

Polarization at HERA- e Status and Plans

15.03.2005

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- Polarization tuning after switching to e^-
- The helicity asymmetry ???
- The beam-beam effect
- Further improvements

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Typical Polarizations

● **HERA-I:**

	⟨achieved⟩	theory incl.misalgn,[w/o BB]
P	50–60%	65–70%

● **HERA-II: e^+**

	achieved/all/ +++/ e^+	achieved/all/ ---/ e^+	theory incl.misalgn&sol,[w/o BB]
P	35–40%	40–50%	57%

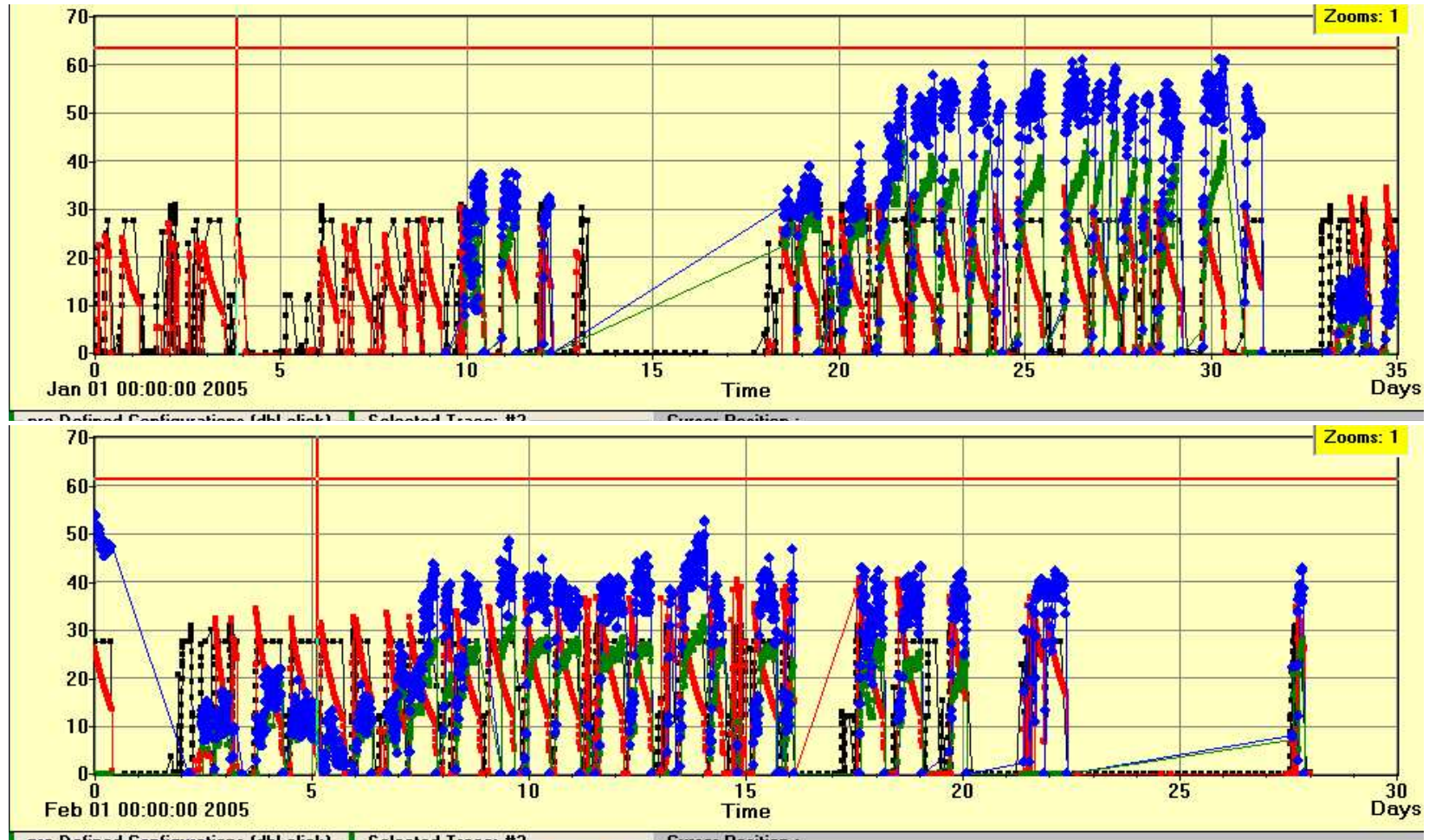
● **HERA-II: e^-**

Start-up with +++ 12.04

02.02.05 : switch to ---

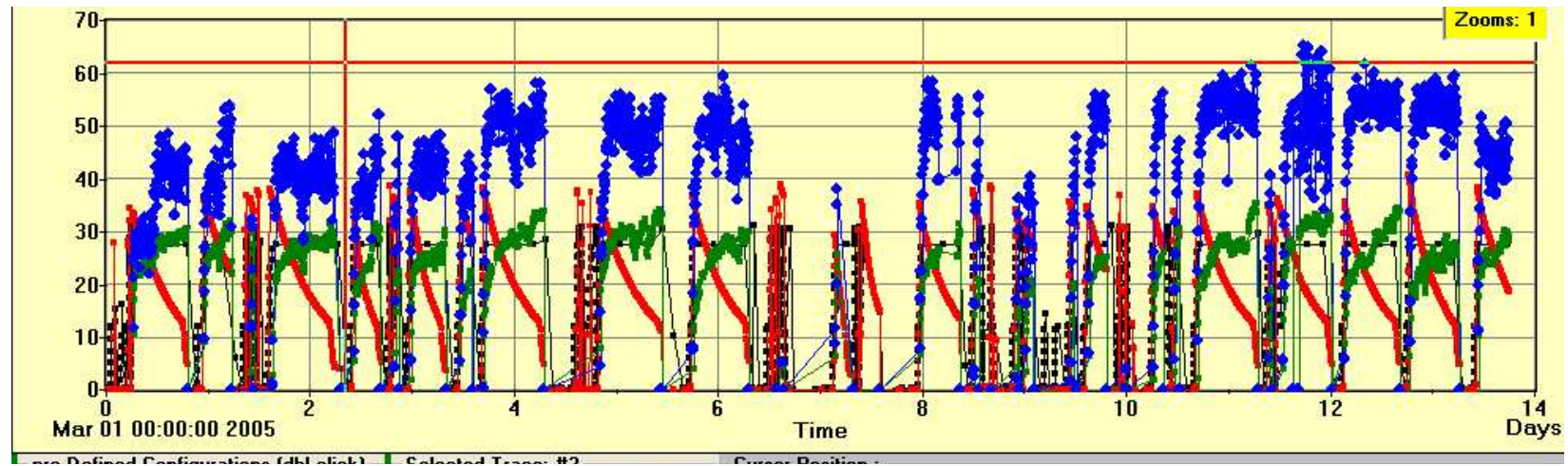
	achieved/all/ +++/ e^-	achieved/pil +++/ e^-	achieved/all/ ---/ e^-	achieved/pil ---/ e^-	theory incl.misalgn&sol,[w/o BB]
P	35–40%	50-55%	30–35%	50-57%	57%
	less beam-beam (I_p^{bunch})		more beam-beam (I_p^{bunch})		

