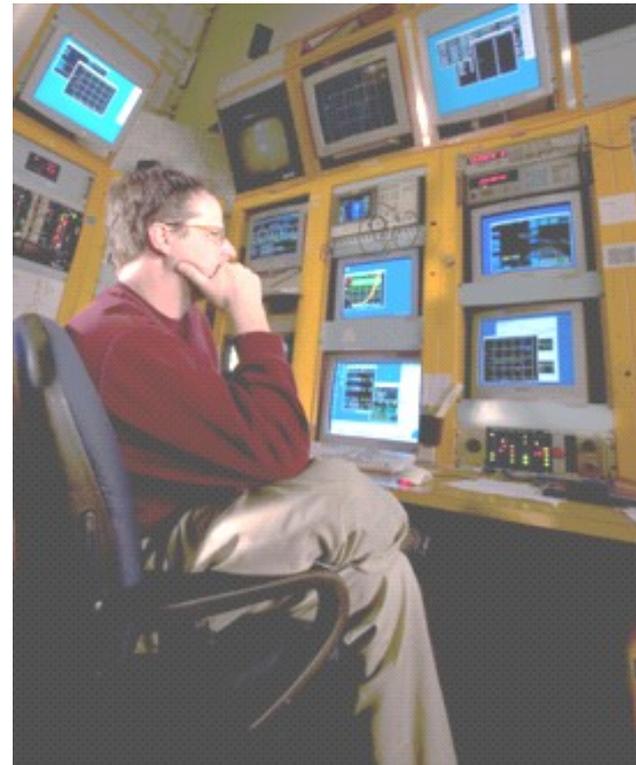
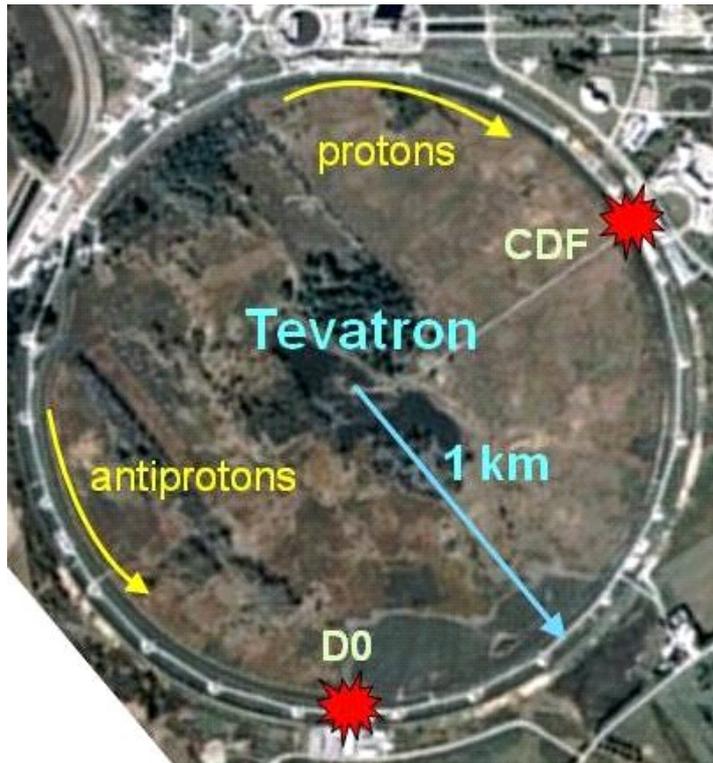


Beam Studies at the Tevatron



Ron Moore

Fermilab – AD / Tevatron Dept. Head



-
- Status of Tevatron Accelerator Studies Program
 - Several ongoing studies
 - What's next?



