

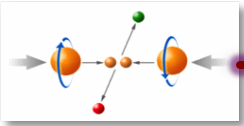
RHIC Store Energy Scan

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Collider Accelerator Dept.

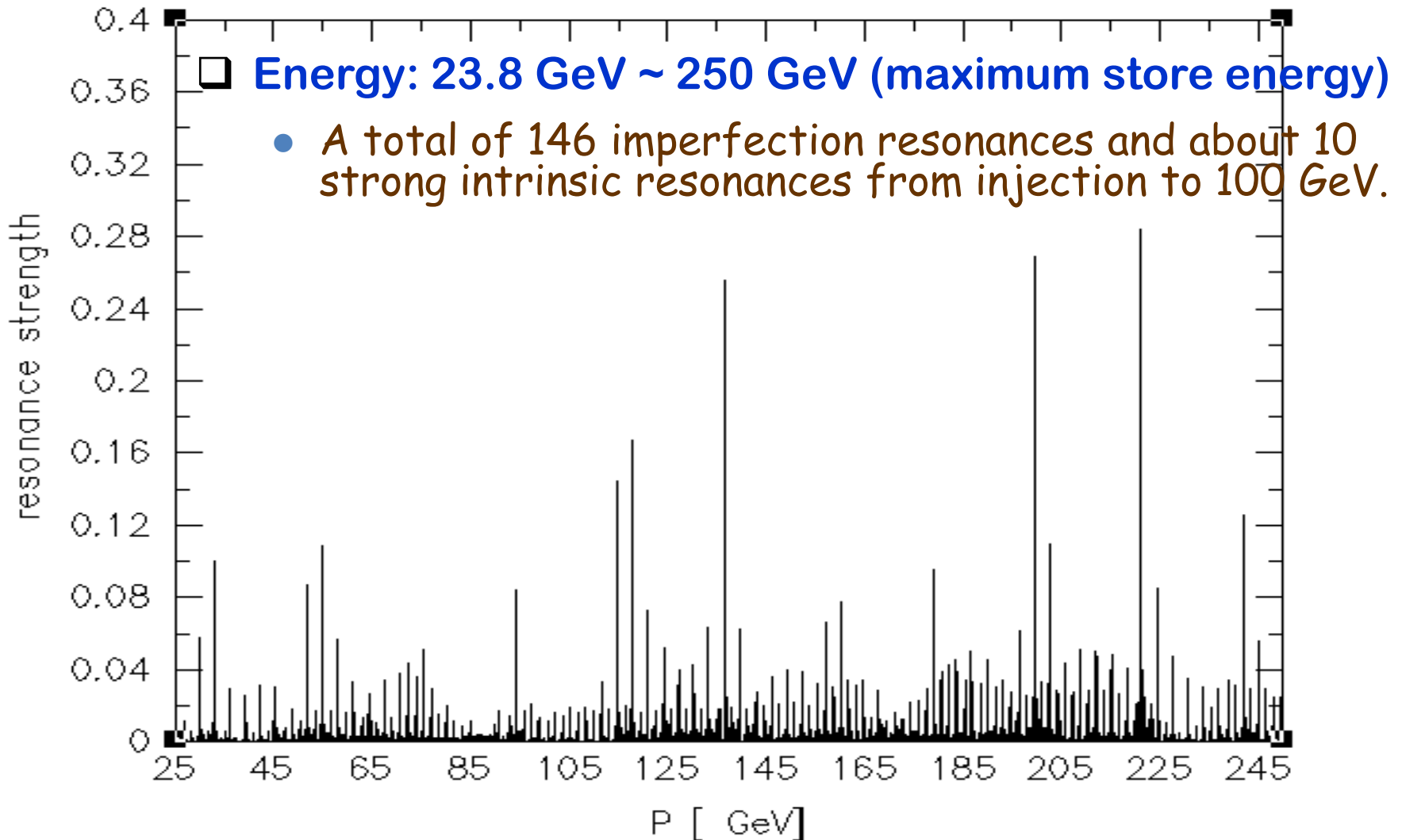
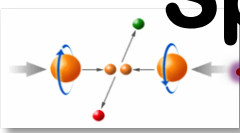
Brookhaven National Laboratory

Motivation

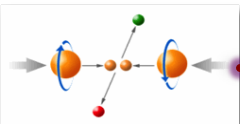


- To check whether our current store energy, i.e. $G_{\text{gamma}}=477.5$, is out of the influence of near-by strong intrinsic spin resonances. If not, find the store energy, which is and also yields the stable spin direction closest to vertical direction
- The benefit of this is to mitigate the polarization lifetime issue, which was observed in RUN11. This should in turn give effective higher store average polarization

