IEFC 2010 Workshop

How to keep the PS operational for the next 25 years.

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PS - Magnets

- **Over the last 5 years 51 main magnets + 4 spares were refurbished with new main coils and pole face windings including the repair of the yoke laminations.**
- **Unless recurrent problems appear it is not considered necessary to refurbish the coils of the remaining 49 magnets.**
- **However!**

PS - Magnets

- **The remaining 49 old PFW's are the weak link.**
  PFW's cannot be repaired.
  Cannot be changed in situ.
  Break down during operation means a main magnet exchange with its spare. Normally a 4 – 5 day stop.

  It is certain that some or even many of the remaining PFW's will not last the next 25 years.

  We should procure 50 sets of PFW's in readiness for an increasing failure rate.
  The purchase of 30 sets is already approved.
  Purchase of the remaining 20 sets is under consideration.
  ~750 kCHF

PS - Magnets

- **Other possible consolidation actions:**

  The replacement of the main bus bars with new. This would require a considerable production program. A study is already in progress.

  Systematic reinforcement of main coil insulation to ground. This would require magnet removal from the machine and a complete magnet strip down.

  Replacement of the main coils with new. This is not considered for the moment a necessary option.

  New improved diagnostics may well identify issues that could change the present philosophy, but for the moment it is believed that the PS magnets can operate during the next 25 years with a very high level of reliability, provided that the present maintenance plan is pursued.

PS - Main and Auxiliary Magnets

Magnet type	Magnet id	Manufacturer	Installed	Spares	Spare Coil sets	
Main unit, multipole, PS type R	**PXMU_HRCWP**	**ACEC**	**35**	**1**	**1**	
Main unit, multipole, PS type S	**PXMU_HSCWP**	**ACEC**	**15**	**1**	**1**	
Main unit, multipole, PS type T	**PXMU_HTCWP**	**ACEC**	**35**	**1**	**1**	
Main unit, multipole, PS type U	**PXMU_HUCWP**	**ACEC**	**16**	**1**	**1**	
Corrector , dipole horizontal, type 205	**PXMCHBAWWP**	**TESLA**	**10**	**1**	**0**	
Corrector , dipole horizontal, type 206	**PXMCHBBWWP**	**OERLIKON**	**5**	**13**	**0**	
Corrector , dipole vertical, type 202	**PXMCVAAWAP**		**5**	**1**	**0**	
Dipole , bumper vertical, type 209	**PXMDBBBCWP**	**LINTOTT**	**4**	**4**	**0**	
Dipole , bumper vertical, type 210	**PXMDBCAWWP**	**OERLIKON**	**1**	**3**	**0**	
Multipole , type 403	**PXMM_AAIAP**	**CERN**	**25**	**1**	**0**	
Octupole , type 802	**PXMONAAFWP**		**6**	**3**	**0**	
Octupole , type MTE	**PXMONDAFWP**	**SEF**	**2**	**1**	**1**	
Quadrupole , long oscillations compensation		**PXMQNACIAP**	**CERN**	**1**	**0**	**0**
Quadrupole , short oscillations compensation		**PXMQNADIAP**	**CERN**	**1**	**0**	**0**
Quadrupole , skew, type 404	**PXMQSAAIAP**	**CERN**	**17**	**1**	**0**	
Quadrupole , type 401	**PXMQNAAIAP**	**CERN**	**29**	**1**	**0**	
Quadrupole , type 402	**PXMQNABIAP**	**CERN**	**11**	**1**	**0**	
Quadrupole , type 406	**PXMQNBAFAP**	**SIGMAPHI**	**4**	**1**	**1**	
Quadrupole , type 407	**PXMQNBCAWP**		**4**	**3**	**0**	
Quadrupole , type 408	**PXMQNBDAAP**		**4**	**4**	**0**	
Quadrupole , type 409	**PXMQNCAAWP**	**SMIT**	**4**	**6**	**0**	
Quadrupole , type 414	**PXMQNCHAWP**		**4**	**2**	**0**	
Sextupole , type 608	**PXMXNBAFWP**	**LINTOTT**	**6**	**11**	**0**	
Sextupole , type 610	**PXMXNCAAWP**	**SMIT**	**1**	**5**	**0**	

