Plan for antiproton trap of GBAR

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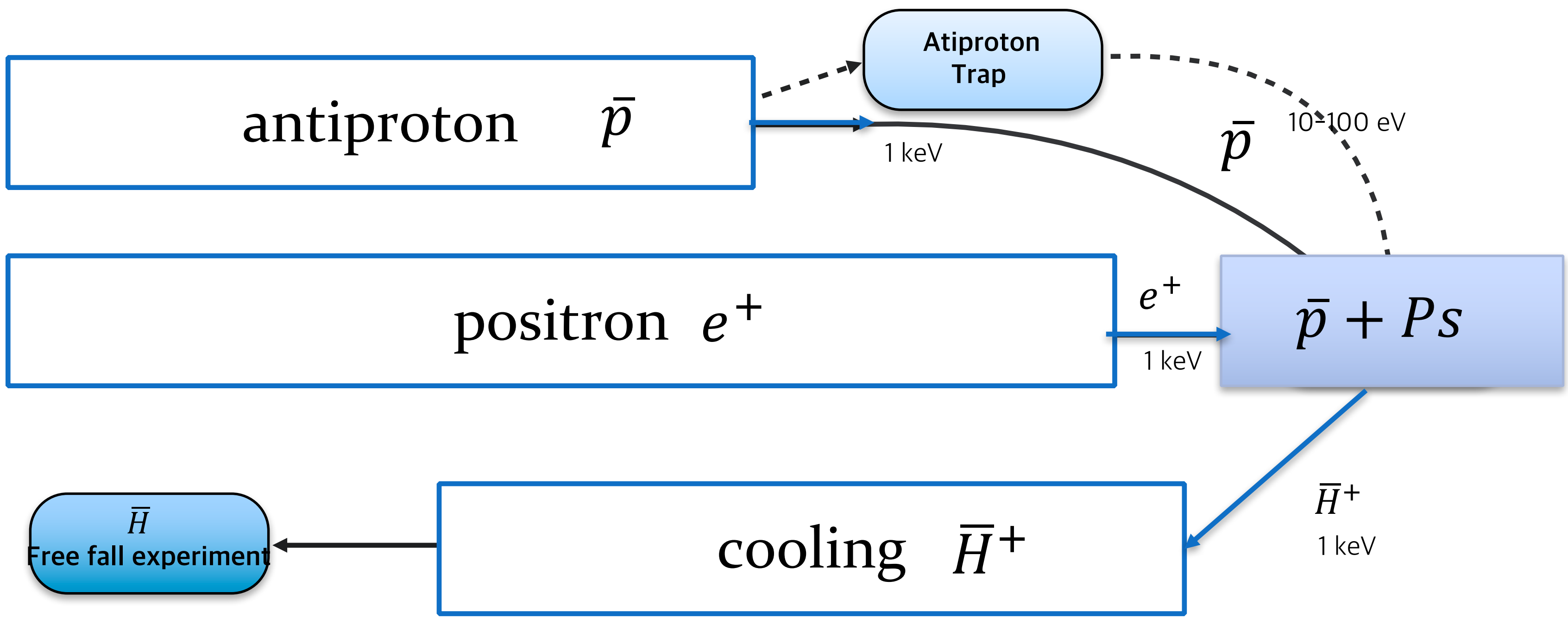
GBAR Experiment Sheme



Why antiproton trap ?

- Current design (w/o antiproton trap)
  - antiproton focusing onto Ps target ~ 10-30%
  - cannot reduce ELENA energy dispersion : anti-ion capture ~ 10%
  - unused antiproton beam will be dumped

