ELENA

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AD consolidation

- A limited consolidation program was launched in 2009 in view of continued AD operation until 2016/17
- Out of some 40 items needing attention, 1/3 was prioritized with a total budget of 2.3 MCHF
  - E-cooler power supplies, HV equipment and controls interface – done
  - Magnetic horn pulser and controls – done
  - Ejection line bpm:s – in progress
  - Ring/transfer line magnets – in progress
  - Ring/transfer line power converters – in progress
  - Vacuum system – in progress
  - RF (C02/C10) – in progress
  - Stochastic cooling – to be started
  - Kickers – to be started
  - Target area – to be started
- With the ELENA approval a new consolidation program is being worked out assuming AD /ELENA will run at least 10 - 15 more years

AD consolidation

- For running until >2026:
  - Expand 2009 program =>
  - ~ 40 items such as:
    - Target area; water cooling, ventilation, interlocks, manipulation devices,
    - Stochastic cooling; parameter control, u-wave amplifiers/power supplies, controls, movement system, vacuum tank spares etc.
    - Electron cooling
    - RF
    - Infrastructure
    - etc.
  - Consolidation campaign started in 2010 for the experimental hall: safety, user facilities etc.

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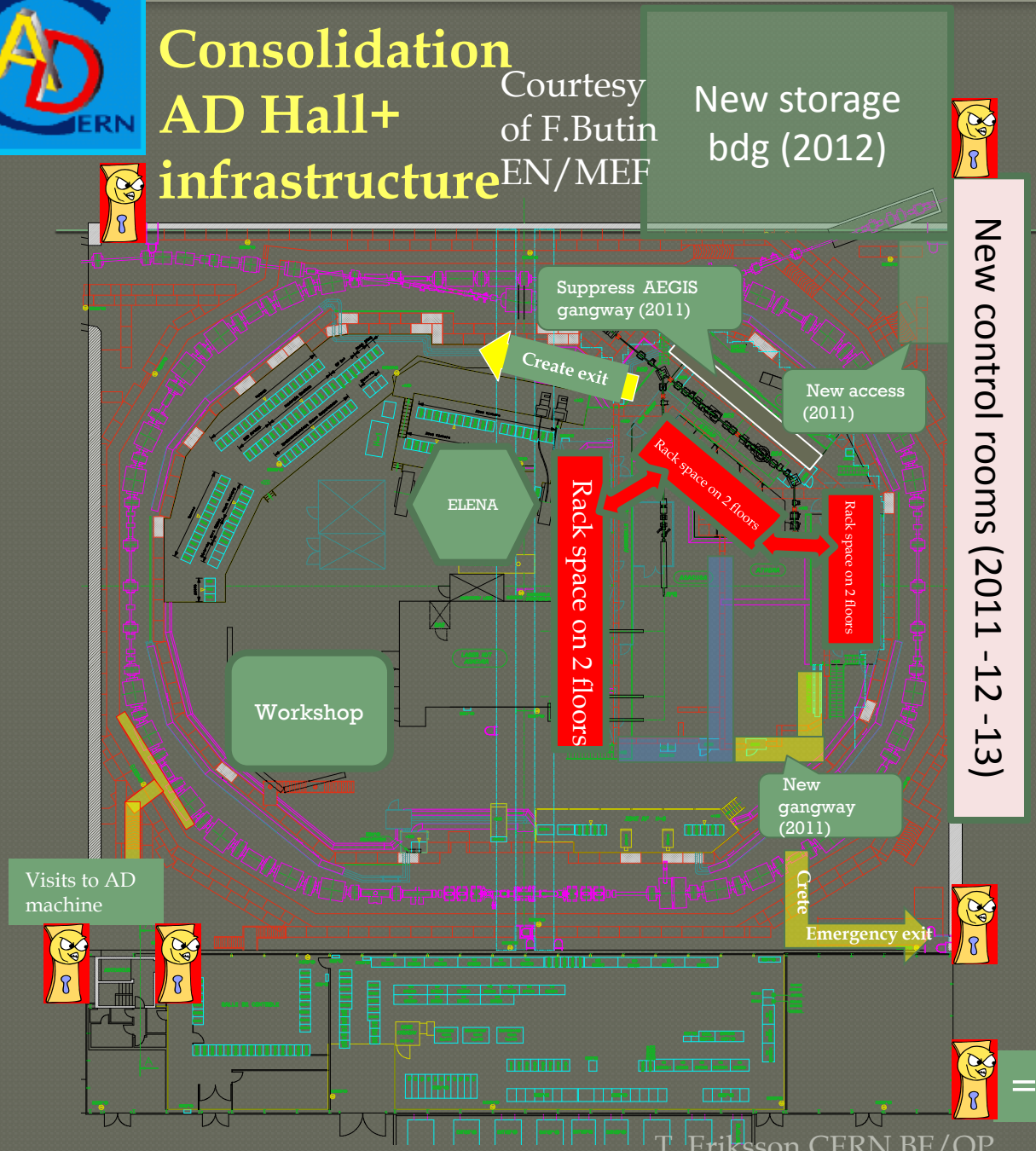
AD Main bending magnets	AT-MCS	15	6
AD power converter spares	AB-PO	15	3
AD MWPC:s	AB-BI	15	2
AD ring quadrupole QFC54	AT-MCS	10	6
AD inj. line pulsed power converters	AB-PO	10	3
AD e-cooling magnet spares	AB-BI	10	6
AD target area spare magnets	AT-MCS	10	4
AD vacuum ion pumps	AT-VAC	9	6
AD kicker vacuum tanks	AB-BT	9	2
AD Stoch.cooling p/u&kicker movement	AB-RF	9	2
