AB-CO Review

Services to Equipment Groups

Controls for Beam Transfer equipment

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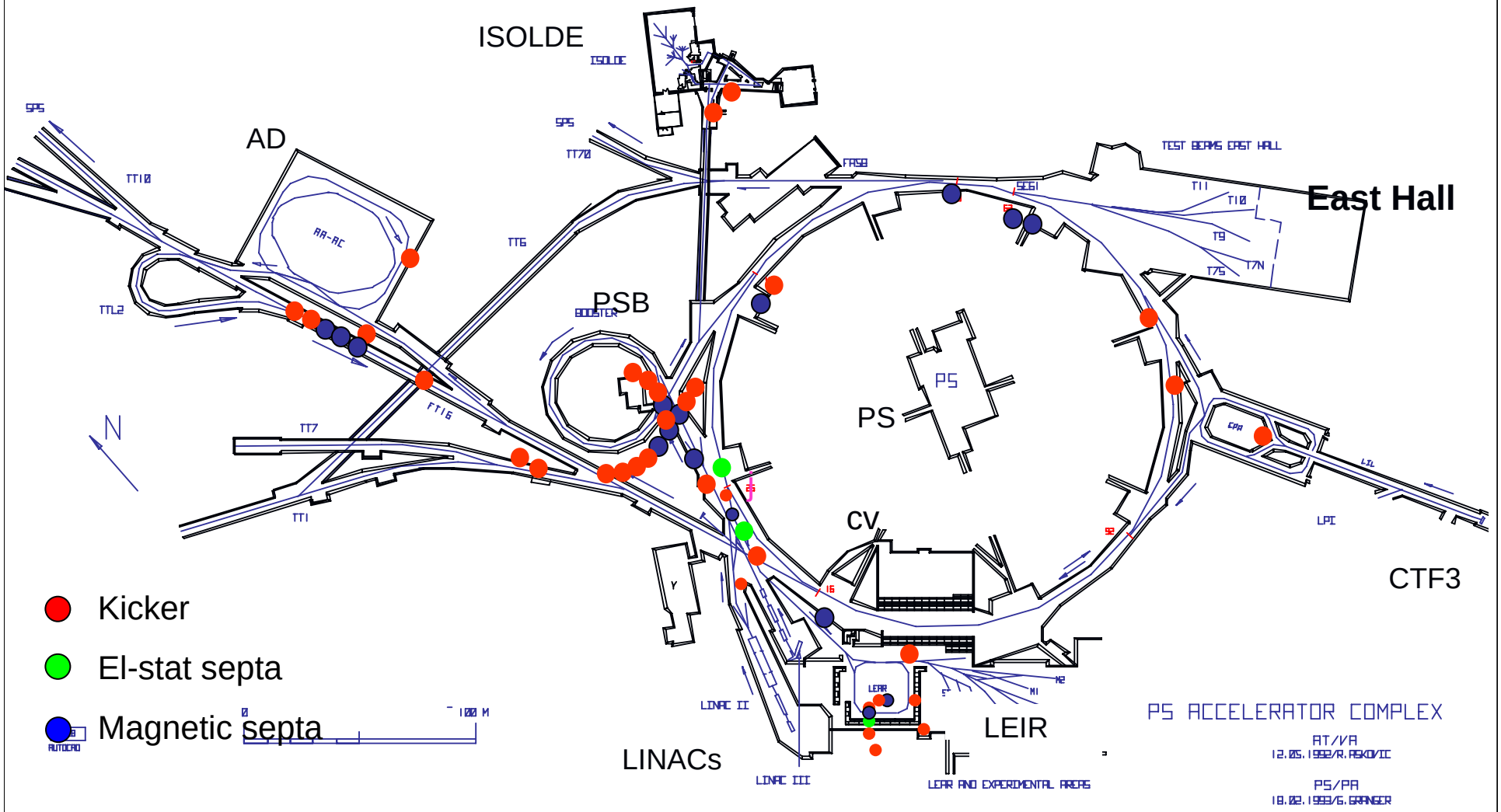
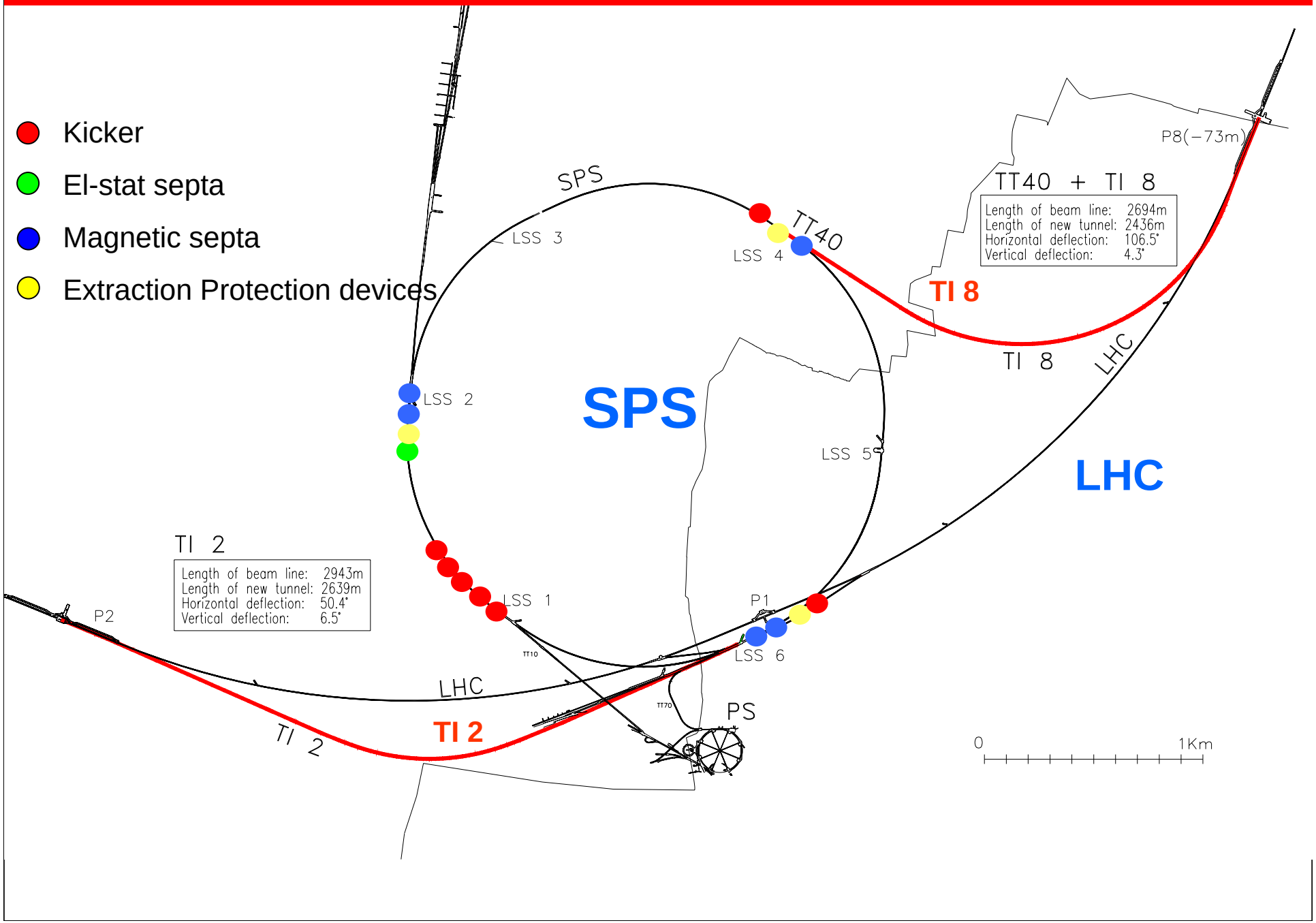
Outline