Tevatron Accelerator Studies Program



- Use Tevatron essentially “as-is” for collider operation
 - No major changes
 - Adding devices in warm straights possible, but difficult due to time constraints
 - But, it doesn't hurt to ask!
- Consider studies during collider operation, a dedicated run, or both
 - End of HEP store studies like T-980 crystal collimation and beam-beam compensation with electron lenses
 - Proton-only or pbar-only studies between HEP stores
 - Desire to have pbars available for dedicated run (collisions and pbar-only)
- Exploit existing Tevatron instrumentation
 - Need support from CDF & D0 for luminosity measurements

Draft 2010-13 Fermilab Accelerator Experiments' Run Schedule

Typically Revised Annually - This Version from June, 2010

Calendar Year	2010	2011	2012	2013
Tevatron Collider	CDF & DZero	CDF & DZero	OPEN	OPEN
Neutrino Program	B MiniBooNE	MiniBooNE #		MicroBooNE
	MINOS	MINOS		OPEN
	MINERvA	MINERvA		MINERvA
	ArgoNeuT			
			NOvA	NOvA
SY 120	MT Test Beam	Test Beam		Test Beam
	MC OPEN	OPEN		OPEN
	NM4 E-906/SeaQuest	E-906/SeaQuest		E-906/SeaQuest

This draft schedule is meant to show the general outline of the Fermilab accelerator experiments schedule, including unscheduled periods.

Major components of the schedule include shutdowns:

In Calendar 2010, a 4 week shutdown for maintenance scheduled to begin July 19.

In Calendar 2011, no shutdown for maintenance is shown.

A 2012-3 11-month shutdown is shown to upgrade the proton source and change the NuMI beam to the Medium Energy (ME) config.

Duration of the MiniBooNE run will depend on preparations for MicroBooNE.

	RUN/DATA
	STARTUP/COMMISSIONING
	INSTALLATION
	M&D (SHUTDOWN)

15-Jun-10

- Tevatron Collider Run 2 still scheduled to continue through Sept 2011
- Few months “available” for dedicated running before 2012 shutdown
- Impacts of FY11/12 budget shortfall or Run 2 extension?



Gathered Ideas at Workshop



- Tevatron Accelerator Studies Workshop held here 13-14 January 2010
 - Organizers: R. Moore, T. Markiewicz, W. Fischer, F. Schmidt
 - ~35 people attended - good mix from FNAL, BNL, CERN, LARP
 - Agenda with presentation slides are available [here](#)
- Enthusiastic presentations and discussions
 - Got initial sense of scale: interest, duration of such a program
 - Somewhat of “chicken and egg” issue
 - More planning and proposals once program approved and schedule
- Provide input for FNAL Accelerator Advisory Committee



Fermilab AAC Meeting (July 28-30)



Fermilab Accelerator Advisory Committee
July 28-30, 2010

Charge (Draft Rev. 2)

The Fermilab Accelerator Advisory Committee is asked to look at activities in three distinct areas related to the development of future programs. The three primary topics for review and discussion are:

1. Proposed Tevatron Collider Studies Following the End of Collider Operations

The Tevatron Collider program is scheduled to end on October 1, 2011. The end of operations offers a unique opportunity to utilize the accelerator complex for a number of studies that could either advance generic knowledge of accelerator physics phenomena in colliders, or provide specific knowledge of utility in maximizing performance of the LHC over the coming decade. A proposal for an extended (4-8 weeks) has been prepared by interested parties at Fermilab, CERN, BNL and elsewhere.

The Committee is asked to review and offer comments/recommendations relative to the end-of-run Tevatron studies proposal. In particular we request specific comments and recommendations in the following areas:

- Are goals of the study period well defined?
- What aspects of the proposal are most compelling in terms of advancing the world's knowledge of the accelerator physics phenomena in high energy proton colliders?
- What aspects of the proposal are most compelling in terms of providing information required to maximize performance of the LHC over the upcoming decade?
- Is the accompanying studies plan/schedule well structured to achieve the goals outlined?

More generally, we would be happy to receive comments and suggestions from the AAC on how the studies plan could be strengthened.

