Antiproton Decelerator (AD)
&
Low Energy Ion Ring (LEIR)

Consolidation

AD consolidation

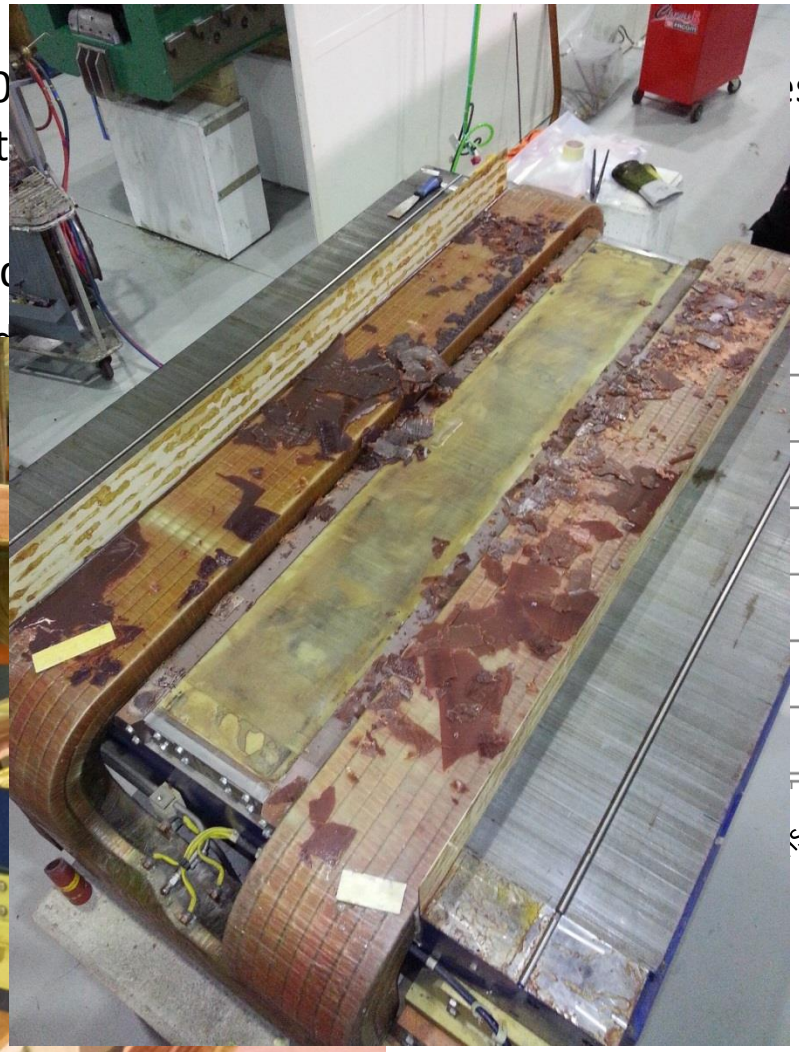
- Most of AD dates from ~1985 => Main components are 30 years old….
- Due to other important CERN programs, only urgent issues were addressed for the first ~10 years of AD operation
- For many years AD was always below the budget cut-off line since it's not part of the LHC program
- A small consolidation program (~2.3 MCHF), separated from the LHC program, started in 2009 in view of running AD until 2016 or so
- After approval of the ELENA project, the scope of the consolidation increased and is aimed at continued operation of AD for at least 10-15 years after ELENA physics has started which means 2030 - 2035
- Concerned items are: Target area, magnets, power converters, beam cooling, control system, Instrumentation, beam transfer equipment, RF, vacuum, Infrastructure etc.
- AD is at the moment in the middle of a major consolidation program with a budget plan of 23.8 MCHF allocated by RPC for the period 2014 – 2020

Consolidation items colour coding

- **Activities approved and needed to operate effectively the machine**
- **Activities not approved and needed to operate the machine effectively**
- **Activities approved or not but not urgent to operate the machine effectively**

Magnets, ring and transfer lines

- **Main bendings** (24):
  - Renovation and re-shimming: DR.BHN0 … ssive coil movement. Regular coil movement … determine which one(s) next.
  - Ongoing activity with 600 kCHF planned …
  - Procurement of spare coils for BHN and …



