How to ensure a bright future of the AD

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- Present and future projects:
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- Impact of ELENA installation
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AEGIS

- **Approved experiment: AD-6**
- Will share beamtime with the 3 existing main users ALPHA, ASACUSA and ATRAP.
- Physics goals:
  - Measurements of gravitational interaction matter-antimatter
  - Hbar spectroscopy
  - Etc.

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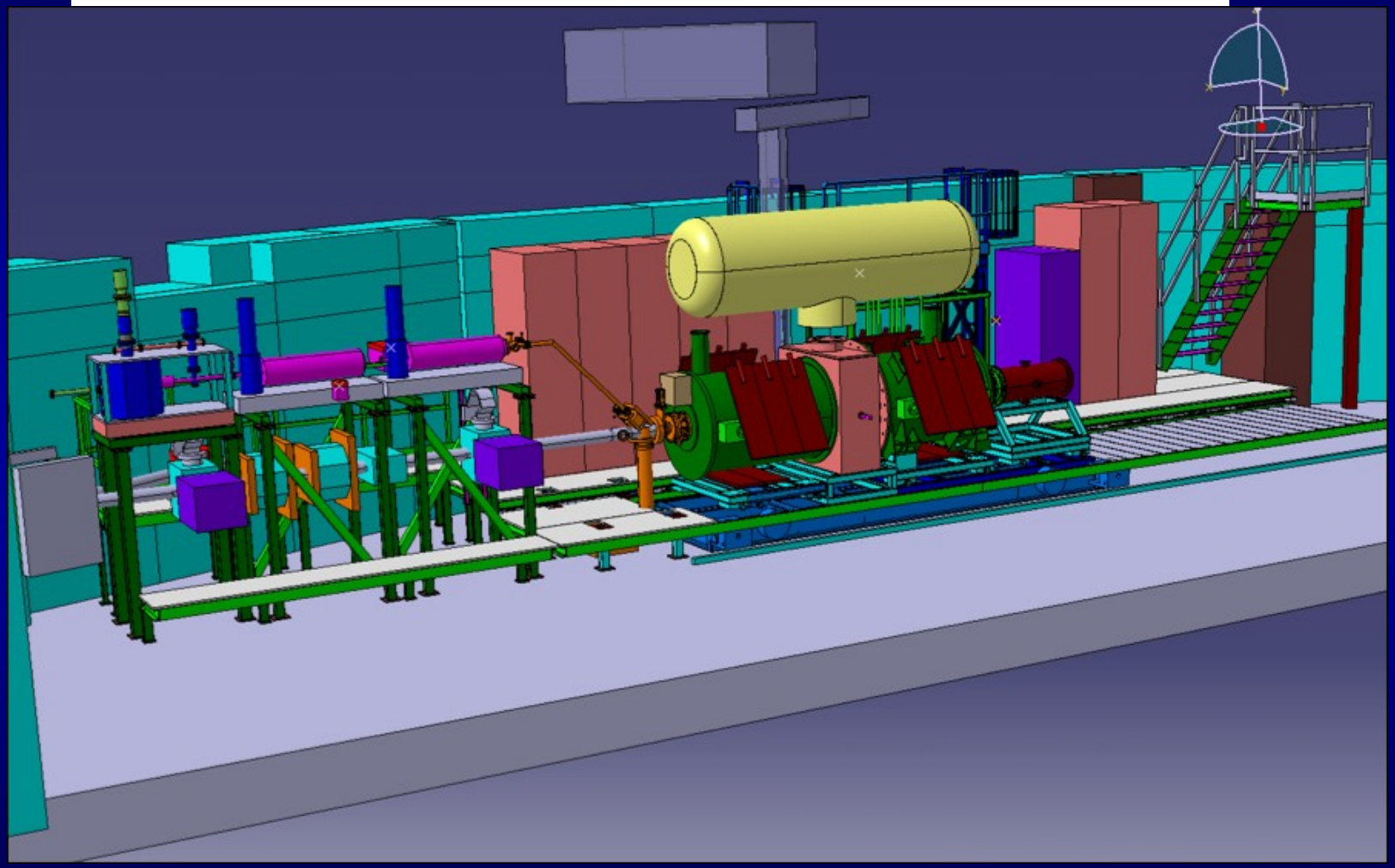
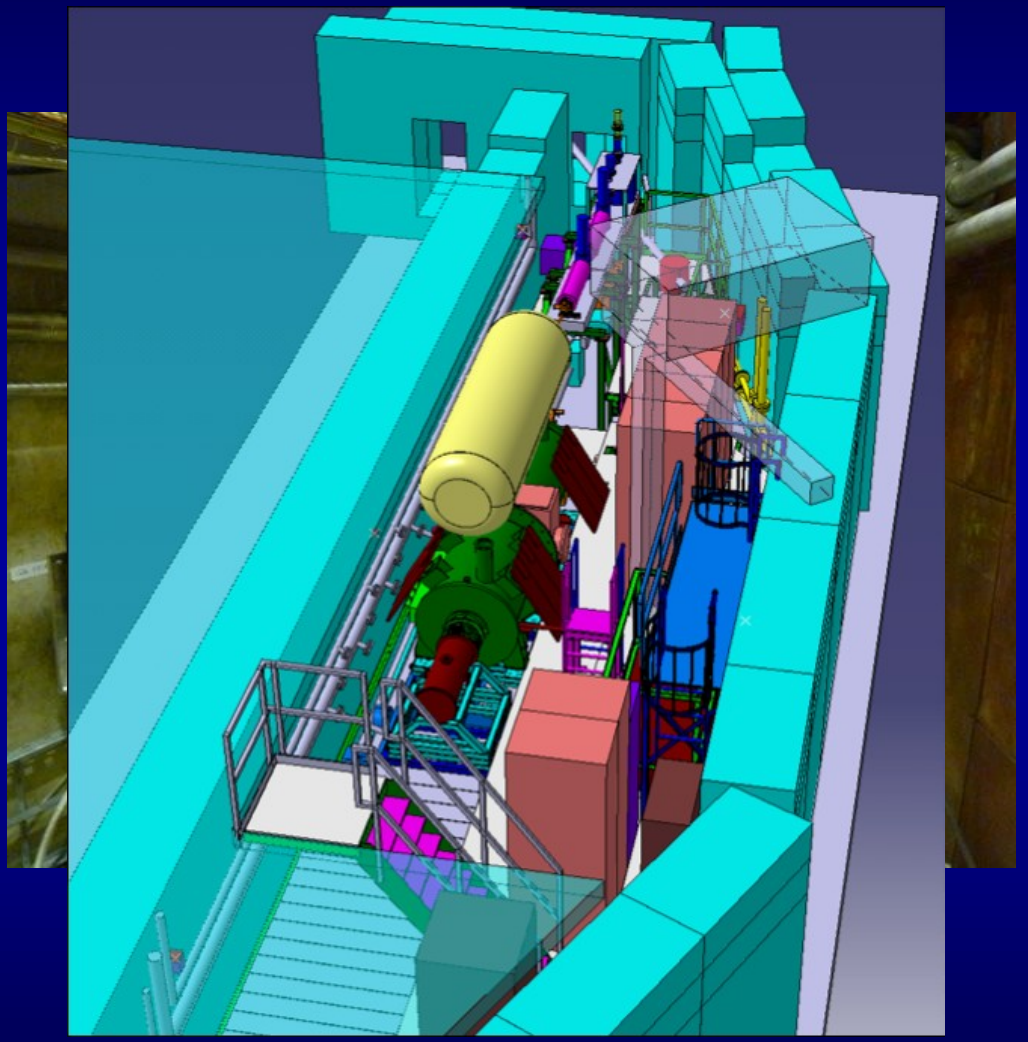
AEGIS



