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CEA-Saclay

BENE workshop

DESY, nov.2, 2004

Report on Trento workshop

on

“the impact of new neutrino beams”

Trento workshop 18-22 october, 2004 at ECT

(organized by Cristina Volpe)

about 25 participants from different communities:

neutrino physicists (experimenters and theoreticians)

nuclear physicists (experimenters and theoreticians)

machine physicists

….

with various interests:

neutrino mixing parameters

SN explosions

neutrino cross-sections

nucleosynthesis

CP violation in hadrons

Tests of standard model…..

Talks:

general reviews on neutrino physics

physics with intense neutrino beams (structure functions)

Uncertainties, correlations, GLOBES program

Beta beams:

- Eurisol, baseline scenario, higher energy options (2 talks)
- physics of very low energy radioactive ions and neutrino beams

Neutrino factories (2 talks)

Detectors (water Cerenkov, liquid argon)

SN : neutrino propagation, sensitivity on θ_{13}

Computation of low energy neutrino cross-sections (4 talks)

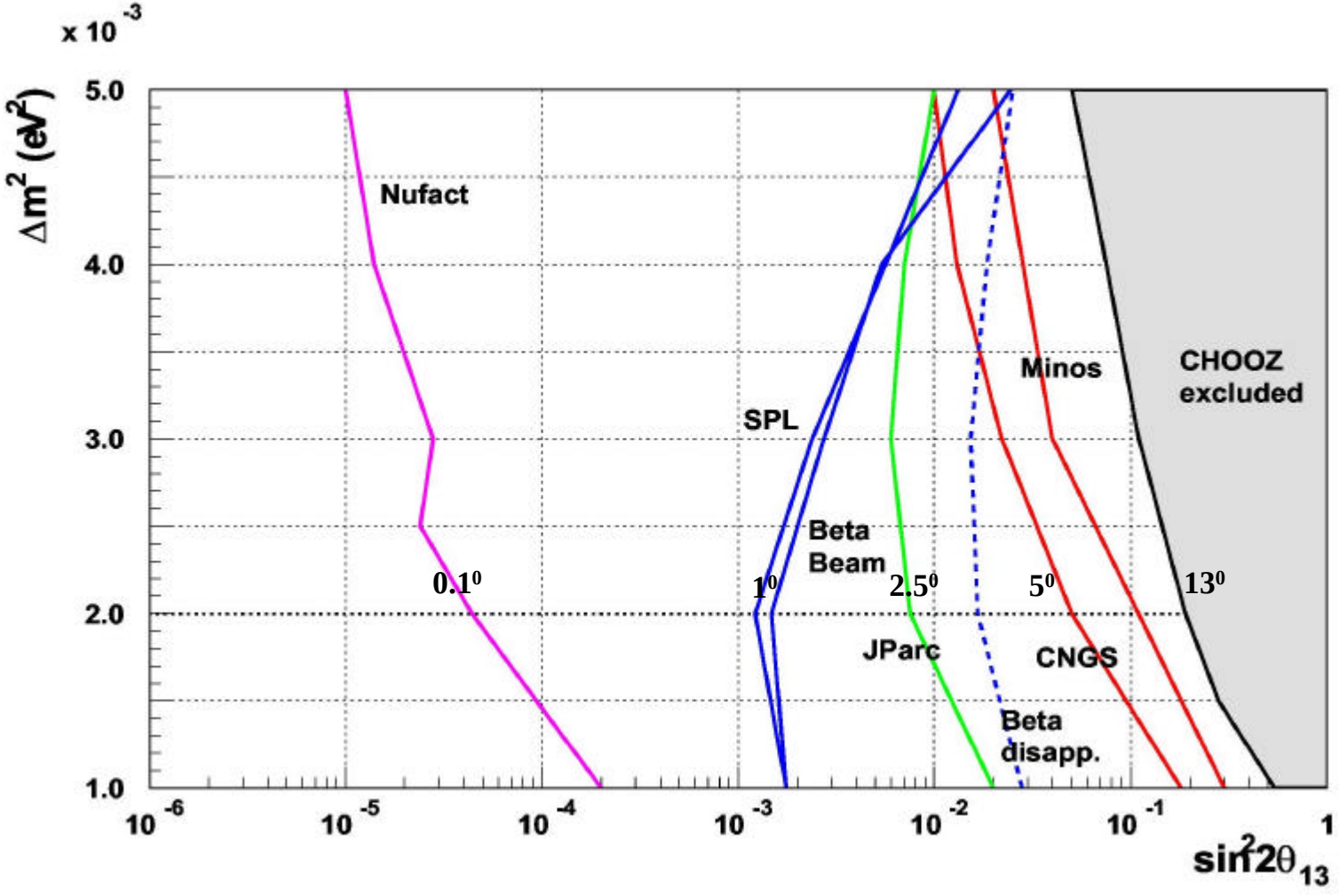
Tests of V-A

Search for lepton number violation

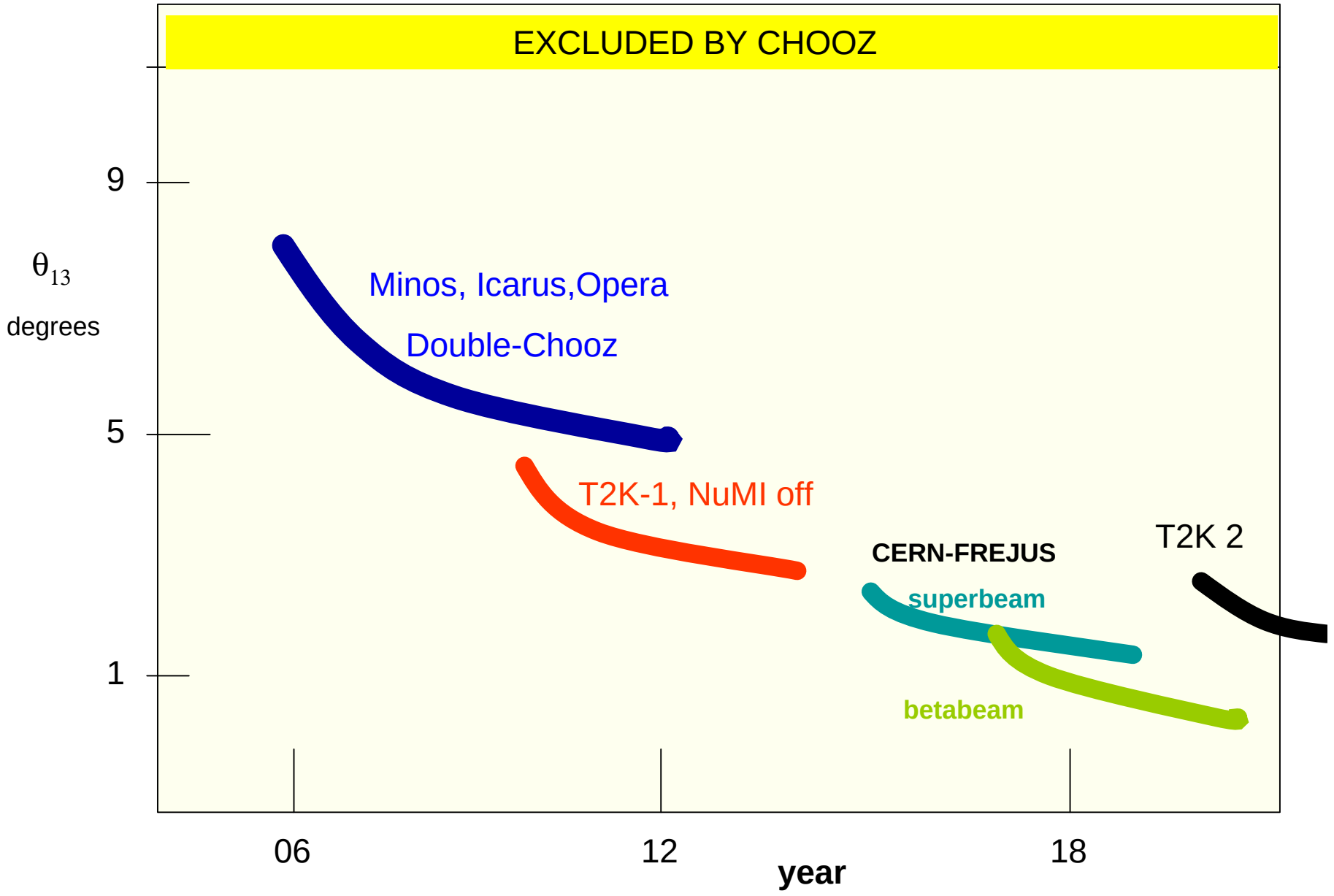
Status of CP violation in quark sector

....

q_{13} sensitivity (90%CL) of various projects



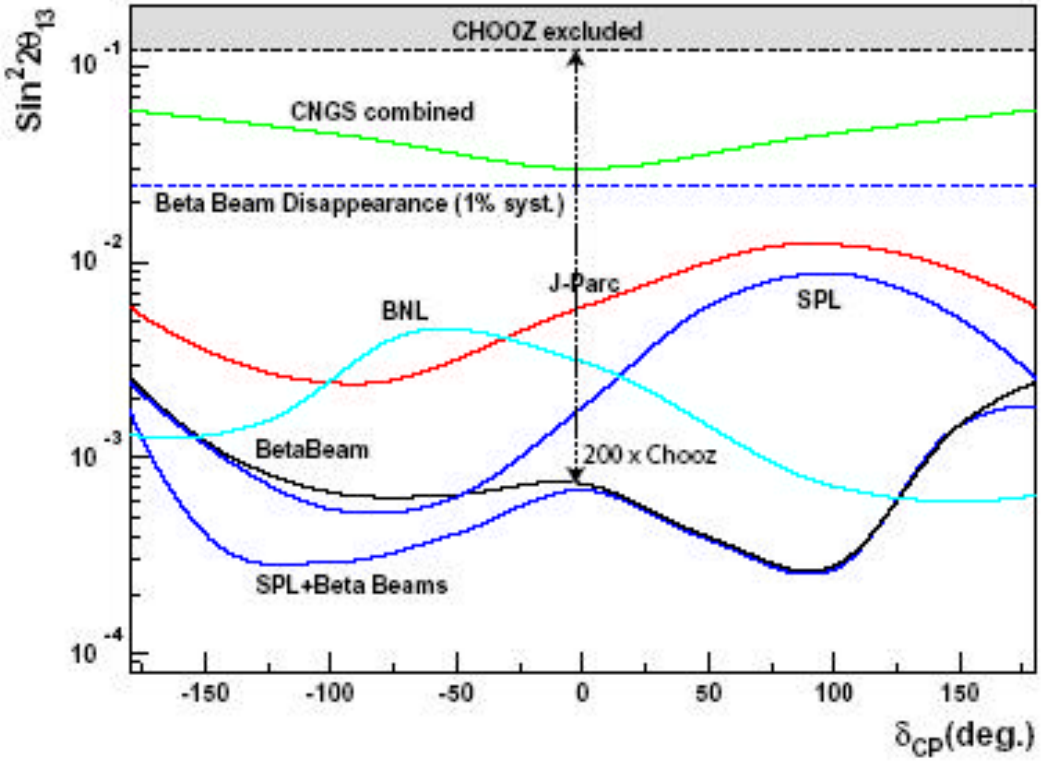
SPL superbeam has sensitivity on CP, T2K phase 1 has NONE


