Antiproton Decelerator
LS1 activities
Start-up in 2014

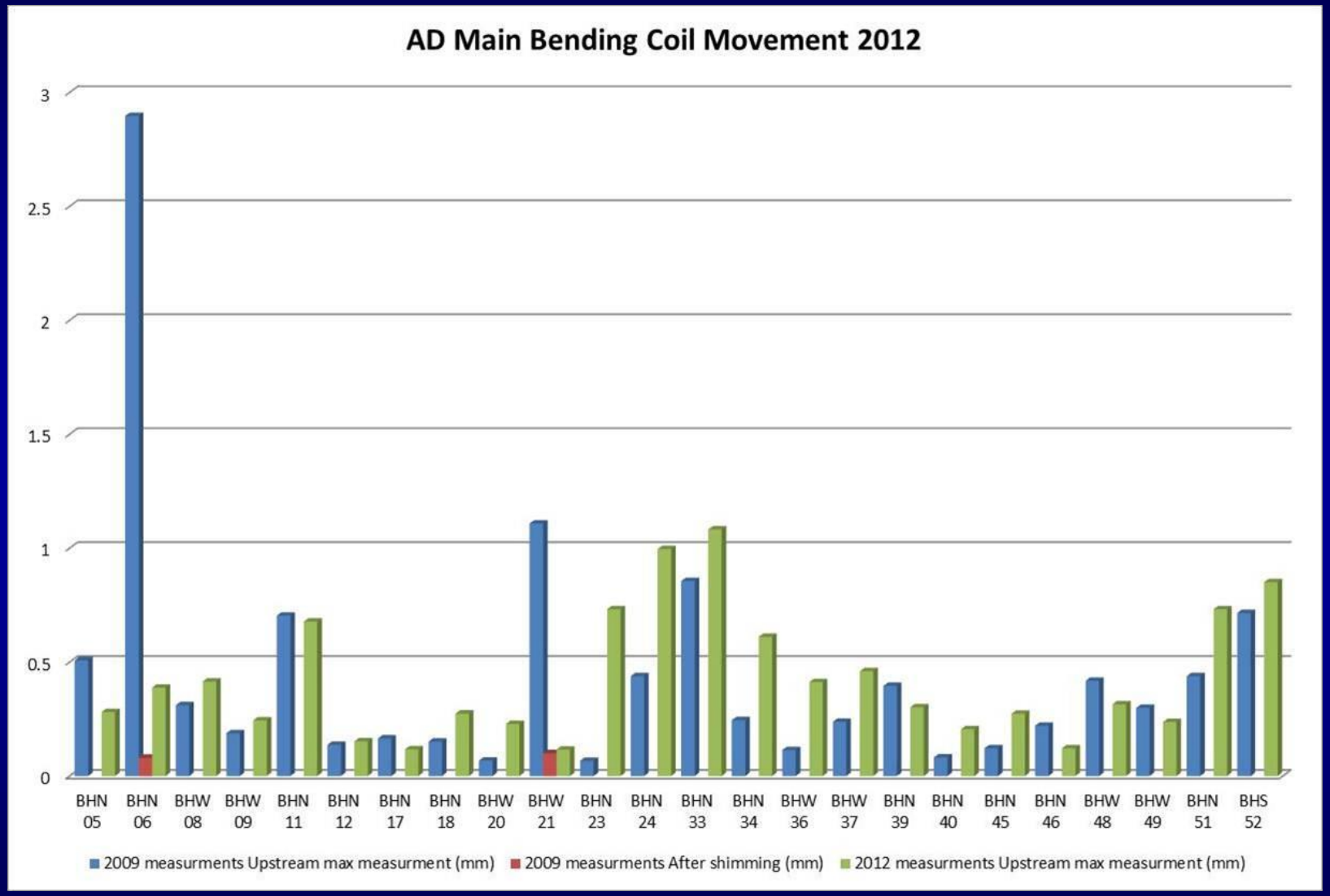
LS1 activities, AD consolidation

- Most of AD dates from ~1985
- A small consolidation program (~2.3 MCHF) started in 2009 with the view of running AD until 2016 or so
- This is now merged with a larger program aimed at continued operation of AD+ELENA for at least 10-15 years after ELENA physics has started; >2025/30
- => Main components will be 45 years old….
- Concerned items are: Target area, magnets, power converters, Stochastic cooling, electron cooling, control system, Instrumentation, beam transfer equipment, RF, vacuum, Infrastructure and also preparation for ELENA installation.
- For consolidation of the AD, a budget of ~ 18 MCHF has been allocated by RPC for the period 2013 – 2020
- LS1: extremely busy period with interventions everywhere, both for ELENA and AD consolidation as well as renewal of most of the control system.
- “exciting” start-up expected in 2014…..

AD HW consolidation LS1

- Magnets:
  - Ring Main bending magnets: DR.BHN06 is now removed (after removal of ATRAP e+ source) and opened up. Severe degradation of the coil shimming (as expected). New spare coils are now available but existing coil looks to be in good shape. Re-installation in February, source re-installation Feb/March.
  - Orbit correctors 2904/2917: Replacements (new design) delivered and tested with some minor concerns regarding field quality. Installation in January.
  - 7020/7030 quads in AD ejection line: new magnets (existing design) to be installed. The complete 7000-line will be modified including branch-off towards ELENA. To be finalised mid-March.
- Long-term:
  - Main bends: Provisional plan for overhaul/coil replacement of several units. Regular coil movement measurements will determine if all or only some units will be renovated.
  - Main Quads: no specific plan, re-shimming done a few years ago
  - Spare inventory is almost complete
  - All ejection line magnets will be replaced by e-static units for ELENA ~2016