AD horn pulser ignitrons	AB-BT	9	3
AD vacuum cryo system	AT-VAC	8	4
AD ring Q-trim power converters	AB-PO	8	3
AD C02 system	AB-RF	8	3
AD kicker oil system	AB-BT	8	3
AD horn pulser electronics	AB-BT	8	3
AD vac.ion pump power supplies&ctrls	AT-VAC	8	2
AD target area ventilation & interlocks	AB-OP	8	3
AD Stochastic cooling electronics	AB-RF	6..9	2
AD ring corrector dipoles	AT-MCS	6	4
AD magnet ancillary equipment	AT-MCS	6	2
AD electron cooler power converters	AB-PO/BI	6	3
AD cooling/ventilation	TS-CV	6	3
AD target water cooling	AB-OP	6	4
AD ejection line power converters	AB-PO	4	2
AD Stochastic cooling power amplifiers	AB-RF	4	2
AD C10 system	AB-RF	4	2
AD kicker power supply/ctrls upgrade	AB-BT	4	2
AD orbit measurement system	AB-BI	3	1
AD beam current transformers	AB-BI	3	1
AD Instrumentation SW + FSU	AB-BI	3	1
AD main quadrupole magnets	AT-MCS	3..4	N.A.
AD injection&ejection septa	AB-BT	3	N.A.
AD Stochastic cooling vacuum tanks	AB-RF	5	N.A.
Items without risk score rating:			
AD controls	AB-CO	N.A	N.A
AD septa controls	AB-BT	N.A.	N.A.
AD beam control	AB-RF	N.A.	N.A.
AD target area remote manipulation	AB-ATB	N.A.	N.A.
AD schottky analysis	AB-RF/BI	N.A.	N.A.

Consolidation AD Hall+ infrastructure

Courtesy of F.Butin EN/MEF



Infrastructure consolidation:

- Access control upgade
- RP shields upgrade
- New gangways for circulation and evacuation improvement
- New control rooms for ALARA respect and racks/ storage space increase
- Cranes upgrade for more efficient and safer handling
- Cryogens distribution audit
- Ventilation system audit
- Review needs for smoke/ODH detection
- Provide long term (bdg 133) and short term (new building) storage facilities
- New cafeteria/ toilets / meeting room / parking
- New visit itineraries and procedures