AEGIS – present status

- Concrete support structure for ATRAP positron installation replaced to make place.
- Water pipes re-routed
- Beamline/vacuum installed
- Magnets/power converters/interlocks installed and tested in 2010
- GEM detectors installation to be finalized 03/2011



AEGIS plan

- 2011:
  - April/May: preparation of the zone for positron accumulator, magnets (incl. power and cabling)
  - June/July: arrival and installation of the positron accumulator
  - August/September: installation of the 5 T magnet + transfer section + traps
  - October: cryogenics installation/commissioning
  - November: commissioning of trapping of antiprotons
- 2012:
  - January/February/March: installation of the 1T magnet + lasers
  - April/May: commissioning
  - June-November: commissioning of the different physics processes
- 2013: work with protons
- 2014-2016: work with antiprotons, antihydrogen, antihydrogen beam

PAX

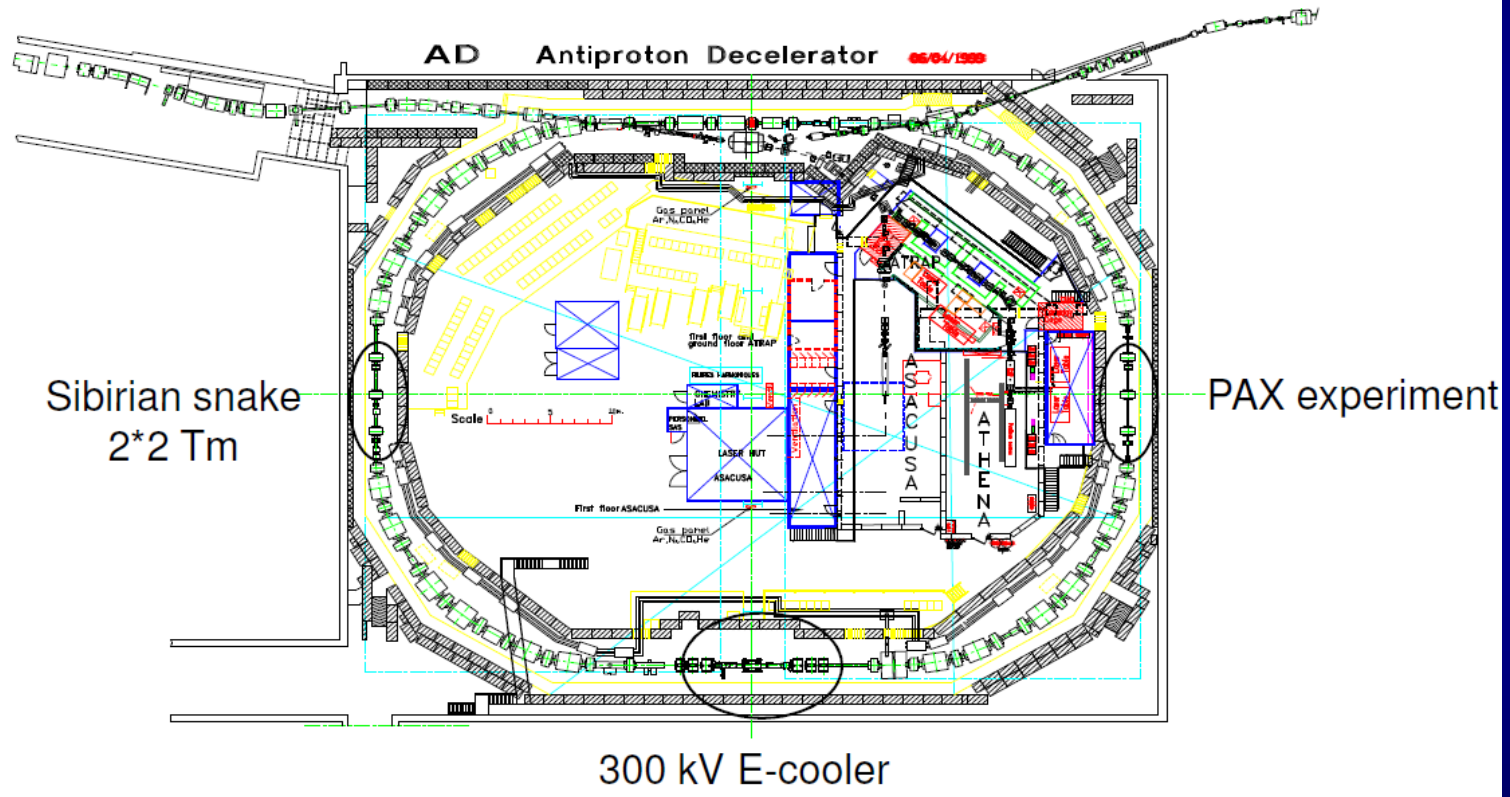
- Spin filtering of antiprotons with internal polarized gas target
- Build up polarized pbar beams in AD (0.3 to 1 GeV/c)
- Low-beta insertion in AD sect.15/16 including openable cell
- Upgrade of electron cooler (40 => 300 kV)
- Stacking in AD
- Siberian snake in sect. 42/43 (longitudinal polarization) to follow
- Step-by-step approach proposed for installation
- Tests and studies with protons ongoing at Cosy

