

# Step IV Schedule

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Last time (CM30, Oxford):

- Solid vs hydrogen first  $\Rightarrow$  stay flexible.
- Machine physics periods: do not rely on.
- More detailed plan.
- Particular dates  $\Rightarrow$  remove for now, all dates tentative.

- Verify cooling formula for various momenta, optics (beta functions), material ( $X_0$  and  $dE/dX$ ).
- 3 beam momenta: 140, 200, 240 MeV/c.
- 3 emittances: 3, 6, 10 mm.
- Flip/non-flip optics.
- Different values of beta at the absorber (low betas are interesting but maybe problematic due to large  $\beta_{max}$ ).

## Step IV, empty with windows + LH2

- Commission system, tracker, detectors, optics.
- Compare  $\varepsilon_{in}$  and  $\varepsilon_{out}$  for some momenta/emittances/betas.
- (Hopefully) much can be done during the long MP period.
- Effect of windows.
- Measure cooling properties of liquid Hydrogen for various momenta/emittances/betas.
- First(?) measurement of ionization cooling.
- Systematic errors.
  
- Summer + early Fall 2012 = installation.
- September 2012 = running with empty LH2 absorber (ISIS run-up + long period of MP + part of the user run).
- October 2012 = filling up LH2 absorber, running with LH2.
- Early November 2012 = remove LH2 module.

Can we do everything in a single run?

## Step IV, empty + flat LiH

- mid-November 2012 = run with no absorber (nor windows); one week of MP, one week of running.
- Late November 2012 = install LiH flat disk; less than a week, but we are going from empty AFC to a solid absorber.
- December 2012 (3 wks) = run with LiH flat absorber, see next slide.
- Late December 2012 = dismount LiH disk.

Time estimates based on tables by John Cobb:

- Absorber replacement: 8 days (maybe less than that, especially going from the empty AFC to a solid absorber).
- Change configuration (3 momenta, 3 emittances, 2 beta functions, flip/non-flip(?)): 8 days (1 day for a flip/non-flip change,  $12 \times 0.5$  days to change reference momentum and beta, 1-1.5 days to change emittances, 3 for each configurations assuming 1 hour to make a change).
- Ensure the parameters are correct and matched well (prior simulations and test + online tools).
- Data taking in each configuration: 4 hours. 36 configurations = 13 days (two configurations per day + change parameters).  
According to Linda a good day yields 10-11 hours of running.
- Total: 5 to 8 days to (re-)place the absorber, 21 days for data taking.
- Not impossible in a single run, but ambitious.

Can we do empty + LiH disk in a single run?



## Step IV, other materials

- Run the next cycle with different materials (since the support structure is already in place), using smaller number of configurations (3 momenta, 3 emittances, 1 beta, no changing polarity).
- Two materials should be possible per run (PE + Al).
- On the other hand, there goes one more run (postpone until after the wedge absorbers were fully tested?). Judge by the degree of readiness for Step V.

## Step IV, LiH wedge

- January–February 2013 (assuming no run with other disks) = install LiH wedge (90 degrees).
- Late February–March 2013 = run with LiH wedge; consider different configuration, possibly, wedge rotation by 90 degrees as well. Time should be sufficient based on the estimates for the flat absorber.
- Time-permitting: consider removing one half-wedge.
- End of March 2013 = remove absorber.

## Step IV, extra cycle, other considerations

- As time permits: run with LiH half wedge absorber + LiH wedge in a different orientation, or other flat absorbers as discussed above.
- If we can get more useful muons per spill data collecting will happen faster. How many muons we expect to see?

- Dedicated run for liquid hydrogen (+ empty AFC).
- Dedicated run for empty channel + LiH disk (detailed study).
- Dedicated run for other two materials (less detailed study, or postponed altogether until after wedge studies).
- Dedicated run for LiH 90 degree wedge (detailed study + possible orientation change).
- Time-permitting: dedicated run for LiH 45 degree half wedge.
- Detailed study: three weeks; short study: two weeks; absorber replacement: 8 days (maybe less), only essential if done in the middle of the run.

## Rough estimates of time for one solid absorber – large error bars!

		Times	Hrs	Days	Tot	
Change absorber		1		8.00	8	A.N. at CM28
Change Flip /non-flip	Need experts, times are	1		1.00	1	<i>Guess - cables must be swapped, checks....</i>
Change momentum & beta of Cooling chan	working days	12		0.50	6	3 momenta x 2 betas x flip / non-flip
Change beam momentum & emittance		36	1	0.04	1.5	3 beam emittances at each of above settings
Run	Non -experts	36	4	0.17	6	~50,000 muons at 5 good muons / spill

Total time

23 days 24 hour / day running

30 days 12 hour / day running

- No large efficiency factors or contingency
  - but many guesses
- Overheads seem to dominate
- May like better to balance overheads & running?
- Suggests ~3 weeks for a complete set of measurements with one material plus 8 days (~2 weeks) to change an absorber
- **Would also like empty (no absorber) running – so double the time?**
  - but do this only once
- Would we really want to do this with all materials?
  - 5 materials → ~150 days ~ 1/2 a year