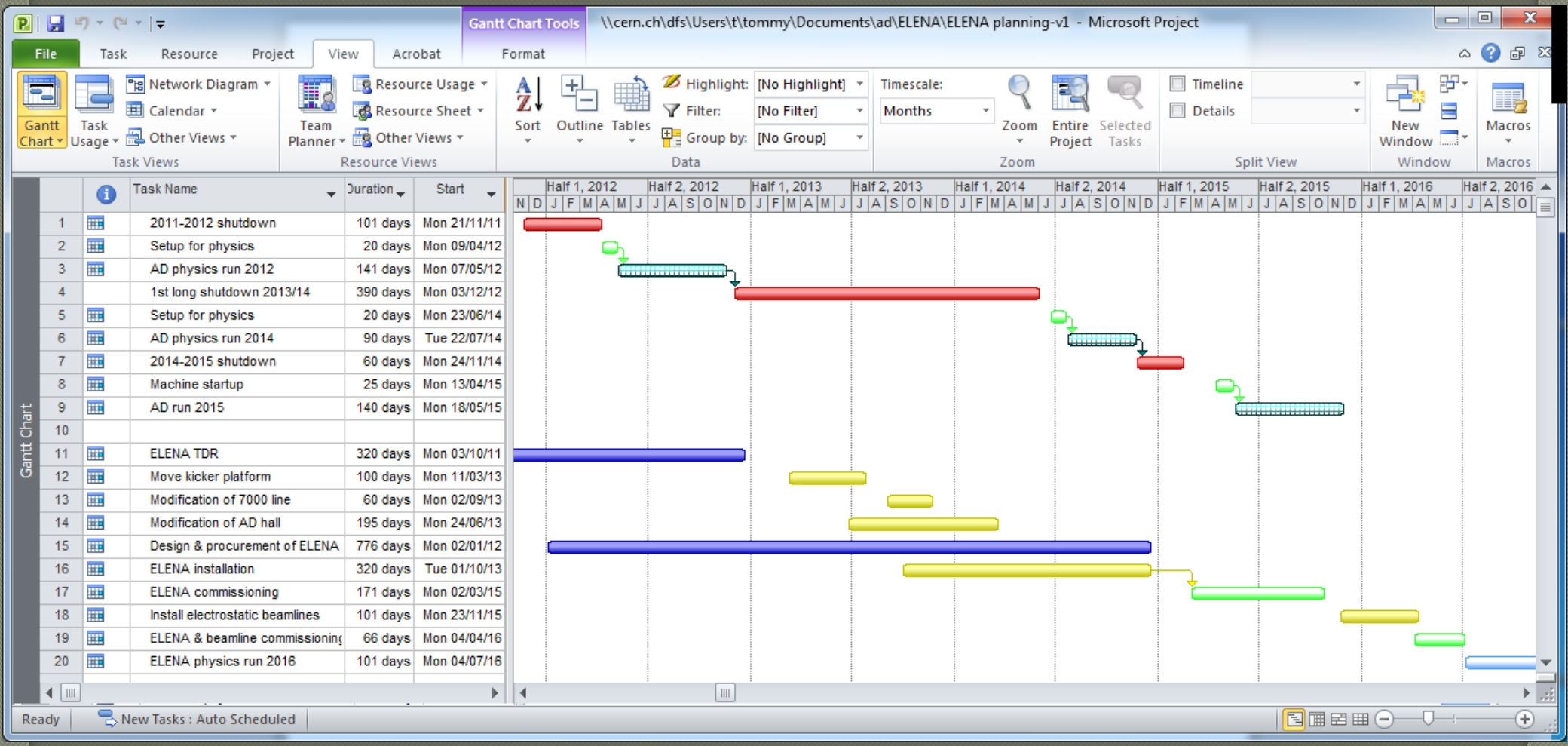
=new access control (5)

ELENA planning

- Planning stretched in order to minimize impact on physics program
  1. Design, fabrication, installation of ELENA whilst using the existing ejection lines for physics @ 5.3 MeV => ~ 3 years
  2. Commissioning of ELENA in parallel with physics => ~ 6 months
  3. Installation and commissioning of new 100 keV ejection lines (physics stopped) => 0.5 to 1 year