Spin depolarization resonance in RHIC

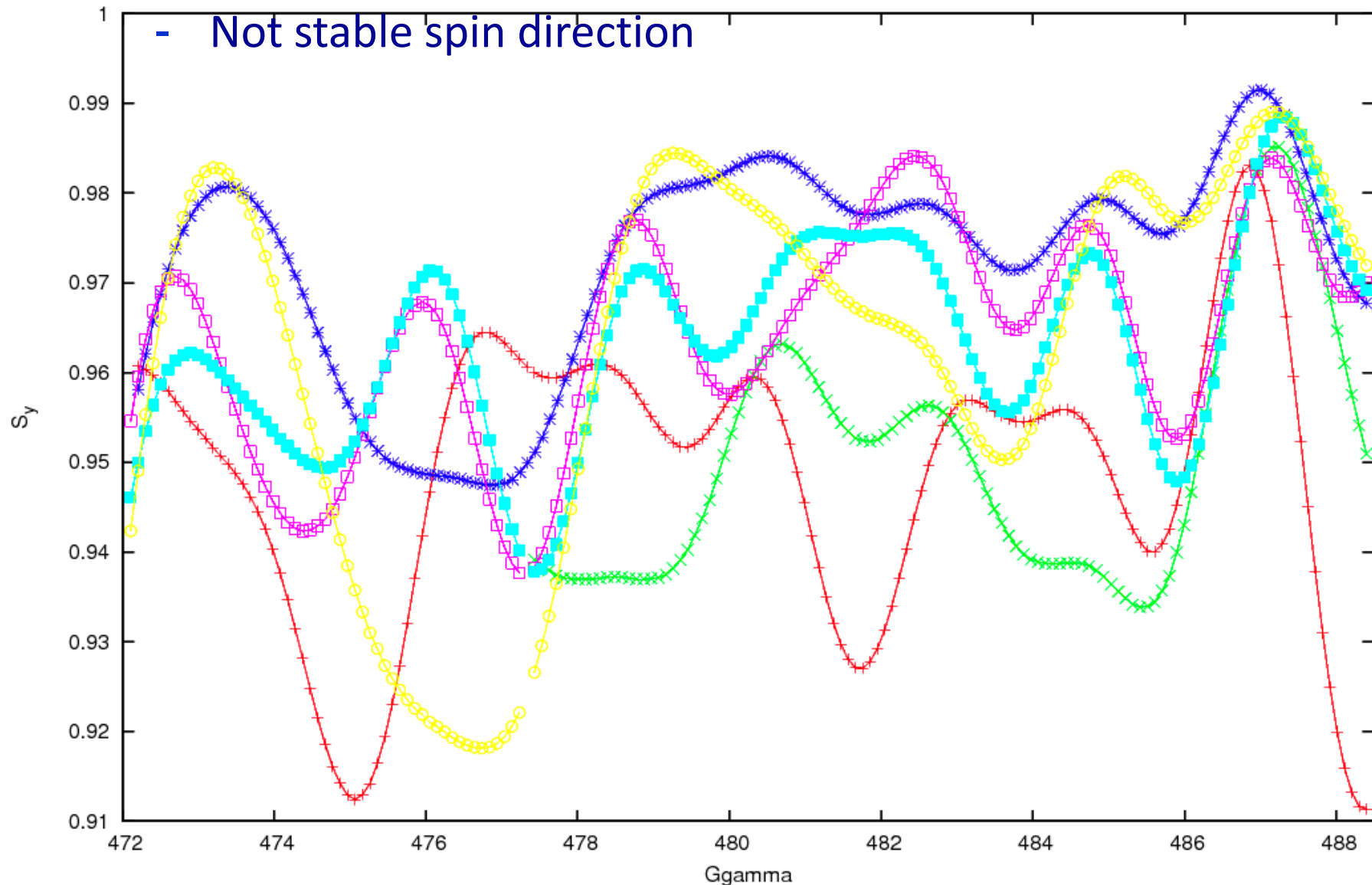


250 GeV Energy Scan

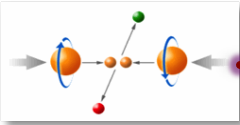


- Averaged $\langle S_y \rangle$ over 1000 turns

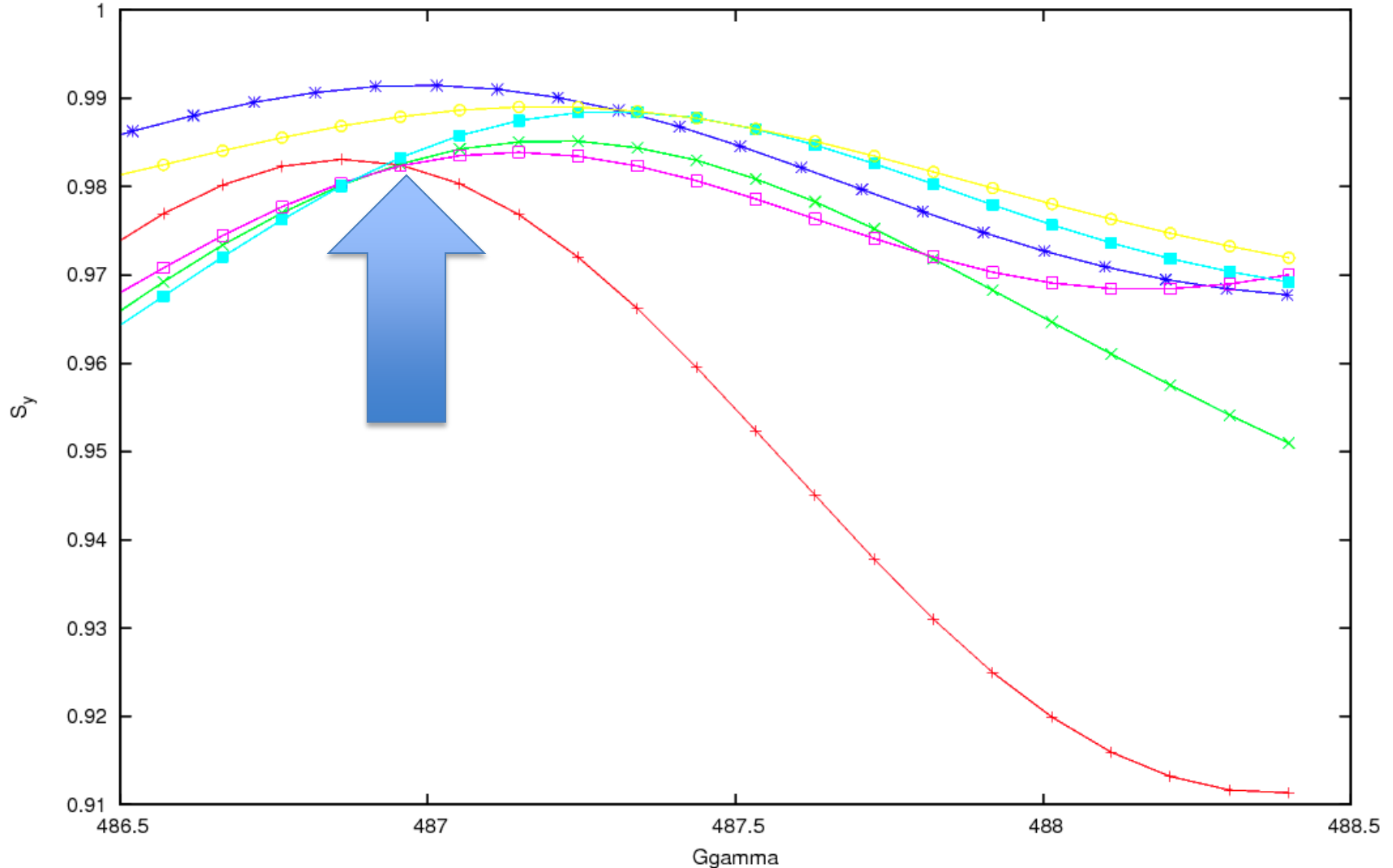
