Summary of the RHIC Retreat 2004

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The RHIC Retreat 2004 took place on June 7-9 2004, a few weeks after the end of Run-4 machine operations. It proved once again a useful forum to assess past and discuss future performance, and to optimally plan for the next run – and beyond – together with the physics experiments. Attendance was relevant C-AD personnel, representative and liaisons from the experiments, and management. The overall agenda and copy of all Retreat presentations can be found at www.agsrhichome.bnl.gov/AP/RHIC2004/Retreat.

The goal of this document is to present a selected list of issues that were discussed at the Retreat, and were recognized to be high priority for work during the shutdown and planning for the next Runs. This list can be used as a work planning document for the next run and as a complementing input to the RHIC Experiements BUP's and PAC, planned respectively for July 28 and September 8-10, 2004, together with the RHIC Collider Projections documents. Points discussed in the latter will not be repeated here.

A concern that was unanimously voiced from the accelerators is that the present timing of the decision process for the RHIC Physics runs does not match the timeline for optimal machine planning . With the schedules for RHIC and BUP's listed above, a final decision for Run-5 would be taken only about 20 days before the start of cool-down, presently planned for October 1st. Plans that are known months in advance would optimize shutdown activity and run preparation by prioritizing activities inherent with a specific operation mode.

An example for Run-5 is the selection of a preferred light ion, which impacts injector preparation and RHIC ramp planning. Another example is the priority of low-energy collisions: if it is high, that would raise the priority of work related to RHIC tuning speed and experiment magnet polarity changes. In general, with limited budget and manpower resources, RHIC run preparations must closely match the effective run requirements.

Moreover, it has become less important for BUP's to wait for conclusive experiment data analysis from the most recent run, since more mature and reliable beam performance now provides more data than can be fully analyzed in a few months. Thus there is more to be gained in machine performance and planning by accelerating the BUPs by 2-3 months than there is to be lost in the input of physics data analysis to the process.

The short term proposal for **Run**-5 is to have a **draft decision** on light ion species and energies by **August 15**, to allow the injector development in early October to be properly planned.

For **Run-6**, and subsequent runs we propose to **shift the physics experiments decision process** (**BUP's and PAC**) **earlier by at least 3 months**, so plans are in place by the time we enter the summer shut-down.
A "drop-dead" date for shutdown work is also proposed for optimal planning and to minimize the risk of delays in the start-up of yearly operations with beams. For Run-5 preparation, all major shut-down work is planned or in progress now, more than 3 months away from the start of cool-down.

The rest of this document is an annotated list of issues from the Retreat, explaning briefly the context or the possible impact where applicable and the action that is taken or planned about it, over the shutdown and during operations. The issues are loosely grouped following the Retreat structure.

1. Interface machine and experiments

Physics

- **Uranium-Uranium collisions**. Interest was expressed for the study of elliptic flow. The machine feasibility needs to be addressed but it is likely feasible when EBIS becomes the ion injector.
- **p-A versus d-A**. Asymmetric collision with protons may have theoretical advantage over deuterons. Machine feasibility assessment is again needed.

Machine-experiments overall planning

- **Accelerator Run planning**. Asking that BUP proposals and PAC are moved ahead by 3 months (cfr. discussion above)
- **Choice of light ions for Run-5**. Asking for a draft decision latest by August 15th.
- **Set-up during holidays**. To be avoided if possible, by defininig start and end of run well in advance. It is recognized that it is impossible to insure that, and the overall system must have the flexibility to absorb unforeseen schedule changes.
- **"Drop-dead" date** for summer shutdown work. All proposals and plans for work during the shutdown should be in place at the latest 3 months before initial cool-down, a guideline already in place for Run-5 preparation.
- **Luminosity from ZDC**. It agrees well with calculation from machine parameters, for both Au and protons. We will rely on ZDC's for official performance monitoring during the next run.
- **Start of physics running**. 4 weeks of set-up and ramp-up are foreseen for the light ion run, 3 weeks for polarized protons. Over the last run, it proved beneficial to start physics as soon as possible. Declaring the start of physics running is based on guidelines – i.e. minimum useful luminosity, and polarization for PP run – that needs mutual agreement from machine and experiments.
- **Performance**. Minimum determined by Run-4 Au performance, maximum by bunch intensity and encountered limitations. Detailed discussion in the Collider Projections document.

Experiments – MCR interface

- **End of store**. A fixed end of store determined by MCR, with count-down procedure, and veto option from the experiments is proposed as the most efficient. That reflects indirect RHIC and direct Tevatron experience.