PAX plan, ~5 yrs

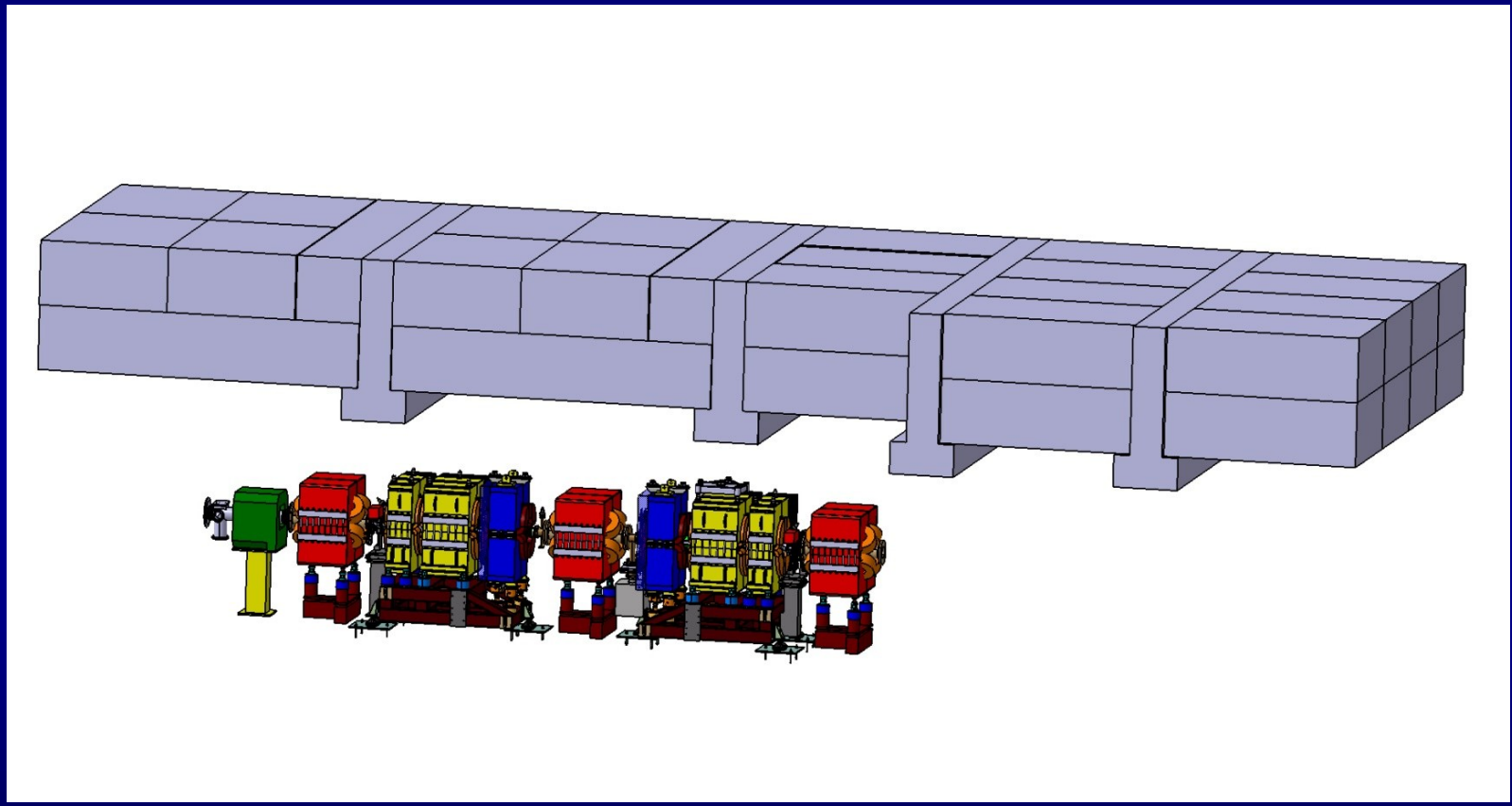
- 1:st stage: Low beta section
  - Set-up AD with insertion (6 quads), QDN15 remains in place
  - PAX optics setup, beam lifetime
- 2:nd stage: Experiment installation
  - Remove QDN15, install PAX target chamber
  - Inject polarized H atoms, measure transverse beam polarization
- 3:rd stage: 300 keV electron cooler
  - Measure transverse polarization at higher energies
- 4:th stage: Siberian Snake
  - Install 2Tm solenoids, measure longitudinal polarization