EXCLUDED BY CHOOZ
9
5
1
θ13
degrees
Minos, Icarus,Opera
Double-Chooz
T2K-1, NuMI off
CERN-FREJUS
superbeam
T2K 2
betabeam
06
12
18
year

θ_{13} 90 % CL sensitivity

5 years running time, sign(Δm^2)=+1

- **Beta Beam can measure θ_{13} both in appearance and in disappearance mode. All the ambiguities can be removed for $\theta_{13} \geq 3.4^\circ$**

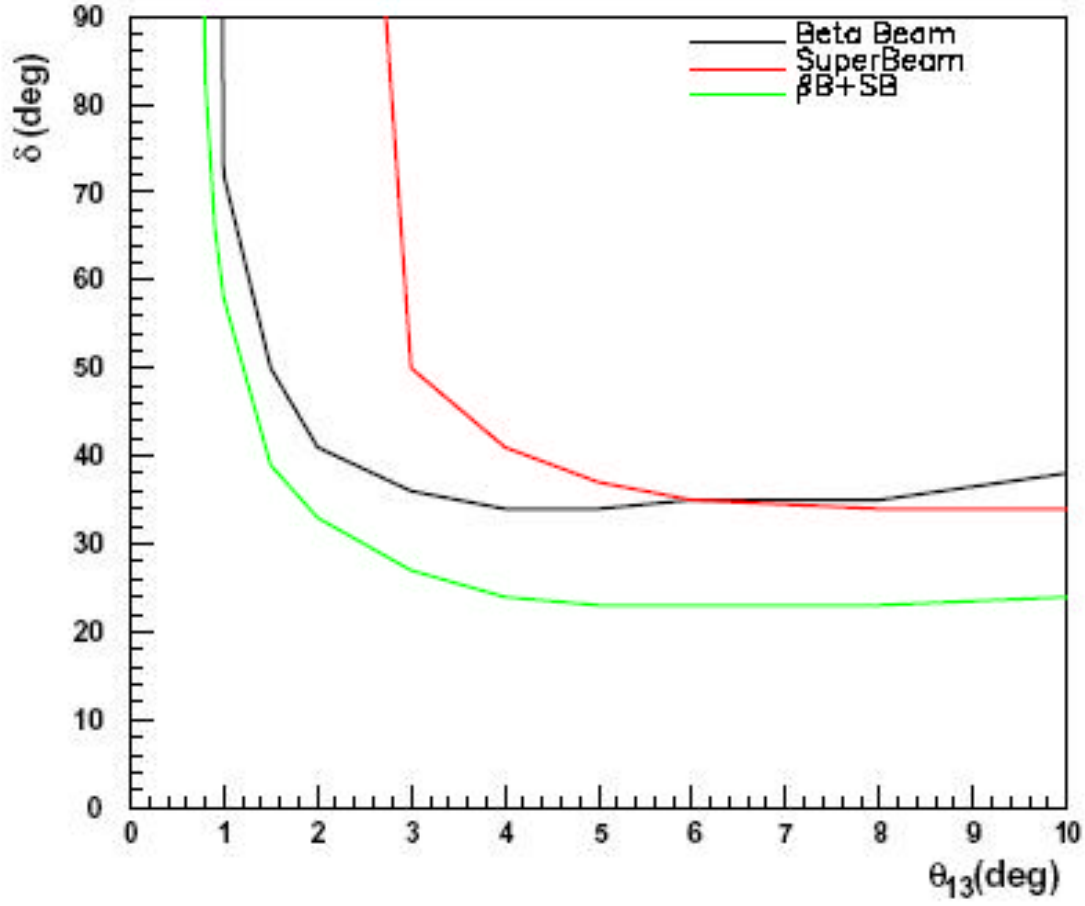


SPL superbeam / beta beam synergies

- 4 different beams in the **same** detector
- redundancies (CP, T, CPT)
- signal for SB is event bulk for BB (nu-e)
- backgrounds are different (charged π for BB, π^0 for SB)