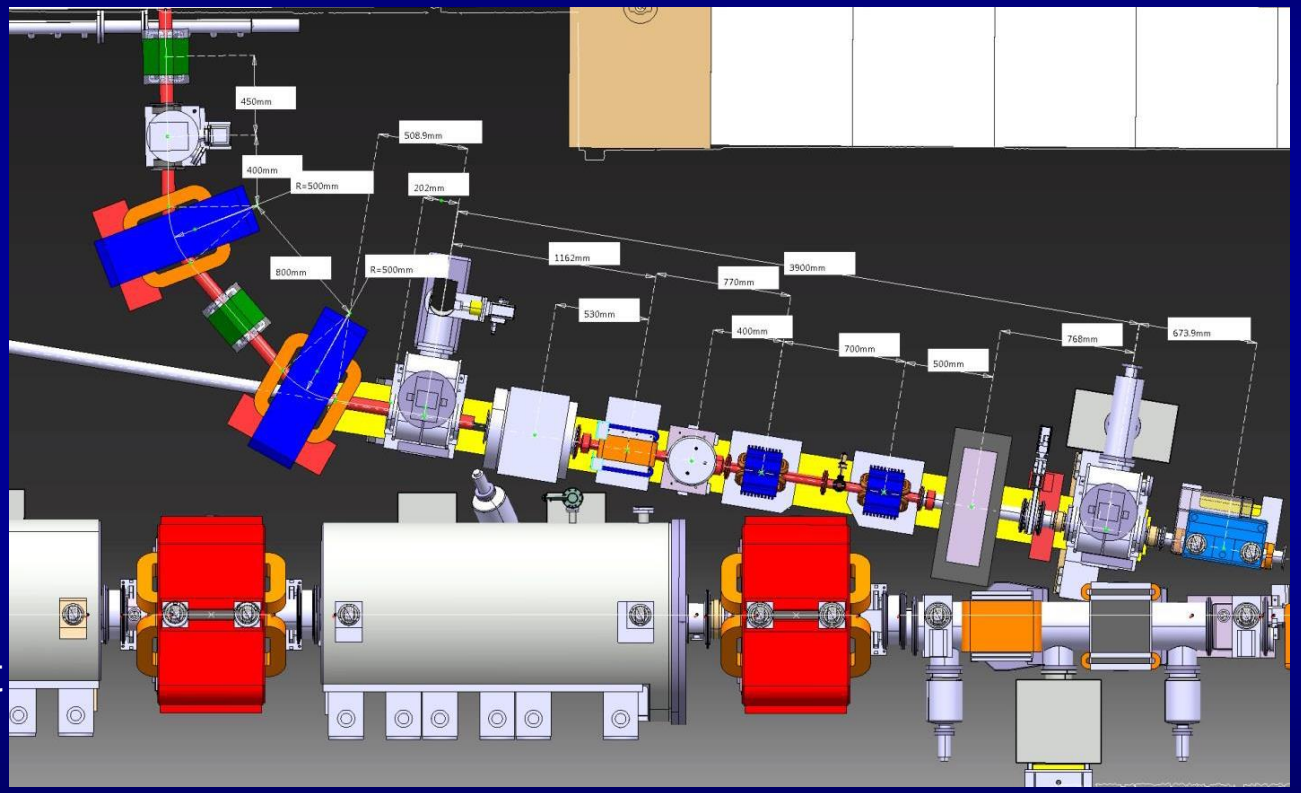
Coil movement DR.BHN06



DR.BHN06

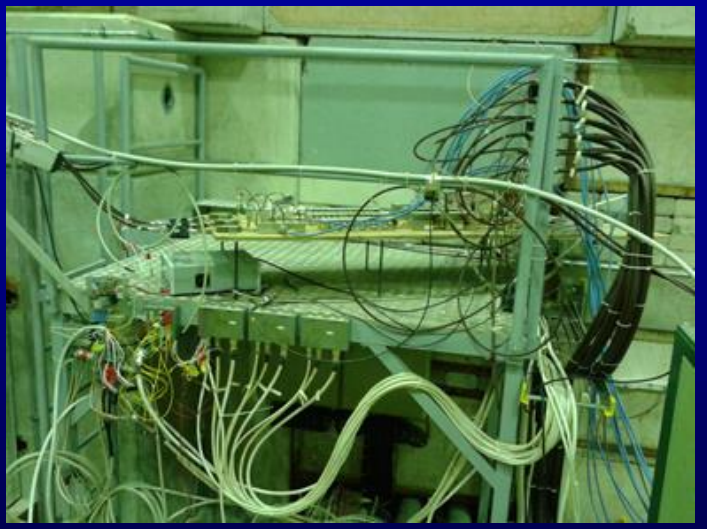
AD ejection/ELENA injection line

- New layout of 7000-line
- New 7020/30 quadrupoles
- New combined H/V corrector replaces separate units
- Re-shuffled and compressed to permit branch-off and matching
- ELENA line equipment will be installed later
- BHZ8000 removed (remanent field problems)
- Installation in February/March
- Set-up/verification of optics during start-up
- Existing straight part will be kept in the future to supply “high” energy beams if needed