- **ZDC's under C-AD control**. We propose that the ZDC's – as main collider performance diagnostics – be controlled by C-AD. This includes control system archives and logs of ZDC parameters such as threshold and timing.
- **Experiments magnet control from MCR**. From last run experience, we could have profited by having the Star magnet under MCR control, for operation efficiency and perhaps power consumption. As the issue in not simple, a working group has been formed to study implications and propose a technical solution for shutdown work.
- **MCR monitoring of experiments DAQ status**. Useful and proposed by operations.
- **Vertex information** from experiments to MCR. Deemed useful to receive vertex information independently from the experiements and the wall current monitor. It was suggested to simplify WCM information.

Scheduling

- **Impact of NSRL run**. NSRL will run the 1st week of October according to the present plan. With cooldown starting October 1st and operation with beam foressen for mid October, the NSRL run overlaps with injector preparation with a new species. Careful operation and scheduling planning will be necessary to minimize conflicts and not to wear out personnel right from run start.
- **Experimental magnets PS testing**. Needs to be done earlier than last year.
- **Dry runs**. From positive previous experience, 2 dry runs will be scheduled, respectively 5 and 1 week before beam.
- **Run meeting structure and organization**. No need to change as it worked well in the past. Emphasis on short and effective meetings. We added an injector run coordinator, responsible for injector integration and configuration control during the run.
- **Luminosity increase development**. After physics running starts, we plan on up to 8h day shifts, Monday to Friday, for luminosity (and polarization) development, in the light ion (and polarized proton) run.
- **Beam Experiments**. After physics running starts, we plan on up to 12h/week, for beam experiments during the light ion and polarized proton run.
- **PASS testing**. Must be scheduled before RHIC starts.

2. Operations

Injectors

- **Integration of injectors**. Generally desirable. Steps to be taken: Tandem presence at 8:30 run meetings, injector run coordinator, integration of RHIC and injectors operations tools (see action items on tools below)
- **Reduce inefficiencies**. A list of inefficiencies in the injector complex was identified at the Retreat that can be fixed with possible good efficiency pay-off. A more complete list is being drafted. A plan for implementing the higher-priority recommendations needs to be drafted as soon as possible, and carried out during this summer shutdown, with the rest carried over successive runs.

- **Injection set-up**. The pay-off has been analyzed at the Retreat. Improvments: a faster injection application, automatic field adjustments in the AGS, interlock of low intensity bunches during the filling process, etc.
- **Evaluation of stripping and overall efficiency**. Needed for the light ion-species as run preparation. In progress.
- **Bunch merge for protons**. The development is not straightforward. Possible options have been discussed after the Retreat at a meeting overviewing RF plans for Run-5, and are being evaluated.
- **Store-to-store optimization**. The goal is to increase store time from the ~55% of Run -4 to ~60% over the next few years through injector set-up improvements.

RHIC

- **Set-up optimization**. Implement suggestions based on machine predictability, preparation, and task scheduling
- **Sequencer**. More automation is needed (steering, collimation), and generally improved error handling.
- **Ramp reverting tool**. A system to fully revert a ramp (magnets and RF) available to operations is needed. We also need this capability for individual step-stones.
- **Decoupling on ramp**. No satisfactory way to operationally correct coupling on the ramp exists yet. The best candidate is via amplitude or phase modulation of skew quadrupole families. An application is being written to do that.
- Faster **RF set-up** with beam. Re-bucketing re-commissioning should start as soon as beam can be stored at flattop.
- **Frequency error on ramp**. Precise centering of the closed orbit in the gamma-t quadrupoles around transition is needed.

Configuration/operations tools

- **Configuration control** and update. Unanimously found necessary, beyond the read-the-elog to keep track of configuration changes. Solution proposed, followed-up after the Retreat, are 2 WEB based configuration tables (tunes, intensities, etc.) one for RHIC, one for Injectors to be linked from the main e-log WEB page. Changes are responsibility of the run and injector coordinators.
- **Automated fill parameters**. Automatic storage in a database of fill and store parameters for display and further query-based analysis was discussed, along the lines of the existing FNAL SDA (Shot Data Analysis). After the Retreat we decided to implement a Phase-1 version, where 10-12 parameters for RHIC and 10-12 parameters from the injectors will be routinely data-based. Phase-1 includes a simple GUI to make this information accessible to operators and users.
- **e-logs**. After discussion it was agreed that e-logs should continue being also a communication tool, but OC should be informed of relevant entries on the e-log. Consolidation is also desired.
- **Remote operation**. Remote set-up and expert work are a fact of RHIC life by now and effective. They will happen under explicit OC monitoring and control. OC will be requested and will grant permission to do work from home **and** the office.

- **Role of operations**. A increased role and responsibility for the operations group during set-up, ramp-up, luminosity development and beam experiments shifts (see later) was proposed and strongly agreed upon.