SPL +betabeam 10 years both polarities

3 sigma discovery potential on d_{CP}



SUPERBEAM OPTIMIZATION (see A.Cazes talk)

(Paper of J.E. Campagne and A. Cazes in preparation)

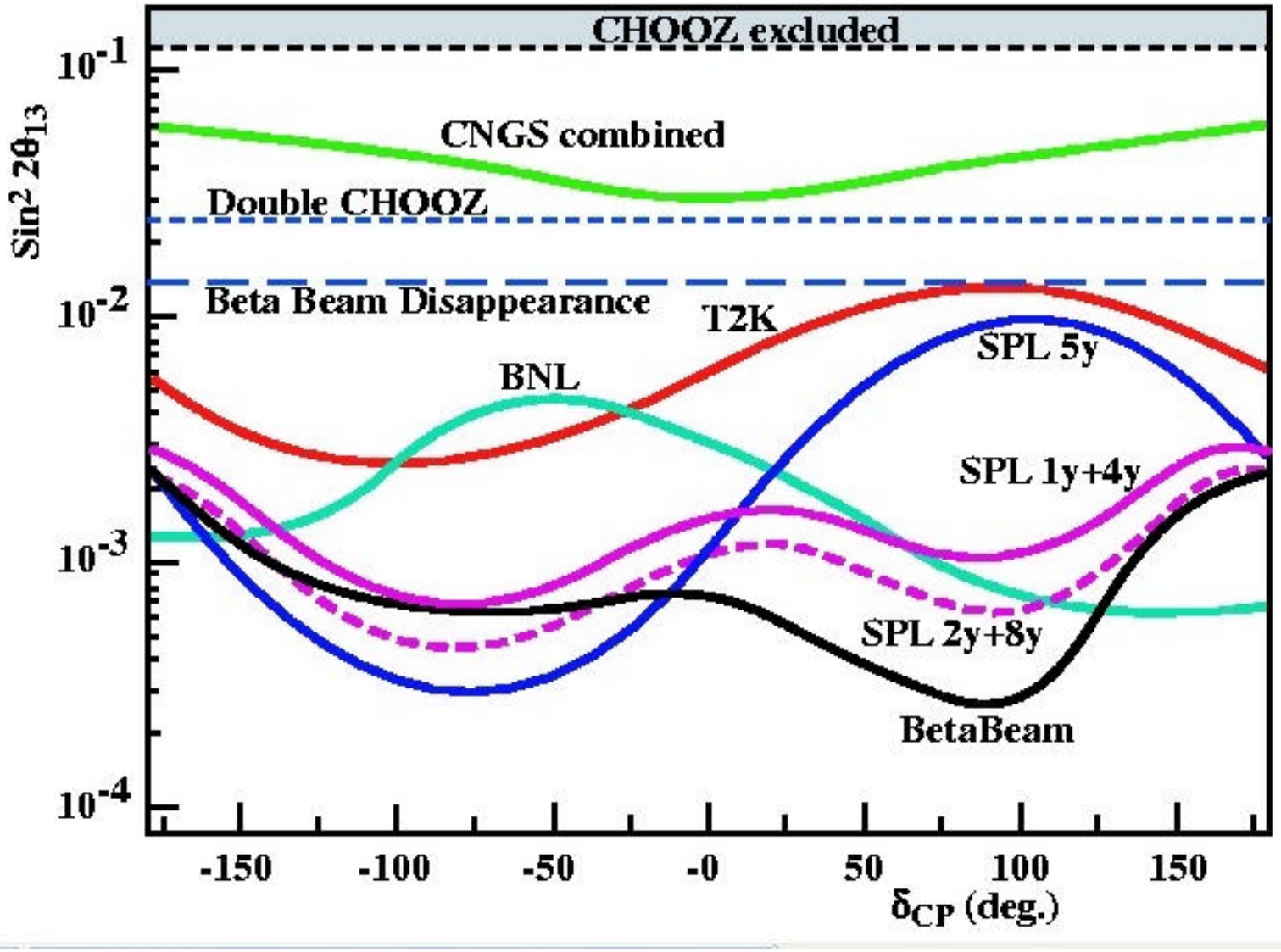
LEP cavities are no more an option (obsolete). This reopened the question of the optimal energy of the SPL.

The actions taken are the following (the CERN-Frejus baseline of 130 km is considered fixed here):

- Bring the proton kinetic energy to 4.5 GeV (3.5 gives similar performances). This gives a better pion p_T distribution and more important significantly increases π^- production improving antineutrino fluxes.
- Enlarge the decay tunnel diameter to 2 m.
- Design the optics to peak to 340 MeV neutrinos instead of 260 MeV: this better matches the baseline and considerably improves cross sections.