PAX layout

PAX@CERN/AD Overview:



PAX 1:st stage:
Insertion 15/16, spin filtering at 300MeV/c



PAX status

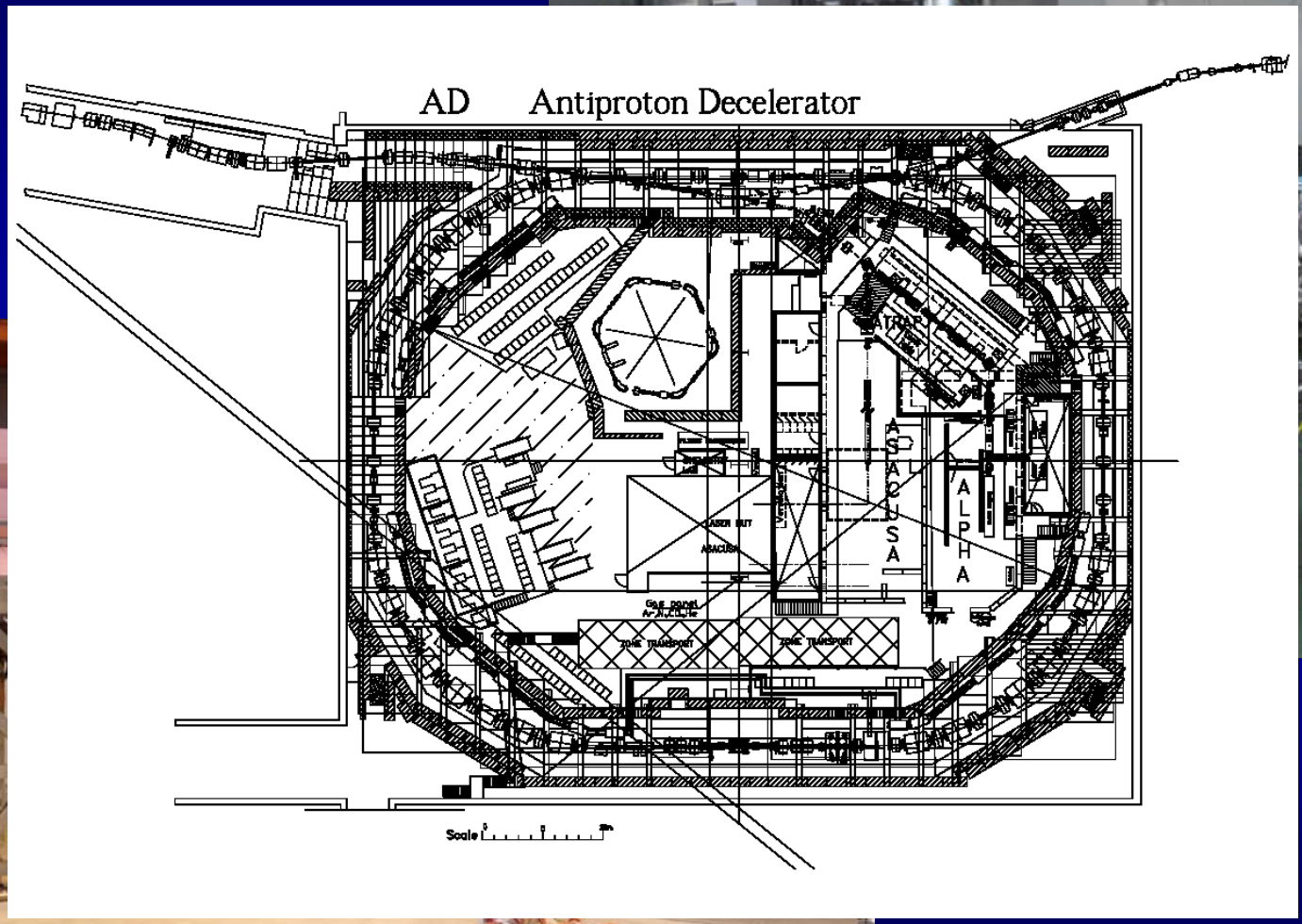
- A detailed step-by-step plan has been worked out
- All equipment will be supplied by PAX
- A rough identification has been made of:
  - CERN manpower needs (~5 MY)
  - Risks
    - Set-up duration
    - AD performance
    - Insertion optics
    - Vacuum
  - Impact on existing physics program
- Proposal submitted to SPSC – under consideration

Gbar

Gravitational Behaviour of Antihydrogen at Rest

- Saclay project – continuation of SOPHI R&D (Irfu)
- Competition with AEGIS
- Proposal being prepared
- Trap (tested at Riken)
- High intensity Positron source (need space in AD hall)
- Need to consider new location of AD kicker platform