- BT Equipment Overview
- BT Work Packages
- BT ←→ CO Border Line
- BT Equipment Controls
- Control requirements for operational equipment
- Control requirements for new projects
- Summary

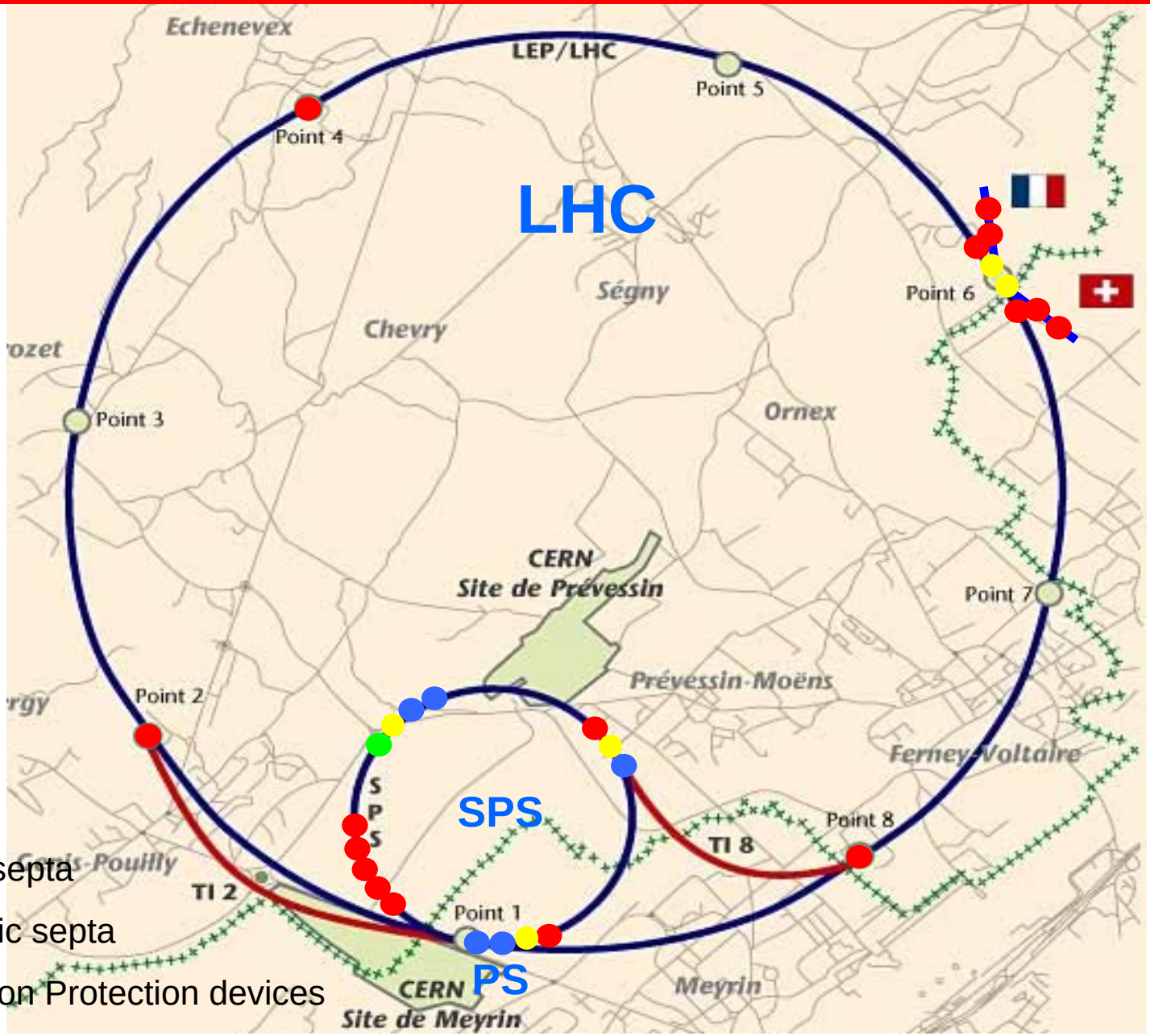
PS Complex


ISOLDE
AD
PSB
PS
PS
CV
East Hall
CTF3
LINACs
LEIR
Kicker
El-stat septa
Magnetic septa
PS ACCELERATOR COMPLEX

SPS


Kicker
El-stat septa
Magnetic septa
Extraction Protection devices
SPS
LSS 3
LSS 4
TT40
TI 8
P8(−73m)
TT40 + TI 8
Length of beam line: 2694m
Length of new tunnel: 2436m
Horizontal deflection: 106.5°
Vertical deflection: 4.3°
TI 8
LHC
LSS 2
SPS
LSS 5
LHC
TI 2
Length of beam line: 2943m
Length of new tunnel: 2639m
Horizontal deflection: 50.4°
Vertical deflection: 6.5°
LSS 1
P1
P2
TT10
LSS 6
LHC
TT70
PS
TI 2
TI 2
0
1Km