- [Link](#) to agenda, etc.
- FNAL, BNL, CERN all represented and made presentations
- Still waiting for report (!)
- Generally supportive of discussed experiments
- Welcomed the collaboration between laboratories
- Suggested we continue such collaborative efforts
- Demand reports as follow-up to justify resources used, especially for dedicated run



Hot Topics



- Crystal collimation
 - Strong support from CERN
 - N. Mokhov outlined plan for continued T-980 studies during Run 2
 - Also expressed desire for collider and proton-only stores in dedicated run
 - D. Carrigan discussed negative-particle channeling with antiprotons

- Hollow e-beam collimation
 - Strong support from CERN
 - G. Stancari described ongoing work, plans
 - Simulation and test bench for generating hollow electron beam
 - Replace gaussian e-gun in TEL-2 with hollow beam gun (summer shutdown)
 - Request end-of-store studies throughout Run 2, dedicated run also useful



Hot Topics 2



- Beam-beam compensation
 - Interest from both CERN and BNL
- Electron lenses (head-on compensation)
 - A. Valishev described ongoing program at Tevatron (gaussian e-beam)
 - Have used both proton-only and colliding beam stores effectively
 - C. Montag outlined BNL's desires – overlap with Tevatron plans
 - Christoph has visited FNAL to participate in studies
- Wire-based BBC (long-range interactions)
 - Of interest for LHC, not RHIC
 - 1 wire unit will become available from RHIC, but likely difficult for Tevatron



Other Study Topics *(not a complete list)*



- ½ integer working point (*A. Valishev*)
- AC dipole measurements (*M. Bai*)
- Generation of Flat Bunches (*C. Bhat*)
- Electron Cloud (*X. Zhang*)
- Tevatron as 120/150 GeV Stretcher Ring (*M. Syphers*)
- Space-Charge Compensation with Electron Column (*G. Stancari*)

- Luminosity leveling (*dynamic β^* squeeze, bunch length control via RF voltage*)

- Exotica (*not necessarily in short study period*)
 - Plasma wakefield acceleration with hadron drivers (*W. Lu*)
 - Demonstrate self-modulation through a plasma?
 - Optical stochastic cooling
 -

- Various other Run 2 studies not completed



LHC's List of Proposed Experiments



NO	Short Description	Responsible	Coll.	BB	Upgrade	General
1	Hollow e-beam	R. Assmann	x			
2	Crystal Collimation	R. Assmann	x			
3	Luminosity Leveling	R. Assmann F. Zimmermann			x	
4	Diffusion & Halo	R. Assmann	x			x
5	Collimator Impedance	E. Metral	x			
6	IBS	F. Zimmermann				x
7	BB & AC-Dipole	R. Miyamoto R. Tomás F. Schmidt		x		
8	BB Emittance Growth	F. Zimmermann		x		
9	BB Bunch Splitting	M. Giovannozzi		x		x
10	Large Piwinski Angle	F. Zimmermann		x	x	

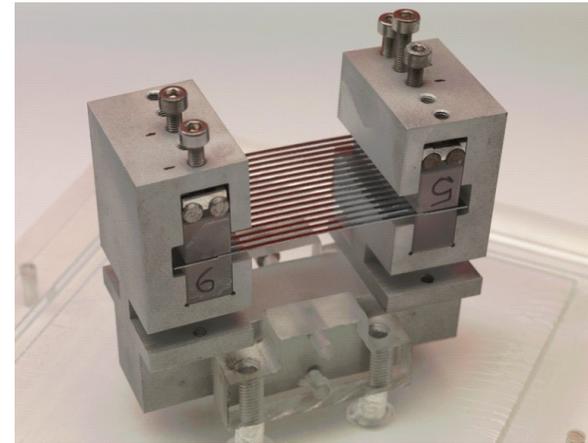
- We have named contacts on Tevatron side, too, so let the work begin!
- Some are proton-only, some end-of-store, some dedicated.
- Any interest from BNL folks to participate?