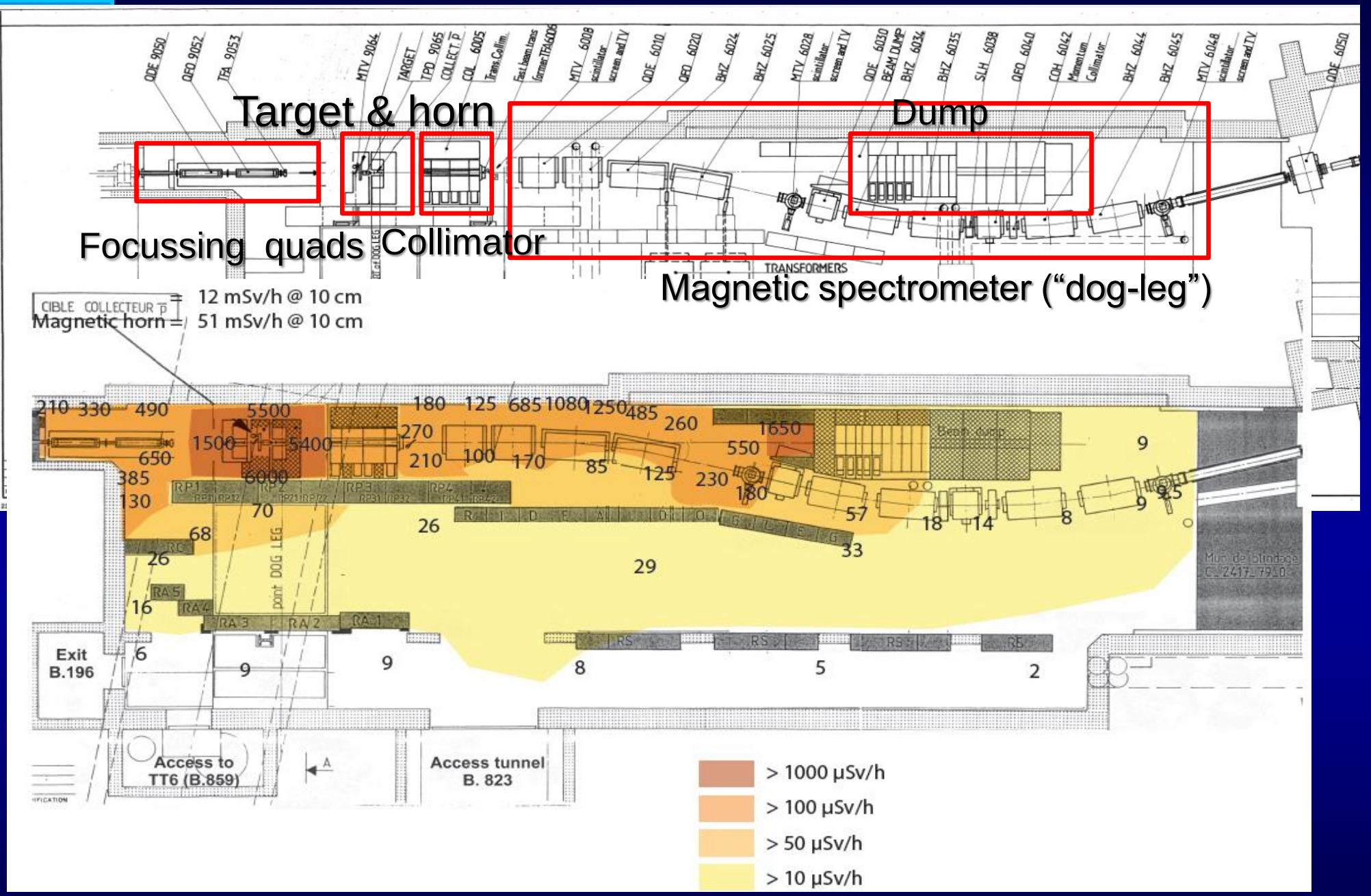
Stochastic cooling consolidation

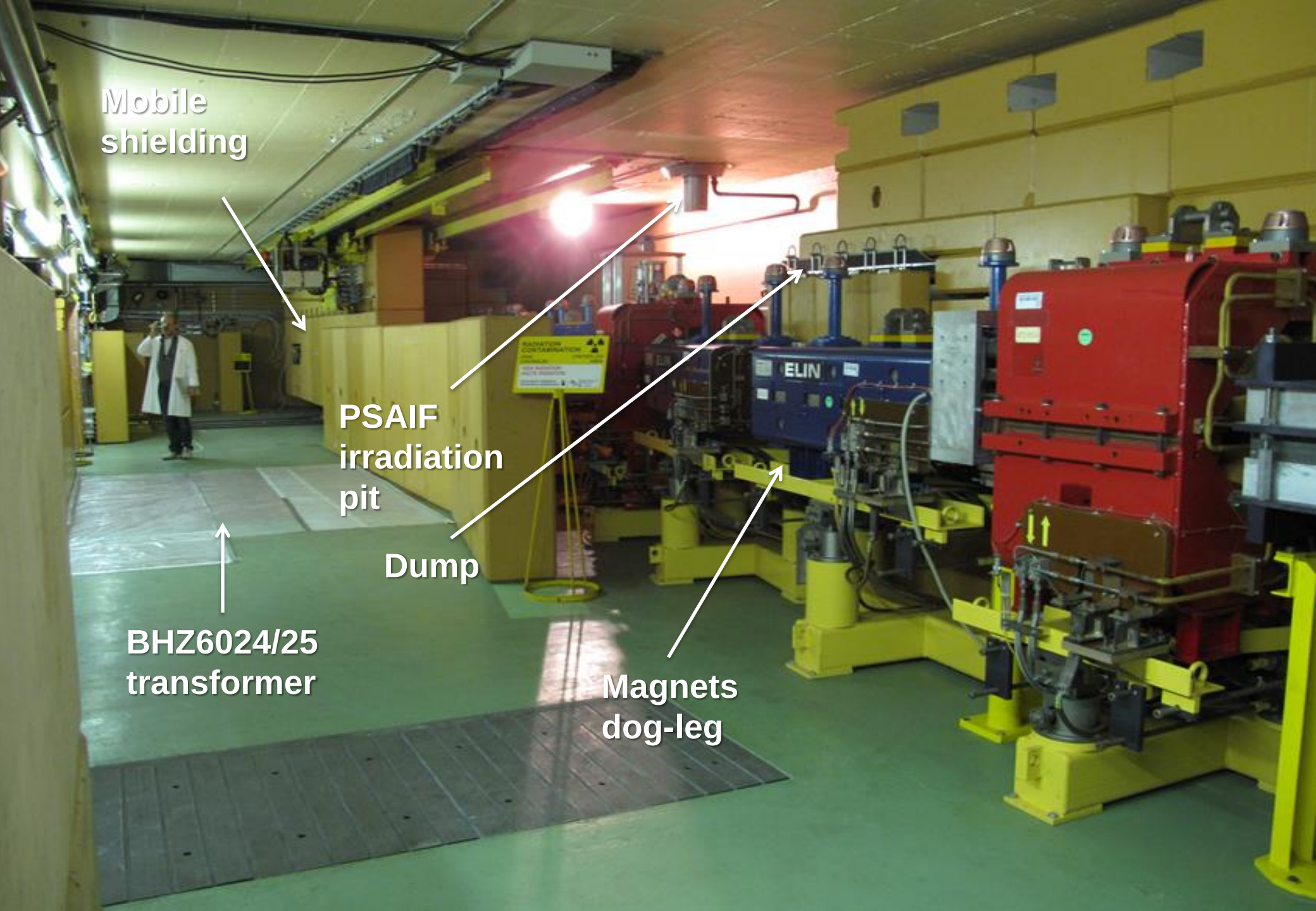
- New individual Power supplies for the 0.8—1.6 GHz stochastic cooling amplifiers. Installation completed.
- Amplifiers will also be replaced
- Cryo-system renovation completed, pickup tanks 31/32 re-installed in ring.
- New electronics for static/dynamic parameter control tested in 2012, to be used in operation from 2014.
- HW cleanup to be completed before startup (s-cool platform in AD hall etc.)
- Pickup/kicker movement: Update of obsolete system with modern digital servo motor controller
- Optical filters will be developed to replace large filter box presently limiting space around ELENA