LHC



- Kicker
- El-stat septa
- Magnetic septa
- Extraction Protection devices

BT Equipment Overview

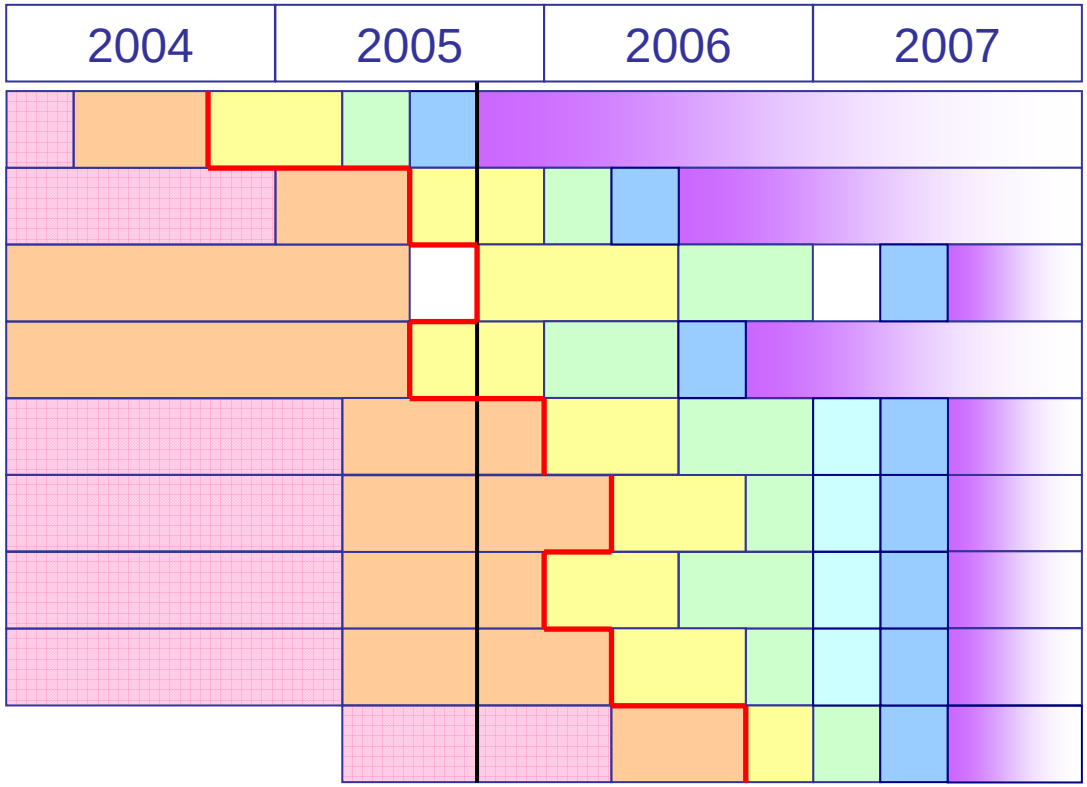
- About **100 distinguishable systems** (which can itself contain several modules) distributed around the different accelerators and their transfer lines
  - Electro-static & Electro-magnetic septa
  - Kickers
  - Passive protection devices
- **Each equipment** is **“Unique”**
  - Hardware characteristics → high voltage generator, magnet, functionality
  - Operational requirements → tightly linked with machine operation and in constant evolution
- **Equipment controls**
  - **Modular hardware & software approach** at the equipment control levels in order to provide all the required functionalities in an **homogeneous manner** to the **application levels**
  - **Heterogeneous integration** within **accelerator controls** due to the **reduced lifetime** of controls framework i.e. the same equipment hardware is integrated in several different ways within the accelerator controls system

Work Packages
(Including Controls Activities)

- **PS complex and SPS exploitation**
  - Kickers, Septa and Extraction Channels
- **Consolidation** electronics and controls for
  - SPS North extraction channels
  - PS Booster Proton Distributor
- Electronics and controls for **Projects**
  - LEIR kickers and septa
  - SPS west extraction channel (kickers and septa)
  - LHC injection kickers
  - LHC extraction and dilution kickers
  - LHC tune and aperture measurement kickers
  - LHC beam dumping system protection devices

Major Milestones

LEIR	Kickers & Septa
SPS	MKE6 & MS6
LHC	MKI2
LHC	MKI8
LHC	MKD63
LHC	MKD67
LHC	MKB63
LHC	MKB67
LHC	MKQA



AB/CO equipment control functionalities (hardware & software) available

Procurement, Manufacturing & Assembly	**Lab. tests**	**Installation**	**Hardware & Software Test**	**Reliability Run**	**Cold Check-Out**	**Ready for beam**