Polarization January/February 2005



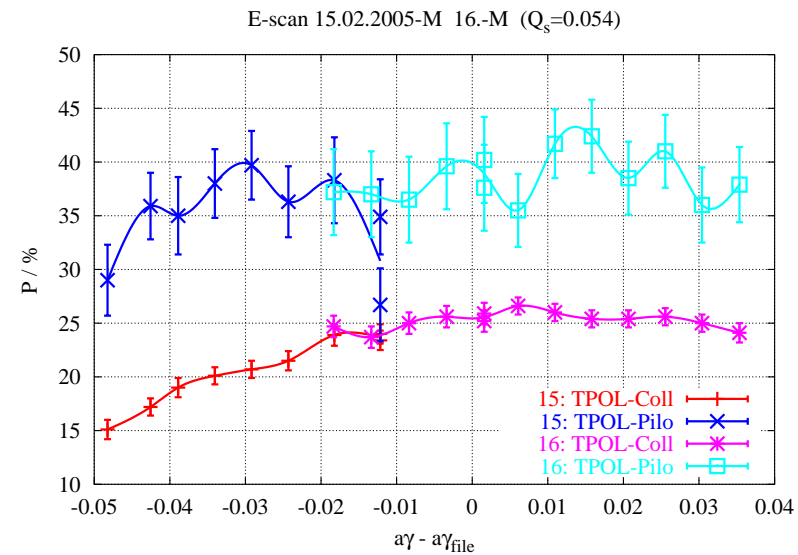
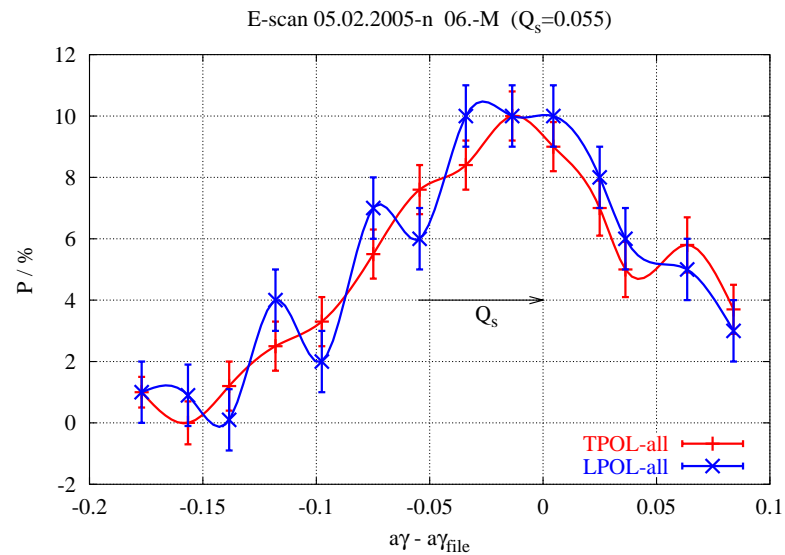
- I_e , TPOL-pilots-5min, TPOL-coll-5min

Polarization until March 14-th 2005



- I_e , TPOL-pilots-5min, TPOL-coll-5min

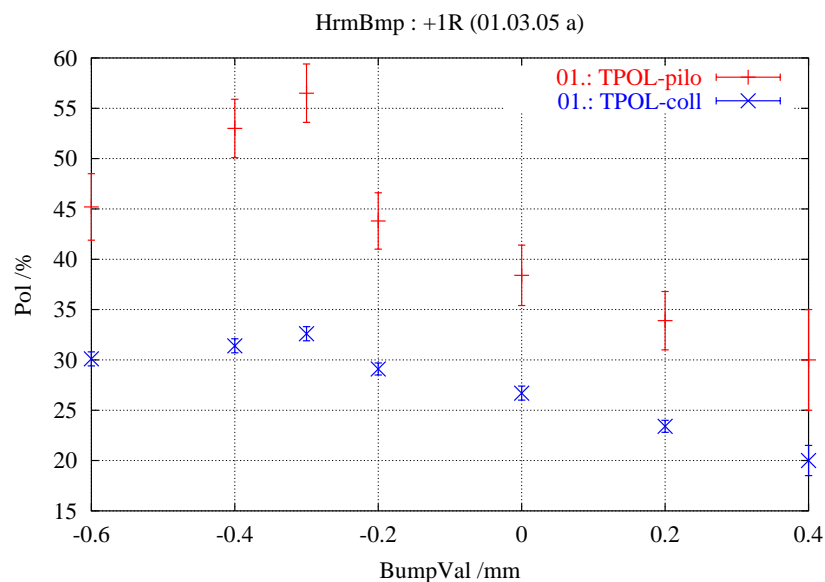
Energy Scans



- Both with helicities : $(-, -, -)$
- 05.02. : before bump scans
- 15.02. : after first round of bump scans
- $\Rightarrow E_{dip} \rightarrow 27.628 \text{ GeV}$
- ... as expected from $(+, +, +)$ & theory

Harmonic Bumps

- Two iterations were needed for 1-st (0R/I, +1R/I) and 2-nd order (-1R/I, +2R/I) bumps.
- scans difficult due to **stability problems & drifts**
- ← improved operational procedures for scans !
- → some 1-st order bumps changed by about 0.3mm
- → some 2-nd order bumps changed by about 1.0mm
- status now : **into LumiFile**
- ← needs continuous monitoring (to compensate the unavoidable machine drifts)



Helicity Asymmetry

- **At the moment effect appears to be gone !**

	ZEUS	H1	HERMES		
first:	+	+	+	$P^{\text{pil}} > 50\%$, $P^{\text{col}} > 35\%$	problem seems gone
	-	-	-	$P^{\text{pil}} > 50\%$, $P^{\text{col}} > 30\%$	

- **but need more (run) statistics !**
- if problems come back ...