  =>Total duration 4 to 4.5 yrs

Initial planning



CERN/LHC run planning (provisional)

2013	LS1 - SPLICE CONSOLI DATION											
2014									RECOM	RECOM	1	2
2015	1	2	3	4	5	6	7	8	9	10	IONS	
2016		1	2	3	4	5	6	7	8	9	IONS	
2017		1	2	3	4	5	6	7	8	9	IONS	
2018	LS2											
2019		1	2	3	4	5	6	7	8	9	IONS	
2020		1	2	3	4	5	6	7	8	9	IONS	
2021		1	2	3	4	5	6	7	8	9	IONS	
2022	HL-LHC upgrade											

Tech. stop or shutdown
Proton physics
Ion Physics
Recommissioning

=> Affects LHC injectors and AD !

Operation

- ELENA ring can be commissioned while 5.3meV physics program is running
- 100keV transfer lines to be set-up once ELENA is running satisfactory.
- Some reinforcement to the op-team is needed – request has been made.
- External help is also welcome !

ELENA systems (not covered elsewhere)

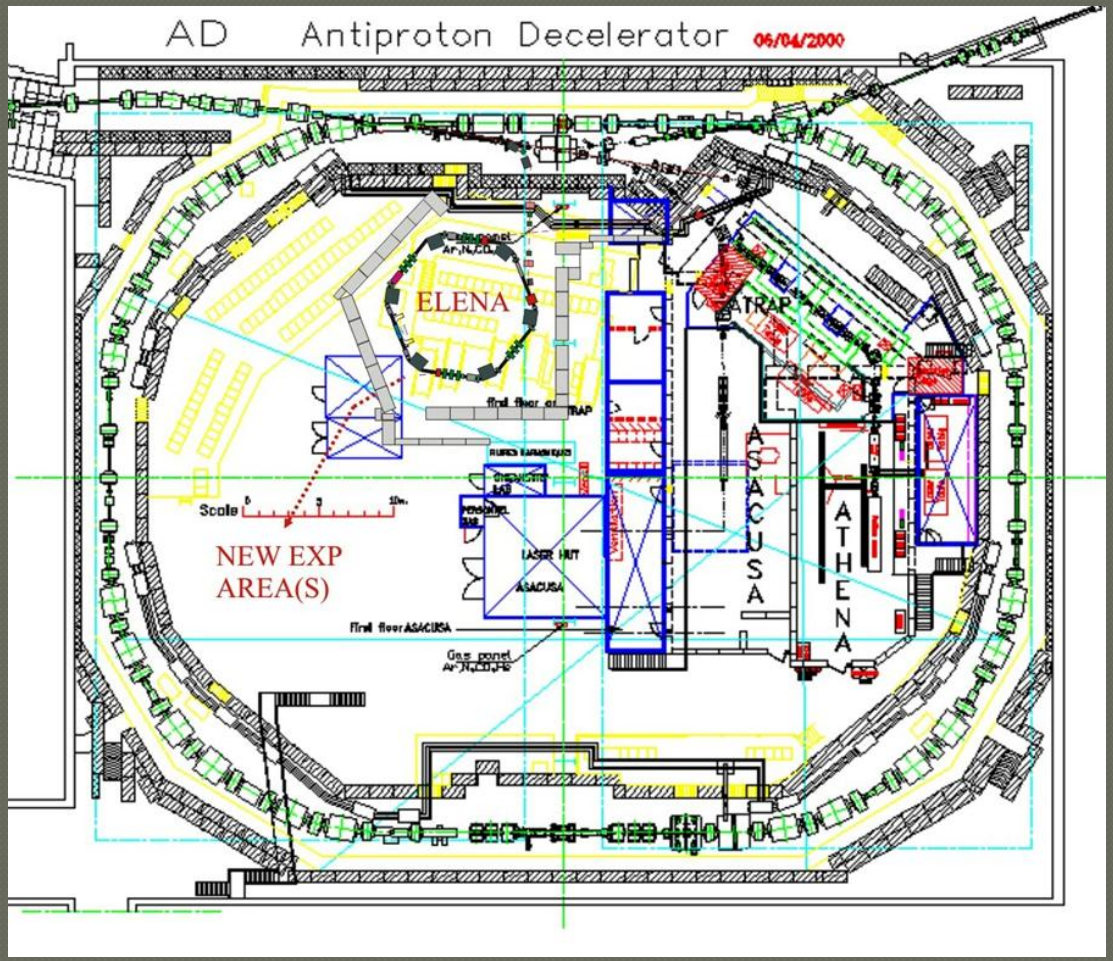
- Infrastructure
- Electron cooler
- Instrumentation
- B-train
- Controls
- Ejection lines
- H-/p source