- Not stable spin direction



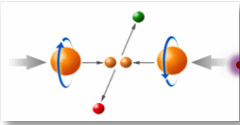
250 GeV Energy Scan (zoom in)



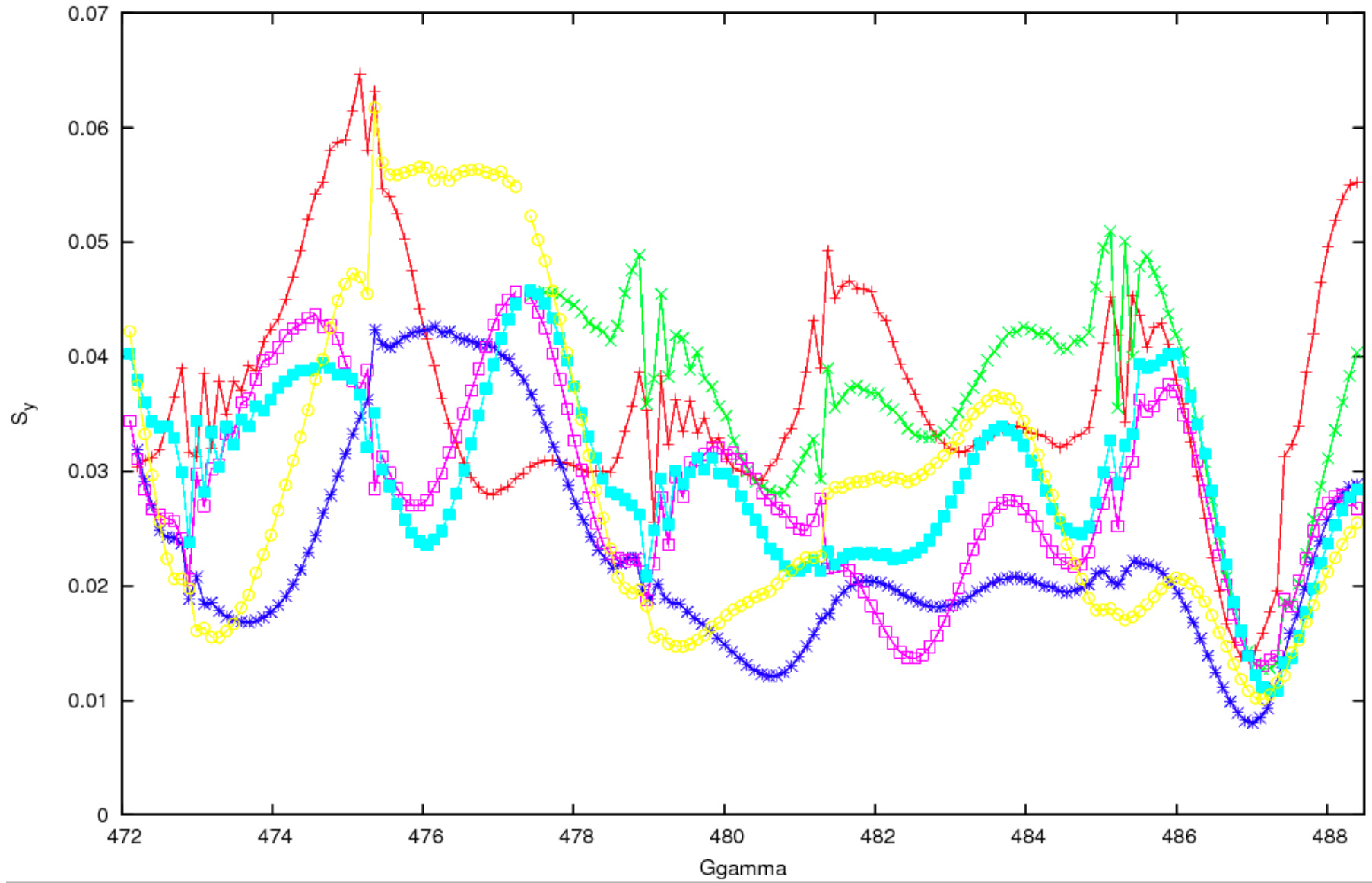
- More vertically oriented
- Less dependant on the betatron amplitude