Crystal Collimation

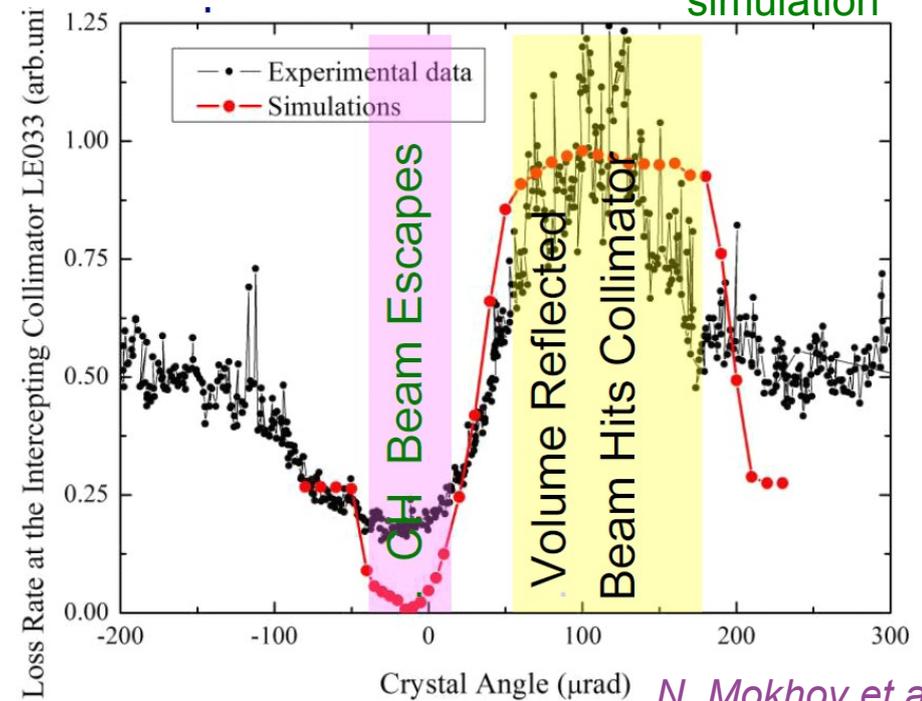


- Ongoing program with strong support from CERN + LARP
- New crystals installed this summer
- Study plan well-developed, end-of-store studies restarting soon
- Hope to install silicon pixel detectors to observe channel/reflected beam directly