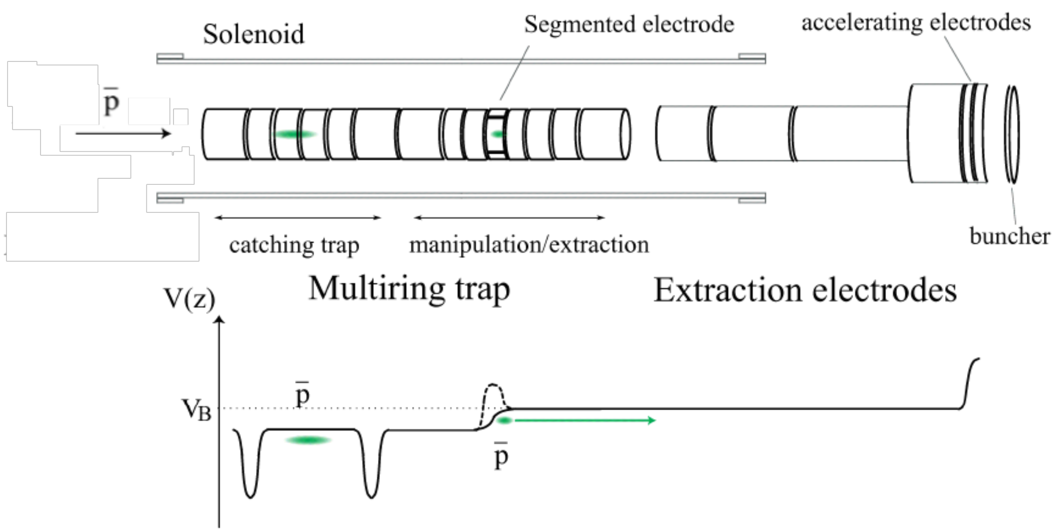
- With antiproton trap
  - antiproton focusing onto Ps target ~ 70%
  - reduce energy dispersion by factor 20 : anti-ion capture ~ 70%
  - unused antiproton beam can be reused
  - lower antiproton energy - higher p-Ps cross section (factor 100 for 10 eV compared with 1 keV)

Much higher sensitivity with antiproton trap !

GBAR Antiproton trap

Penning-Malmberg Trap

- Constant axial magnetic field and Electric field to confine charged particle plasma
- Important components in antimatter study (e.g., CERN의 ATHENA, ALPHA, ASACUSA, etc)
- Ultra high vacuum (~ 10^{-12} mbar)
- Cooling of antiproton by interaction with electrons. Electrons are cooled by synchrotron radiation



GBAR Antiproton trap

Functional requirement

- Receive and catch the antiproton bunches from ELENA with GBAR decelerator
- Cool antiprotons and reduce the size of the beam
- Inject to GBAR reaction chamber
- Recapture unused antiprotons from the reaction chamber

Input

- Antirptoton energy : 1-6keV (300 eV ΔE)
- # Antiprptons/cycle : 4 x 10^6
- Emittance : 40 π mm mrad
- bunch length : ~ 450 ns
- cycle time : 110s

Output

- Antirptoton energy : 10-100 eV(15 eV ΔE)
- # Antiprptons : 1 x 10^7
- Radial beam size : 1 mm
- bunch length : ~ 100 ns