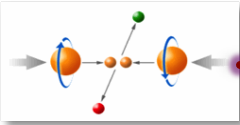
250 GeV Energy Scan



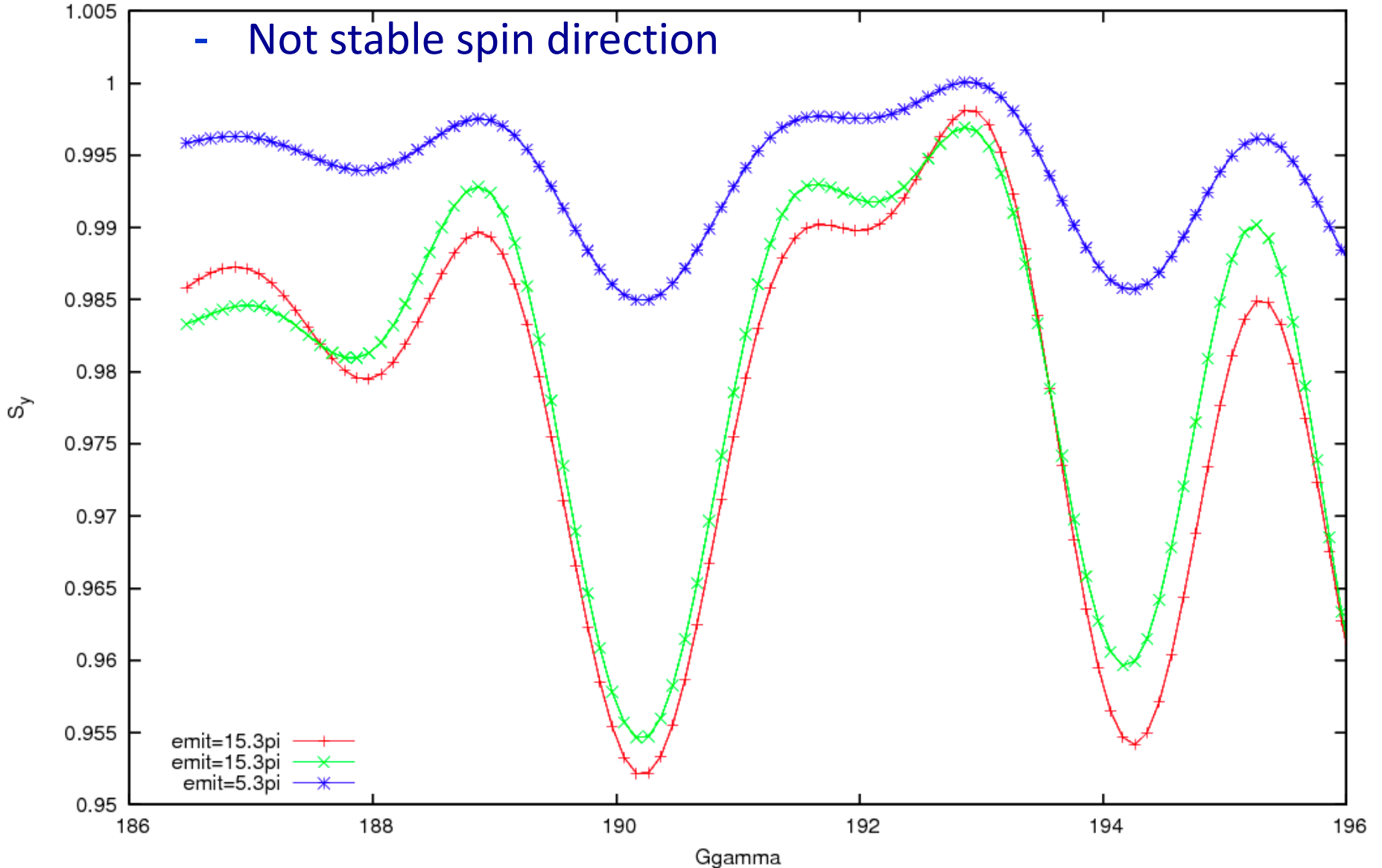
- Spread of S_y over 1000 turns



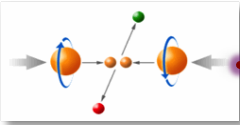
100 GeV Energy Scan



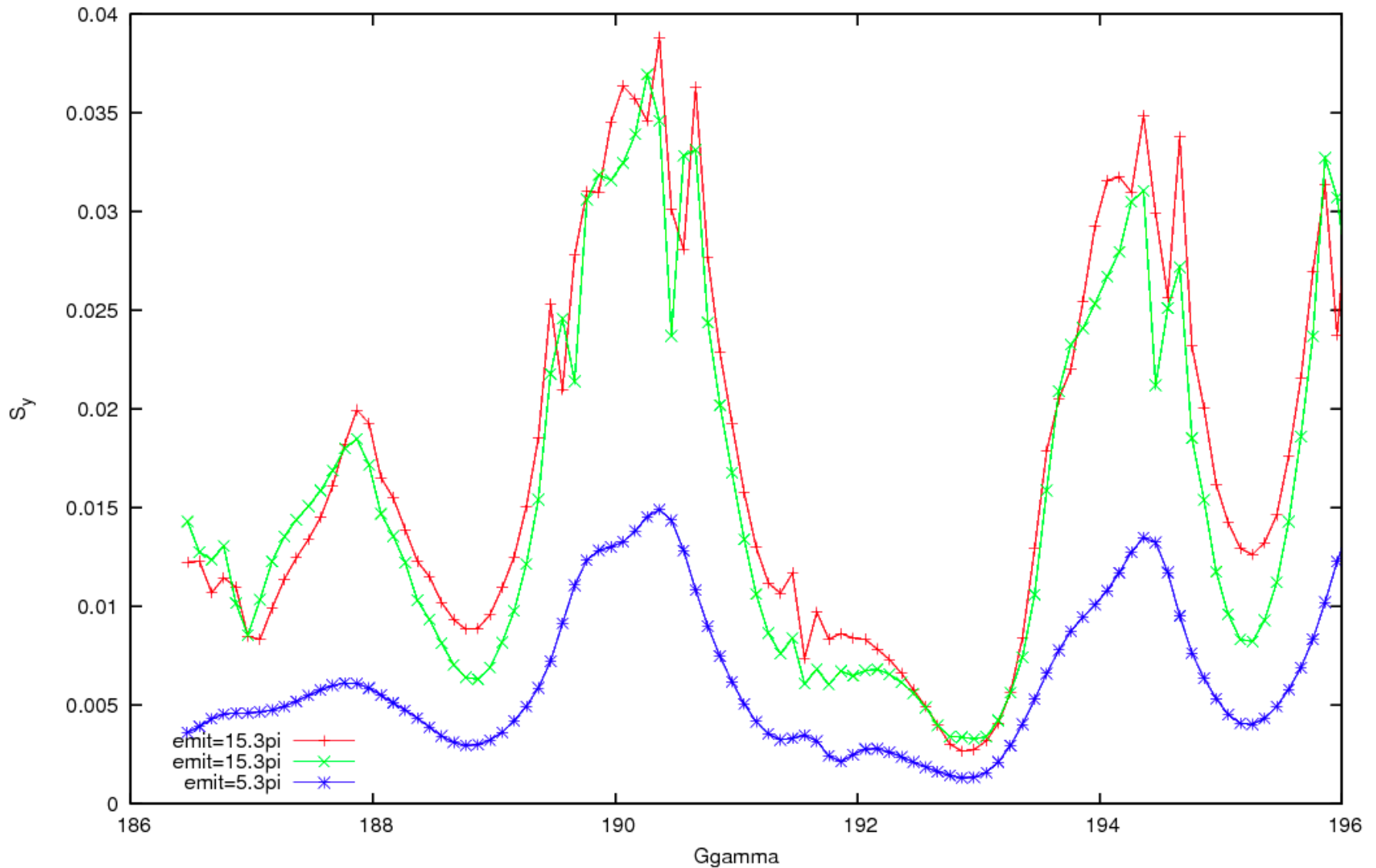
- Averaged $\langle S_y \rangle$ over 1000 turns
- Not stable spin direction



