The Run II Upgrade Project(s)

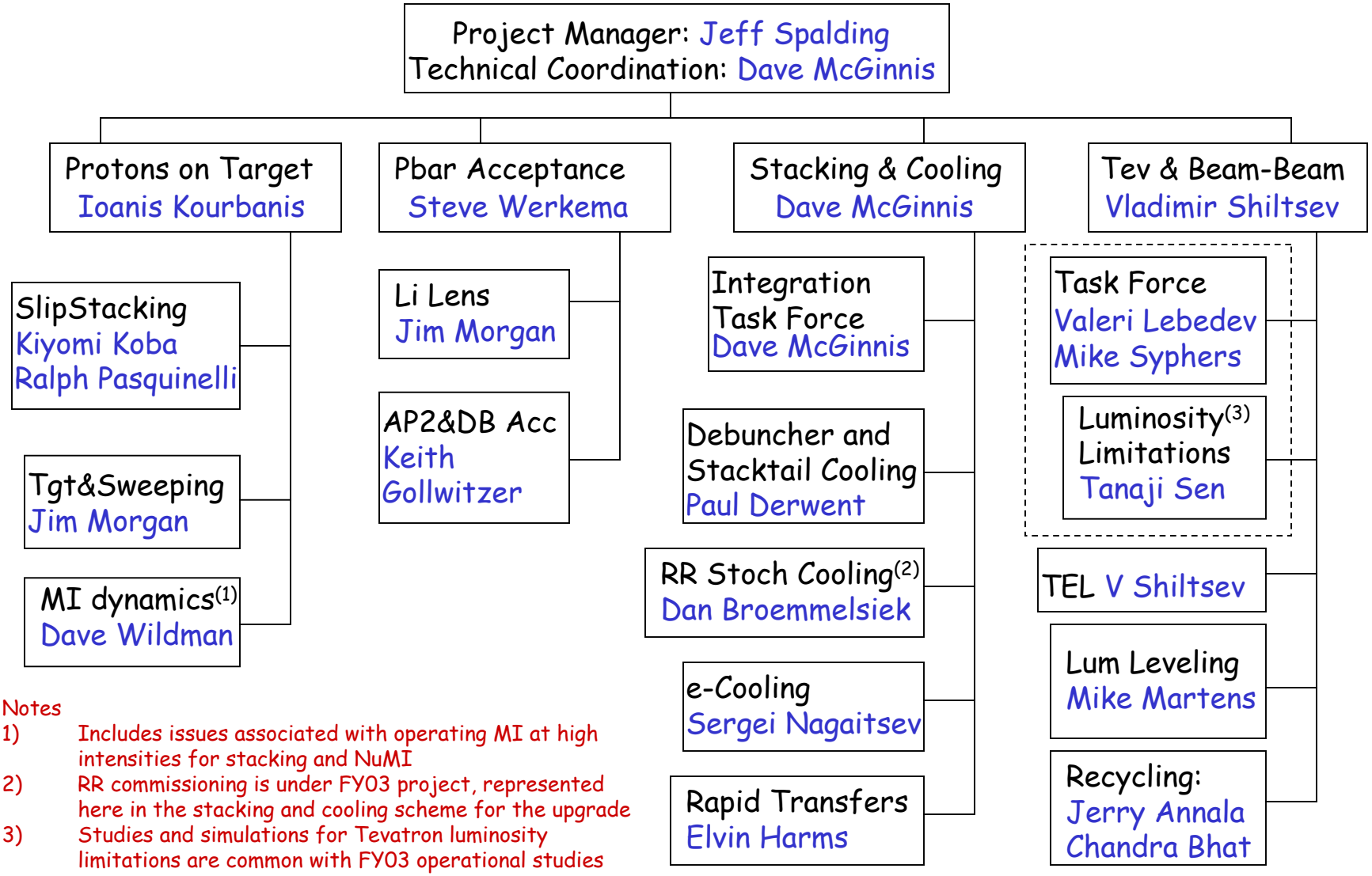
- Project Organization
- Performance Goals and Scope
- Introduce Tomorrow's Talks
- Project Plan for the next few months

The Run II Upgrade Project(s)

- A set of upgrades, building on:
  - Run II Handbook and Recycler TDR = Run IIa
  - Plans for Run IIb (presented to AAC Dec 2001)
  - Report to Director on 132 nsec Operation
  - Operating experience

