Workshop on cryogenic and vacuum sectorisations of the SPL

CERN, 9th -10th November 2009

Workshop Organisation and Goals

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TE-MSC

Agenda

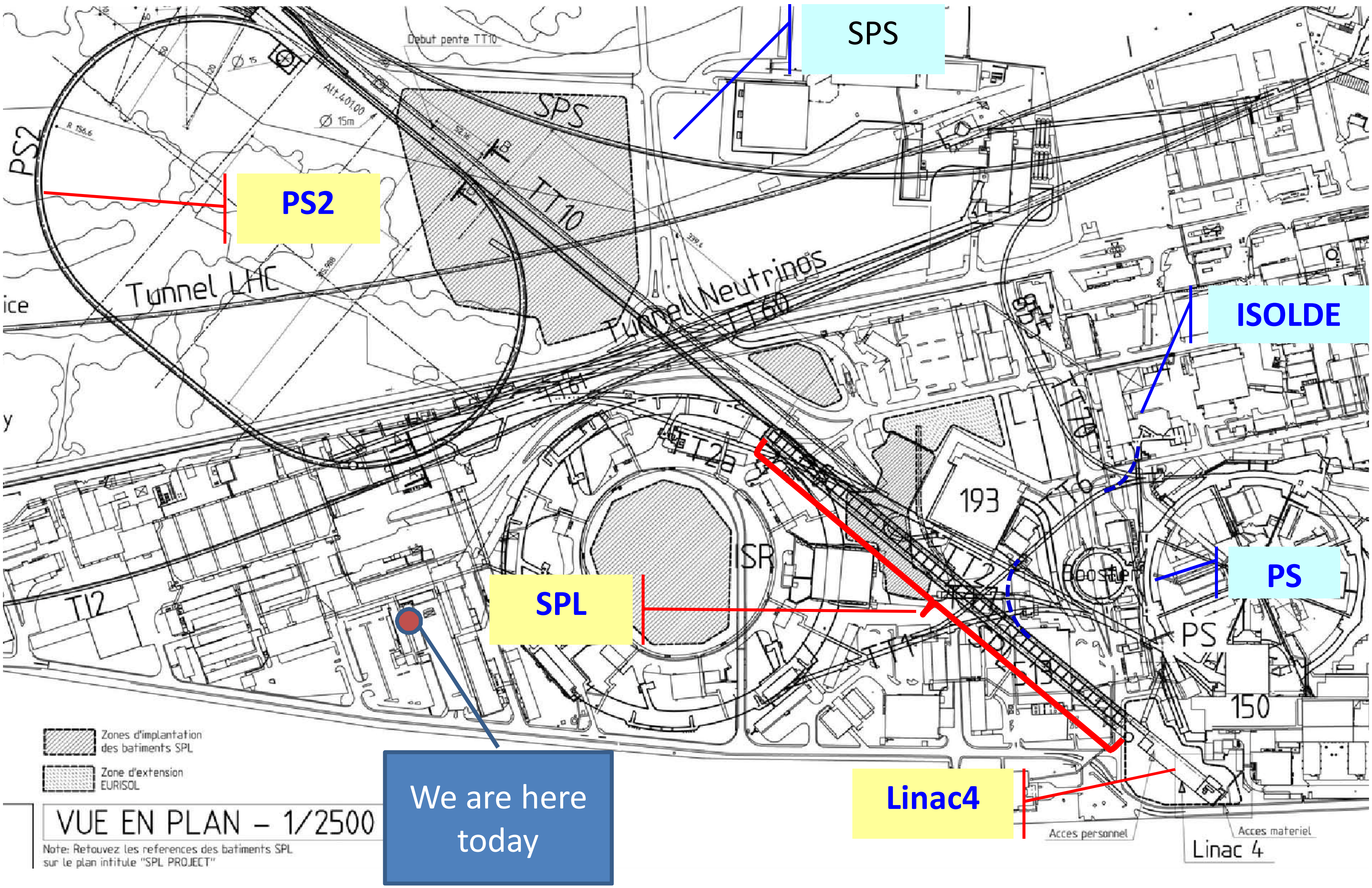
Monday 09 November 2009

14:00	Welcome (10')	Roland Garoby (*CERN*)
14:10	Workshop organization and goals (20')	Vittorio Parma (*CERN*)
14:30	SPL machine architecture (30') (slides)	Frank Gerigk (*CERN*)
15:00	SPL integration layouts (20') (slides)	Sylvain Weisz (*CERN*)
15:20	Coffee break (15')	
15:35	Experience from SNS (30')	Fabio Casagrande (*ORNL*)
16:05	Experience from DESY (30') (slides)	Bernd Petersen (DESY)
16:35	Cryogenic cooling schemes (30') (Slides)	Udo Wagner (*CERN*)
17:05	Vacuum sectorisations (30')	Paul Cruikshank (*CERN AT-VAC*)
17:35	1st interaction session on SPL open issues (1h00')	
19:00	"No host" Dinner (2h00') (Glassbox (Rest. no 1 Main building))	