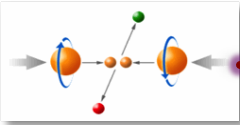
100 GeV Energy Scan



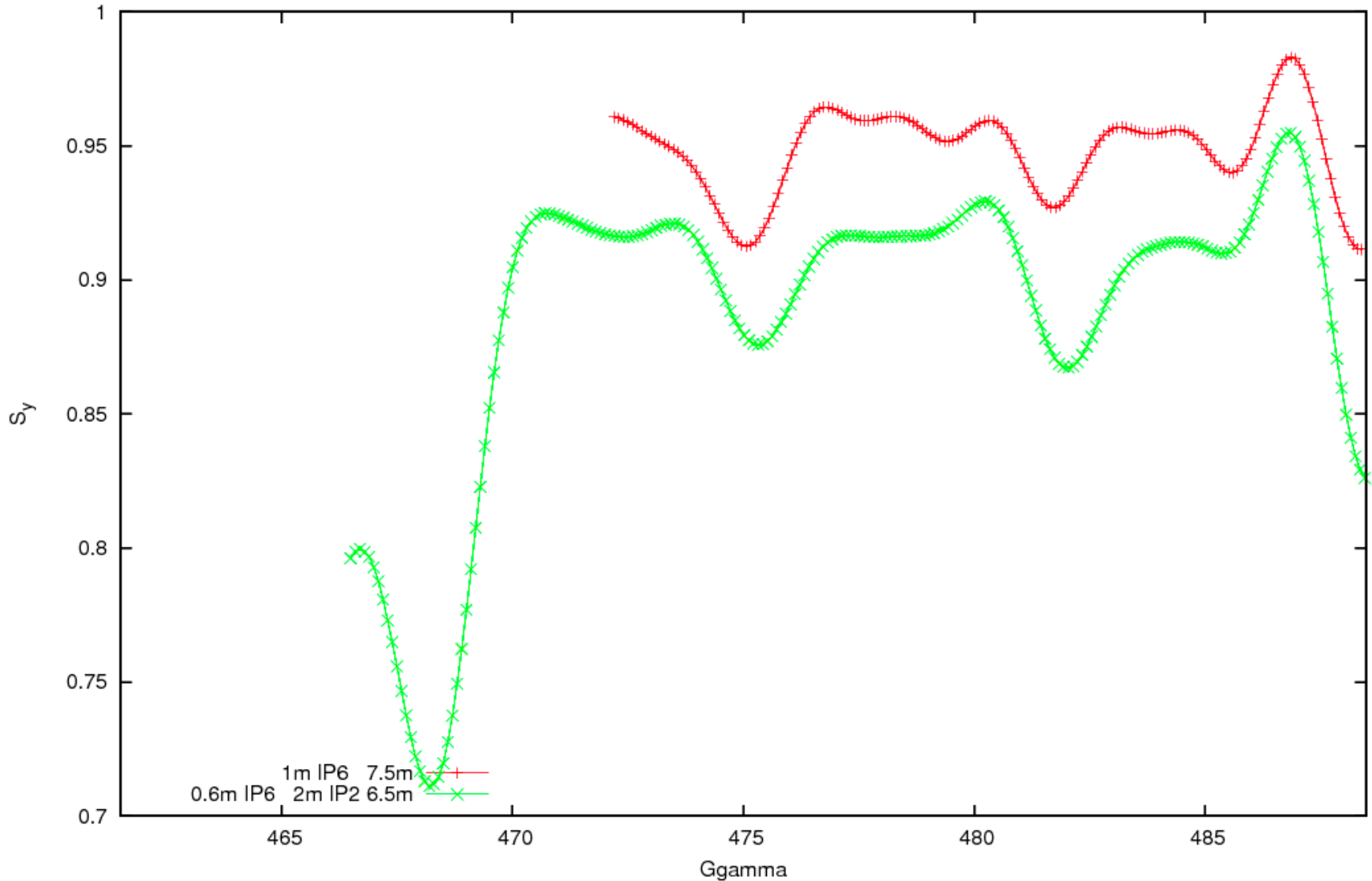
- Spread of S_y over 1000 turns



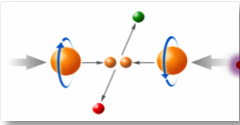
250 GeV Energy Scan