UPDATED SPL SUPERBEAM (3.5 or 4.5 GeV)

90 % CL sensitivities



BETA BEAM OPTIMIZATION
(M.Mezzetto)

After all, running both ions together is not a good idea :

1. complicates design of the decay ring
2. implies a compromise between gamma values

   60 slightly too low for He6 (efficiency on muon)

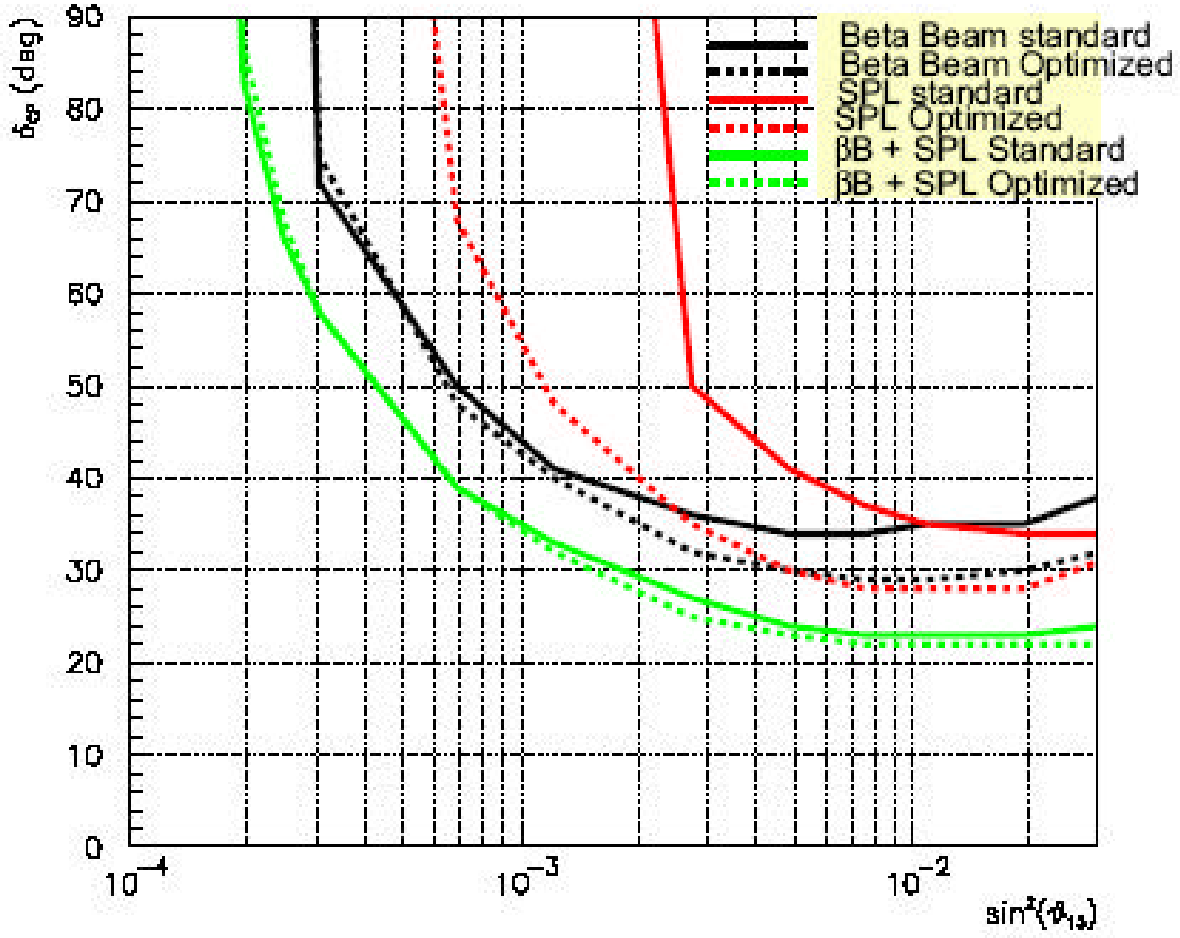
   100 slightly too high for Ne18 (background)

Much better to run ions sequentially :

