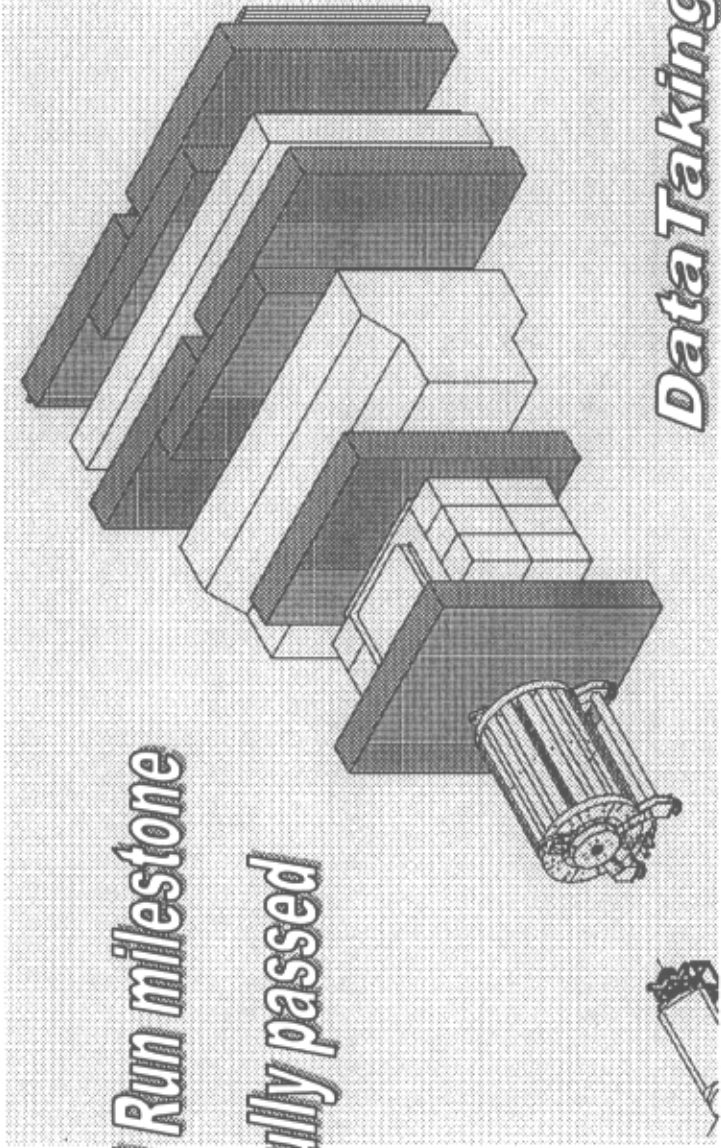
Muon cooling initiative



HARP Experiment

*Measurements for Proton Drivers at Neutrino Factory
Precision measurements for the Atmospheric Neutrino Flux*