Magnets, ring and transfer lines

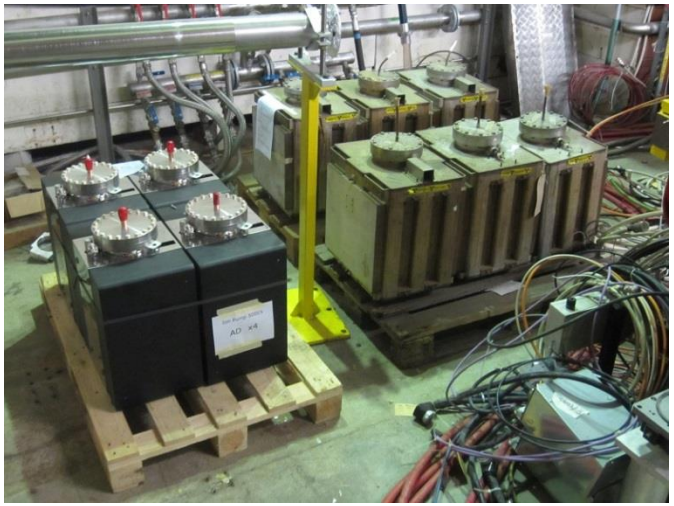
- **Target area magnets:**
  - Quadrupoles upstream of target (9050 & 9052). Area is very hot.1 spare exists but lack of knowledge about state, manipulation & connections. Alternative designs are being considered.
  - Spare Quad 6030/6040
  - 450 kCHF requested for 2015 – 2017
  - RS = 15
  - Remaining Bendings and quads: renovation of spare units, plan to be worked out
- **Spare magnet PXMCCBAWCC** (DI. D
  - 50 kCHF requested for 2015
  - RS = 9
- Ring Quadrupoles: no specific plan, re-shir
- Spare inventory almost complete
- All ejection line magnets will be replaced b

Power converters

- General consolidation program for 2015 – 2020 requested for a total of 2.2 MCHF:
- Replacement of **orbit corrector units** with standard Cancun supplies in 2015
- **2/4 kV pulsed injection line converters** to be replaced by new Megadiscap in 2016 – 2018
- Replacement of **thyristor converters** by commercial units in LS2

Vacuum system

- **General consolidation of complete vacuum system**. 2.2 MCF 2013 – 2018
  - Completed: Control system renewal, Cryo system, Sublimation pump filament renewal, 6000-line primary pumps, Turbo-pump groups , Previdage valves, Penning/Pirani gauges.
  - Ongoing: Bakeout equipment renewal, Ion pump feedthrough heaters, Ion pumps (1 sector/year), BASE integration.
  - To be started in 2015: Spare vacuum chambers, Standardisation of straight sections, Ion gauges renewal, Fast valve electronics renewal, Spare Cryo compressors, Gas injection system.
  - >2015: RGA PVSS integration, ELENA integration
- In total ~ 25% of complete program is done.