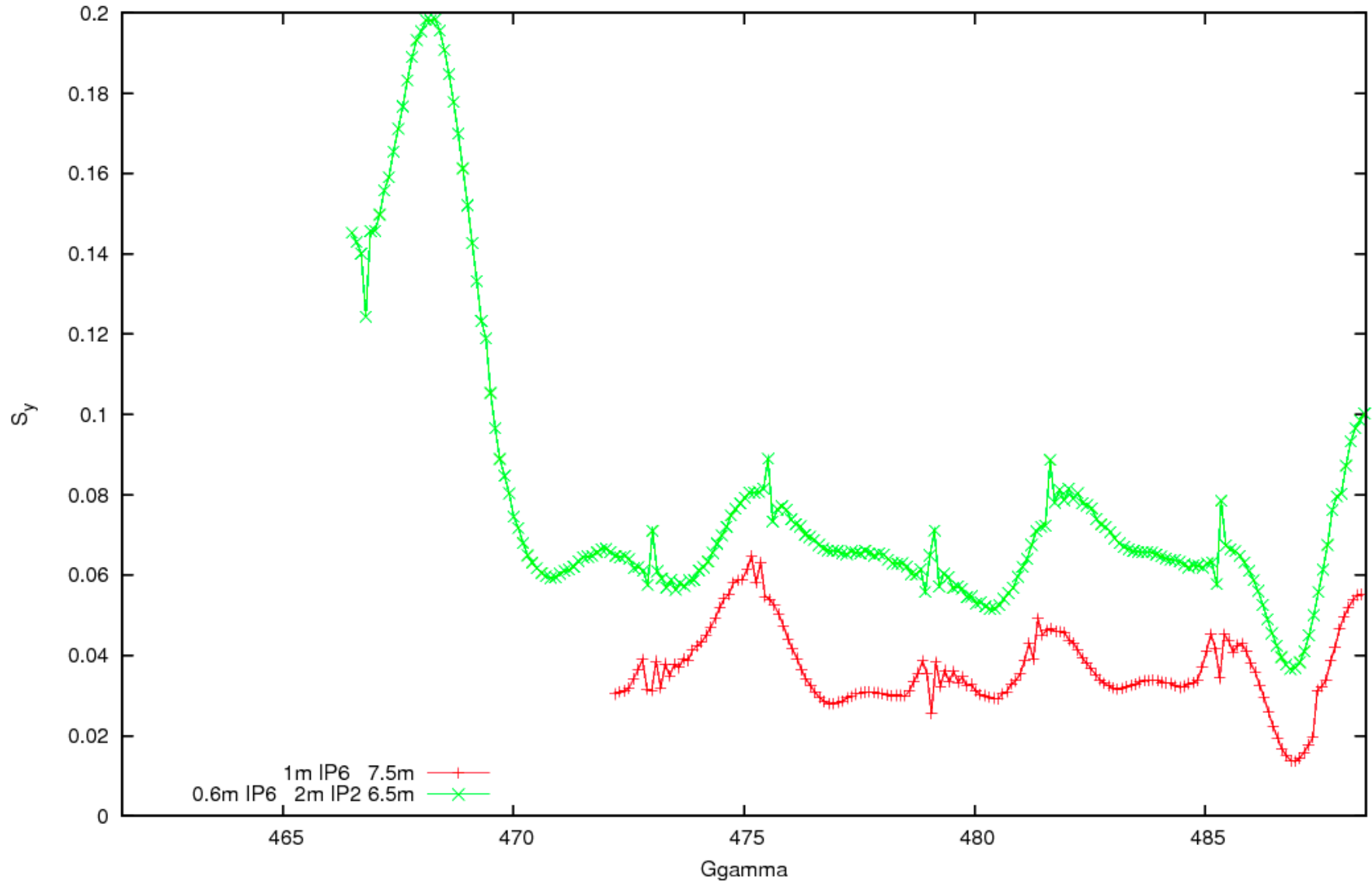
- Blue with two different lattices



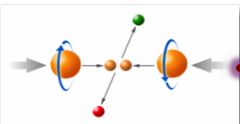
250 GeV Energy Scan



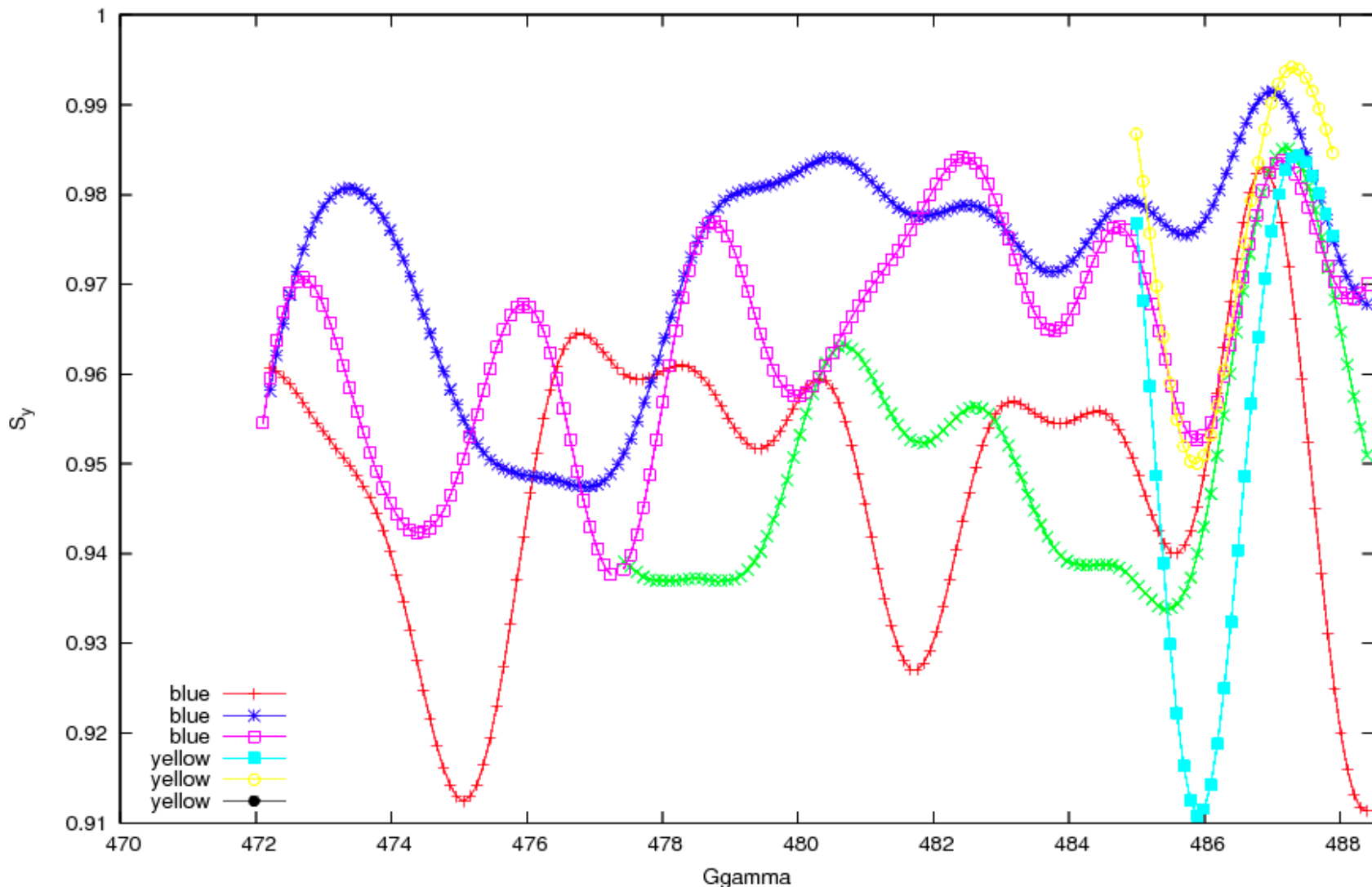
- Blue with two different lattices