New multi-strip crystal installed this summer

Developing volume-reflection simulation



N. Mokhov et al.



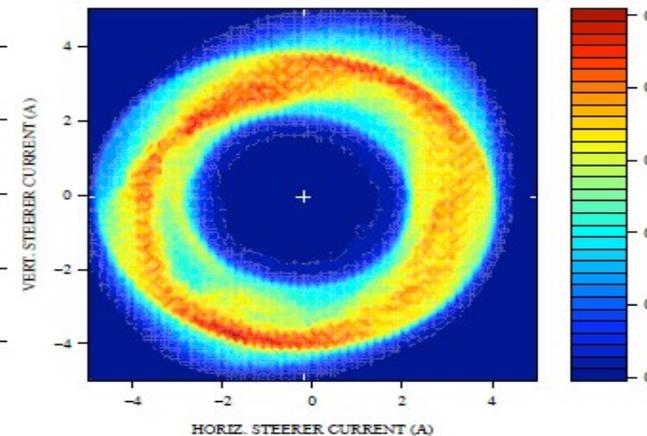
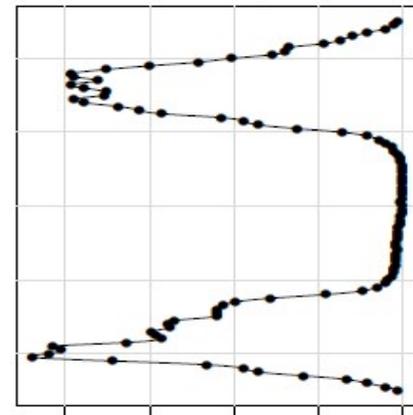
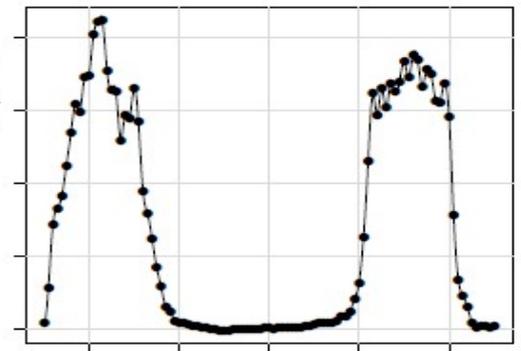
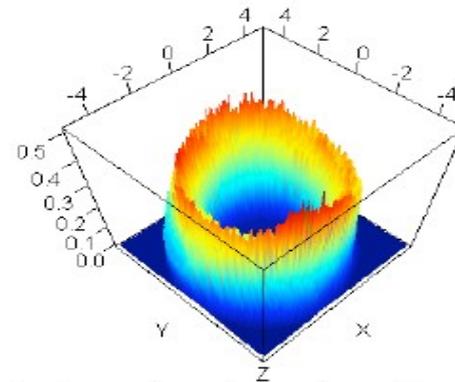
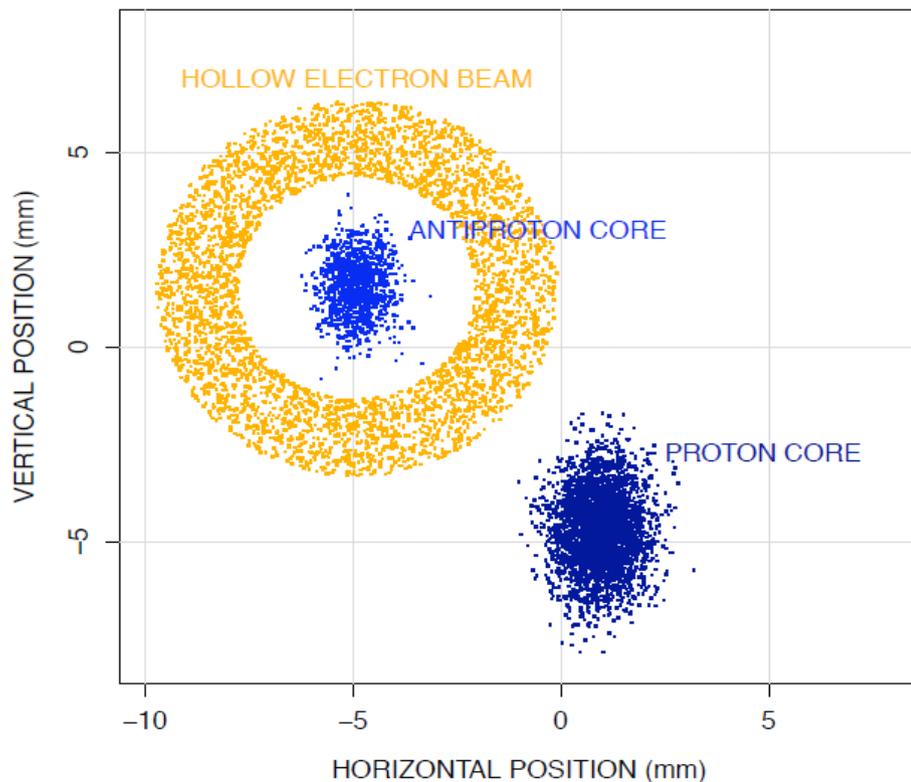
Hollow e-beam Collimation



- Hollow e-beam gun in TEL-2 during the summer
- First end-of-store studies recently completed
- Request ongoing end-of-store studies throughout Run 2
- Dedicated running also useful (guess: 5 8-hour shifts)