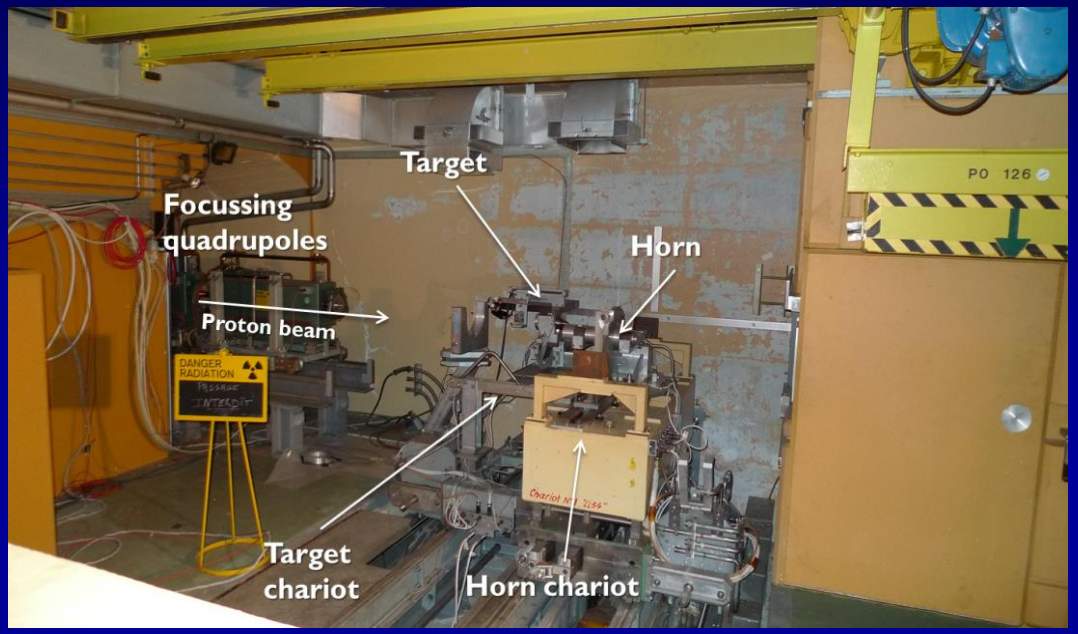
Target Area

- During p$\bar{p}$ program a full team was looking after design, operation and maintenance of AD-T
  - During AD physics no serious follow-up was done
  - ... Most of control equipment conceived as prototypes
- Few problems occurred during 12 years of AD operation
  - Repetition rate is now ~ 100s, the target area was designed for 2,4 s
  - Very reduced maintenance over the year – loss of expertise
- Major consolidation activity has started in 2011/12, is continuing during LS1 and will do through LS2
  - Consolidation of controls, interlocks, safety and services
  - Consolidation of tunnel areas
  - Consolidation of surface buildings


Target & horn
Dump
Focussing quads
Collimator
Magnetic spectrometer (“dog-leg”)
CIBLE COLLECTEUR p
Magnetic horn
12 mSv/h @ 10 cm
51 mSv/h @ 10 cm
TRANSFORMERS
Beam dump
Exit B.196
Access to TT6 (B.859)
Access tunnel B. 823
> 1000 µSv/h
> 100 µSv/h
> 50 µSv/h
> 10 µSv/h