Tuesday 10 November 2009

09:00	Experience from FNAL (30') (112-R-028)	John WEISEND (*SLAC*)
09:30	Experience from KEK (30') (112-R-028)	N Ohuchi (*KEK*)
10:00	Experience from BNL (30') (112-R-028)	Rama Buchi Rao Calaga (TBC)
10:30	Coffee break (15') (112-R-028)	
10:45	Experience from LEP and LHC (30') (112-R-028)	Olivier Brunner (*CERN*)
11:15	2nd interaction session on SPL open issues (1h00') (112-R-028)	
12:15	Workshop lunch (by invitation only) (1h45') (La Caravelle (Restaurant no 2))	
14:00	3rd interaction session on SPL open issues (1h00') (112-R-028)	
15:00	Coffee break (15') (112-R-028)	
16:00	Conclusions and recommendations (30') (112-R-028)	Vittorio Parma (*CERN*)

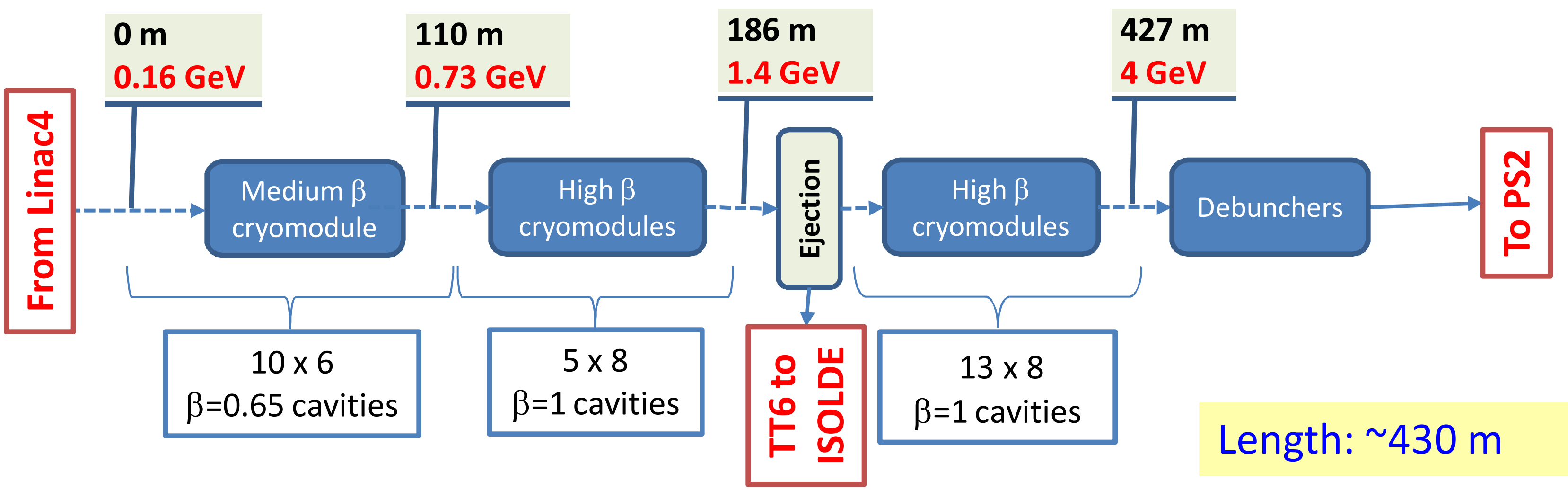
Layout injector complex



The SPL study

Goals of the study (2008-2012):

- Prepare a Conceptual Design Report with costing to present to CERN's management for approval
- …aimed at a start of construction of the low power SPL (LP-SPL) optimized for PS2 and LHC at the beginning of 2013