Gbar

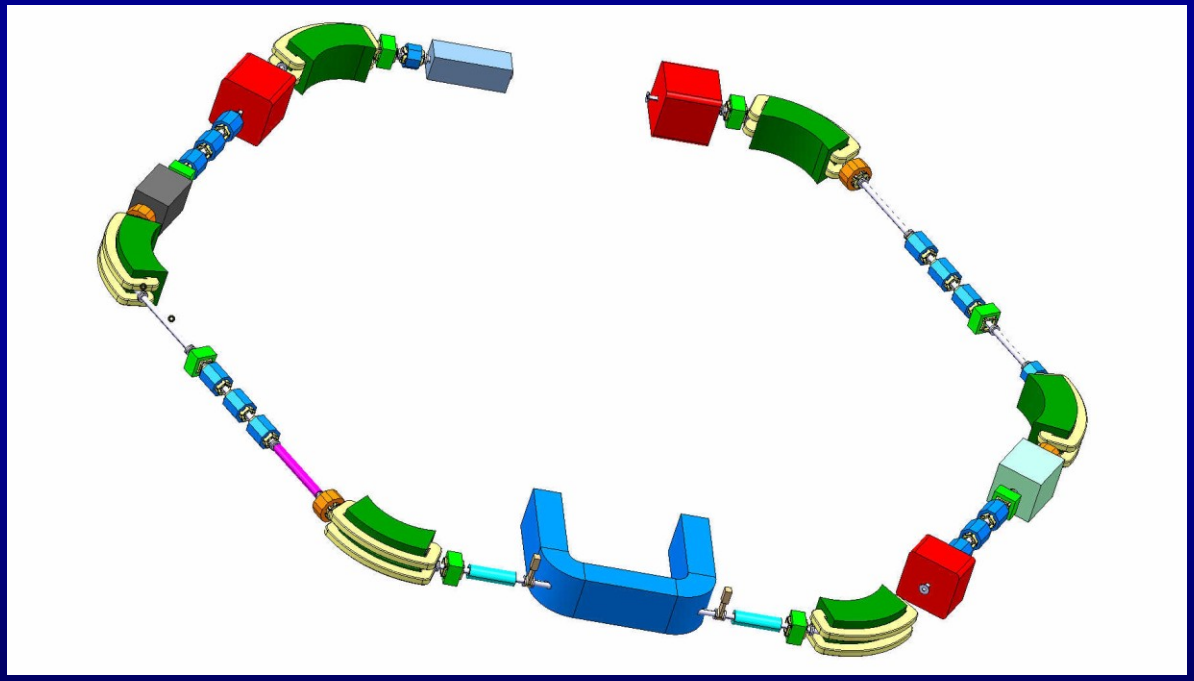

AD Antiproton Decelerator
TRAP
ASACUSA
ALPHA
ZONE TRANSPORT
ZONE TRANSPORT
Scale

Other: new ASACUSA sub-group

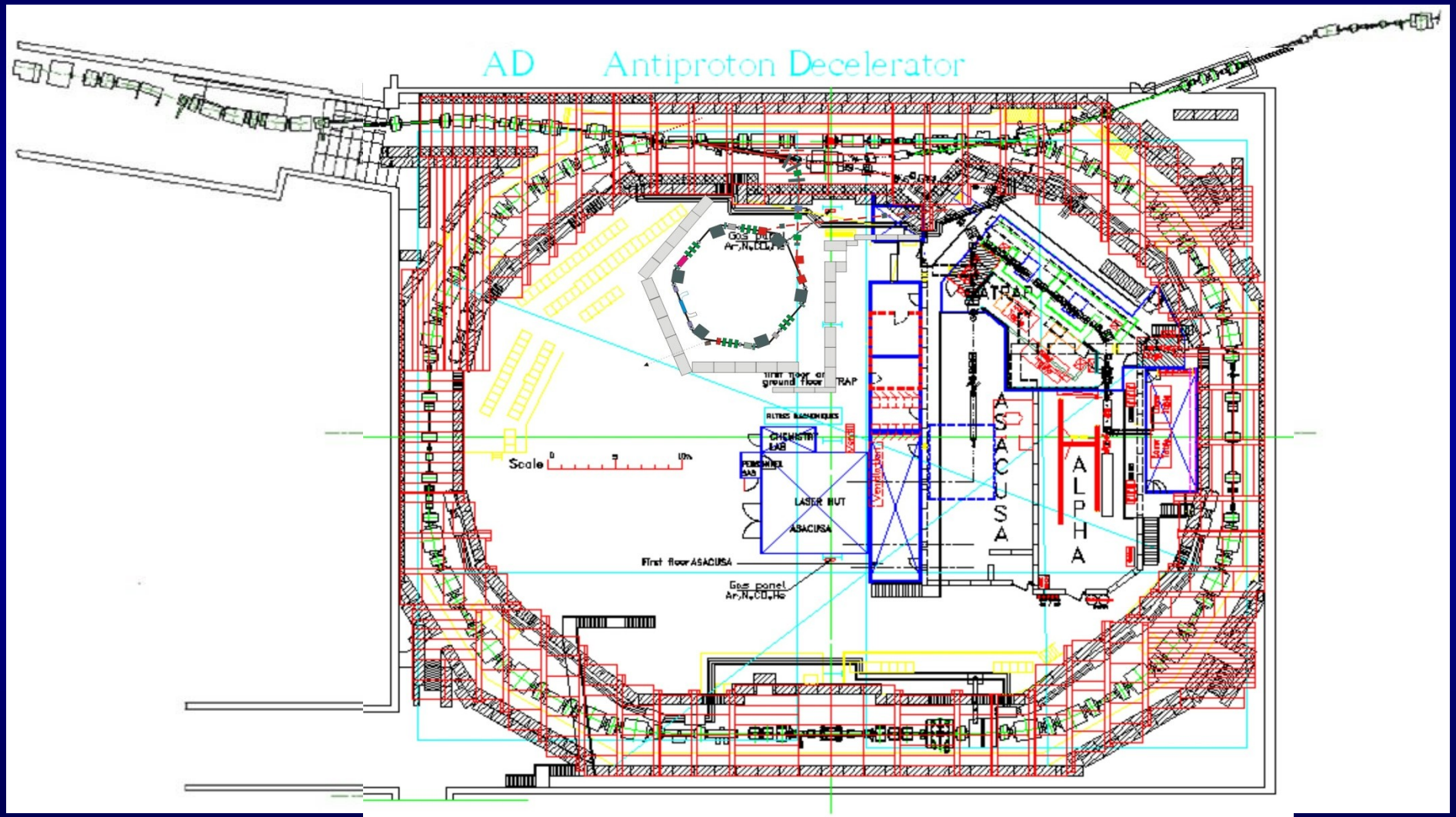
- New ASACUSA experiment proposal (SPSC in 2011?)
- Internal gas-jet target
- Requires circulating beam at 40keV
- Need only a few thousand turns
- Initially planned as new e-static ring in ASACUSA zone
- Could be done in ELENA by deceleration down to 40 keV
  - Deceleration with e-cooler => avoid beam blow-up
  - Main B field 500 => 300 G
  - No vacuum improvement needed