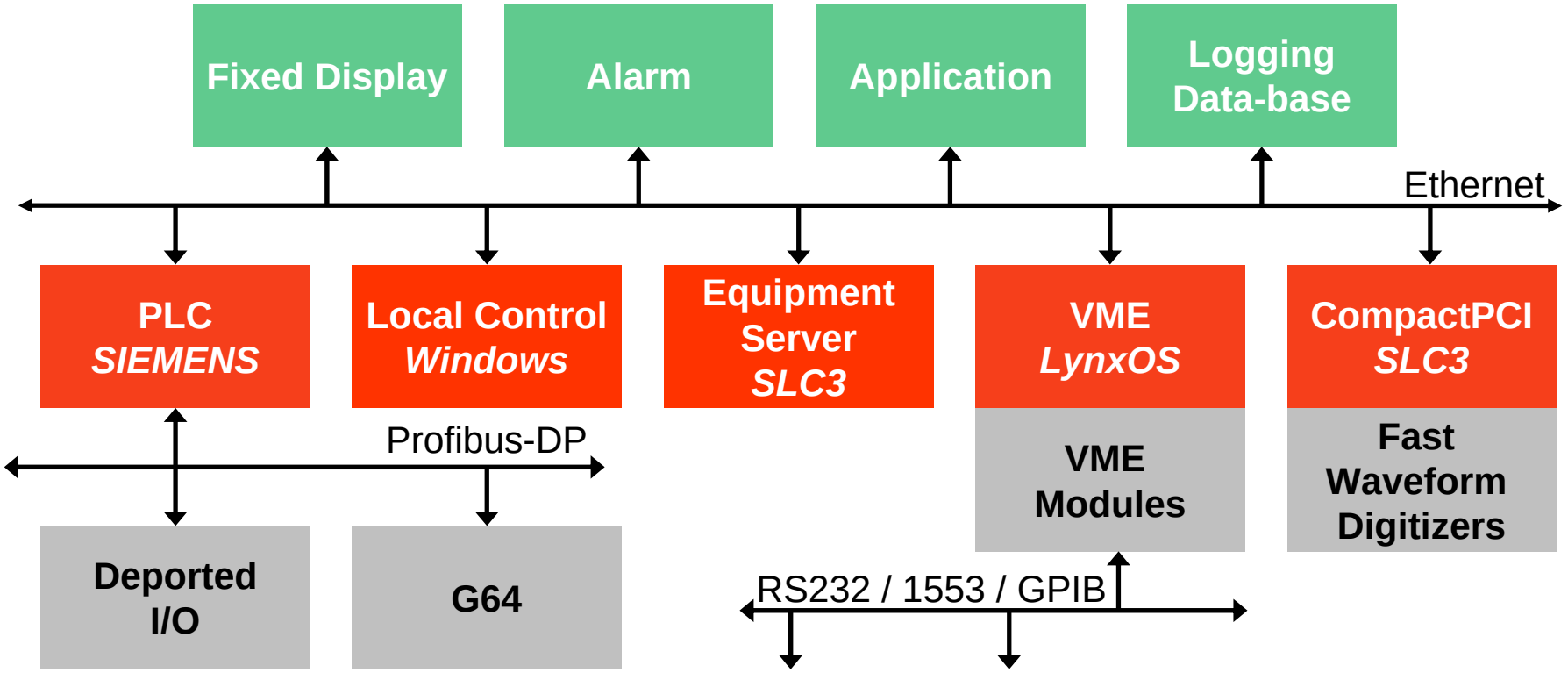
Responsibilities of Equipment Group

- Equipment **control architecture design**
- **Infrastructure** specification, **cables** specification, **actuators** and **sensors** selection
- Equipment **grounding & shielding**
- Equipment **server** & **real time** thread
- Equipment **state** control
  - Translation of global requests into low level commands
  - Determination and management of equipment state
- Equipment **fine settings** control (…fine tuning)
  - Machine cycle independent settings
- **Equipment protection** against **internal fault**
- **Machine protection** against **equipment fault**
- Alarm generation, equipment monitoring
- Expert programs
  - Diagnostics tools for commissioning, maintenance and piquet interventions
- Equipment surveillance, performance monitoring and post-mortem generation

Responsibilities of Controls Group

- **Integration** of **equipment** control **into accelerator** control framework
- **Delivery** of application client programs for remote control and operation of equipment group hardware
- **Guardian** of control system **homogeneity**
- **Supply** of uniform **services** to integrate equipment functionality into the accelerator control framework (contracts…)
- **Supply** of common **complete solution** for specific functionalities required by more than one equipment group (signal acquisition, timing distribution…)
- **Delivery** of services for **horizontal communication** between equipment groups (data exchange between equipment)
- **Coordination** of equipment group needs and **knowledge** in view of **common developments**
- **Competence center** for consulting on specific material or controls solutions.
- **Vision** of medium/long term **controls trends**. **Guidelines** for the choice and **evolution of controls solutions**

AB/BT Equipment Controls
Hardware Architecture



Slow control
→ State control (on/off/Standby)
→ Monitoring
→ Fast Interlock Monitoring