- Remarks
  - Now operating+commissioning+upgrading → integrated approach for planning and scheduling
  - Work In Progress
    1. Technical scope and issues
    2. Project plan (WBS) and Resource Loaded Schedule

Upgrade Project Organization



Notes

1) Includes issues associated with operating MI at high intensities for stacking and NuMI
2) RR commissioning is under FY03 project, represented here in the stacking and cooling scheme for the upgrade
3) Studies and simulations for Tevatron luminosity limitations are common with FY03 operational studies

Initial Charges to the Two Task Forces

(1) Tevatron Task Force

- Describe operating scenario and implementation for Tevatron operation with ~27E10 protons per bunch and 5E12 pbars total
- Identify the key performance parameters and technical issues
- Outline the simulation/study plan

(2) Stacking and Cooling Task Force

- Describe operating scenario and implementation for an average stacking rate of 40E10/hr for 12 hours, with recycling
- Identify the key performance parameters and technical issues
- Outline the simulation/study plan

Plan to "bootstrap" from this initial charge to a set of operating parameters and definition of technical scope

Performance Goals

Target: Meet or exceed the "stretch goal" = 3fb^{-1} pa (~3-4E32)

- Performance goals will be defined via the Task Forces ("bottom up")
- Starting point:
  - 27E10 protons per bunch (achieved in Run 1b)
  - pBar bunch intensity = 50% p bunch intensity (beam-beam interactions: limit for strong-weak)
  - sustained pBar stacking rate = 40E10/hr, transfers Accumulator → RR every > 30min (< Run IIb spec)
  - 2 hours shot setup (between stores)
  - on completion of the upgrades: 46 weeks per year HEP with 48 hours downtime per week

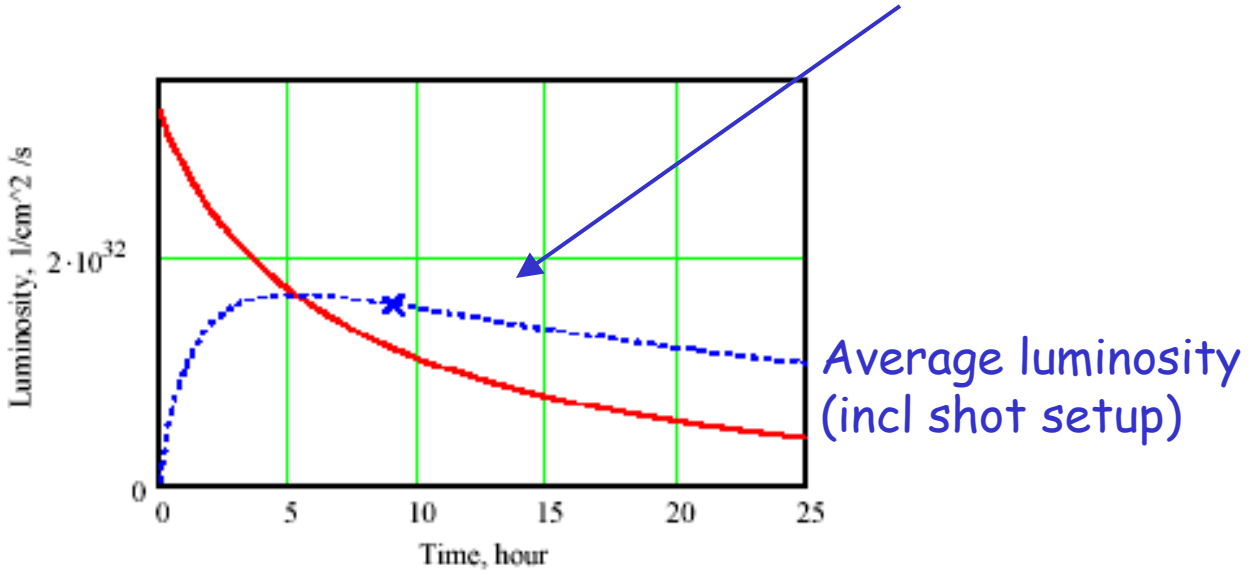
Performance Goals/Scope

- 132/396 nsec (see V Lebedev's talk)
  - Original impetus for 132 nsec operation was to reduce the number of interactions /crossing – this now appears manageable @396 (see below "luminosity leveling")
  - 132 requires a crossing-angle → ~40% red. in luminosity
  - pBar/bunch x1/3, total protons >x3 → concern about long range beam-beam interactions and instabilities
  - Crossing-angle → large orbit offsets in low beta quads
  - Would require large study and simulation effort
  - Significant work on hardware (separators, RF cavities… and instrumentation)