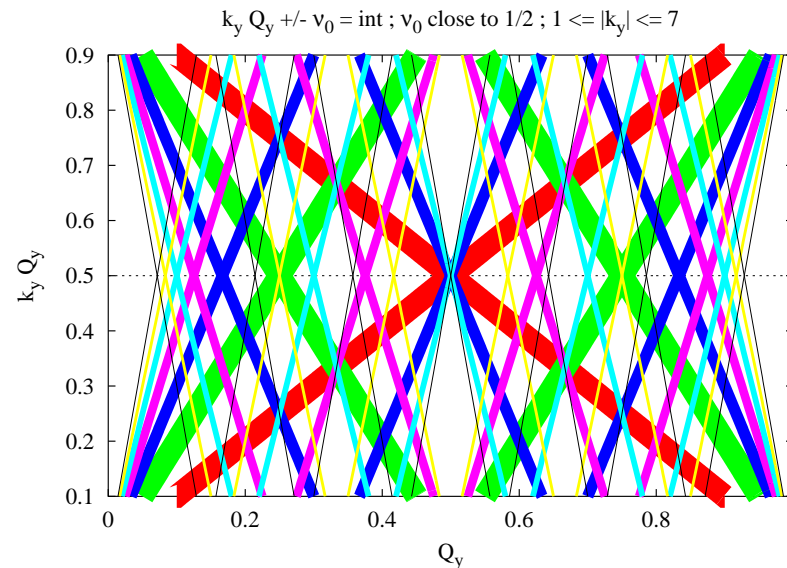
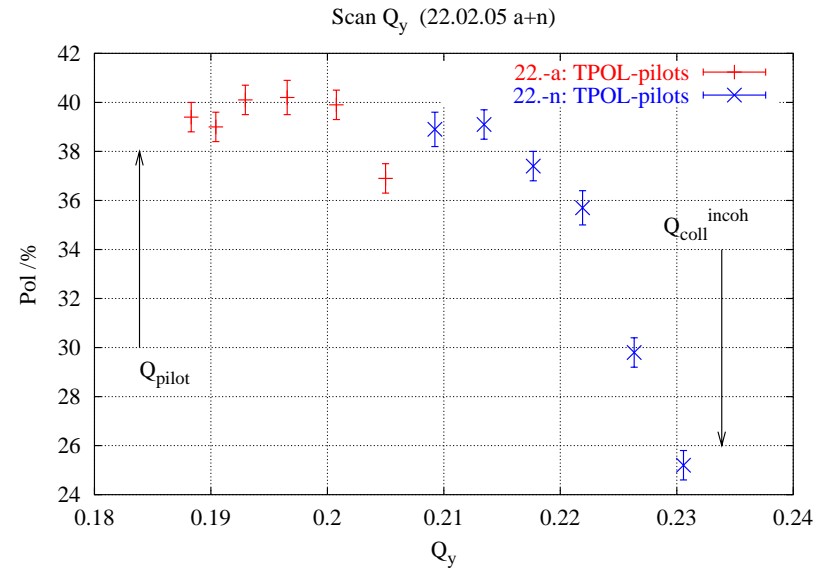
1. Rotator settings : Which IR is giving us trouble ???