GBAR Antiproton trap

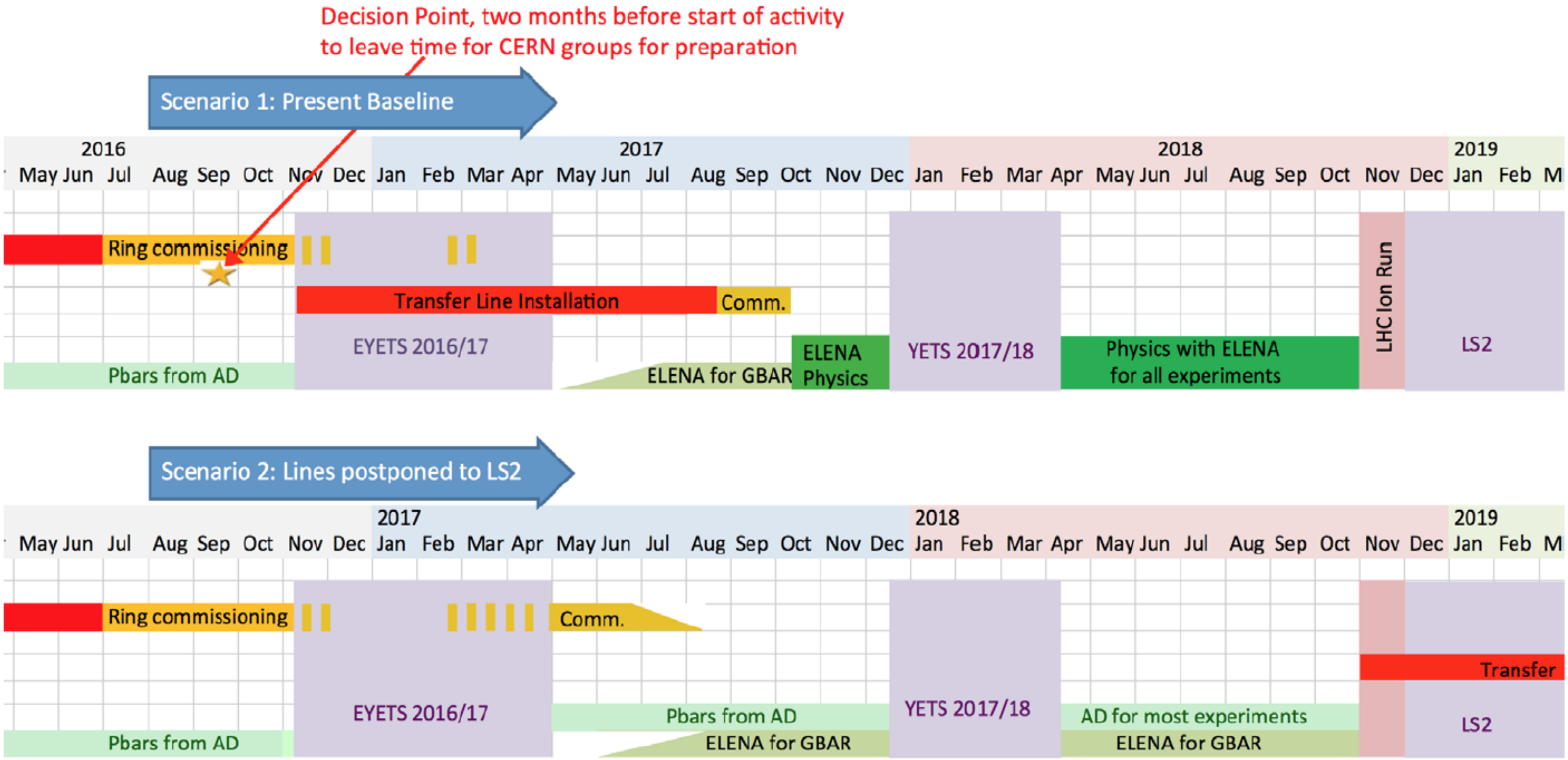
Components and job sharing

- SC Magnet : SNU + KU
- PIC simulation : UNIST
- Electrodes : SNU + UNIST
- HV Power supply and control : SNU
- Vacuum system : SNU + UNIST
- Electron source : KU
- Beam extraction and buncher : KU
- Beam monitor : SNU + KU

Help/collaboration from GBAR will be very important

(Tokyo, Swansea, Saclay…)

Installation of the new Lines to the existing Experiments (Project "Phase 2")