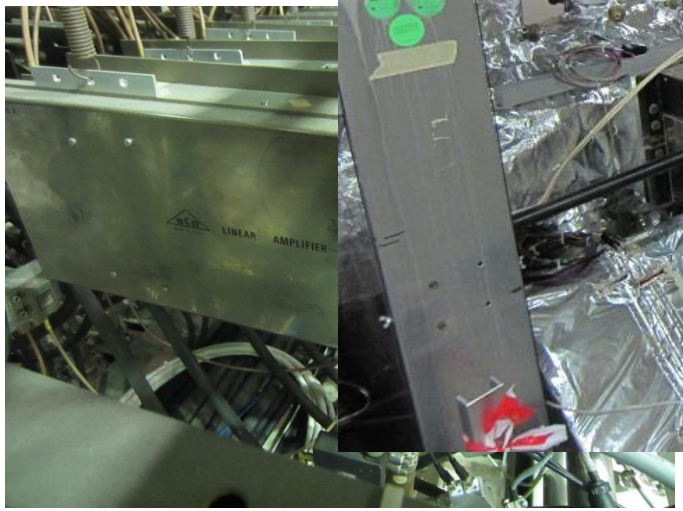


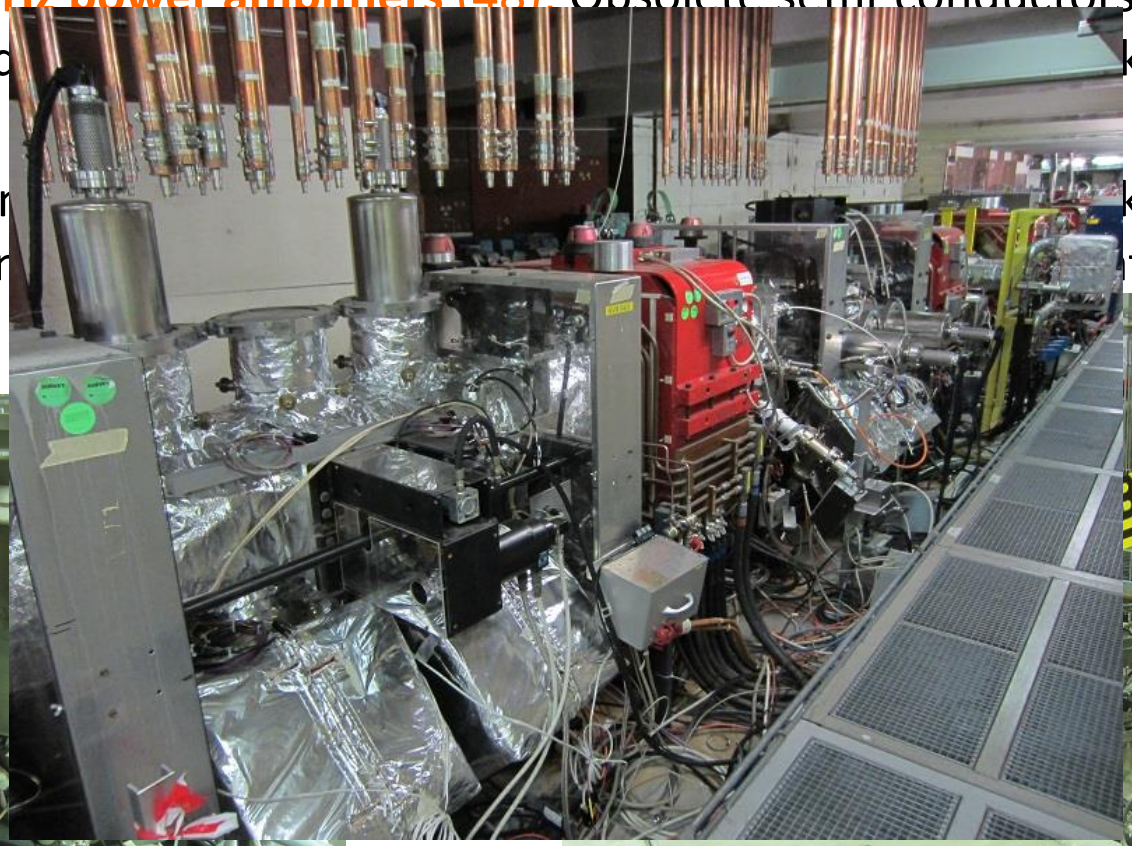
Beam transfer

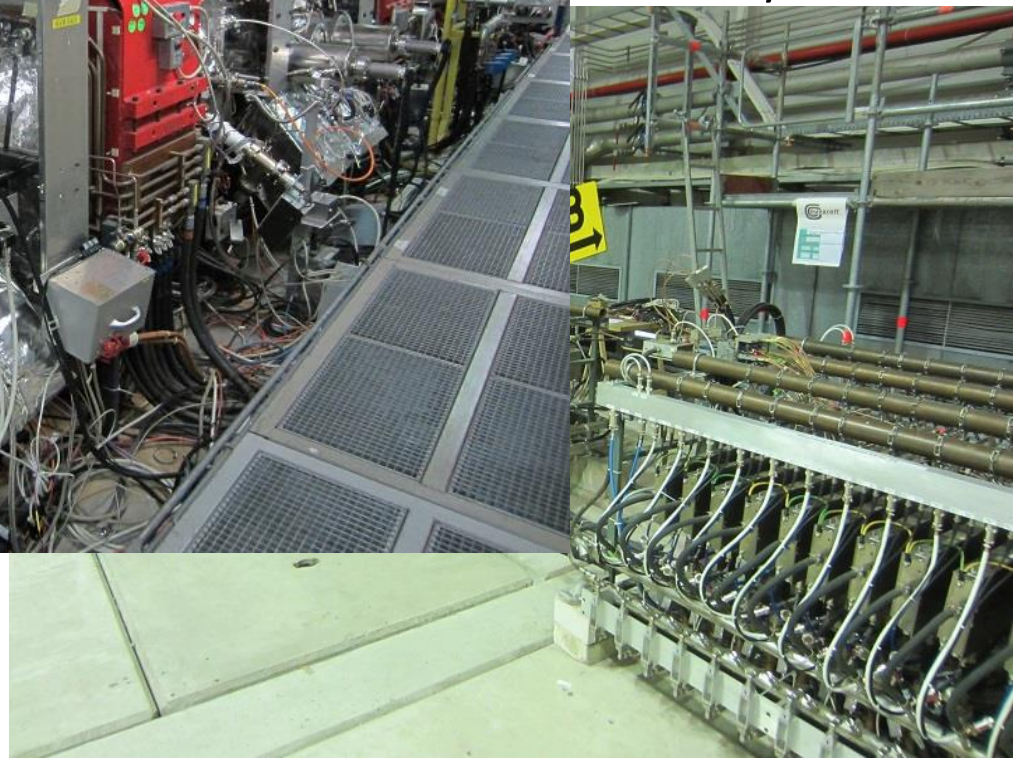
- **Kicker dump/main switch** consolidation. 75 kCHF in 2014/15
- **Kicker electronic/controls** renewal. (Re-location of Pulse generators to B393) 145 kCHF in 2014/15. RS=6
- **Septa electronics/controls** renewal. 95 kCHF in 2014/15. RS=6.
- **Magnetic Horn HV power supply.** Replace with modern unit. 145 kCHF in 2014/5. RS=9
- **Horn ignitron mercury switch** phase-out. 250 kCHF in 2014 – 2016. RS=9. Manpower situation needs clarification
- **Horn test bench**. Re-located from B174 to B195. 250 kCHF requested for 2016/17. RS=6

Stochastic cooling

- **Notch filters**: Replacement of large cable-box with optical filter system. Increased stability and simplicity. 35 kCHF in 2014/15
- **0.8 – 1.6 GHz power amplifiers** (48): Obsolete semi-conductors, increased failure rate. New d kCHF in 2015/16. RS=10
- Vacuum tar kup and kicker vacuum tar tion not yet adressed.







Electron cooling consolidation

- **Renewal of electron cooler**:
  - Build a new state-of-the-art cooler ~ 2.5 MCHF 2015 – 2019. Aim for installation in LS2.
  - Including adiabatic expansion, variable density electron beam and electrostatic deflector plates for efficient collection of the electron beam
  - Existing cooler:
    - Is >30 years old
    - We have no spare magnets; very long down time if failure, significant cost for new spares
    - Performance issues
    - e- bpm:s not operational
    - RS = 10

Momentum pbar	300 MeV/c	100 MeV/c
		
dp/p	10^{-4}	$< 7 \times 10^{-5}$

RF

- **C02 Low-Level:** Migration to PSB/ELENA-like DSP based system (including Schottky analysis). 150kCHF 2016 – 2018.

- **C10 Low-Level & High-Level renewal**: C10 final stage (obsolete TH116 valves, very small chance of finding more spares): Spares enough for another ~5 years of operation. With only 1 of 2 systems, AD will have 70% of nominal intensity. New power amplifier/control/interlock systems to be developed: 4MCHF 2016-2018.