- **ie. 245 Magnets 24 different types**

Davide_Tommasini_Magnet_report+25years.pdf

PS - Auxiliary Magnets

- All the auxiliary magnets except the fast bumper dipoles have been exchanged in the last ten years.
- 90% of the Auxiliary magnets are of the type which can be split and replaced on the beam line in approximately 4 hours without vacuum intervention.
- The fast bumper dipoles type 209 have captive chambers and require approximately 2 days to change.
- The Magnets the most highly stressed are the Doublets type 406 and 408 which are pulsed at around 3 kV. They are 30 year old magnets and their condition needs to be established.
- All auxiliary magnets have at least one spare and the procurement or in house manufacture of additional spares in case of need is not considered to be an issue.

PS – Power Supplies

- There are 192 Auxiliary Power supplies in the PS Ring.
- 28 have been upgraded since 2000.
- 164 range from 1969 to 1998.
- 189 must be upgraded between 2015 and 2020.
- Estimated cost at 2010 prices 2885 kCHF.

- EPC_JP_Burnet_PS_Injecteurs+25ans_PS_Complex.xlsx
- EPC_Y_Gaillard_Booster_Isolde_ZN_Conso_Estim+25years.xls

PS – Auxiliary Power Supplies

Model	Quantity	Designation	Last upgrade	Unit Cost (kCHF) 2010 ESTIMATION	Total Cost (kCHF) 2010 ESTIMATION	Comment
DVT.MNTK	20	PR.DVT [±10A, ±40V]	1998	5	100	
QN-AMP	40	CBE [±10A, ±35V]	1975	7	280	High speed needed for MTE
DHZ-AMP	50	PR.DHZ [±10A, ±40V]	1974	5	250	
QSK-AMP	20	PR.QSK-AMP [±10A, ±30V]	1969	5	100	
QSK-MNTK	20	PR.QSK-MNTK [±10A, ±40V]	1998	5	100	
AuxPS1	3	AuxPS 1 [±450A, ±450V]	2009	10	30	Replace electronics
AuxPS2	9	AuxPS 2 [±900A, ±450V]	2009	10	90	Replace electronics
AuxPS3	1	AuxPS 3 [±450A, ±900V]	2009	10	10	Replace electronics
GH-1kA	3	PS10 [500A, 2000V]	1995	100	300	15 yrs old. Replace power components and electronics.
GH-3kA	4	PS12 [3000A, 2000V]	1995	100	400	15 yrs old
P2KV	2	P2KV2KA [±2000A, ±2000V]				>25yrs old. Once MTE operational, these can be removed. Should be changed if MTE does not work?
PS11	4	PS11 [6000A, 1500V]	1997	100	400	12 yrs old. Replace power components and electronics.
MINIDISCAP	1	MINIDISCAP [±20A, ±700V]	2005	8	8	5 yrs old
PL-SW-6000	2	PL-SW-6000	2008	75	150	Replace electronics
S250-PLS	2	S250-PLS [250A, 350V]	2007	40	80	Replace electronics
SEPTUM-16	1	SEPTUM-16 [±30000A, ±4000V]	Electronics upgrade only 1995.	160	275	>30 yrs old. Replace converter + tunnel interface + electronics + spare
ALG-3	1	Septum 26	Electronics upgrade only 2005.	130	250	>30 yrs old. Replace converter + electronics + spare
RPHFB	1	PC:[10kA 8V 1Q] FWD:8kA DCCT:13kA Mode:Pulsed	2007	75	75	
RPHHA	1	PC:[4kA 16V 1Q] FWD:6kA DCCT:1.6kA Mode:Pulsed	2007	75	75	
PFW1	6	PFW1 [±1200V, ±250A]	2009	10	60	Replace electronics
PFW2	1	PFW2 [±600V, ±1600A]	2009	10	10	Replace electronics
Total	**192**				**3043**	

TT2 – Power Supplies

- There are 31 Auxiliary Power supplies in TT2.
- 14 have been upgraded since 2000.
- 17 are >30 years.
- 29 must be upgraded between 2015 and 2020.
- Estimated cost at 2010 prices 4150 kCHF.
- EPC_JP_Burnet_PS_Injecteurs+25ans_PS_Complex.xlsx