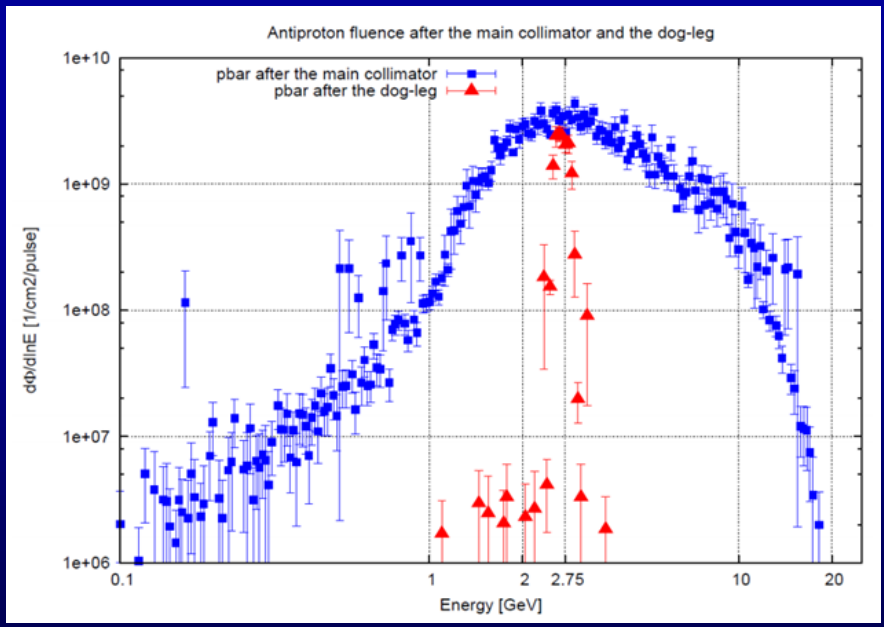

Mobile shielding
PSAIF irradiation pit
Dump
BHZ6024/25 transformer
Magnets dog-leg
ELIN

Target area consolidation



FLUKA simulations cross-checked by in-situ radiation and particle fluence measurements:
- confirms the effect of the magnetic spectrometer
- estimation of energy deposition in area elements (cooling needs)
- horn/target mis-alignment loss estimations

(Blue: fluence downstream of horn, Red: fluence at end of spectrometer)



Target Area LS1 consolidation

- Target/horn control system (movements, interlocks etc.)
  - Replace old hardware built as prototype and running since initial AD operation
  - New radiation hard-cameras in the target area for surveillance
  - New machine interlocks acquisition system
  - New software for AD operators supervision and expert interface for equipment operation
  - Additional safety added
    - Status of horn supply, zone access, strip line temperature, mobile shielding status etc.
  - Separation of machine and access interlocks
  - Temporary repair of Horn chariot position (New chariots in consolidation plan)
- Safety aspects:
  - GSM network operative in AD-target enclosure since August 2013
  - TETRA radio safety system will be operative end of 2013
  - Clarification of evacuation paths together with HSE
  - Review of lighting system of the target area (operation to be performed later in 2014)
  - Ventilation tests performed in May and July to study the effectiveness of the ventilation and smoke detection systems

Target Area LS1 consolidation

- Service vehicle (elephant): complete overhaul of electrics/hydraulics after breakdown in 2012
- Tunnel areas:
  - Water infiltration at entrance repaired with resin injection
  - New airtight door at target zone entrance
  - New resin floor throughout tunnel
  - Improve infiltration situation in TT6
- Surface buildings:
  - B232: Removal of legacy radioactive waste, Re-creation of a buffer zone adapted for large radioactive object from target area, Water tightness
  - B195: Retention vessel for the AD-target cooling station, Sealing penetration to target area

- After LS1 => Intense consolidation activities until ~2018

AD consolidation – other major HW items

- Power converters: DR.Q-TRIM2,4 and 5 upgrade in LS1 => “small” AD ring supply consolidation terminated
- Electron cooling: HV power supply renewal
- RF: C02 tuning system and HV-supplies renewal and re-location of RFQD racks/supplies: necessary to make space for ELENA and BASE
- Injection kickers: Structural improvement of KFI55/56 tanks (vacuum/weld problems), tanks completed and re-installed
- Replacement of SMH53 (leaking ejection septum), to be done in February
- Magnetic Horn: HV power supply renewal (electronics & interlock system already done)
- Vacuum system general renovation (started): Cryo system renovation; Bakeout system upgrade; General controls upgrade; Ion pump HV feedthrough improvement (refurbishing + heating system) ; Ion pump replacement; Turbo pumps + power supplies + gauges; Turbo pump controls; Gas injection system; Dogleg components
- Instrumentation: IPM renovation + merging H and V systems into 1 tank (sect.15 => 42)
- Cabling: Replacement of damaged power/interlock cables, discovered while re-routing cables for B393
- Removal of components of the obsolete transferline PS=>AD via TTL2 loop

