“FULL PERFORMANCE” ACCELERATOR COMPLEX

Why ?

Specifications

Sketch of a set-up

Why is it worthwhile ?

- to check if there is a way to satisfy all requests at a reasonable cost !
- to show what it could be like, giving a taste of the implications,
- to have a reference for estimating the merits of the other scenarios,
- as a long-term goal, with which new/modified components should be compatible.

Specifications (Sources)

As of today:

- LHC upgrade study [H3 workshop – Oct. 2004]
- SPSC Villars – Sept. 2004
- Multi-MW workshop – May 2004
- HIF04 – June 2004
- Neutrino Factory workshops (NuFact's 1999 – 2005)
- EURISOL Design Study

Future additions:

- NuPAC – Oct. 2005
- POFPA !

Specifications (beam characteristics)

Summary (preliminary before POFPA analysis)

Application	Energy [GeV]	Beam power [MW]	Longitudinal & transverse parameters
Nuclear physics (EURISOL) + beta-beams	1 - 4	5	Continuous or high duty factor. Typ.: ≥ 50 Hz/1 ms burst
ν super-beam (short base line)	3.5	4	Pulsed/low duty factor Typ.: 50 Hz/3 μs
ν factory	3 - 15	4	Pulsed/low duty factor/short bunches Typ.: ≤ 50 Hz/3 μs/1 ns bunches
k physics	30 - 1000	~ 1	Pulsed/long spill Typ.: 0.1 Hz/5 s
LHC luminosity upgrade	450 -1000	>1	Pulsed/very high brightness/ 10 - 25 ns bunch spacing

Components of a “full performance” complex

Present accelerator	Replacement accelerator	Improvement	INTEREST FOR			
			LHC upgrade	ν physics beyond CNGS	RIB beyond ISOLDE	Physics with k and μ
Linac2	Linac4	50 → 160 MeV $H^+ \rightarrow H^-$	+	0 (if alone)	0 (if alone)	0 (if alone)
PSB	>2.2 GeV RCS* for HEP	1.4 → >2.2 GeV 10 → 250 kW	+	0 (if alone)	+	0 (if alone)
	>2.2 GeV/mMW RCS*	1.4 → >2.2 GeV 0.01 → 4 MW	+	++ (super-beam, β-beam ?, ν factory)	+ (too short beam pulse)	0 (if alone)
	★ >2.2 GeV/50 Hz SPL*	1.4 → >2.2 GeV 0.01 → 4 MW	+	+++ (super-beam, β-beam, ν factory)	+++	0 (if alone)
PS	RSS*/** for HEP	>30 GeV Intensity x 2	++	0 (if alone)	0	+
	★ 5 Hz RCS*/**	>30 GeV 0.1 → 4 MW	++	++ (ν factory)	0	+++
SPS	★ 1 TeV RSS*/**	0.45 → 1 TeV Intensity x 2	+++	?	0	+++

RCS=Rapid Cycling Synchrotron
RSS=Rapid Superconducting Synchrotron
SPL=Superconducting Proton Linac