ELENA

Extra Low ENergy Antiproton ring for antiproton deceleration after the AD



ELENA layout in AD Hall



ELENA main parameters

Momentum range, MeV/c	100 - 13.7
Energy range, MeV	5.3 - 0.1
Circumference, m	30.4
Intensity of injected beam	3×10^7
Intensity of ejected beam	2.5×10^7
Number of extracted bunches	4
Emittances (h/v) at 100 KeV, π·mm·mrad, [95%]	4 / 4
$\Delta p/p$ after cooling, [95%]	10^{-4}
Bunch length at 100 keV, m / ns	1.3 / 300
Required (dynamic) vacuum, Torr	3×10^{-12}

2010 ELENA cost estimate

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	

ELENA - status

- Updated ELENA project and cost estimate has been presented to various CERN committees
  - IEFC, SPSC, SPC
  - recommendation made at RB in December:

"An updated cost and feasibility study has been finalized for the ELENA upgrade of the AD facility [8], validated by the IEFC committee.

The SPSC re-iterated its strong support to the project.

The motivation has been strengthened by recent breakthrough at the AD with the successful trapping of antihydrogen.

The Research Board endorsed the strong scientific case for ELENA.

All efforts are encouraged to ensure that the required resources are found, within the collaboration or elsewhere, so that ELENA can go ahead, securing the long-term future of the AD program."

- No approval in March 2011 RB, but very positive outlook:
  - Project structure under discussion => answer soon…
  - TDR to be started ASAP
  - Should be put in MTP