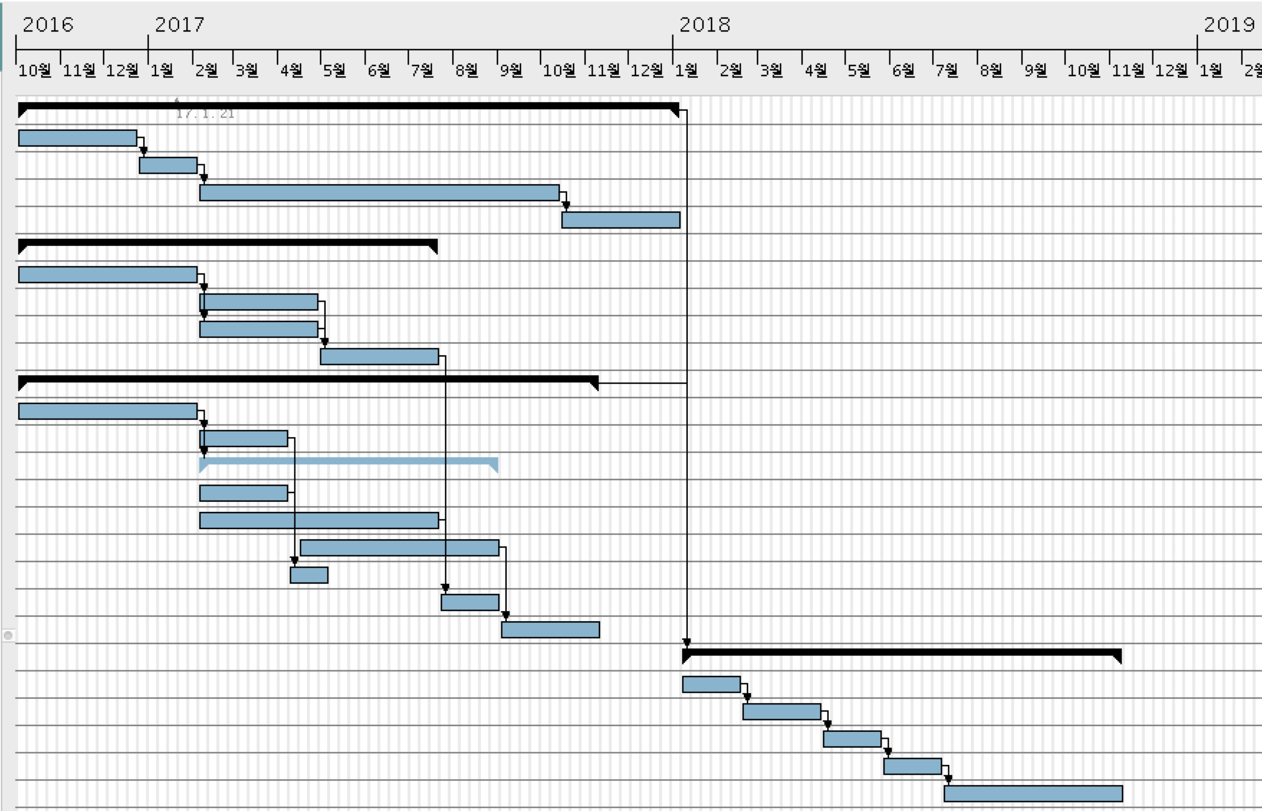


GBAR Antiproton trap

Schedule

GANTT project

이름	시작일	종료일	기간
⊟ Magnet	16. 10. 3	18. 1. 5	330
Magnet design	16. 10. 3	16. 12....	60
Magnet order	16. 12. 26	17. 2. 3	30
Magnet Fabrication	17. 2. 6	17. 10....	180
Magnet comissioing	17. 10. 16	18. 1. 5	60
⊟ Electrodes	16. 10. 3	17. 7. 21	210
Electrodes design	16. 10. 3	17. 2. 3	90
Electrodes fabrication	17. 2. 6	17. 4. 28	60
Power supply	17. 2. 6	17. 4. 28	60
Electrodes test	17. 5. 1	17. 7. 21	60
⊟ Vacuum system	16. 10. 3	17. 11....	290
Vacuum system design	16. 10. 3	17. 2. 3	90
Vacuum chamber fabrication	17. 2. 6	17. 4. 7	45
⊟ Vacuum pump purchase	17. 2. 6	17. 9. 1	150
Scroll pump	17. 2. 6	17. 4. 7	45
TMP	17. 2. 6	17. 7. 21	120
Cryopump	17. 4. 17	17. 9. 1	100
Vacuum test 1	17. 4. 10	17. 5. 5	20
Vacuum test 2	17. 7. 24	17. 9. 1	30
Vacuum test 3	17. 9. 4	17. 11....	50
⊟ System Integration	18. 1. 8	18. 11. 9	220
Magnet+Vacuum System	18. 1. 8	18. 2. 16	30
Electron commissioing	18. 2. 19	18. 4. 13	40
Move to CERN	18. 4. 16	18. 5. 25	30
Installation	18. 5. 28	18. 7. 6	30
comissioning	18. 7. 9	18. 11. 9	90



1st milestone : design/specification of components Feb. 3, 2017

—> another mini-workshop to finalize the design

Discussion

- Schedule
- Magnet specification (B, length, …)
- Elctrodes design and fabrication
- HV distribution/control
- Vacuum system
- Beam interface : injection/ejection/electron source
- Do we need degrader ? How thick ?
- Injection beam energy ?
- Recycling sheme
- …
- May need to be conservative ?