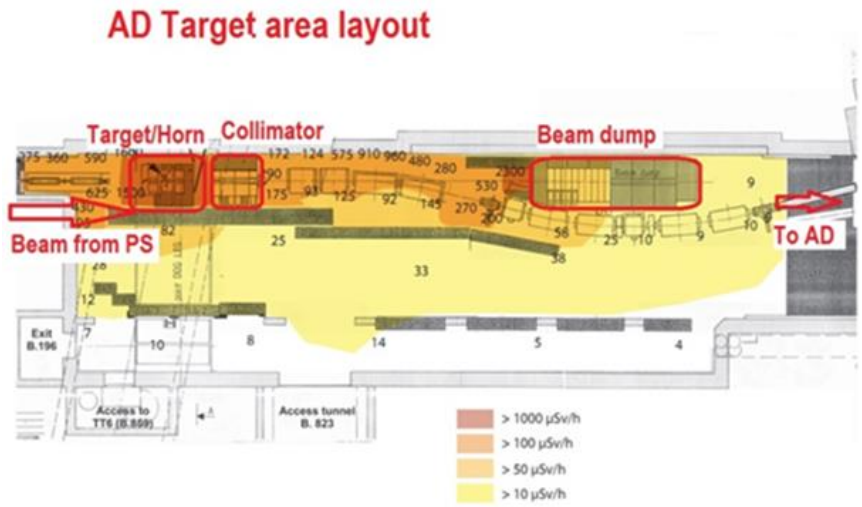
Instrumentation

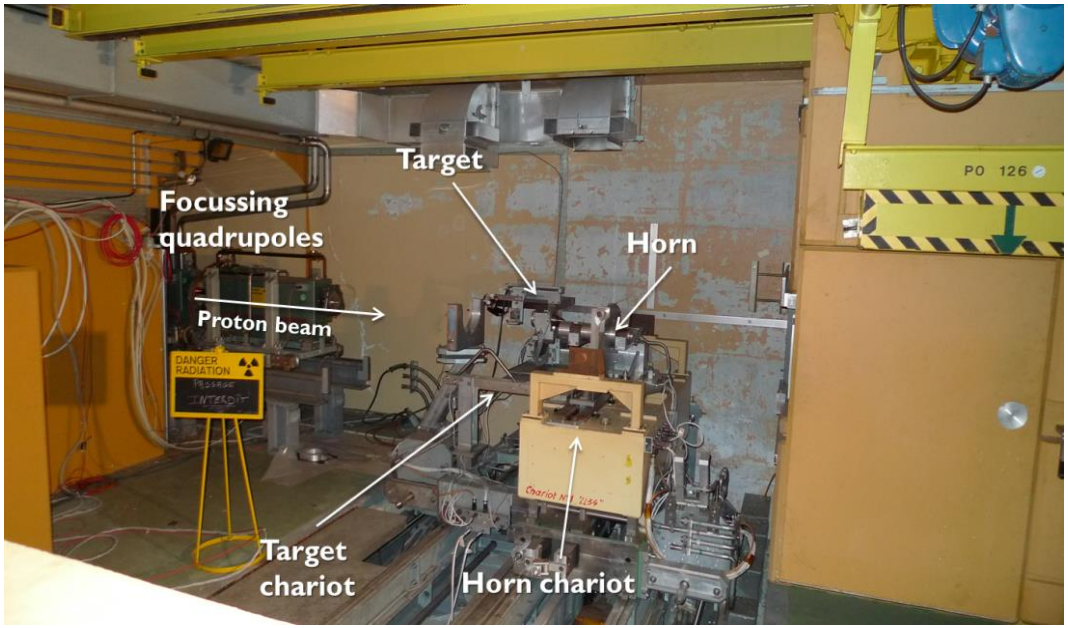
- **Schottky analysis** (longitudinal): integrate ageing DSP equipment into new C02 LL beam control system + new system for visual monitoring => BE/RF
- **Orbit system**: solution with individual ADC:s in 2015 based on ELENA system to replace outdated network analyzer and single read-out channel. Will permit measurements during ramps. 250 kCHF 2014 – 2016. RS = 6
- **BCT** (4 units) renewal: Similar toTT2/PS. 200 kCHF in 2015
- **BBQ-tune measurement**: Using existing pickup, ready to be commissioned
- **CCC** (Cryogenic Current Comparator): Intensity measurements of low-intensity beams. To be used in ELENA as well. 250kCHF 2014 – 2016
- **BCT/BPM in Target area**: Improved efficiency monitoring. 120kCHF in 2014&2017

Target Area – from M.Calviani EN/STI

- The AD-target zone production and focusing elements and the associated infrastructure requires a **major consolidation program**
- During LS1, an initial and limited consolidation program has started, treating the most urgent items
- Significant **impact on AD physics** in case of failure between LS2 and LS3
  - Know weak points (target, horn, magnets…)
  - Very long physics stops (**≥ year**)
- Increase **contamination levels and associated radiological risks**
- Further degradation of equipment due to water penetration
- Horn assembly failure discovered in LS1 is an indication that urgent consolidation is needed for the whole area

Target Area


AD Target area layout
Target/Horn
Collimator
Beam dump
Beam from PS
To AD
Exit B.196
Access to TT6 (B.859)
Access tunnel B. 823
> 1000 µSv/h
> 100 µSv/h
> 50 µSv/h
> 10 µSv/h


Target
Focussing quadrupoles
Horn
Proton beam
Target chariot
Horn chariot
DANGER RADIATION