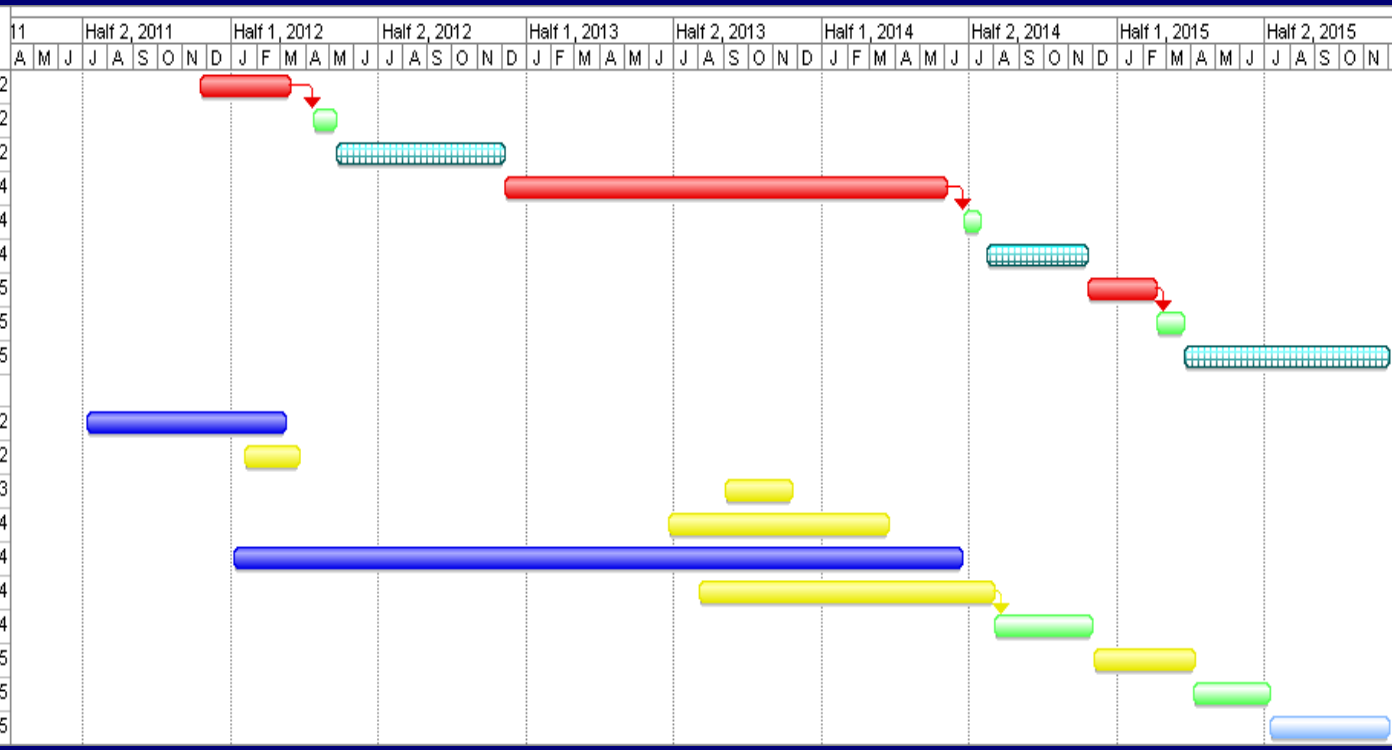
Planning

- 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

Possible ELENA planning

ID	Task Name	Duration	Start	Finish
1	2011-2012 shutdown	80 days?	Mon 21/11/11	Sun 11/03/12
2	Setup for physics	20 days	Mon 09/04/12	Sun 06/05/12
3	AD physics run 2012	150 days	Mon 07/05/12	Sun 02/12/12
4	1st long shutdown	390 days?	Mon 03/12/12	Sun 01/06/14
5	Setup for physics	15 days	Mon 23/06/14	Sun 13/07/14
6	AD physics run 2014	90 days	Tue 22/07/14	Sun 23/11/14
7	2014-2015 shutdown	60 days?	Mon 24/11/14	Sun 15/02/15
8	Machine startup	25 days	Mon 16/02/15	Sun 22/03/15
9	AD run 2015	180 days	Mon 23/03/15	Sun 29/11/15
10				
11	ELENA TDR	176 days?	Mon 04/07/11	Mon 05/03/12
12	Move kicker platform	50 days	Mon 16/01/12	Fri 23/03/12
13	Modification of 7000 line	60 days	Mon 02/09/13	Fri 22/11/13
14	Modification of AD hall	195 days	Mon 24/06/13	Fri 21/03/14
15	Design & procurement of ELENA par	645 days	Mon 02/01/12	Fri 20/06/14
16	ELENA installation	261 days	Thu 01/08/13	Thu 31/07/14
17	ELENA commissioning	87 days	Fri 01/08/14	Fri 28/11/14
18	Install electrostatic beamlines	90 days	Mon 01/12/14	Fri 03/04/15
19	ELENA & beamline commissioning	67 days	Fri 03/04/15	Mon 06/07/15
20	ELENA physics run 2015	104 days	Tue 07/07/15	Sun 29/11/15



CERN Pbar timeline

- **1980-1986 AA**
  - 3.57 GeV/c Antiproton Accumulator ring;
  - 10^12 pbars stored (peak). p/pbar collisions in SPS
  - + low energy experiments in LEAR
- **1986-1996 AAC (AA+AC)**
  - Large acceptance Antiproton Collector ring added. Production rate increased 10-fold to 6*10^10 pbars/h
- **1998-2015? AD**
  - AC converted from fixed energy storage ring to Decelerator. 5*10^7 pbars slowed down to 100 MeV/c (5.3MeV kinetic). Local experimental area.
- **2016?-2026+ AD/ELENA?**
  - Small post-decelerator ring to be added
  - Cooling and deceleratoin to 100 keV
  - Electrostatic beamlines and new experiments…

Consolidation – AD machine

- A limited consolidation program was launched in 2009 in view of continued AD operation until 2016/17 (=1/3 of the proposed items/budget):

Item	Group	RS	RS after	Σmanpower	ΣM	M09	M10	M11	M12	M13
				MY	kSfr	kSfr	kSfr	kSfr	kSfr	kSfr
AD Magnets	TE-MSC	15	6	<2.4 (*)	325			125	200	
AD power converters	TE-EPC	10	3	<4.3 (*)	650		350	300		
AD controls	BE-CO	N.A	N.A	0	0		0	0		
AD vacuum ion pumps	TE-VSC	9	6	0.8	90		45	25	20	
AD vacuum ion pump power supplies&controls	TE-VSC	8	2	0.4	350		50	150	150	
AD Stochastic cooling p/u&kicker movement	BE-RF	9	2	1	50		50			
AD Stochastic cooling electronics	BE-RF	6..9	2	0.5	100		50	50		
AD C02 system	BE-RF	8	3	1	160		80	80		
AD target area ventilation & interlocks	EN-STI	8	3	1	100		20	80		
AD target water cooling + ctrls	EN-STI	6	4	0.1	50			50		
AD kicker oil system	TE-ABT	8	3	0.75	60		30	30		
AD kicker power supply/controls upgrade	TE-ABT	4	2	0.25	125			65	60	
AD ejection line power converters	TE-EPC	4	2	0.25	90			90		
AD C10 system	BE-RF	4	2	0.2	80		80			
AD power converter spares	TE-EPC	15	3	0.25	50		50			
Yearly total (kSfr)						**0**	**805**	**1045**	**430**	
Grand total (kSfr)					**2280**					