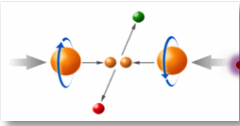
250 GeV Energy Scan



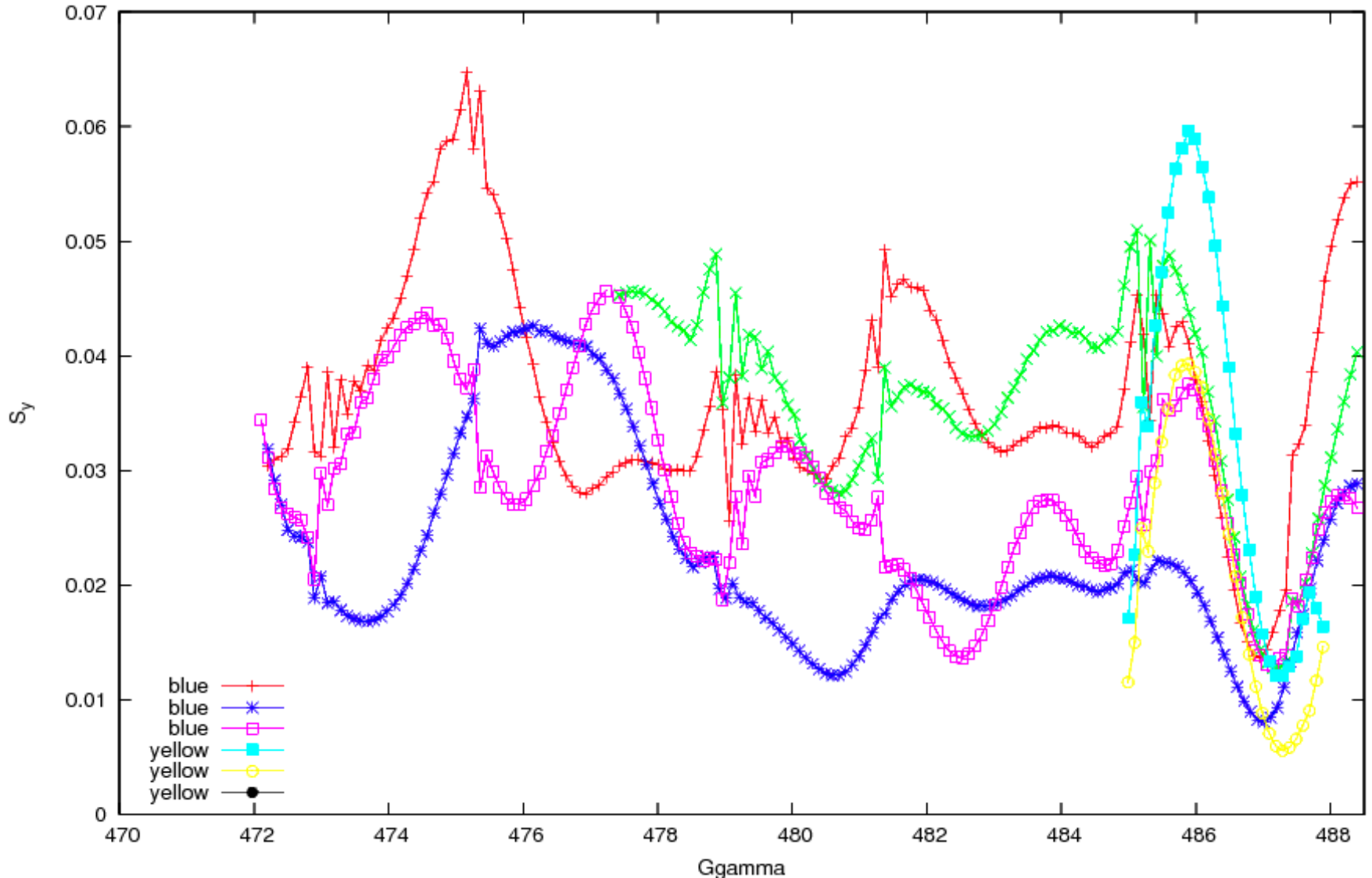
- Yellow sweet spot is also around $G\gamma=487$. But about 0.5 unit away from Blue sweet spot