1. No loss of flux
2. Optimize gamma for each ion ($\gamma = 75$)

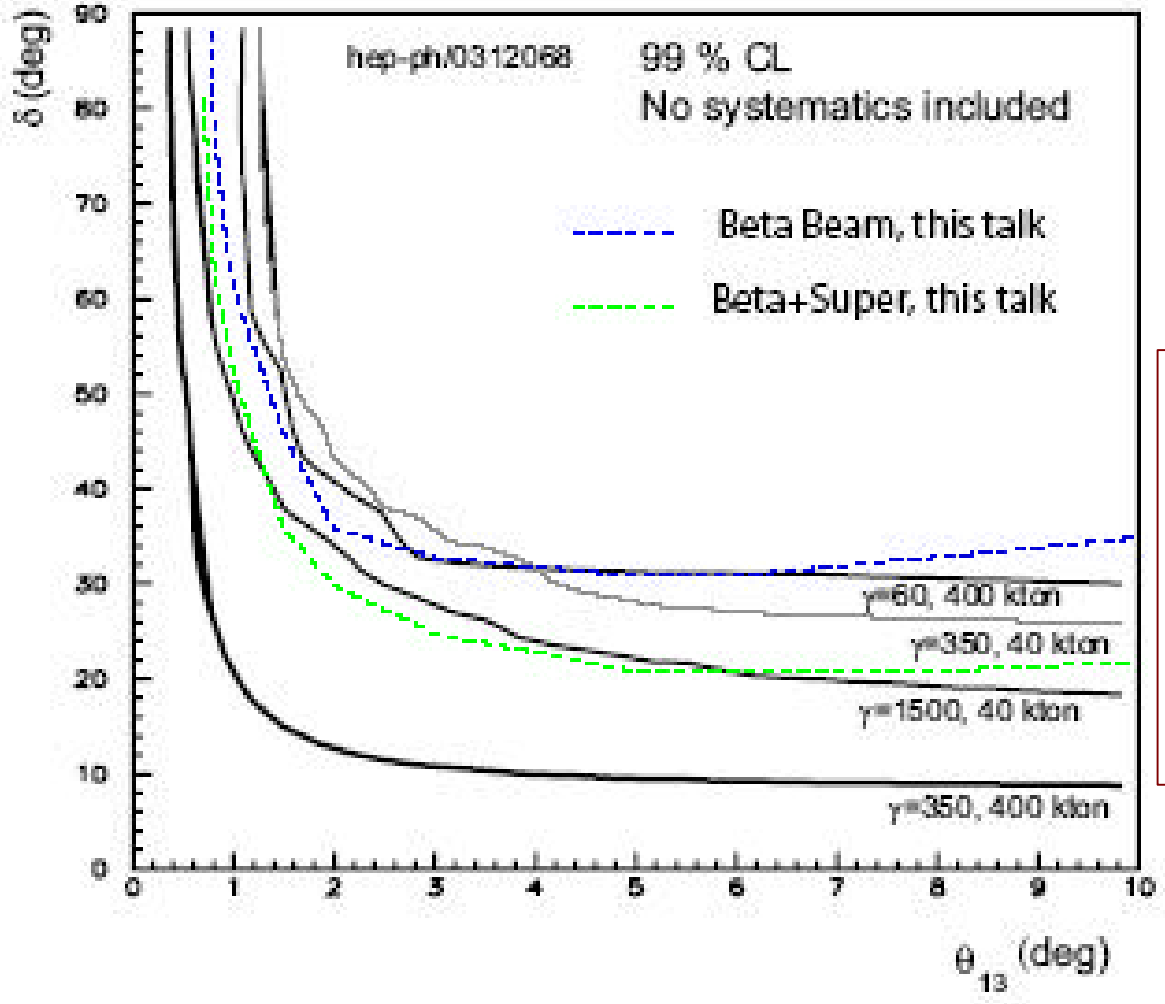
UPDATED SUPER AND BETA BEAMS

3 s discovery potential after 10 years



HIGH ENERGY BETA BEAMS (I) (J.Burguet-Castell)

P. Hernandez, J.J. Gomez-Cadenas et al., hep-ph/0312068



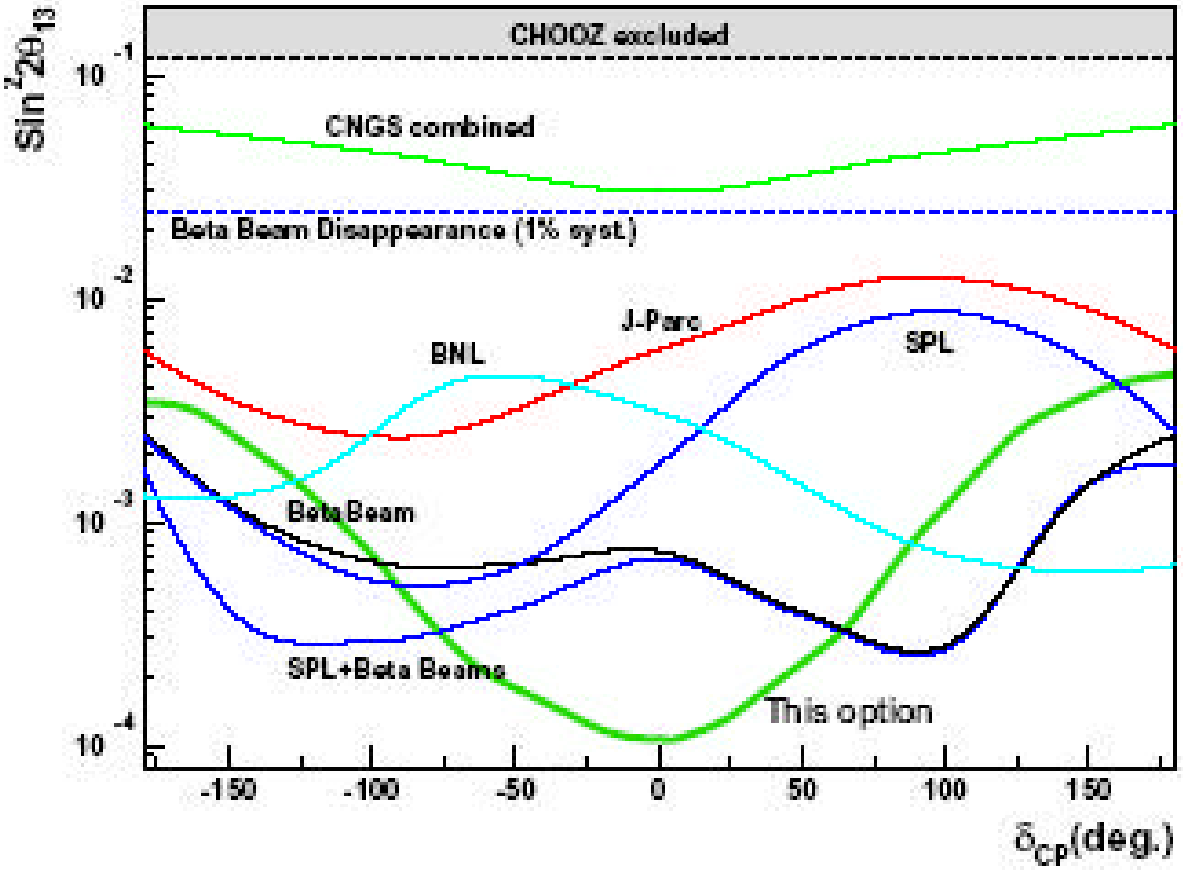
1. beta beam standard
2. γ =350, 732 km, 400kT
3. γ =1500, 3000 km,40 kT