	ZEUS	H1	HERMES
if new	-	+	-
trouble	+	-	-

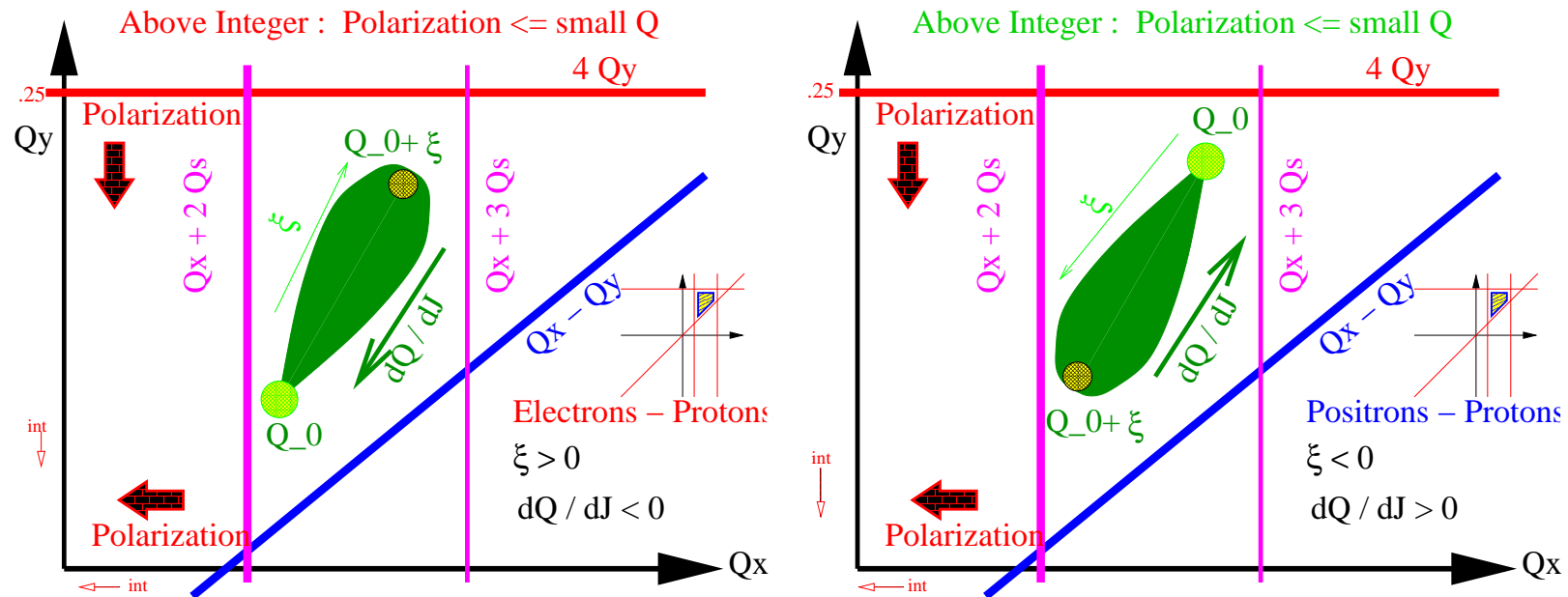
2. Vary rotators (BF/BG) NL/NR ←H1-Sol/GO overlap
3. Vary rotators (BF/BG) NL/NR ←ZEUS-Sol tilt ?
4. New Ideas ?
5. Simulations : Tilted solenoids →(MB-MapGen, Slim/Slick/SITF, SLICKTrack)

OUR LARGEST PROBLEM : BEAM-BEAM

- scan 22.02.05 : e -only run
- With **electrons** on protons : tune shift positive
- \Rightarrow colliding bunches have **higher** tunes
- plus beam-beam nonlinearity
- and beam-beam increased w.r.t. HERA-I
- **BUT** : more space in spin-orbit resonance diagram when **tunes are small** \Rightarrow
- (density of **low order** resonances at $\nu_0 \approx 1/2$ is smaller if Q is **closer to the integer**)