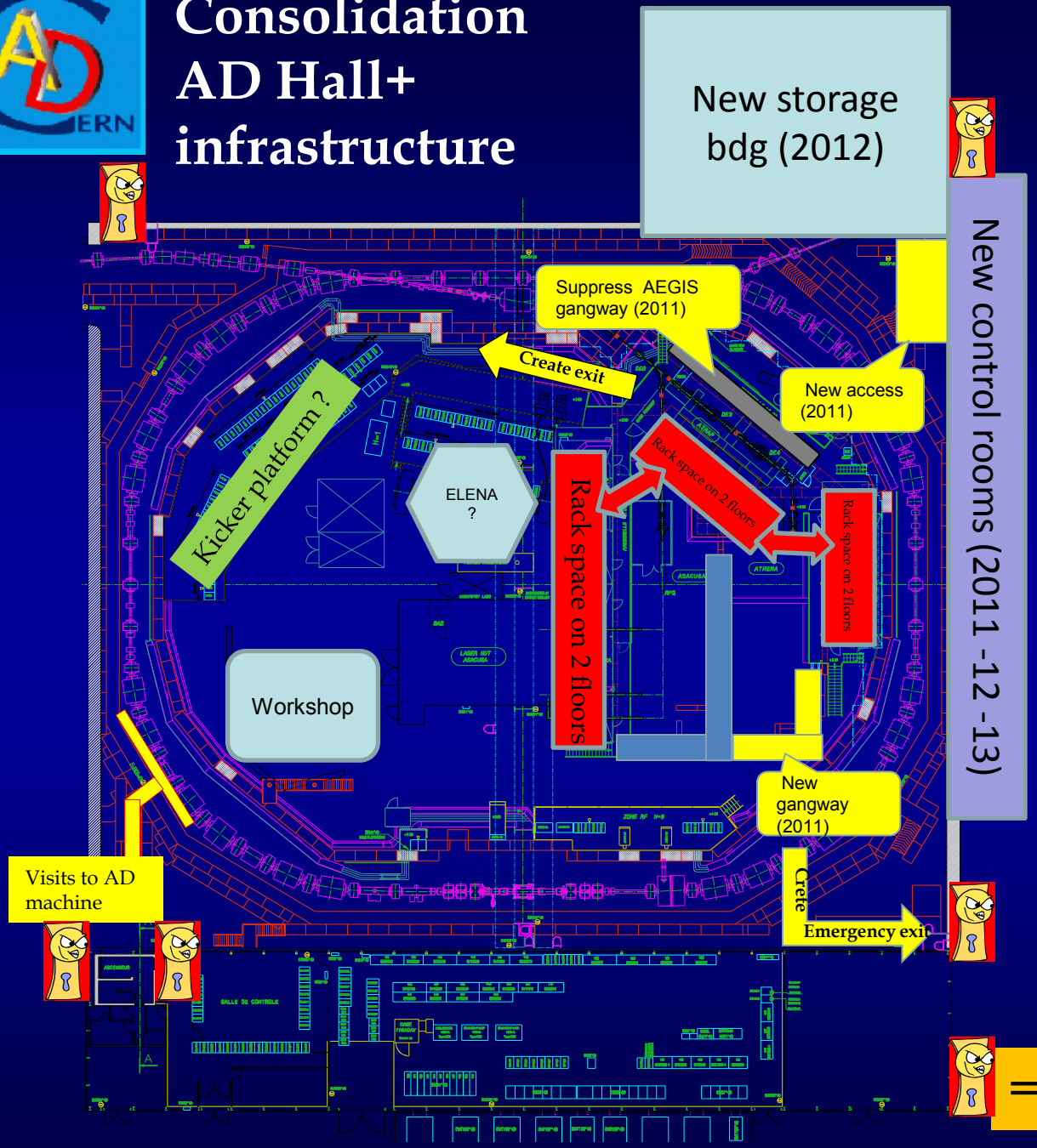
AD consolidation

- For running until >2026:
  - Re-iterate 2009 exercise =>
  - ~ 40 items such as:
    - Target area
    - Stochastic cooling tanks
    - Etc.
  - Infrastructure…
  - Consolidation campaign started in 2010 for the experimental hall: safety, user facilities etc.

==➔

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



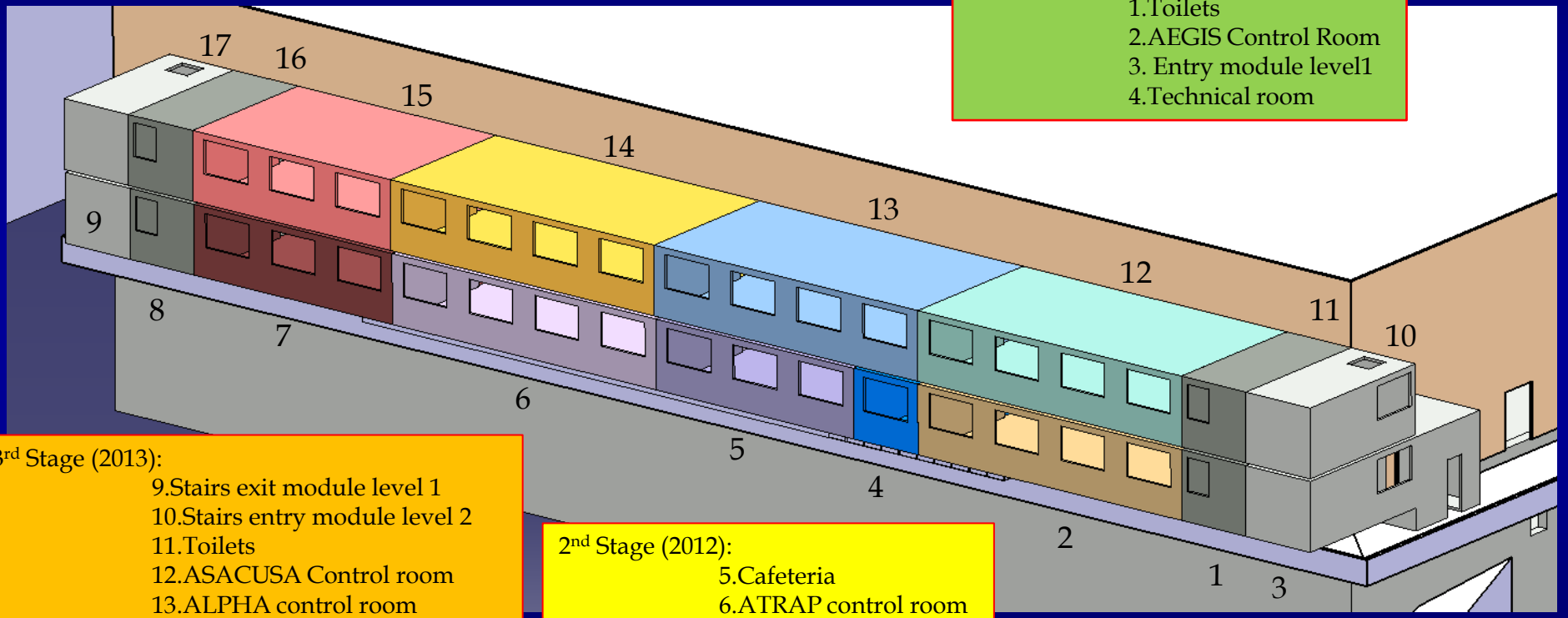
Infrastructure consolidation:

- 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)

New control rooms for AD experiments

1st Stage (2011):
1.Toilets
2.AEGIS Control Room
3. Entry module level1
4.Technical room



3rd Stage (2013):
9.Stairs exit module level 1
10.Stairs entry module level 2
11.Toilets
12.ASACUSA Control room
13.ALPHA control room
14. Meeting room
15.ELENA related control room
16.Toilets
17.Stairs exit module level 2

2nd Stage (2012):
5.Cafeteria
6.ATRAP control room
7.ACE Ccontrol room
8.Toilets