2010 ELENA cost estimate

- Initial expectations: 50/50 CERN/external

Item	Material (kCHF)	Manpower FSU or charged (kCHF)	CERN Manpower FTE (MY)	Needed manpower contribution FTE (MY)
Magnets (ring+inj. line)	1590(*)	135	2.5	2.8
Power converters	955		3.8	
Injection/ejection septa	75		0.3	0.7
Injection/ejection kickers	1706		6.3	2.8
Electron cooler	1300		5.0	1.0
Vacuum, ring+inj.line	1475	50	3.0	2.0
RF + Schottky diagnostics	303	30	3.8	0.4
B-trains	80		0.7	
Diagnostics	655	85	1.2	1.3
Controls	804		1.0	
H- source	400		0.5	
Experimental area:lines, vacuum, monitors	4235		6.3	6.5
Mech. Design/Drawings		347kCHF/4 MY (**)		13.0
Div.	290		5.0	2.0
Total (MCHF/MY)	13.868	.647	39.4	32.5
Grand Total (MCHF/MY)	14.515		71.9	

Infrastructure



- ELENA related:
- Electricity distribution
- Cooling/ventilation
- AD kicker PFN:s
- Equipment racks
- Storage AD equipment
- Storage/assembly for experiments

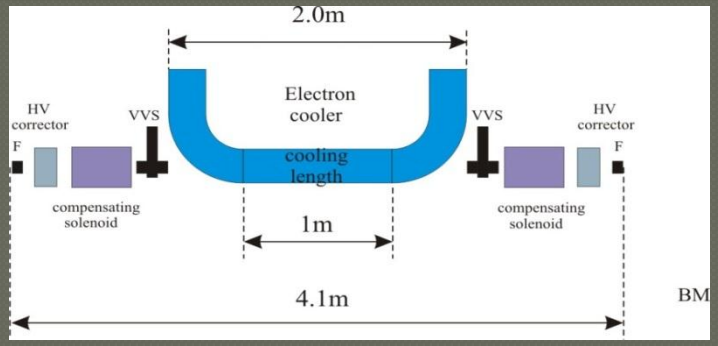
ELENA electron cooler

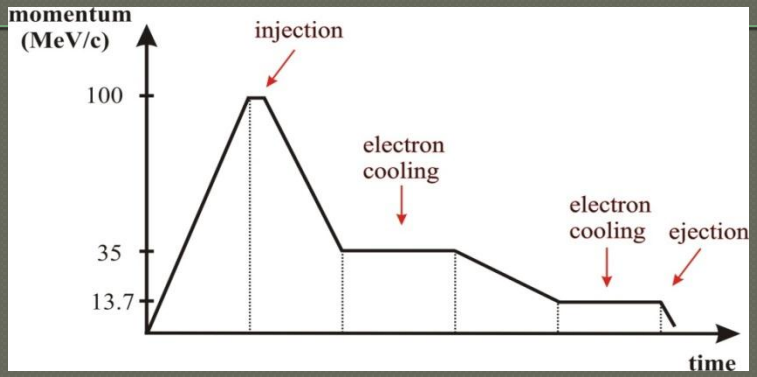
- Cooler, solenoid compensators, orbit correctors and valves will occupy one complete straight section
- Cooling at 35 and 13.7 MeV/c MeV/c for efficient deceleration (compensation for adiabatic blowup) and to ensure that the phase-space characteristics of the extracted antiproton beam fit the requirements of the experiments.
- Special attention must be paid to the design of the electron gun and the quality of the longitudinal magnetic field guiding the electrons from the gun to the collector => small transverse components ($B_{\perp}/B_{\parallel} < 10^{-4}$)
- Partly based on existing designs (ext. collaboration?)