*Technical Run milestone
successfully passed
(2000)*



Data Taking : 2001

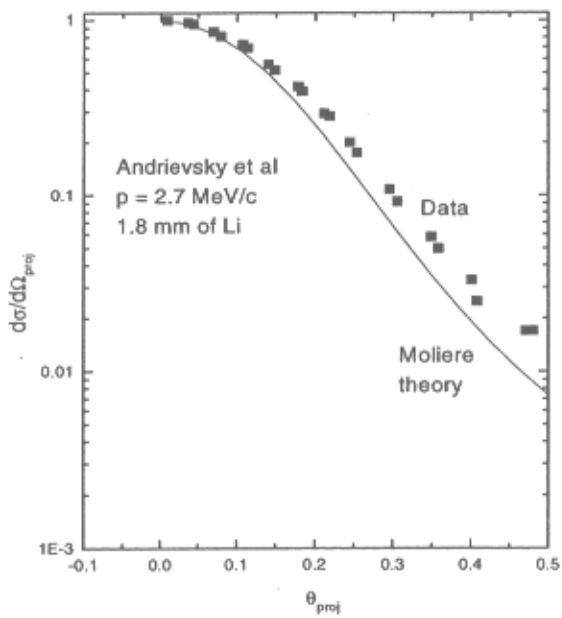
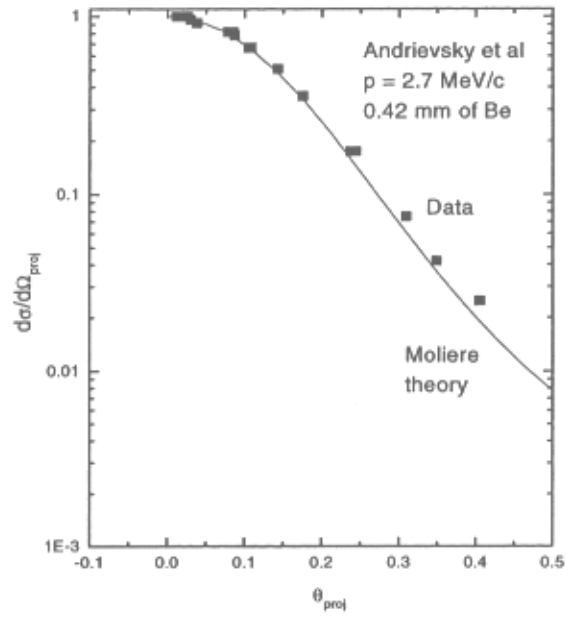
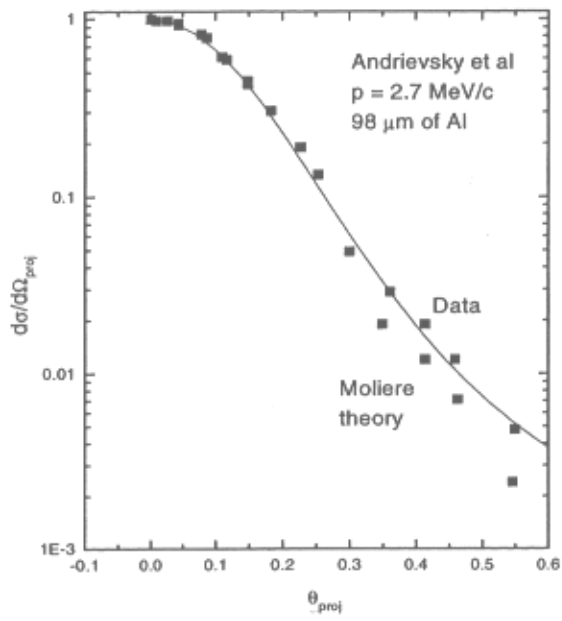


Figure 1: A comparison between Moliere theory and the electron scattering data of Andrievsky et al on aluminium, beryllium and lithium. The scattering angle is plotted in radians.

Physics at a Neutrino Factory

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THE NEUTRINO FACTORY: BEAM AND EXPERIMENTS

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Abstract

The discovery of neutrino oscillations marks a major milestone in the history of neutrino physics, and opens a new window to the still mysterious origin of masses and flavour-mixing. Many current and forthcoming experiments will answer open questions; however, a major step forward, up to and possibly including CP violation in the neutrino-mixing matrix, requires the neutrino beams from a neutrino factory. The neutrino factory is a new concept for producing neutrino beams of unprecedented quality in terms of intensity, flavour composition, and precision of the beam parameters. Most importantly, the neutrino factory is the only known way to generate a high-intensity beam of electron neutrinos of high energy. The neutrino beam from a neutrino factory, in particular the electron-neutrino beam, enables the exploration of otherwise inaccessible domains in neutrino oscillation physics by exploiting baselines of planetary dimensions. Suitable detectors pose formidable challenges but seem within reach with only moderate extrapolations from existing technologies. Although the main physics attraction of the neutrino factory is in the area of neutrino oscillations, an interesting spectrum of further opportunities ranging from high-precision, high-rate neutrino scattering to physics with high-intensity stopped muons comes with it.