Target Area budget

- Budget specification for **AD-target consolidation** 2014-2019 produced
  - EDMS #1312698
- **~5.5 MCHF** total budget requested scattered between the various WP (EN/STI, EN/CV, EN/HL, EN/HE, TE/ABT, TE/MSC, BE/BI and DGS/RP)
- Budget soon to be approved
- Activities need to start ASAP to be ready for LS2 installation

Target Area equipment consolidation

- **Production of antiproton target designs & spares**
  - Only 1 spare target available. RS = 15
- **Magnetic horn spares and new stripline/junction box**
  - Critical for operation – only very radioactive spare horn available. RS = 15
- **Consolidation of target and horn chariots**
  - Very old equipment, monitoring being lost year by year. RS = 6
- **Consolidation of radiation protection detectors**
  - Air monitoring + PMI/IG5. RS = 4
- **Review of target area magnets**
  - Upper quads critical for operation! RS = 15
- **Consolidation of transport methods**
  - Moving heavy and radioactive equipment. RS = 6
- **Consolidation of beam instrumentation**
  - BCT + BPM

Target Area infrastructure consolidation

- **Ventilation and cooling system replacement**
  - Safety improvement, integration into new access system. RS = 9
- **Target area decontamination**
  - RS = 3
- **Refurbishment of surface buildings and tunnel**
  - RS = 4
- **Consolidation of electrical infrastructure**
  - RS = 6

Infrastructure

- **B193/B195 cooling/ventilation:**
  - 5.9MCHF requested for 2019 major upgrades/renovation of the cooling plant, air conditioning units and extraction units. RS = 9
- **B193 cranes:**
  - 0.75 MCHF requested for LS2
- **Cryo-distribution/recovery line for AD experiments:**
  - Avoid movement of dewars inside AD hall. Intermediate storage outside B193. 0.80 MCHF in 2015/16

Controls/software

- Completed during LS1 and commissioned:
- Renovation of timing & cycle generation: re-design for de-coupled AD/injector complex & ELENA functionality
- Front-end upgrade (ACCOR): complete (80-90%) renewal
- GM => FESA, Java migration, InCA: majority has been completed

- => No major consolidation needs !

LEIR consolidation

- LEIR is based on LEAR which was built ~1983
- It is now 10 years since it was transformed into a heavy Ion accumulator
- No general consolidation program has been worked out
- Today we have only a few consolidation requests

LEIR consolidation, Magnets

- **Main bending magnet spare coils:** Production underway in Sigmaphi (FR) where the prototype coils is currently being validated. 190 kCHF
- **Main quadrupoles spare coils:** are produced and currently under geometrical inspection at Danfysik (DK). 110 kCHF including spare magnet
- **Ring Extraction bumper & corrector magnet:** Spare magnet & coil sets. Priority 2
- **Bending magnets for LEIR transfer lines:** Spare magnet & coil sets. Priority 3

LEIR consolidation, Power converters

- **Transfer line DANFYSIK converters:** ~20 units. Reliability issues. Study needed since not compatible with standard EPC units. ~600kCHF.
- **ER.SMH11 renewal:** Old non-standard unit also with some reliability issues. To be replaced with commercial unit. ~ 100kCHF + installation.
- **Compatibility with 100ms/10Hz operation:** Needs study.

LEIR consolidation, Instrumentation

- **Schottky system:** is based on Agilent Spectrum analyzers. This system does not allow practical remote operation from terminals in CCC and the windows operating system of these Agilent network analyzers is no longer supported from CERN IT. The idea is to update the system with an in-house development.
- **Orbit measurement system:** Uses old front-end electronics and acquisition cards. Can be upgraded to use hardware developed for ELENA. 250 kCHF in 2017/18. RS = 8

LEIR consolidation, other items

- **Low-Level RF:** Upgrade to the same hardware and software as deployed/commissioned in the PSB this year. This will happen before the end of 2015, depending on manpower available in the RF group. The end 2015 is a hard deadline for the upgrade as the CO group will not support anymore some parts of the system. Also, as from this year, for yet unknown reasons (CO changes or hardware that is getting old?) we start have crashes in the real time part of some FESA classes for the LEIR LLRF.

- **Spare collector/gun for electron cooler:** No spare collector, only 1 spare gun. Vacuum leak would compromise LHC Ion run. 150kCHF in 2014. RS = 10