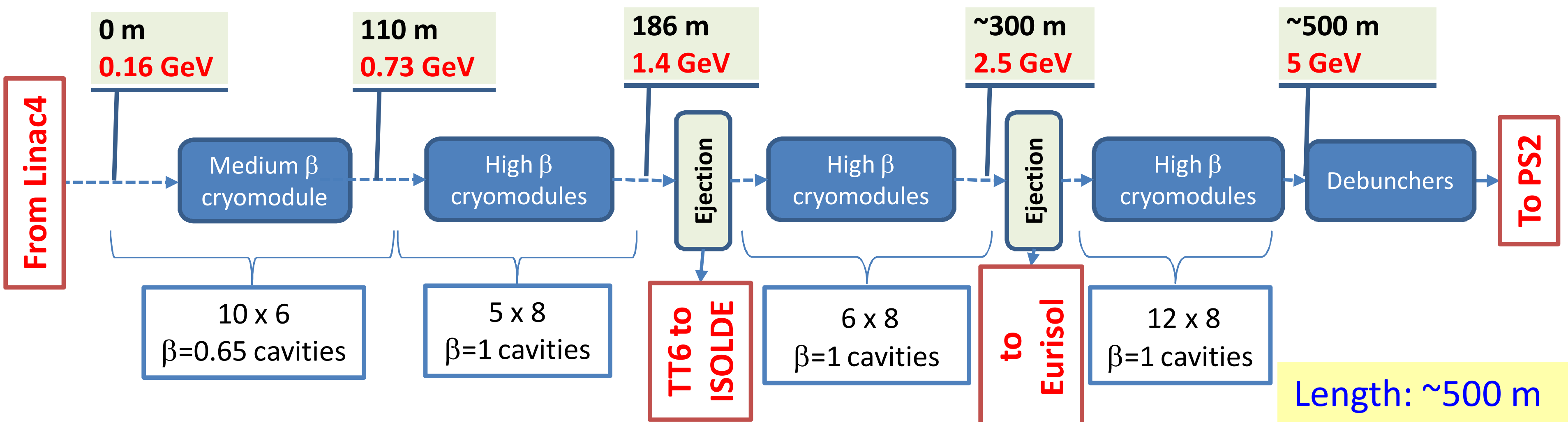


LP-SPL beam characteristics

Kinetic energy (GeV)	4
Beam power at 4 GeV (MW)	0.16
Rep. period (s)	0.6
Protons/pulse (x 10^{14})	1.5
Average pulse current (mA)	20
Pulse duration (ms)	1.2

The SPL study (cont.d)

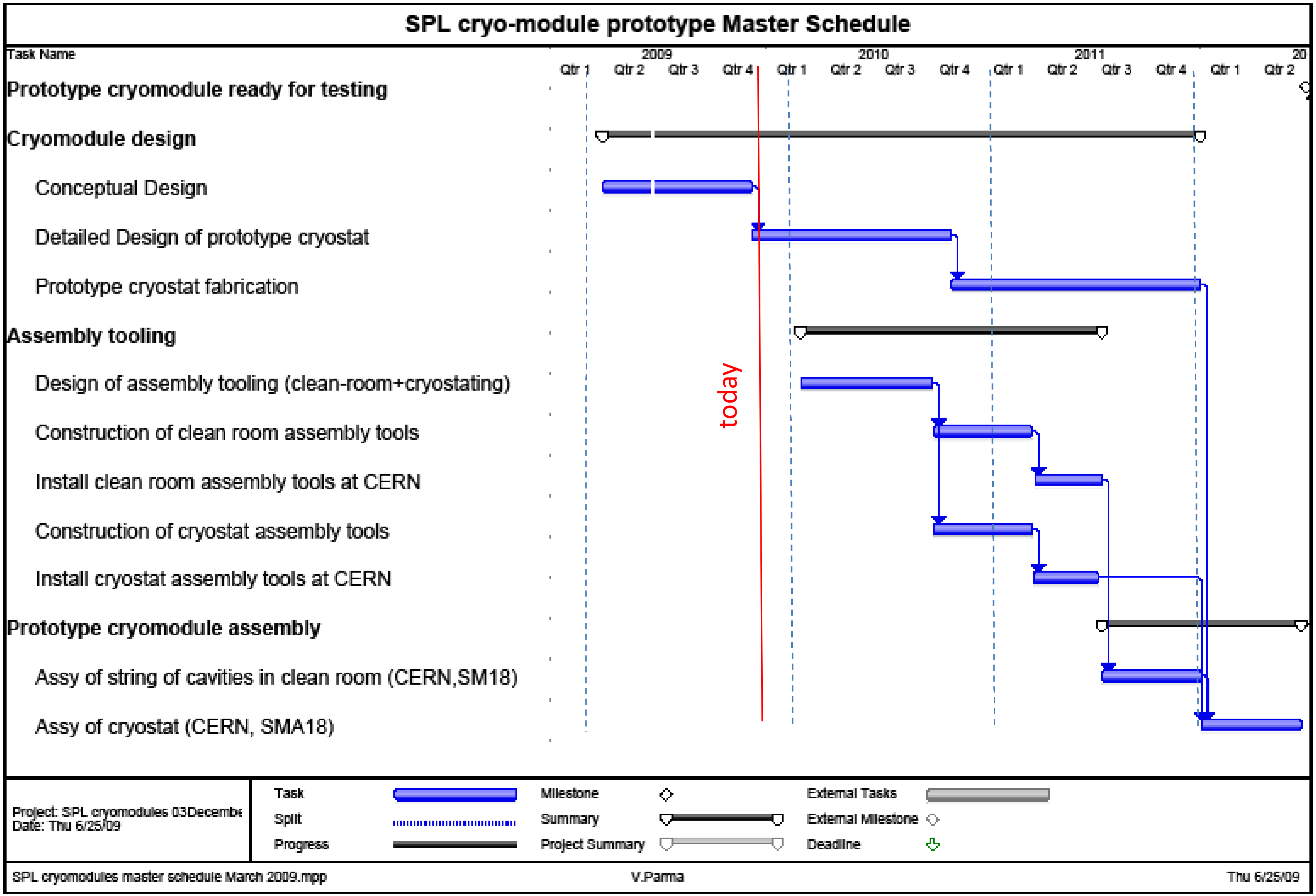
- … with an optional possibility of a later upgrade to 5 GeV and multi MW high power beam (HP-SPL).