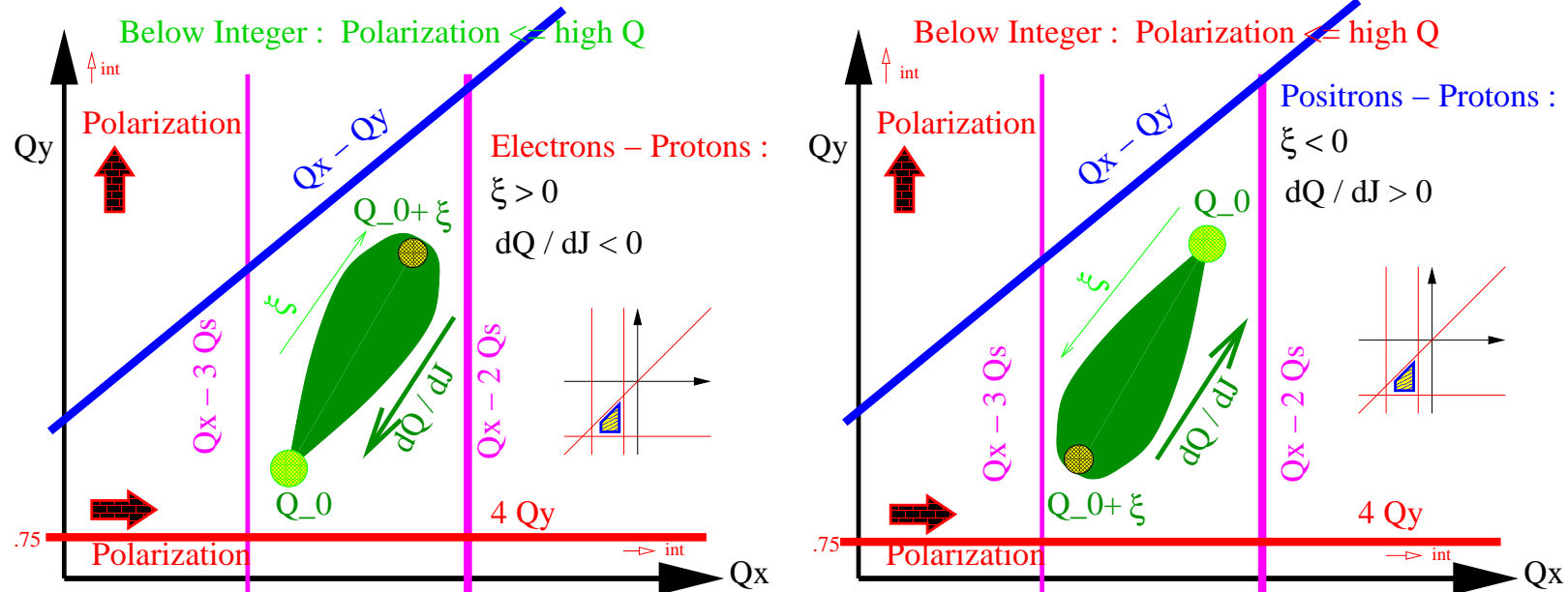


Electron- versus Positron- Tune Space **Above the Integer**



- Limited by
 2-nd and 3-rd satellite (x), and by coupling resonance and 4-th integer (y)
- **Positrons** : beam-beam tune shift drags tunes of colliding bunches **down towards integer**
- **Electrons** : beam-beam tune shift pushes tunes of colliding bunches **up away from integer**

Electron- versus Positron- Tune Space Below the Integer

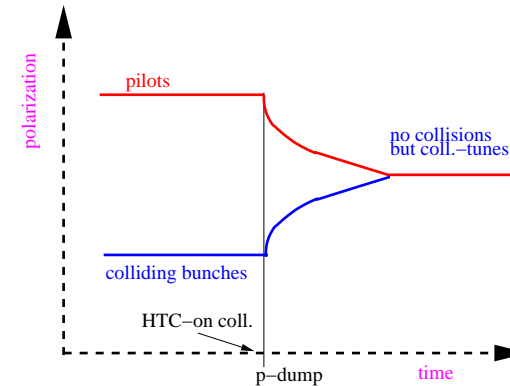


- x : 2-nd and 3-rd satellite interchanged & sum \rightarrow difference
- y : coupling resonance and 4-th integer “interchanged”
- **Electrons** : beam-beam tune shift pushes tunes of colliding bunches **up towards integer**
- **Positrons** : beam-beam tune shift drags tunes of colliding bunches **down away from integer**

Running below the Integer ???

- Complete **new** set of electron files needed
⇒ inj & lum : **OK** [E.G.-W.] / zwi on its way
- Beam-beam collective effects :
during ramp, in case of insufficient separation : $Q_y^e + Q_y^p \rightarrow$ sum resonance
→ potentially more dangerous ⇒ **to be checked**
- ← **if bad** : Can we also run with HERA- p below the integer ??? ⇒ **major effort**
- Resistive Wall instability below integer ⇒ **to be checked**
- Technical issues : e.g. feed back, HTC, ... ⇒ **to be checked**
- Synchrotron satellites change from sum to difference : strengths still comparable?
⇒ **OK** [F.W.]
- If all of the above is checked and settled :
Needs at least a week to tune up operations with “mirror” tunes
- This is not just two machine shift after a maintenance day !
- **and then:** How much is tune shift and how much is non-linearity?