* with brightness x2

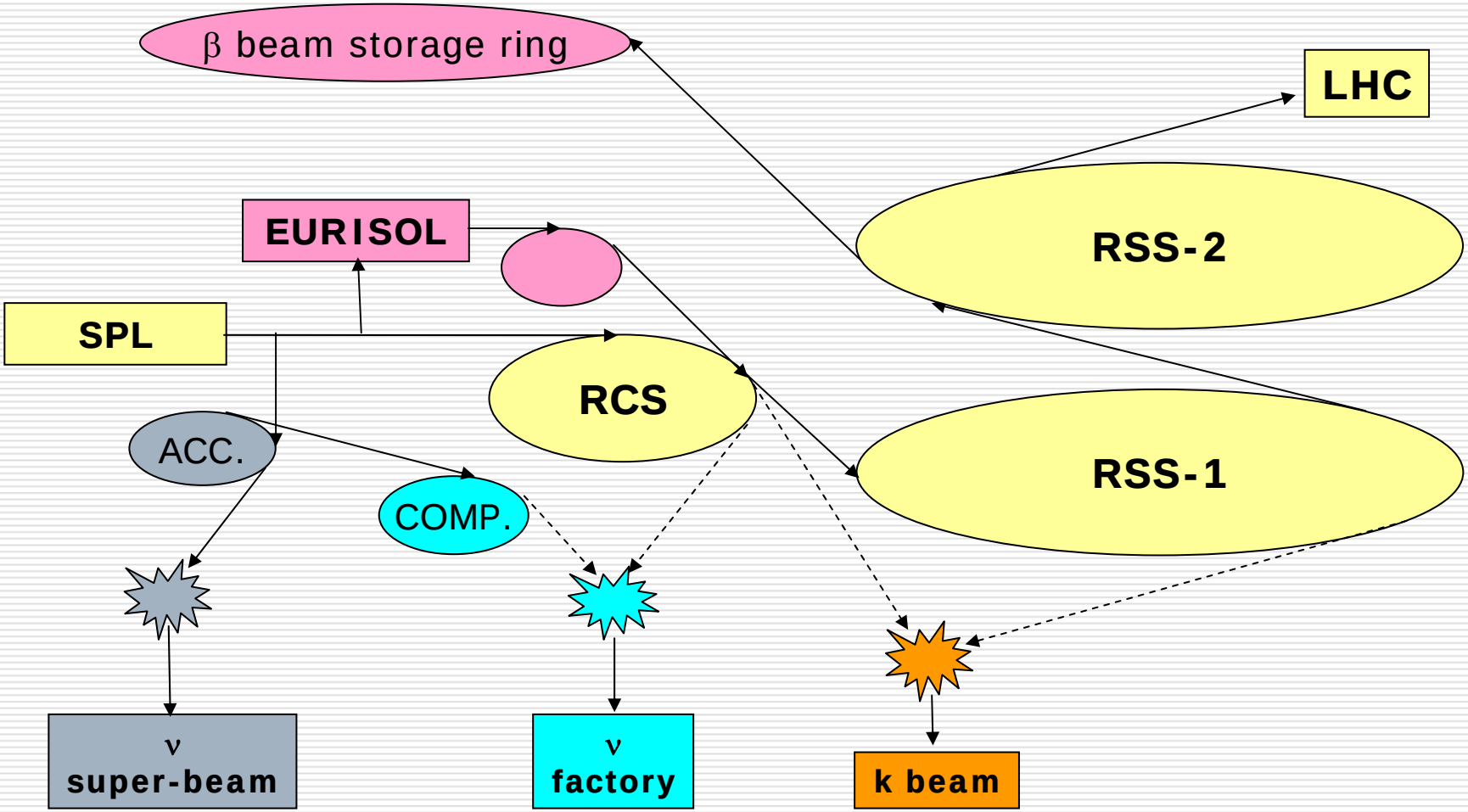
** need new injector(s)

Main accelerators of a “full performance” complex

Type of accelerator (rep. Rate)	Output energy [GeV]	Main features for				
		EURISOL + beta-beams	ν super-beam	ν factory	k physics	LHC $\mathcal{L}$ upgrade
SPL (25-50 Hz)	3.5 (-8?)	Beam power Time structure	**SBL** **+ accumulator** Beam power	**+ accumulator** **+ compressor** Beam power **High rep. rate** **Short bunch distance**		Brightness (x4 at 3.5 GeV)
RCS (5-10 Hz)	30-50		**MBL** Beam power	Beam power Low rep. rate	Beam power **Beam energy** **Spill length**	> energy & rep. rate than the PS
RSS1 (0.5 Hz)	150-300		**MBL** Beam power		Beam power Beam energy Spill length	Booster for 1 TeV LHC injector
RSS2 (0.1 Hz)	1000		**MBL / LBL** Beam power		Beam power Beam energy Spill length	x2 injection energy in LHC > x2 beam intensity

Remark: available beam power is ~ 4 MW at all energies simultaneously !

Sketch of a “full performance” complex



Refined analysis

- PAF:
  - Improved analysis of components (e.g.: RCS replacing the PS ? RSS-1 and 2 ?)
  - investigation of alternative solutions (e.g.: RCS instead of SPL ? FFAG ?)
  - Order of priorities (accelerator aging / quick benefit /...)
  - Minimization of disturbance for physics

- POFPA:
  - Need for high beam power at all energies ?
  - Priorities of goals [Between physics communities ? Inside communities (e.g.: ν-factory of β-beam ? k at 50 GeV or n x 100 GeV ?]
  - Planning ? (Timeline of the various applications ? “Windows” of physics stops ?)

Main accelerators of an “LHC upgrade” complex

Type of accelerator (rep. Rate)	Output energy [GeV]	Main features for				
		EURISOL + beta-beams	ν super-beam	ν factory	k physics	LHC $\mathcal{L}$ upgrade
Linac4+ (50 Hz, 200 kW)	0.4	**Beam power**				Brightness x4
RCS (50 Hz, 2 MW)	3.5	**Beam power Time structure**	**SBL Beam power**	**Beam power High rep. rate**		Brightness x4
PS (1 Hz, 0.4 MW)	>30				**Beam energy** Spill length	> energy & rep. rate than the PS
RSS1 (0.1 Hz, 0.8 MW)	150-300		**MBL** Beam power		Beam power Beam energy Spill length	Booster for 1 TeV LHC injector
RSS2 (0.1 Hz, 4 MW)	1000		**MBL/LBL** Beam power		Beam power Beam energy Spill length	x2 injection energy in LHC > x2 beam intensity