	Option 1	Option 2
Energy (GeV)	2.5 or 5	2.5 and 5
Beam power (MW)	3 MW (2.5 GeV) or 6 MW (5 GeV)	4 MW (2.5 GeV) and 4 MW (5 GeV)
Rep. frequency (Hz)	50	50
Protons/pulse (x 10^{14})	1.5	2 (2.5 GeV) + 1 (5 GeV)
Av. Pulse current (mA)	20	40
Pulse duration (ms)	1.2	0.8 (2.5 GeV) + 0.4 (5 GeV)

HP-SPL beam characteristics

Construction of a cryo-module prototype
(as part of the SPL study)



Topics for discussion

- What is already decided *(not for discussion today):*
  - Cavities cooled in saturated superfluid helium (T~ 2K, P~ 3.1 kPa)
  - Cavities RF frequency: 704 MHz
  - One surface cryoplant at mid lenght of the SPL:
    - ~ 6 MW @ 4.5K for LP-SPL (~ 20 MW @ 4.5K for HP-SPL)

- What is to be discussed today:
  - Cryogenic cooling layouts and schemes and consequences on machine cryostats:
    - Single "continuous" cryostat vs. fully "segmented" cryostat with cryo distribution line
    - Intermediate variants
  - Vacuum systems and consequences on machine cryostats:
    - Insulation vacuum and need for vacuum barriers
    - Cavity/beam vacuum and need for gate valves
    - possibly also coupler vacuum

- We need to learn from the experience of other machines and labs

Road map of the workshop

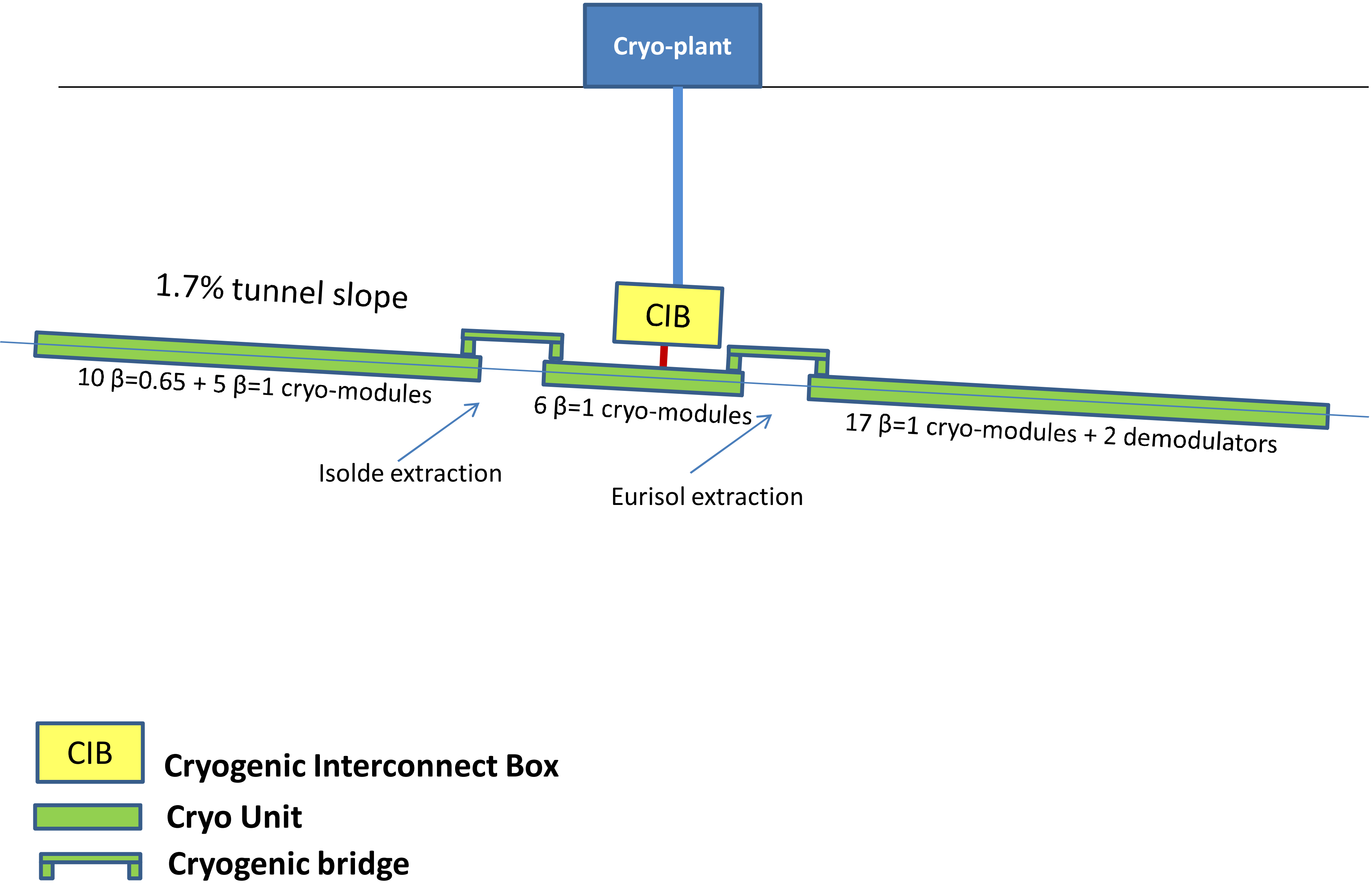
- Machine availability:
  - "work-horse" in the injection chain
  - 100% availability not viable,.What is achievable? And at which cost?
- Reliability of built-in components and operational risks (degraded performance without intervention)
  - Typical faults expected on:
    - Cavities
    - Couplers
    - Tuners
    - ..
- Operation with degraded performance and mitigating measures:
  - Degraded performance of cavity/ies → reduced energy
  - Degraded optics (quads, steerers) → reduced beam quality
  - Operating with leaks
  - ...
- Built-in redundancy (e.g. need for installed spare cryo-modules)
- Maintainability:
  - Radioactive cool-down time
  - Warm-up/cool-down . Time and reliability. Need for partial or complete warm-up of strings to replace built-in components or even one cryo-module
  - Accessability of components for regular maintenance or repair
- Design complexity of compared solutions
- Operational complexity (e.g.cryogenics with 1.7% slope)
- Installation and commissioning
- Coping with incidents (MCI). Loss of beam and/or insulation vacuum :
  - helium leaks
  - Air leaks
- Cost differences between options
- - …

