How to ensure a bright future of the AD
Contents

• Present and future projects:
  – AEGIS
  – PAX
  – Gbar
  – Other

• Impact of ELENA installation

• AD consolidation
• 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.
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:

- Sibirian snake 2\times2 Tm
- 300 kV E-cooler
- PAX experiment

IEFC 22 March 2011
T. Eriksson CERN BE/OP
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

IEFC 22 March 2011 T. Eriksson CERN BE/OP
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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Momentum range, MeV/c</td>
<td>100 - 13.7</td>
</tr>
<tr>
<td>Energy range, MeV</td>
<td>5.3 - 0.1</td>
</tr>
<tr>
<td>Circumference, m</td>
<td>30.4</td>
</tr>
<tr>
<td>Intensity of injected beam</td>
<td>$3 \times 10^7$</td>
</tr>
<tr>
<td>Intensity of ejected beam</td>
<td>$2.5 \times 10^7$</td>
</tr>
<tr>
<td>Number of extracted bunches</td>
<td>4</td>
</tr>
<tr>
<td>Emittances (h/v) at 100 KeV, $\pi \cdot \text{mm} \cdot \text{mrad}$, [95%]</td>
<td>4 / 4</td>
</tr>
<tr>
<td>$\Delta p/p$ after cooling, [95%]</td>
<td>$10^{-4}$</td>
</tr>
<tr>
<td>Bunch length at 100 keV, m / ns</td>
<td>1.3 / 300</td>
</tr>
<tr>
<td>Required (dynamic) vacuum, Torr</td>
<td>$3 \times 10^{-12}$</td>
</tr>
</tbody>
</table>
## 2010 ELENA cost estimate

<table>
<thead>
<tr>
<th>Item</th>
<th>Material (kCHF)</th>
<th>Manpower FSU or charged (kCHF)</th>
<th>CERN Manpower FTE (MY)</th>
<th>Needed manpower contribution FTE (MY)</th>
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</thead>
<tbody>
<tr>
<td>Magnets (ring+inj. line)</td>
<td>1590(*)</td>
<td>135</td>
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<td>2.8</td>
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<tr>
<td>Power converters</td>
<td>955</td>
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<td>Injection/ejection septa</td>
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<td>0.7</td>
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<tr>
<td>Injection/ejection kickers</td>
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<td>RF + Schottky diagnostics</td>
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<td>B-trains</td>
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<td>Diagnostics</td>
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<td>85</td>
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<td>1.3</td>
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<td>Controls</td>
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<td>H-source</td>
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<td>Experimental area:lines, vacuum, monitors</td>
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<td>6.3</td>
<td>6.5</td>
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<tr>
<td>Mech. Design/Drawings</td>
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<td>347kCHF/4 MY (***)</td>
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<td>Div.</td>
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<tr>
<td>Total (MCHF/MY)</td>
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<td>.647</td>
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<td>Grand Total (MCHF/MY)</td>
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<td></td>
<td>14.515</td>
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<td>71.9</td>
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</table>
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
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 $6 \times 10^{10}$ pbars/h

• **1998-2015?**  **AD**
  – AC converted from fixed energy storage ring to Decelerator. $5 \times 10^{7}$ 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):

<table>
<thead>
<tr>
<th>Item</th>
<th>Group</th>
<th>RS</th>
<th>RS after</th>
<th>manpower</th>
<th>MY</th>
<th>M09</th>
<th>M10</th>
<th>M11</th>
<th>M12</th>
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<tr>
<td>AD Magnets</td>
<td>TE-MSC</td>
<td>15</td>
<td>6</td>
<td>&lt;2.4 (*)</td>
<td>325</td>
<td>125</td>
<td>200</td>
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<td>AD power converters</td>
<td>TE-EPC</td>
<td>10</td>
<td>3</td>
<td>&lt;4.3 (*)</td>
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<td>300</td>
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<td>AD controls</td>
<td>BE-CO</td>
<td>N.A</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>AD vacuum ion pumps</td>
<td>TE-VSC</td>
<td>9</td>
<td>6</td>
<td>0.8</td>
<td>90</td>
<td>45</td>
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<td>AD vacuum ion pump power supplies&amp;controls</td>
<td>TE-VSC</td>
<td>8</td>
<td>2</td>
<td>0.4</td>
<td>350</td>
<td>50</td>
<td>150</td>
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<td>AD Stochastic cooling p/u&amp;kicker movement</td>
<td>BE-RF</td>
<td>9</td>
<td>2</td>
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<td>AD target area ventilation &amp; interlocks</td>
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<td>8</td>
<td>3</td>
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<td>100</td>
<td>20</td>
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<td>4</td>
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<td>AD kicker oil system</td>
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<td>125</td>
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<td>AD power converter spares</td>
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<td>3</td>
<td>0.25</td>
<td>50</td>
<td>50</td>
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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.

===>

IEFC 22 March 2011 T. Eriksson CERN BE/OP
Consolidation AD Hall+
infrastructure

Infrastructure consolidation:
• Access control upgrade
• 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 level 1
4. Technical room

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

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