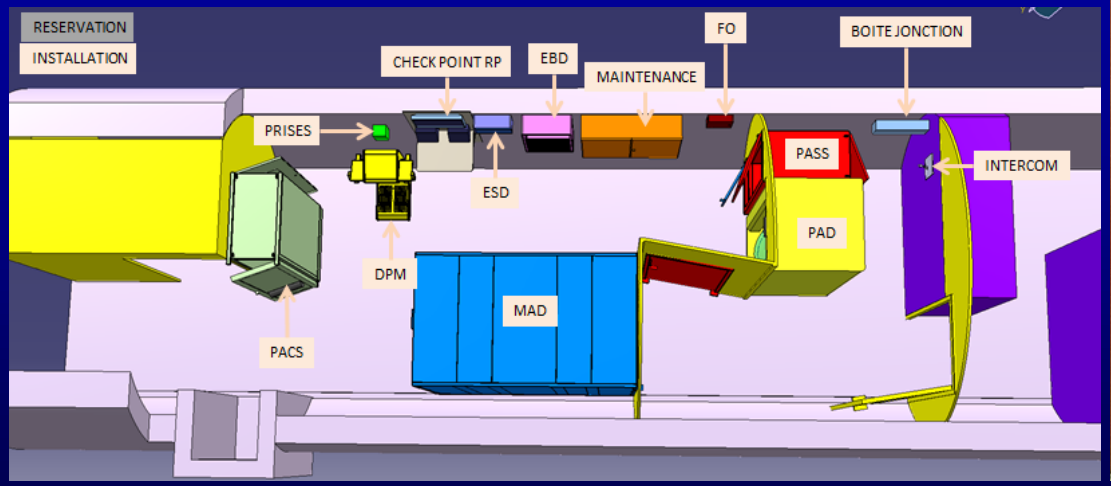
Controls/software

- Major LS1 renovation:
  - Front-end upgrade (ACCOR): ~complete (80-90%) renewal in LS1
  - Central Timing: re-design for de-coupling AD from the LHC injector complex
  - Cycle Generation: adaptation to comply with new timing system
  - New Beam Request Server
  - Similar CT, CG and BRS systems will be implemented in ELENA
  - FESA, Java migration, InCA: majority will be completed (standardization)
  - Some implications:
    - All AP:s will have to be adapted (OP + Eq. groups)
    - Eqp.Survey (parameter logging) will be replaced with TIMBER => in use by the AD experiments
    - Major debugging effort expected!
    - Etc. etc. etc.

Access/Safety

- New PAD/MAD access doors for AD ring & Target Area
- Complete renewal of interlock system, cabling, sectors, logic etc.
- Target Area: new sectorization (to facilitate access in TT6, manipulation through shaft etc.)
- Separation of access and machine interlock systems
- Standardization

Target area access point:



AD ring access point:

Start-up milestones

- Demineralized water back: 10/2
- New access system tests:
  - local equipment 3/3 -7/3
  - global 10/3 -14/3, general 31/3 – 4/4 => no access
- Control system tests:
  - Timing system ready 1/4
  - CO integrity tests 27/5 – 3/6
  - CO + Eq. group tests 8/6 – 9/6
  - CO + Eq. group + OP tests 25/6 – 4/7
- AD ring closure, unlock power equipment: 30/5 – 2/6
- HW tests: 3/6 -16/6

Start-up milestones

- Search/close ring+target area, DSO tests: 18/6 – 20/6
  => AD responsibility transferred back to BE/OP
- “Cold Check-out”: 23/6 – 4/7
- Setting-up with beam: 10/7 – 27/7
- First pbars for physics: 28/7
- Shutdown 2014: 16/12 => 22 weeks of physics in 2014

Conclusion

- AD future is now better known => a general consolidation program could be launched

- LS1: extremely busy time @ AD
- Upgrades to most systems (including controls)
- 2014 start-up will be more of a re-commissioning than a regular start-up…
- Start-up schedule is tight…