Goals

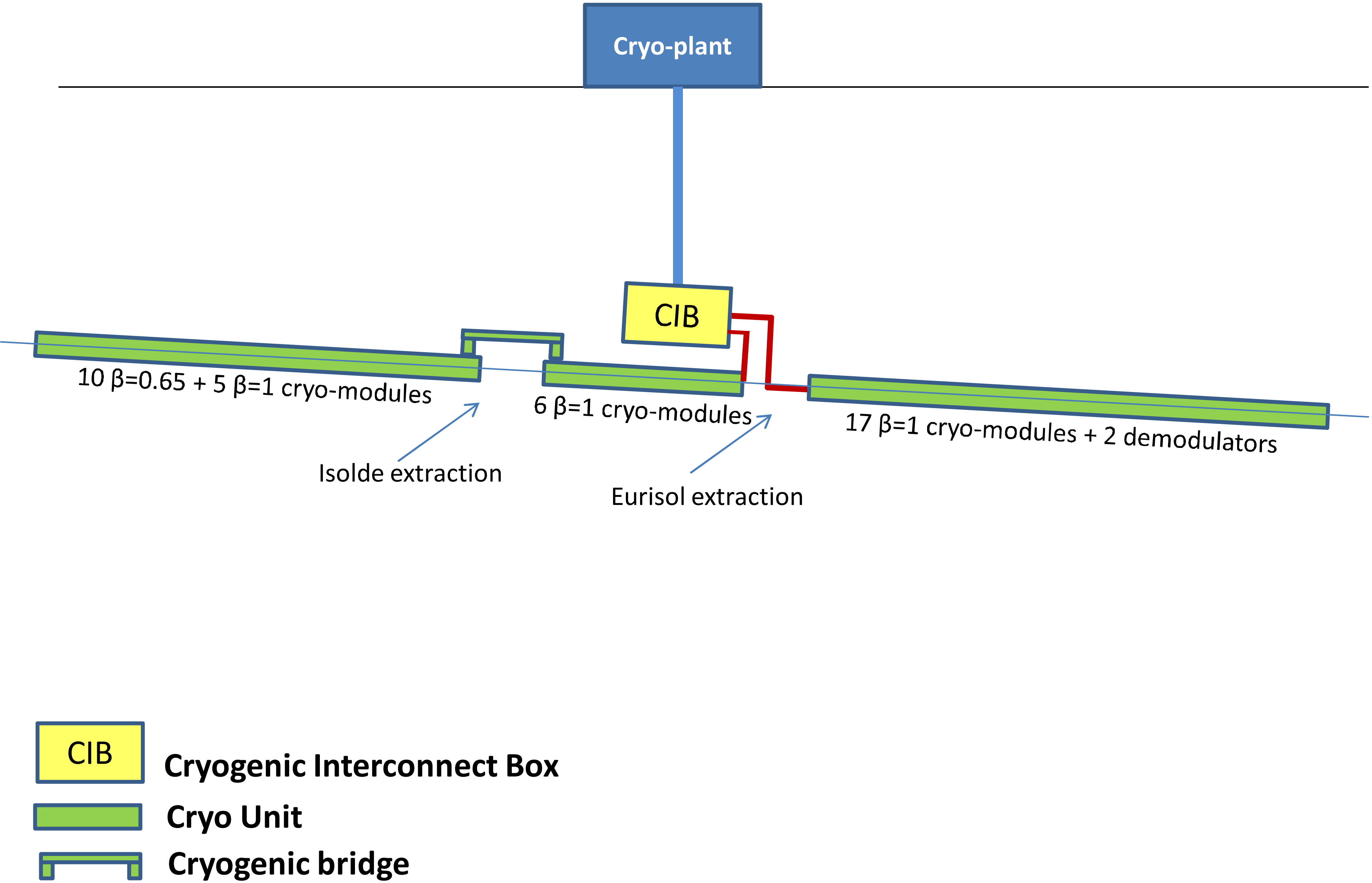
- Primary goals:
  - Identify the main operational and intervention scenarios for the cryogenics and vacuum systems of the SPL
  - Elaborate an exhaustive technical and economical comparison between *single "continuous" cryostat* and *"segmented" cryostat with cryo distribution line*
  - Possibly reccomend a choice between the two options
  - Define a "baseline" cryogenic distributions scheme and vacuum sectorisation
  - Elaborate, if necessary, a list of further developments for making a choice
- Other goals:
  - Identify advantages for alternative sectorisation schemes (intermediate solutions)
  - Technical comparison between layouts with warm and cold magnets
  - Identify other machine architectures to be explored for an improved sectorisation (e.g. alternative optic schemes)