TT2 – Power Supplies

Logical Name	Model	Designation	Last upgrade	Next upgrade
F16.BHZ 117	TYPE4/1	Power Converter : TYPE4/1 [±300A, ±80V]	>30 ans	2015
F16.BHZ 147+447	TYPE4/2	Power Converter : TYPE4/2 [±400A, ±80V]	>30 ans	2015
F16.BHZ 167	TYPE3	Power Converter : TYPE3 [±200A, ±50V]	>30 ans	2015
F16.BHZ 377 S	TYPE8	Power Converter : TYPE8 [±500A, ±200V]	>30 ans	2015
F16.BTI 247 S	TYPE10	Power Converter : TYPE10 [±1550A, ±197V]	>30 ans	2015
F16.BVT 123	TYPE5	Power Converter : TYPE5 [±350A, ±100V]	>30 ans	2015
F16.BVT 173	TYPE5	Power Converter : TYPE5 [±350A, ±100V]	>30 ans	2015
F16.DHZ 327	S250C	CONVERTER : S250C	2009	None
F16.DHZ 327 SPARE	S250C	CONVERTER : S250C	2009	None
F16.DHZ 337	NBL 600M-30	Power Converter : TYPE9 [±20A, ±15V]	2000	2015
F16.DVT 353	NBL 600M-30	Power Converter : TYPE9 [±20A, ±15V]	2000	2015
F16.QDE 120	TYPE1	Power Converter : TYPE1 [±350A, ±120V]	>30 ans	2015
F16.QDE 150	TYPE1	Power Converter : TYPE1 [±350A, ±120V]	>30 ans	2015
F16.QDE 163	RB10CBLb	Power Converter RB10CBLb	2005	2015
F16.QDE 180	TYPE1	Power Converter : TYPE1 [±350A, ±120V]	>30 ans	2015
F16.QDE 207	RB10CBLb	Power Converter RB10CBLb	2005	2015
F16.QDE 210	RB10CBL	Power Converter RB10CBL	2005	2015
F16.QDE 213	RB10CBLb	Power Converter RB10CBLb	2005	2015
F16.QDE 217	RB10CBLb	Power Converter RB10CBLb	2005	2015
F16.QDE 220 S	TYPE6	Power Converter : TYPE6 [±350A, ±420V]	>30 ans	2015
F16.QFO 105	TYPE2	Power Converter : TYPE2 [±700A, ±50V]	>30 ans	2015
F16.QFO 135	TYPE1	Power Converter : TYPE1 [±350A, ±120V]	>30 ans	2015
F16.QFO 165	TYPE1	Power Converter : TYPE1 [±350A, ±120V]	>30 ans	2015
F16.QFO 205	TYPE8	Power Converter : TYPE8 [±500A, ±200V]	>30 ans	2015
F16.QFO 215	R14CBL	Power Converter R14CBL	2005	2015
F16.QFO 225 S	TYPE7	Power Converter : TYPE7 [±350A, ±450V]	>30 ans	2015
F16.QFO 375	TYPE5	Power Converter : TYPE5 [±350A, ±100V]	>30 ans	2015
F16.SNP 208	LPS1-SPE UPS	PC : LPS1-SPE [25A, 120V] with UPS	2000	2015
F16.UES 228	LPS1-SPE UPS	PC : LPS1-SPE [25A, 120V] with UPS	2000	2015
RB49 SPARE	RB49	CONVERTER : RB49 [600A, 700V]	2009	2020
SPARE 7/2	TYPE7	Power Converter : TYPE7 [±350A, ±450V]	>30 ans	2015
TYPE1.RES	TYPE1	Power Converter : TYPE1 [±350A, ±120V]	2005	2015

Budget selon Etude M.Royer (cf specification https://edms.cern.ch/file/856110/1/FuncSpecTT2_July_06_2007.pdf) avec convertisseurs Thyristors = 3 MCHF (2007) ==> mis à jour 3.3MCHF en 2010

Hypothèse de consolidation avec convertisseurs 4Q à découpage: +25% = 4150000 CHF

Rem: cette consolidation inclue un upgrade complet des Electroniques de type PS (MIL1553) au profit d'une Electronique de type FGCxx (WorldFip)

PS - RF

- Issues
- RF Bypasses
- Tuning supply upgrade underway.
- C10 Control electronics upgrade underway.
- New 1-turn feedback in pipeline.(~250 kCHF)
- Tomoscope upgrade underway.