*G. Stancari,
A. Valishev*

Hollow-beam collimation concept
at TEL2 location in Tevatron



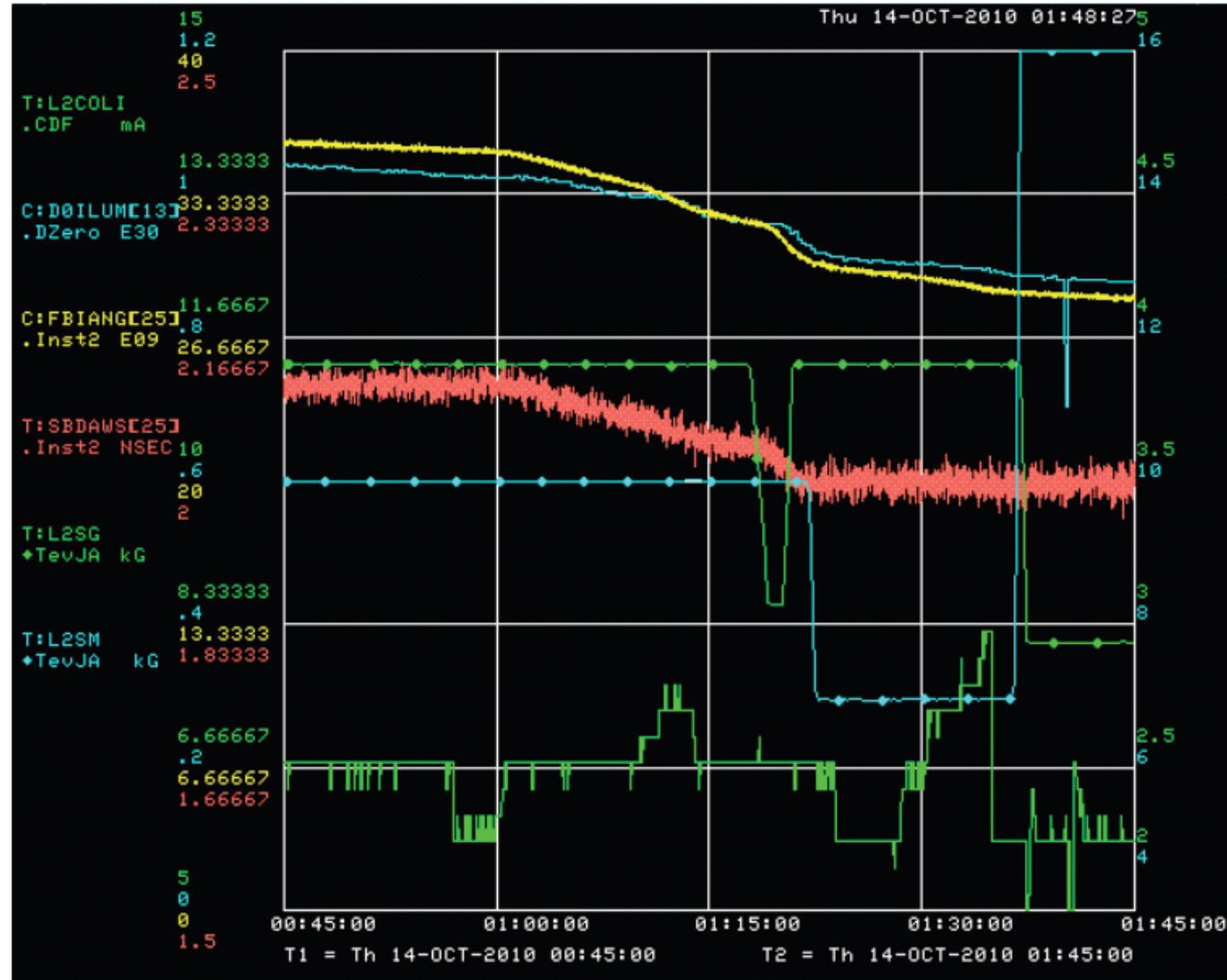


Hollow e-beam Collimation



- Aligned e-beam on pbar bunch
- Watch effect as e-beam size varied (longitudinal shaving for small hole)
- Essentially parasitic, nearly ready to use during HEP stores