Background information on sectorisation schemes

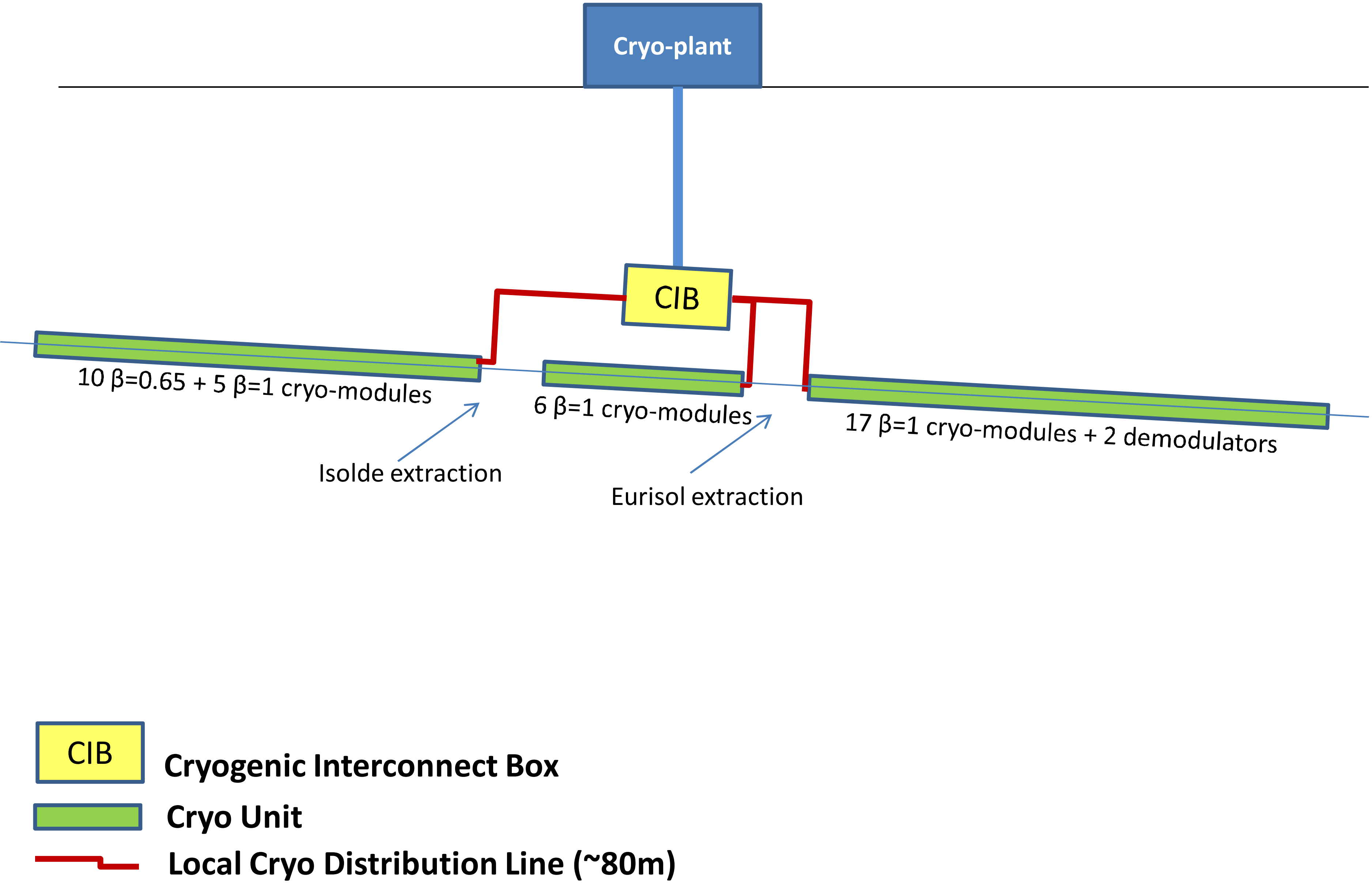
Possible cryogenic feeding



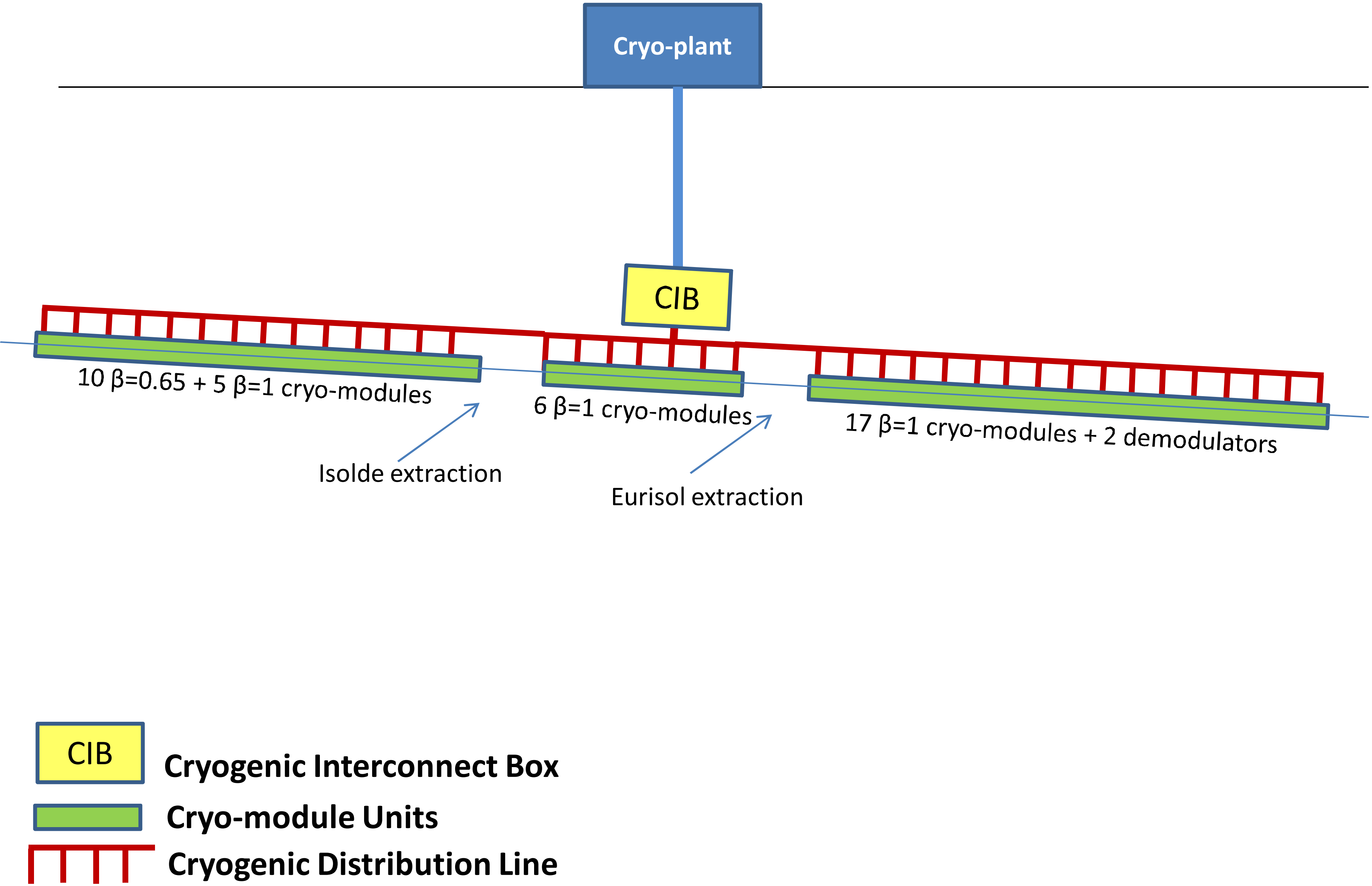
Possible cryogenic feeding



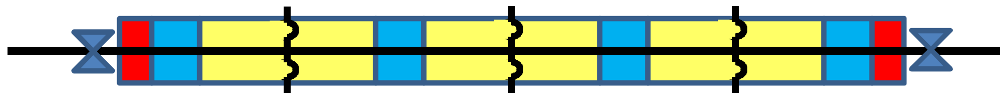
Possible cryogenic feeding



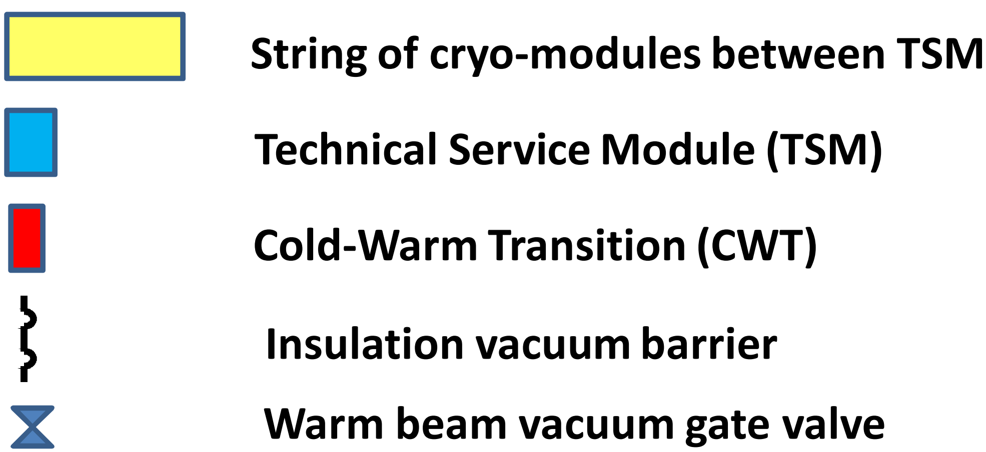
Possible cryogenic feeding



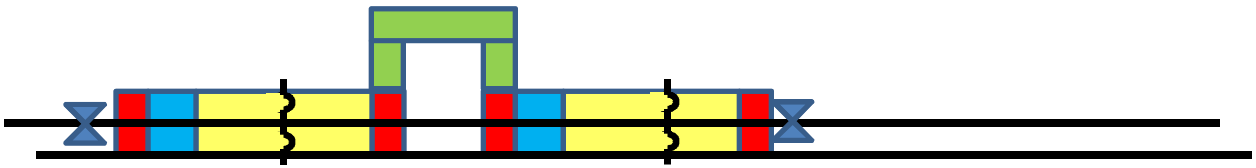
“continuous” cryostat



- “Long” and “continuous” string of cavities in common cryostat
- Cold beam tube
- “straight” cryogenic lines in main cryostat