PS - RF

- C10 upgrade with new drivers

  Tube YL1056 to be discontinued

  Study ~300 kCHF

  11 New drivers ~2.2 MCHF

  Preferable to upgrade the whole systems which would be more expensive.

PS - RF

- **Gap relays for C10 and C20:**
  Continue to search for alternatives.
- **C10 ferrite cooling plates to be replaced.**
- **C201 and C206 to be modernized ~200kCHF**
  like the other 4.
- **Redesign of RF bypasses, estimated cost for new bypasses: 30 kCHF**
- **Vacuum chamber flange clamps must be improved.**

PS - RF

- **Modernisation/generalisation of coupled-bunch feedback (should also include quadrupolar modes, e.g.), ~150 kCHF without a dedicated kicker**
- **To be studied: Do we need an additional wide-band longitudinal kicker? (Like LEIR system, if required: ~1.5 MCHF)**
- **Transverse FB to be made operational for MTE (2011, ~50 kCHF)**

PS - RF

- Transverse FB power upgrade will be required around 2023:~210 kCHF.
- C40 and C80: complete automatic tuning system for all 5 cavities. (Butterworth)
- Major re-cabling to be foreseen ~1 MCHF

PS – Septa

- **Design a new thinner Septum 16 for cleaner MTE extraction.**
- **Maintain existing Septa configurations.**
- **Maintain the spare septa.**
- **Phase out Septum 31 as MTE becomes operational.**

PS - Kickers

- **BFA 9-21.**
  Refurbish 21 as a spare for 9.
  Refurbish entrance boxes & TMR's.
  Change HV cables.
- **DFA 242-254.**
  Add 2 spare HV cables.
- **KFA4.**
  Change transformer insulating fluid.
- **KFA13-21**
  No comments.
- **KFA 28.**
  Change HV cables, build new HV switch.

PS - Kickers

- **KFA45.**
  Build one new spare module
  Refurbish 4 new TMR,s
  Refurbish HV switches and PFL gaskets

  KFA71.
  Refurbish tank and HV switches

  KFA79,
  Build 2 spare modules. Refurbish tank, TMR's and HV switches
  Change HV 30 ohm cables

PS - Kickers

- **Thyratrons**
  - **Buy and store sufficient for the next 25 years.**
  - **Single source supplier - could disappear.**

PS - Beam Instrumentation

• TMS	Modernize acquisition	300 kCHF
• BCTDC	Monitor modifications plus new electronics	50 kCHF
• 1000 turn	Cabling plus new ATFA48	220 kCHF
• BCTFR	Cabling BTMTRA, ISO Transformer plus Acquisition Chain	160 kCHF
• WCM	2 WCM's and one fast scope	200 kCHF
PU's	TFB and sensitive PU electronics	60 kCHF

Total Approximately 990 kCHF
Man power 220MM.

BI_Lars_Soby_PS+25years.xlsx

PS - Dumps and Collimators

- **Internal Beam Dumps**
  2 new spares are in consolidation.

- **Beam Stoppers**
  Standard maintenance
  Replacement of components
  Spare situation ok.

- **Will the existing hardware sustain the eventual increased intensity from Linac4?**

- Oliver_Aberle_Copy_of_Liste_des_equipements+TCD+25years.XLS
- Oliver_Aberle_Dumps_stoppers_slits+25years.doc

PS - Beam Interlocks

- **Beam Interlocks as yet do not exist in the PS complex.**
- **Foreseen to deploy BIS in Linac transfer lines to the Booster and Isolde in the framework of Linac4 installation.**
- **For the PS ring, BIS is actively under consideration, possibly to be deployed together with the new access system.**

  Budget and resources not known to date.

PS - Warm Magnet Interlocks (WIC)

- **PS Interlocks have never been renovated.**

  The spare situation is poor.

  The WIC environment could be implemented in the PS in a straight forward manner for an estimated 250 kCHF.
- **It is urgent that PS magnet interlock responsibilities are transferred to TE/MPE a.s.a.p.**

PS – Tunnel Ventilation.

- Can the PS continue to run with the tunnel over atmospheric pressure?
- Assuming no change.

  Replacement of the PS ventilation systems.

  With all the problems and cost that go with Asbestos.

  These systems are original and the pipes are in poor condition. Their replacement is essential!