The ELENA Electron Cooler

Momentum (MeV/c)	35	13.7
b	0.037	0.015
Electron energy (eV)	355	55
Electron current (mA)	15	2
Expected cooling time (mS)	150	20
Bgun (G)	400	
Bcooling section (G)	100	
Cathode radius (mm)	12.7	
Electron beam radius (mm)	25.4	

The ELENA Electron Cooler





Cycle length = 10-15 s

- Compact cooler for cooling at 35 MeV/c and 13.7 MeV/c
- Corresponding electron beam energies of 355 eV and 55 eV
- Conventional thermionic cathode ($n_e \approx 3x10^{12}$ cm^{-3})
- Effective cooling length ~ 0.8m
- 100 G magnetic field in toroids and main solenoid to reduce perturbations to the ring
- Placed flat for ease of maintenance (vertical orbit distortion)
- Challenges :
  - Generation of a cold low energy electron beam ($T_\perp < 0.1$ eV, $T_\parallel < 1$meV)
  - Electron beam energy stability
  - Reliable electron cooling diagnostics
  - Dynamic vacuum 10^{-12} torr
- External contribution possible: 1MY electronics technician (0.5 * 2yrs)

Instrumentation

- Ring pickups
  - 8 combined H+V units
  - Based on existing AD design:
    - Diagonally cut electrodes (redesign?)
    - Existing head amplifier design
  - Network analyzer used @ 100Hz BW, 30ms per p/u
  - Theoretical resolution with 1E7 pbars: 0.1mm
  - External contribution possible (~1MY):
    - PU/electronics/head amplifier design and tests
    - Manufacturing and tests

Instrumentation

- Profile measurements:
  - Similar to existing AD system
  - 4 motorized scrapers
  - 2 scintillators/photo multipliers/HV supplies
  - Electronics in rack outside machine enclosure
- Tune measurements:
  - Dedicated kicker and DSP-based BTF
- Intensity/longitudinal Schottky:
  - Covered in RF/Schottky
  - BCT needed for calibration ? (ext. contribution?)

Instrumentation

- Electron cooler related:
  - Non-destructive H/V profile measurements:
    - Ionisation Profile Monitors (pressure bumps needed)
      - Mainly for startups/md:s
      - ~1mm resolution
  - Recombination detector at exit of 1:st bending downstream of e-cooler (proton test beams)

B-trains

- 2 systems needed: measured (mainly for commissioning) and synthetic
- ~Standard PS-complex design
- Flux coil in bending magnet

Controls

- Standardized CERN accelerator control system (FGC3, PLC, OASIS, timing DSC:s)
- Existing rack space near ELENA
- Cycle generation to be developed to present CERN standards (INCA, LSA)
  - AD cycle sw/hw will be upgraded at the same time

100 keV beamlines

- ~60m total length
- 4-layer shielding (fringe fields from AD and trap solenoids)
- electrostatic deflectors + lenses
- 28 u-wire profile monitors, Faraday cups, Cherenkov counters
- Vacuum ranging from 10E-9 to 10E-12
- External manpower contribution possible ~6FTE in total

H- source

- Being considered….no descision yet
- For setting-up independent of PS complex
- Injection at 100keV, acceleration (low energy operation to be established first ?)
- 2 possible locations:
  - In injection line (space?)
  - In new ejection line for reverse injection (no cooling)
- External contribution possible

Extra Low ENergy Antiproton ring (ELENA) for antiproton deceleration after the AD