- common insulation vacuum (between vacuum barriers, if any present)



“bridged” cryostat



- Variant of the continuous cryostat
- Warm beam zones, 2 CWT at every cryo-module
- cryostat “bridges” between adjacent cryo-modules
- “bent” cryogenic lines through “bridges” → CDL not needed
- common insulation vacuum (between Vacuum Barriers, if any present)

Cryostat “bridge” with integrated cryo-lines

Single cryo-modules

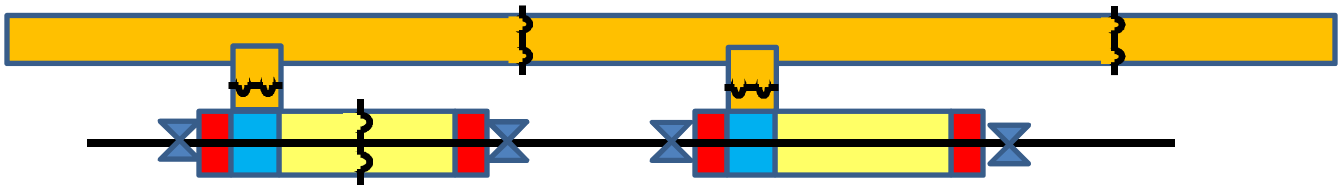
Technical Service Module (TSM)

Cold-Warm Transition (CWT)

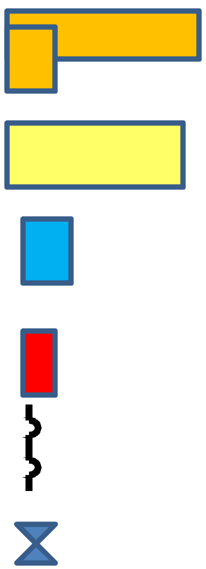
Insulation vacuum barrier

Warm beam vacuum gate valve

“segmented” cryostat



- Cryostat is “segmented”: strings of (or single) cryo-modules, 2 CWT each
- Warm beam zones
- Cryogenic Distributio Line (CDL) needed
- Individual insulation vacuum on every string of cryo-module (Vacuum Barriers, w.r.t. CDL)



Cryogenic Distribution Line (CDL)

String of (or single) cryo-modules

Technical Service Module (TSM)

Cold-Warm Transition (CWT)

Insulation vacuum barrier

Warm beam vacuum gate valve