Position: base scope is 36 bunch operation (396 nsec) with lum leveling if needed – will do no further work for 132 nsec operation

Performance Goals/Scope

- Parametric model: achieves 3.2fb^{-1} pa (V Lebedev's talk)
- How robust?
  - Leveling @2E32: lose ~12% (if required by experiments)
  - No recycling: lose ~10% (longer stores)
  - pBar=40%p: lose ~14% (shorter stores)
  - Average stacking = 30E10/hr: lose ~10% (longer stores)



Store length

Performance Goals

Compared to now

x1.5 ➡

x5 ➡

x3.5

x5.7 ➡

	Typical Run Ib	Store 1953	Goal: FY03	Run II Target	
Peak Luminosity	1.6	3.7	6.6	33.0	$x10^{31} cm^{-2} sec^{-1}$
Integrated Luminosity	3.1	6[(1)]	12.0	70.0	pb^{-1}/wk
Store hours per week	84	86[(1)]	81[(3)]	98	
Interactions/crossing	2.5	1.0	1.7	8.5	
Pbar Bunches	6	36	36	36	
Form Factor	0.59	0.60	0.63	0.63	
Protons/bunch	23.0	16.3	24.0	27.0	$x10^{10}$
Pbars/bunch	5.6	2.5	3.1	13.5	$x10^{10}$
Total pbars	33.6	91.0	113.0	486.0	$x10^{10}$
Peak Pbar Prod. Rate	7.0	11.5[(2)]	18.0	45.0	$x10^{10}/hr$
Avg. Pbar Prod.Rate	4.2	6.9	11.0	40.0	$x10^{10}/hr$
Pbar Transmission Eff.	50	60	80	85	%
Stack Used	67	152	141[(4)]	572	$x10^{10}$
β*	35	35	35	35	cm
MI extraction Long.Emit.		3.5	2.5	2.5	eV s
Bunch Length (rms)	0.6	0.6	0.54	0.54	m
Proton Emittance (at coll)	23	19	20	20	π-mm-mrad
Pbar Emittance (at coll)	13	14	15	14	π-mm-mrad
Store Length	16	22	15	9	hr

(1) typical for Dec-Jan 03 (other numbers in this column are for store 1953)

(2) best stacking rate achieved $13.1x10^{10}/hr$

(3) excluding studies

(4) additional pBar stack used for RR commissioning

Project Scope

- Luminosity Leveling
  - June 02: Report on 132nsec Operation → leveling at 2E32 $cm^{-2}s^{-1}$ (~6 interactions/crossing)
  - Aug 02: charge to experiments - planned upgrades designed to operate efficiently up to 4E32 $cm^{-2}s^{-1}$ (with ~no contingency)
  - Expect to operate with peak luminosities < 4E32 $cm^{-2}s^{-1}$
  - Will develop ability to level luminosity by varying β^*, should this be needed
  - 12% reduction for leveling @2E32$cm^{-2}s^{-1}$ is "worst case"

Project Scope

- Recycling (V Lebedev's, V Shiltsev's talks)
  - Historically ~30% of stores end prematurely
  - P. model: ~75% pBar left, 70% acceptance to RR

  } 37% pBars return to RR

  - Recoup with longer stores → lose ~10% in integrated luminosity
  - Biggest issue is the timely removal of protons (without risk to experiments or quenching), followed by pBar deceleration
  - Would require significant studies

Position: will not include recycling in the base scope

Project Scope

- Bunch Intensities (see V Shiltsev's talk)
  - Increasing both proton and pBar bunch intensities is key
  - Need to understand long range beam-beam effects
  - Plan to mount a program of studies to benchmark beam-beam effects and dynamic aperture →parametric model
  - Expect improvements from increased orbit separation
    - Short term - C0 Lambertson removal → will learn
    - Longer term – ideas for additional separators
  - Beam-beam compensation:
    - TEL – studies continue, electron gun upgrade → 2nd TEL
    - Consider also wires (as for LHC) ?