Effect on A25 for different ebeam sizes

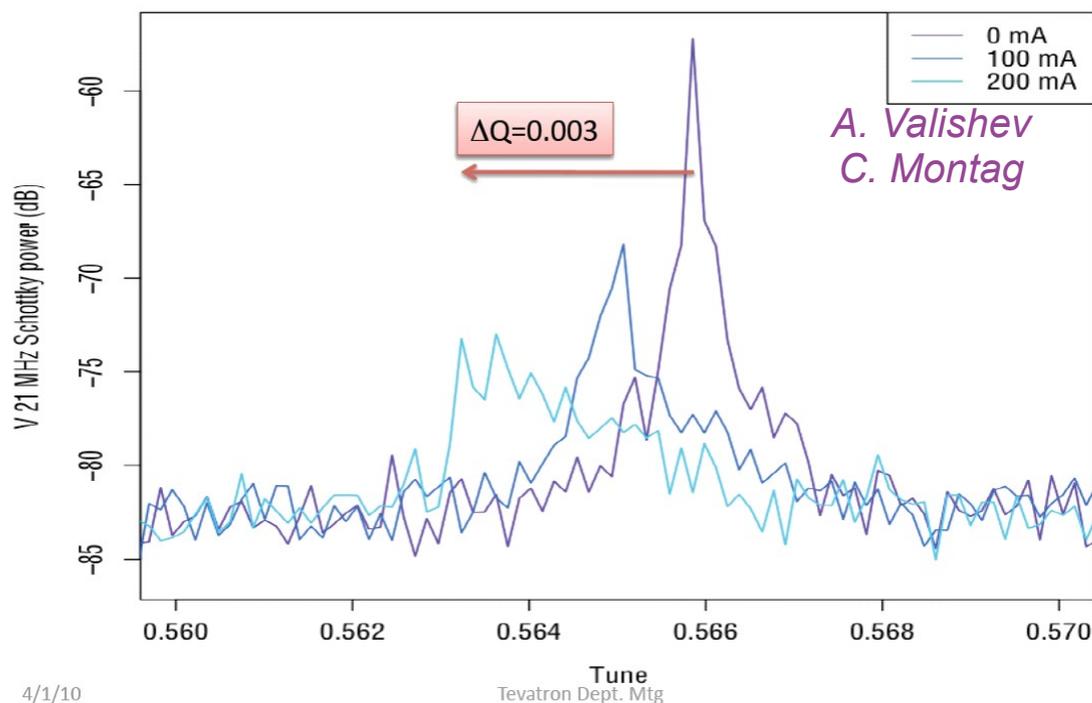




Tune Shift and Spread by Gaussian TEL-2 (antiproton-only study)