3. Systems

Polarization

- **Polarimeter**. Great progress was made during Run-4 in polarization measurements. The electronics must be upgraded to allow independent measurement in blue and yellow. A polarimeter application is needed for efficient use of the polarimeter by operation.
- **Polarization related equipment**. Controls need improving (data access, looging, set-up)

Power supplies

- **Y7TQ6 high resistance**. It did not impact operations in Run-4 but it is metaphorically a loaded gun. In a meeting after the Retreat, decision was taken to open the cryostat and attempt a repair. The magnet will need to be taken out of the tunnel and the repair – depending on outcome - may potentially affect overall shutdown and run planning. We will need to address the capability of producing magnet spares over the life of the project.
- **QLI reduction program**. The overall goal is to reduce the number to under 200 in Run-5 from the ~250 in Run-4.
- **Faster down-ramps**. A factor 2 reduction seems feasible. No ramp rate changes are foreseen for the up ramp.
- **Corrector PS failures**. The situation improved considerably during Run-4. A plan is drafted to reduce further failures in Run-5.
- **Voltage tabs for leads**. Adjust to required lead-flow, increase reliability.
- **Valve boxes**. bring valve boxes in line with drawings

Instrumentation

- Move all **BPM electronics** into alcoves.
- **IR BPM boards**. A re-work to get rid of the relays on the IR BPM borads have been proposed. Testing of the solution after the Retreat gave positive results and the boards will be modified.
- Replace **10 FEC's** with radiation hard ones.
- installation of 10 self-correcting **memory cards** in alcove 7c.
- **BPM timing** and **DX timing drifts.**
- Change thresholds and/or time constant of BLMs to reduce beam induced QLI's. Analysis of Run 04 data is in progress.
- **IPM upgrade**. A new gated readout to avoid MCP (micro channel plate) damage has been proposed. A system analysis and model has been asked to evaluate the solution before the test with beam.
- **Schottky**. A complete analysis of the LF and HF Schottky has been presented after the Retreat with a plan for improvement. The development emphasis will be on measurements at store.
- **PLL**. No plans for tune-feedback are in place for ramp set-up in Run-5. Feed-forward is in the plan.

Vacuum

- Installation of ~250m **NEG coated beam pipes**
- **STAR and BRAHMS** vacuum upgrade
- Faster vacuum read-out in cold arcs, diagnosis of **cold bore pressure rise**

Controls

- **Reduce controls downtime.** Mainly traced to old controllers, quench/permit 6B, file system, radiation in alcoves types A and C.
- Overview and prioritization of controls **software projects** for Run-5

Others

- **5 o'clock triplet**. A program of work and tests for the stiffening and the roll correction is in place. The timeline for now is consistent with machine cooldown starting October 1st.
- Install last **vertical collimators**
- **Re-alignment**. On the basis of recent survey data, a re-alignment of the 12 o'clock IR, that keeps sinking at a rate of 1mm/year, is necessary as well as re-alignment of selected magnets in 5 o'clock arc.
- **Cryogenic system** reliability

4. Machine configuration, Model, Beam Experiments

Configuration

- Basic **optics configuration** from last run
- Development of ramp to **beta*=0.85-0.90**. Online matching capability of online model is necessary, to keep dispersion and power supplies currents under allowed operational limits. A ramp will be developed over the summer and a decision on the initial beta8 configuration.
- **Working point**. Recommendation to run at the SPS working point (~0.69) – favourable for beam-beam and polarization - for both light ions and polarization. Tune swing on the ramp or third-order compensation at injection are necessary.

Online model

- Understanding and control of **linear optics at store.**
- Minimize **turn-around time** for different ramps
- Quartic start of **brho ramp**. Separate ps tracking and transition.
- Reduce **PS tracking erros** at flattop. Slow down flattop approach.
- Fix **chromaticity mismatch.**
- Fix remaining 0.3% of **TF error.**
- Predict tune/coupling effect from **orbit bumps.**
- **Fit capability** in the online model.

Offline model

- Offline model based on integration of **MADX, SXF and UAL**. Tests with dynamic aperture, IR bumps, physics aperture in progress.
- **Resolve difference** between UAL and MADX dynamic aperture calculations and complete the comparison with measured data.

- **Comparison model-machine** data for IR correction, analyze sextupole errors in D0's.

Beam Experiments

- **Scheduling**. 12h/week during LI-LI and PP run, the latter including polarization experiments.
- **Beam Experiments Workshop** to plan Run-5 in September 2004.
- Increased **role of operations** group during beam experiments.
- **e-cooling** request: IBS measurements
- **e-RHIC** request: study parasitic beam-beam and all issues concerning operation with large number of bunches.