Project Scope

- Stacking Rate
  - RR with electron cooling is key to large stack sizes – without "1/N" loss in cooling (x1.5)
  - Developing on an integrated plan for stacking and cooling (D McGinnis' Talk)
  - Once RR commissioned into operations (late calendar 03),re-optimize the Debuncher and Accumulator for stacking rate (P Derwent's talk)

  Also
  - Slip-stacking: low intensity studies very encouraging, writing specs for beam-loading compensation for high intensities (I Kourbanis' talk)
  - Beam sweeping – testing in the next 2 months
  - pBar aceptance: a lot of progress on higher gradient lens, ramping up on documenting and improving the AP2 and Debuncher acceptance (S Werkema's talk)

Essential Components

- Tevatron
  - Increase protons per bunch (x1.6 from present)
  - Increase pBars (x5)
    - Increased separation?
    - Beam-beam compensation: TEL?
- pBar production rate
  - Protons on target (x2 from present, 8E12/2sec)
    - Slip-stacking (beam loading)
    - Beam sweeping / improved target material
  - pBar acceptance increase (x2-2.5, pBar/p 16→35x10^{-6})
    - Lithium Lens upgrade (745→1000T/m)
    - AP2+DB Acceptance (20πH,12πV un-norm →>35π)

Essential Components

- pBar production rate (continued)
  - RR commissioned into Operations (see S. Mishra Talk)
  - Debuncher Momentum Cooling upgrade (--)
  - Stacktail Cooling upgrade (--)
  - Rapid Transfers to RR (every 30 min)

  } x1.5

- Cooling large stacks
  - Electron Cooling in the RR (beam from Acc and Recycling: 22 eV-s/hr and 1.2π mm mrad/hr per 100 mA)

- Develop a phased approach, while continuing to operate and increase luminosity
- Limited shutdowns: <6 wks per summer, ~6 months for experiment upgrades

Studies

- Expect to come up with a substantial study plan
- Tevatron
  - Simulation of beam-beam effects, mis-alignments …
    →dedicated stores to benchmark (one pBar bunch?)
- Pbar Source
  - Reverse protons for acceptance studies (ongoing)
  - Studies to fully characterize present cooling and benchmark calculations and simulations
  - Maybe proton stacking to benchmark at high rates
- Plus - learn from on-going studies, RR Commissioning, MI Slip-stacking, e-Cooling at Wide Band

These studies will be essential to put the upgrade plan on a solid technical foundation

Tomorrow's Talks

Description of the status and discussion of the issues

• 8:00 - 8:40	Tevatron Task Force (Lebedev)
• 8:40 - 9:30	Stacking and Cooling Task Force (McGinnis)
• 9:30 -10:00	Discussion
•10:00 -10:15	Break
•10:15 -10:45	Protons on Target (Kourbanis)
•10:45 -11:15	Antiproton Acceptance (Werkema)
•11:15 -11:45	Stacking and Cooling (Derwent)
•11:45 -12:15	Tevatron and Beam-beam (Shiltsev)
•12:15 -12:30	Discussion

Project Status and Plans

1. Define the Project Scope
   - Basis: all the work in the Run II Handbook…. Run IIb Plan
   - You are here ➡ Develop parametric model for Tevatron stores
   - Develop integrated scheme for stacking and cooling
   - Identify key issues and parameters and define study+simulation plans

   } Task Forces

   - Preparing documentation on Project, Scope, Issues and Status
   - Good progress on many of the subprojects

2. Review technical scope
   - Are there "fixes" we should add?
   - Are there extensions that should be studied in parallel?
   - How robust is the plan? (backup scenario)
   - Review gain/scale/risk ← started
   - Include B.Div and experiments in the "review"

Project Status and Plans

3. First pass at defining tasks (WBS) and est. resources and schedule (bottom up)
   - Resources: personnel, $ and dedicated study time
   - Difficult to estimate for many of the subprojects
4. Progress on the study plan ←crucial
   - Plan may include significant dedicated study periods
     - for parameterizing beam-beam effects
     - for benchmarking pBar cooling systems

→April ←

5. Second pass, consolidate across Run II, "resource leveling"

6. Prepare documentation for DOE (< June 1)

Conclude

- Technical basis is well established
- Developing integrated approach and defining scope
- Developing performance model and engineering specs
- Performance parameters and schedule will be "bottom up"
- Project is highly constrained (time and operations)
- We welcome your input!

From Review Charge

- Is the strategic approach to increasing luminosity into the range 2-4×10^{32} $cm^{-2}sec^{-1}$ sound?
- What are the primary accelerator physics and technology risks associated with this strategy? Can the level of risk be translated into a luminosity performance uncertainty?
- Do opportunities exist for mitigation of these risks through alternative approaches?
- Are operational scenarios developed that appropriately account for the simultaneous needs of fixed target operations?