  Long lead in time. Requires a firm planning and fixed execution date.

  PS could be done over 3 shutdowns of 3-4 months or all 8 stations in approximately 1/2 year.

PS – Magnet Cooling

- **For the 2 cooling stations of the PS main magnets and Central building for Auxiliary magnets:**

  Replacement of the cooling towers, the valves, the control and electrical part and possibly replace several heat exchanger .

- **Change the reverse osmosis station for the production of demineralized water.**

PS – Personnel Protection System (PS-PPS)

- **The PPS project for the PS has started.**

  First installation scheduled for 20011/12 shutdown.

- Pierre_Ninin_PS_Personnel_Protection_System_+25years.doc

1. SU Work Needed in the PS Complex for the Next 25 Years

• PS-Ring: measure and align every 10 y = 2* 50kCHF	100kCHF
• PSB:measure and align every 10years + new network = 2*25kCHF +6kCHF	56kCHF
• Transfer lines LT, LTB, BI: check each line every 10y = 2*20kCHF	40kCHF
• Transfer lines BT, BTM, BTP, BTY: check each line every 10y = 2*30kCHF	60kCHF
• Transfer line FT16: check every 10y = 2*36kCHF	72kCHF
• FTA: check every 10y = 2*12.5kCHF	25kCHF
• Ion injector chain: check every 10y = 2*12.5kCHF	25kCHF
• F61, FTN: check each line every 5 y = 4*12kCHF	60kCHF
• AD: global check every 10y = 2*25kCHF	50kCHF
• Databases: introduction of GEODE data in LAYOUT and synchronisation	75kCHF
• Annual maintenance of all lines: 25*25kCHF	625kCHF
• TOTAL	1188 kCHF

PS – Cables

- **A new campaign is required to clean out old unused cables of which there are many in the PS.**
- **Cable trays are overloaded and it is often difficult to find space. A study and cost estimate is required.**

  It is a difficult and time consuming exercise and could be done during every shutdown in small steps.

PS - Cables

- **The operational cables which are most at risk are those directly connected to equipment just meters from the beam line. Many of these may well need changing at least once in the next 25 years.**

  Cables in the cable tunnels away from the radiation do not degrade, even cables installed on the walls just 3m from the beam line show negligible signs of radiation damage.
- **Many old cables subjected to UV and weather on the cable trays outside are damaged and need to be replaced. A study and cost estimate is required.**

PS - Cabling

- **In building 355 the old auxiliary magnet cabling needs to be removed including the isolation drawers.**

  This was done in building 365 in 2008/9 with new cabling right up to the magnets which should be good for the next 25 years.

PS – Power Distribution

- **Low Voltage 400/240V.**

  Including: switchboards, racks, canalis, UPS, safety lighting, old equipment removal, cabling of new equipment, on site work tooling and controls = 14MCHF.
- **High Voltage 18kV.**

  Renovation of 3 substations (ME16, ME49 and M76) + Isolde loop splitting: 1,3 MCHF
- **Power Transformers**
- **Changing 17 of 46 transformers: 0,8 MCHF.**
- Electrical+25years+Francois_Duval.doc
- EL_+25years_Francois_Duval.xlsx

PS - Maintainability

- **Radiation is the largest threat to reliability and maintainability.**

  MTE must work.

  Every effort to reduce losses must be encouraged.

  Any changes which will result in increased losses must be discouraged.
- **Vacuum flange clamping must be improved to reduce intervention time. Hard earned experience on 5 septa exchanges in 2009/10.**

PS - Radiation Protection Matters

- **The ventilation system must be renovated to modern standards (dynamic depression of tunnel, air extraction at defined points)**
- **All shielding must be reviewed (Route Goward passage needs shielding)**
- **The use of the PS centre-of ring must be determined (likely no office space)**
- **A state-of-the art BLM system would help to detect (and then reduce) beam loss**
- **All interventions in the PS for repair and upgrade will have a significant “cost” in personal dose**

Vacuum

- A report is in preparation for the injector chain
- First “estimate”
  - Operation to 2022 replace 50-70% of system hardware
  - Operation to 2035 replace 100%
- SPS
  - Spares (windows in target areas?)
  - TIDVG upgrade
  - MKE?
- Any major consolidation campaign (ABT, MSC, RF etc…) would involve a lot of vacuum activity


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