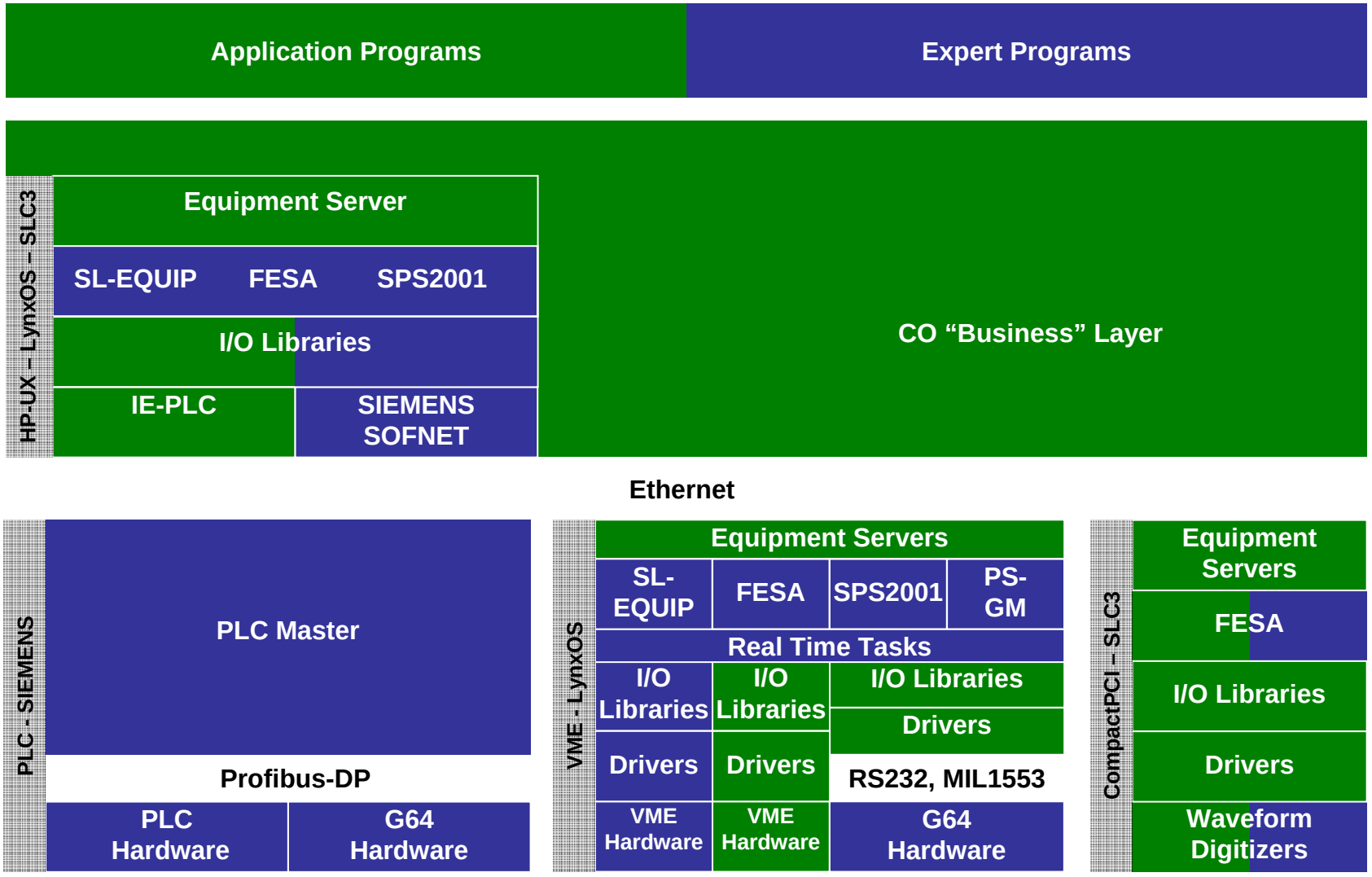
Fast Control
→ Settings
→ Acquisitions
→ Timing delay
→ Voltage