Questions:

1. Is the same flux realistic?
2. 400 kT at GS?
3. Price of decay ring
4. Schedule? (Tevatron)

HIGH ENERGY BETA BEAMS (II) (P. Migliozzi)

P. Migliozzi, F. Terranova et al., hep-ph/0405081



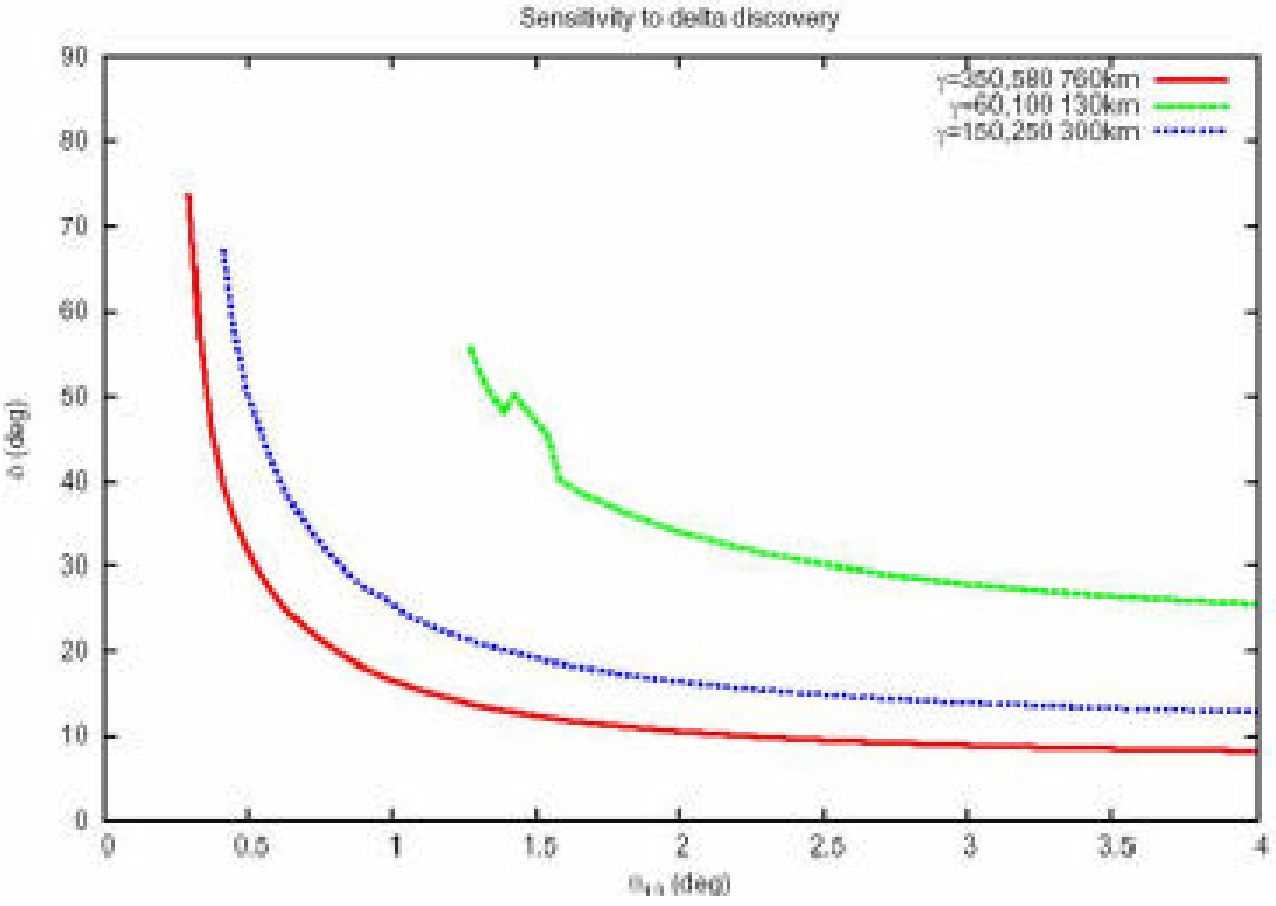
$\gamma = 2500$ (LHC)

cheap detector (muon counting) installed at Gran Sasso

Question:

Flux ????