Beam Beam Experiment & e -only run



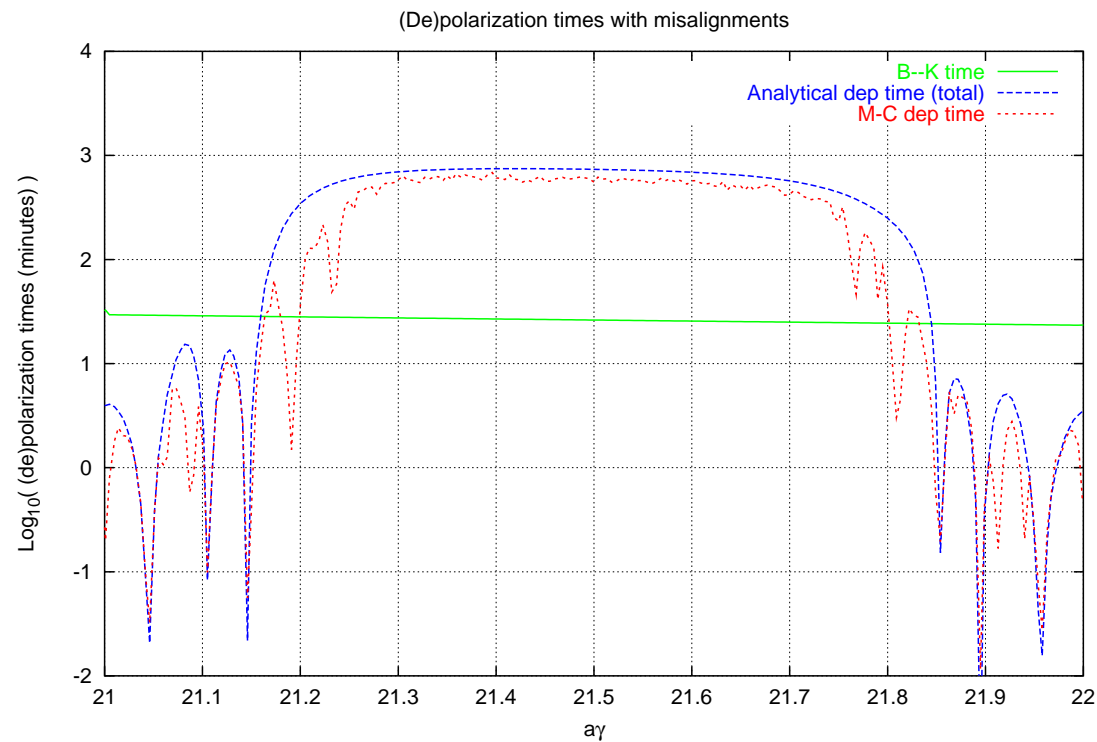
- 24.01.2005-n : end of lumi run (still with +, +, +,) :
measure $\Delta Q^{e'}$'s, p -dump, move coherent $Q^{e'}$'s to $Q^{e,coll}$, wait $\rightarrow P_\infty$

- measured polarizations :

pilot	coll	no-coll at $Q^{e,coll}$
50-55%	40%	45%

- **Need to redo experiment with one simple modification :**
set non-colliding tunes to **incoherent** tune of colliding bunches
 $\Delta Q^{\text{incoherent}} \approx 2\Delta Q^{\text{coherent}}$
- ... plus really non-linear radiative spin-orbit tracking \Rightarrow

Non-Linear Radiative Tracking



- New code SLICKTrack by D.Barber

- Will replace old and “buggy” SITROS

⇐ Example : e -RHIC

τ_{dep} vs. $a\gamma$

→ nonlinear sidebands

- Will soon include
weak-strong
beam-beam

Polarimeters and Tools (1)

- TPOL: rise-time fit → **thanks a lot!**
- Manually triggered average in TPOL-Monitor rise-time-fit display
→ **even more thanks !**
- 10.03.05 : **Cavity-LPOL** saw first **Comptons** → Congratulations !
We put a lot of hope into this new polarimeter !
- **Depolarization kicker** should be commissioned **ASAP** !
(one recent attempt failed due to a technical problem with the amplifier)

Summary

- If enough time and care is spent on optimization, and operation is sufficient stable & reproducibility, then the achieved polarization is not too far from what can be expected for HERA-II with
2 uncompensated solenoids and **increased beam-beam**
- in particular the **helicity asymmetry appears to be gone**
⇐alignment and setting of rotators and solenoids seem to be off the hook...
- The remaining top issue is **beam-beam** :
mainly tune shift plus probably some residual **non-linear effects**
- We pursue the prospects of a new set of electron optics with **tunes below integer**
- However, several issues with these tunes have to and will be addressed
- Even after the feasibility of the “mirror tunes” has been proven, a non-negligible operational effort is needed to establish luminosity operation with these new optics
- Further Improvements :
 - new cavity-LPOL made first big step !
 - depolarization kicker business not yet satisfactory — but experts from both M & F are working on it.