Analog Acquisition
→ OASIS
→ Shot-by-Shot logging
→ Post Mortem

CO Responsibility

BT Responsibility

AB/BT Equipment Controls
Software Architecture



Exploitation Framework(s) (PS & SPS Complex)
AB/CO Tools Box

VME Front-End, CompactPCI Front-End, Application Server, LynxOS 4.0, SLC3, SPS prepulse distribution, MIL1553/MSG, MIL1553/CR (G64 & MPX), TG8/PS, TG8/SPS, PS/CO standard VME hardware module (VMOD, GPIB, RS232, RS422…), nAos, OASIS, C-Tree, MACSy Server Side (LynxOS 4.0 & HP-UX 10.20), MACSy Client Side, Device Explorer, SPS2001, m_alarm, CAS, timsyncd, SSIS, MACHST & BEAMST, CAMAC, LynxOS drivers, FESA framework, Laser, JavaGUILS, HP-UX 10.20, SL-EQUIP, PS-EQUIP, Software development Environment, PS Software Module, Operational Environment, Application Program, SL-EQUIP, Passerelle, IE-PLC, SOFNET, Oracle, Measurement Database, XRT / XUIMS, SPS Fixed Displays, UIL, RPC, NC, JAVA, NODAL…

Actual AB/CO support level for all these tools has to be maintained to its actual level at least until 2008

In the ‘medium term’, an increase of homogeneity “might” be Welcome…

Migration of TS Toolkit
HP-UX Eradication

- 90% of the SPS BT application controlled from the TS Toolkit Software will be migrated to other frameworks (FESA or SPS2001) for the 2006 start-up… (already 75% in 2004)
  - AB/CO responsible for application layer, logging, reference data management, archiving…
  - AB/BT responsible for equipment level control & contract implementation (alarm, setting, measurement…)
- **Remaining application for 2006** within the TS Toolkit will be **SPS Emergency Interlock System** (Emergency Dump & Injection Inhibit)
  - Will be stopped in 2007 if new SPS Machine Protection System from AB/CO is “fully” available and the validation tests of new have been successful in 2006
- Major limitation of the actual system：
  - It is not a multi-cycling system, and
  - 25 years old (still MPX based), very few spares and strong decrease of reliability during the last years.

SPS2001 (MACSy) Framework
Actual Situation – Short Term

- **75% of BT SPS equipment** are **controlled via the SPS2001** framework as requested by AB/CO in 2001
  - Injection kicker
  - Beam dump kicker
  - North extraction (ElectroStatic & ElectroMagnetic Septa)
  - East extraction (Kicker & ElectroMagnetic Septa)
  - West extraction (ElectroMagnetic Septa)
- Some **basic functionalities are still missing** (already requested in 2003 for 2004 run) and are mandatory for 2006 startup
  - Save/Load operational settings to/from remote database
  - Connection of measurement contracts to logging database
  - …
- **Standard integration** of these equipment within the **SPS application layer** has **still to be performed (LSA + JAPC +…)**

SPS2001 (MACSy) Framework
Open issues – Medium Term

- **MACSy servers** are implemented under
  - **LynxOS 4.0 front-ends** for real time task connected to the SPS timing though SPS-TG8, and
  - **HP-UX 10.20 server** for equipment state and slow control
    - →Support for HP-UX 10.20 will be mandatory either until migration of existing MACSy server to FESA framework (not foreseen before 2009 startup at the earliest) or the of SPS2001 framework will be available for SLC3
- **Dynamic cycle management** within the **SPS2001 framework** (not based on the timing event payload) has to **upgraded** in order to follow the **evolution of the SPS timing system** for **SPS operation in multi-cycling mode**

→ A **battle plan** has to be put in place in order to define **how to progress** with the **integration of SPS2001** based equipment within the **accelerator control**

FESA Framework
Overview

More feedback from Jean-Jacques

- → Basic **required functionalities for BT** equipment control **seems to be available** within the **FESA framework**
  - Server actions, real time action
  - Event scheduler
  - Machine timing (CTIM & LTIM)

  but the **increase of complexity** for integration of equipment group hardware within the accelerator control is **not negligible**
- → FESA framework seems to be robust and stable…when not upgraded
- → **Vertical slice successfully** implemented for the **LEIR septa** (from PLC to application knobs with surveillance and alarms)
  - → It has not been a quiet & easy path…
  - → But, Very good support by FESA team and CO group.
- → **FESA** has now to be **considered** as an **operational framework**.
  - → Software validation protocol after FESA version upgrade has to be defined in order to avoid collateral effects.
- → A **lot of progresses** are **still / now MANDATORY** to **fully integrate FESA** framework within accelerators **controls framework.**

Control requirements for SLI & CNGS operation in 2006

- Normal operation' of LSS4 extraction channel (CNGS & TI8 test)
- Commissioning of LSS6 extraction channel & TT60
- Interleaved LSS4/LSS6 extraction (LHC injection sequence…)