Pbar-only store 7720 – TEL on A1–A4



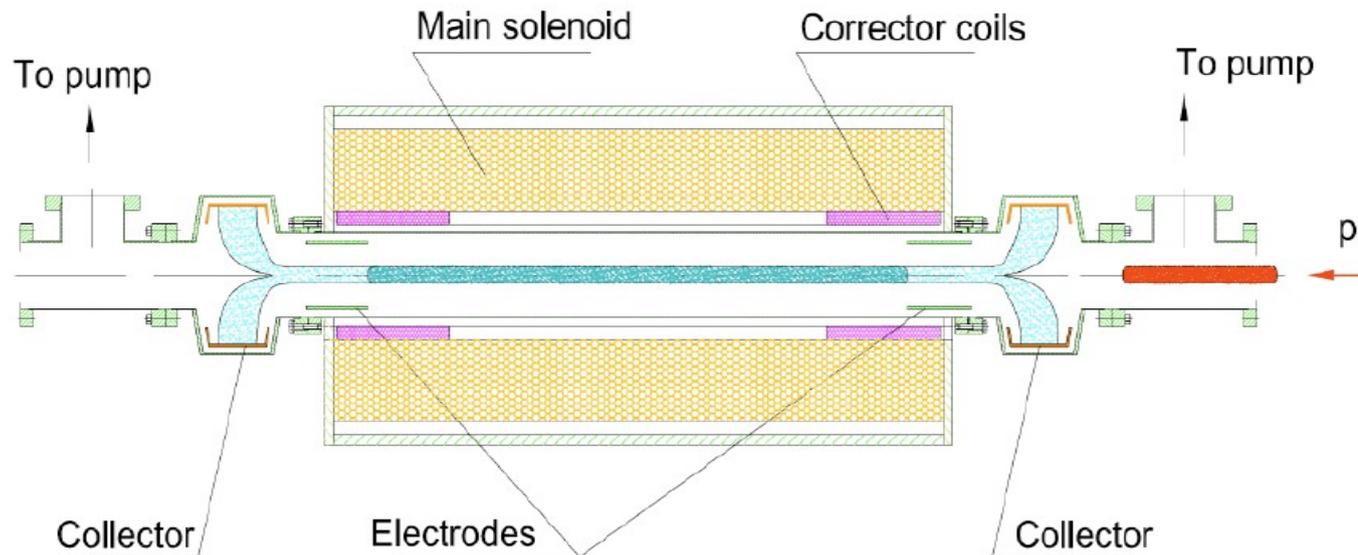
4/1/10

10

- Interest from RHIC, LHC
- Demonstrate tune shifts & spread
- Investigate tolerances of beam alignment over several hours in HEP operation
- Gaussian e-beam gun was removed from TEL-2 for the hollow beam gun



- Use existing TEL to trap e from beam-ionized gas (*G. Stancari*)
 - Have attempted preliminary experiments
 - Proton-only stores during Run 2 and dedicated run (guess: 4 8-hour shifts)
 - Find stable electrode configuration
 - Detect charge accumulation
 - Measure tune shifts vs beam intensity, electrode voltage, gas pressure
 - Extend to 8 GeV for Main Injector or Recycler for intensity frontier?



Shiltsev, PAC07



What's Next?



- Plenty of interesting topics to be pursued
 - Just for science itself and relevance to advancing machine operation
- Overall schedule – impact of external effects?
 - FY11/12 budget impact could reduce Tevatron operation
 - Possible Run 2 extension would delay dedicated run
- Studies not requiring a dedicated run are more attractive
 - Proton-only or even pbar-only stores
 - At end of HEP stores or parasitic in-store operation
- Need more formal proposal/approval mechanism for studies (*BNL APEX*)
 - Helpful for planning support from local experts
 - Also provide feedback to proponents in advance
 - Prioritize, organize, schedule
 - May need to coordinate pbar production, help from CDF and D0



Summary



- Strong interest in experimental accelerator program using the Tevatron
 - During ongoing Run 2 and a ~several week dedicated program
 - CERN+LARP, BNL, FNAL all interested
 - Inter-laboratory cooperation is a key motivation
- Moving forward on LHC studies list (crystal & hollow e-beam collimation)
 - Will be developing the others, too
- Dedicated run is uncertain (funding and possible Run 2 extension)
 - Run 2 extension could mean more time for other studies
 - May be < 1 year until Tevatron end, or 4 years?
- Contact me with your ideas



CERN Support (letter from Steve Myers)



We are strongly interested in, or would like to propose, the following experiments and tests with Tevatron beam:

- Tests of hollow e-beam scraping of proton beams for improved LHC collimation.
- Tests of crystal-based halo cleaning for improved LHC collimation.
- Tests of cryogenic beam loss monitors for improvements of present LHC IR's and future IR upgrades.
- Tests of luminosity leveling with dynamic beta squeeze or dynamic crossing angle variation for future LHC performance upgrades.
- Measurements of equilibrium proton beam distribution for improved benchmarking of diffusion and halo models.
- Measurements of transverse resistive impedance from collimators for improved benchmarking of impedance models.
- Measurements of intra-beam scattering (IBS) with various intensities for improved benchmarking of IBS theory and models.
- Measurements of beam-beam resonances using an AC dipole.
- Measurements of beam-beam effects with various harmonic transverse perturbations for improved benchmarking of emittance growth models.
- Measurements of beam-beam effects for different schemes of transverse bunch splitting.
- Collisions with large Piwinski angle, and possibly with longitudinally flat bunches.
- Study of noise effects in collision, in view of future LHC crab cavities.

Proposals for additional experiments and measurements will likely originate from LHC beam experience in 2010. We estimate that the above-mentioned studies require about 25 shifts of 8 hours, which should be distributed over a period of 6-8 weeks.