HIGH ENERGY BETA BEAMS (III) (J.J. Gomez-Cadenas at NOW04)



Baseline scenario

Tevatron option

SPS option, 300 km, γ =150/250

Remarks:

Baseline 3 σ before optimization

other 99% with no systematics

Questions:

Where?

When?

Low energy Beta-beams

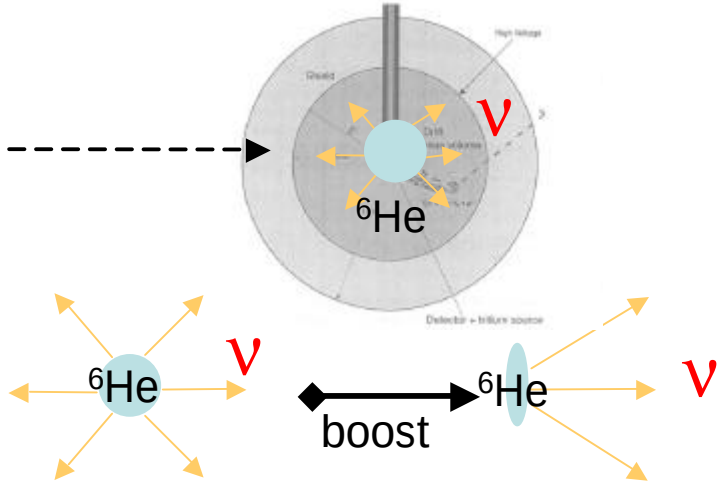
Volpe, Journ. Phys. G. 30 (2004).

THE PROPOSAL

To exploit the beta-beam concept to produce intense and pure low energy neutrino beams.

PHYSICS POTENTIAL

- Neutrino properties, like the ν magnetic moment.
- Neutrino-nucleus interaction studies.
- …



A BETA-BEAM FACILITY FOR LOW ENERGY NEUTRINOS.

Beta-beam task

- **Objective:** Study all components of a beta-beam facility above 100 MeV/u
- **Deliverable:** Conceptual Design Report (CDR) for a beta-beam facility
- **Participating institutes:** CERN, CEA, IN2P3, CLRC-RAL, GSI, MSL-Stockholm
- **Parameter group to define the conceptual design and follow the evolution of the beta-beam facility:** Higher intensities and higher gamma

Work Units (WU) in beta-beam task

- **Low energy ring and RCS:** CERN leads the WU
- **PS and SPS:** CERN leads the WU
- **Replacements for PS and SPS:** GSI will be asked to lead WU
- **Design of decay ring:** CEA leads the WU
- **Collimation and machine protection (simulation of decay losses):** CERN leads the WU
- **Low energy ring, study of critical components:** MSL leads the WU
- **Longitudinal simulations and stacking:** CERN leads the WU
- **Parameter group:** Chaired by Steve Hancock, CERN
- **Synergies to nufact:** RAL will be asked to lead the WU

Present CERN commitement (including EU): 17 FTE over 4 years

Beta-beam

CERN Job descriptions

- **Title: Accelerator physicist**
  - Name: Mats Lindroos
  - Availability: 0.5 FTE/year
- **Title: Accelerator physicist**
  - Name: Michael Benedikt
  - Availability: 0.5 FTE/year
- **Title: Accelerator physicist**
  - Name: Steven Hancock
  - Availability: 0.5 FTE/year
- **Title: Accelerator physicist**
  - Name: New staff, To be advertised autumn 2004
  - Availability: 1 FTE/year
- **Title: Physicist or engineer**
  - Name: New fellow (3 years), To be advertised autumn 2004
  - Availability: 1 FTE/year
- **Title: Physicist or engineer**
  - Name: New fellow (3 years), To be advertised autumn 2004
  - Availability: 1 FTE/year

Beta beam task (machine aspects)

1. Pursue the baseline scenario studies:

- explore other possible ions
- store He and Ne ions separately at $\gamma = 75$ or so
- look also the case of maximum γ affordable by SPS (150/250)
- study possible release of duty cycle

and get possible fluxes for physics

2. Study a greenfield scenario for higher gammas

3. Study a low energy beta beam for nuclear physics, astrophysics and neutrino physics (and build a pre-SPL test facility)

all this needs strong interaction between machine and neutrino physicists

task for physicists

better simulations (bckgrnds)

above questions….

some personal thoughts

- **main aim in the coming years: θ_{13} , δ_{CP} , sign (Δm^2)**
- **Europe is absent from first round of superbeams**
- **Can Europe regain strong position for 2nd round?**

  I think so if we are able to start between 2015 and 2020 super+betabeams superior to T2K phase2 and arrive before (if we stick to "baseline" scenario) so that Europe can attract a worldwide collaboration.

  If detector and beams wait for the other to take first step, nothing will happen

- **The alternative is to skip second round and prepare 3rd round (neutrino factory or higher energy beams)**

  I personally find this risky for Europe

We should try to find again a consensual road map for Europe