→ LSS6 Extraction Kicker → FESA
→ LSS6 Extraction Septa → SPS2001

→ All the "standard" required control functionalities for operation of SPS extraction channels towards LHC must available and operational from the SPS start-up in April 2006 (Cold check-out)

- Application software for extraction channels control
- OASIS : Kicker signal acquisition & Shot-by-Shot logging
- Machine Protection : Extraction Permits & Beam Permit, Safe Setting Management
- Timing System : **Slow timing** and **fast prepulse** distribution **for extractions interleaved mode operation**
- Logging: beam losses, beam position, septa, kicker…
- Alarms and **Software Interlocks**

Control requirements for LHC

"From LSA to Equipment Hardware"

→ Detailed functional specifications in preparation

	Hardware Test			Sector Test			Reliability Run			Cold Check Out			Beam Operation		
	Injection	LBDS	MKQA	Injection	LBDS	MKQA	Injection	LBDS	MKQA	Injection	LBDS	MKQA	Injection	LBDS	MKQA
FESA	X	X	X	X				X		X	X	X	X	X	X
Logging	X	X	X	X				X		X	X	X	X	X	X
Alarms	X	X	X	X				X		X	X	X	X	X	X
Application Software	X	X	X	X				X		X	X	X	X	X	X
Fixed display				X				X		X	X	X	X	X	X
"Standard" post-mortem	X	X	X	X				X		X	X	X	X	X	X
Safe Setting Management				X				X		X	X	X	X	X	X
Timing and LHC Mode Information	X	X	X	X				X		X	X	X	X	X	X
LHC Mode Sequencer				X				X		X	X	X	X	X	X
LHC Injection Sequencer				X						X			X		
Safe LHC Parameters System	X	X	X	X				X		X	X	X	X	X	X
Automatic Post-Injection beam quality checks	X			X						X			X		
Automatic External LBDS post-operational checks		X						X			X			X	
LBDS connection to injection kicker	X	X						X		X	X		X	X	

01/2006 09/2006

Controls Requirements for LHC

- **Infrastructure and hardware** needs are **under control**
  - Front-end (VME, CompactPCI), Network, Timing…
- **Definition** of interfaces with Machine Protection System **well** under progress
  - Beam Dumping System & Injection Permit System
- **Definition of the** software **tools** included into the AB/CO tools box **to be used** for **LHC equipment control** have **still to be validated**
  - What will be available? When will it available? …We need them now!
- **Definition of 'standard' FESA contracts** and related **application software interfaces** within the AB/CO control framework have still have to frozen and delivered:
  - Equipment state, settings and acquisition → OK
  - Equipment safe setting management → to be defined
  - Alarm generation and management → In progress
  - Post-mortem system and time stamping → to be defined
  - Shot-by-shot and continue logging system → to be defined
- **Delivery** of a complete **fully validated vertical implementation** of **standard contracts within** AB/CO control framework has **still to be performed**

Controls Requirements for LHC

- **Better communication paths** have to be established between AB/OP, AB/BT and AB/CO (…up to the section level)
  - **Client of AB/BT** is **AB/OP** with application software and controls **infrastructure provided by AB/CO.**
  - **Impact of operational requirements** on control framework (at all levels) have to be better **evaluated** before **implementation**
- Clear **responsibility splitting** between equipment groups and controls group **has to be established**
  - **Coherent** hardware & software **resources sharing** at the front-end level
  - **Detailed interface definition** between equipment groups and controls group **have to be provided** and **supported**
- Better coordination between **needs** and **supplies**
  - **Equipment groups** have to **work on their application** and **not on** the validation of the **control framework**
- **Increase** of accelerator **control framework complexity** has to be taken into account in order to **permit** to **equipment groups** to **keep** their **capabilities** to implement (**within** the accelerator **control framework**) easily and rapidly complete simple application and expert programs
  - Some simple and easy to implement “scripting” interface from application layer to equipment layer would be welcome…

Summary

- From now and up to end 2006, **AB/BT** has to **integrate 10 new systems** into the **AB/CO accelerator control framework**
  - Technical choices for hardware low level control are frozen and validated
  - Low level software and local control software are frozen and validated
  - For the first system, installation and commissioning will start in Q4/2005
- **AB/BT relies heavily on the Controls group for a successful accomplishment of all these projects**
- The next step is the **integration of the equipment controls** within the **AB/CO accelerator control framework**
  - From development and prototyping to production
- **No resources** are available anymore within AB/BT
  - To wait longer for availability of fully operational “standard” control functionalities
  - To continue to participate in the “validation” of the control framework
- AB/BT implements today the technical solutions that will be used for LHC commissioning with beam