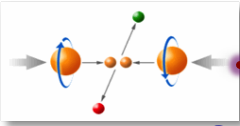
250 GeV Energy Scan: spread of spin vector



- Blue vs. Yellow

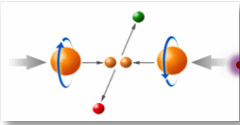


Calculate Stable Spin Direction



- Stable spin direction
 - Direction that spin vector returns to when particle returns to the same coordinate, i.e. it's a function of phase space
 - The ideal case, all vertically aligned!
 - Can be calculated by stroboscopic averaging
- Mapping out the stable spin direction of the phase space
 - Heavy computation power
 - In UAL spink by V. Ranjbar, but not user friendly yet
 - Not in zgoubi yet. In working progress
- Calculate the stable spin direction for a phase space location
 - a code to post-process the zgoubi single pt tracking results(Mei)
 - Track two cases with initial spin vector in radial and longitudinal, respectively
 - Post-process the data
 - Disadvantage is this is very time consuming. Right now, each data point takes 1.5 hour. Can be parallized to map out the phase-space

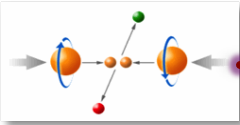
Stable Spin Direction



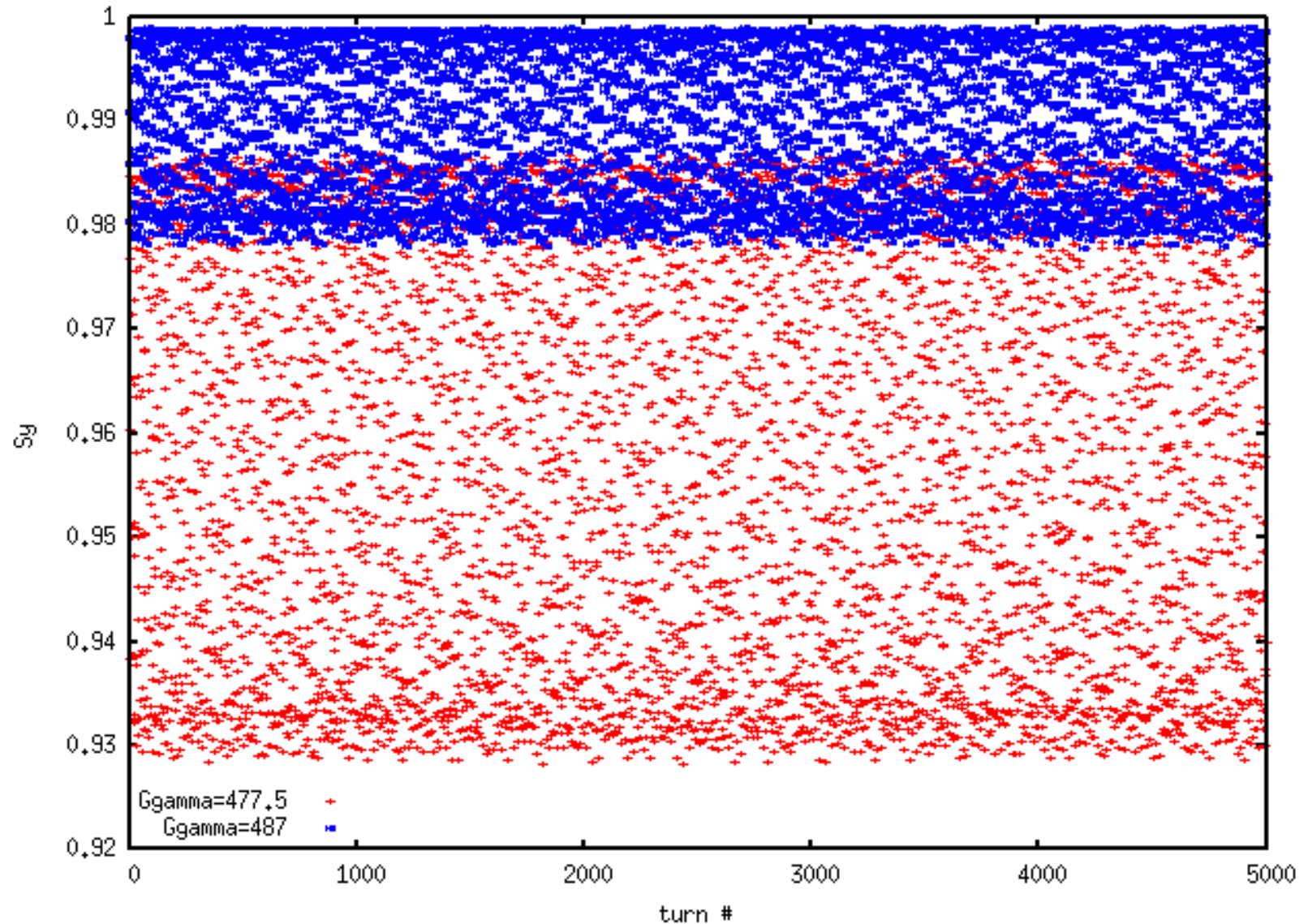
- Single particle tracking 10k turns
- Calculate the SSD for the phase coordinate
- Verify by re-launching the particle with SSD

Ggamma	radial	longitudinal	vertical
477.5: 5pi	-0.0238645	0.073279	0.9970259
487.0: 5pi	-0.0327464	-0.032942	0.9989207
477.5: 30pi	-0.0660028	0.2040741	0.9767279
487.0: 30pi	-0.0983716	-0.0941945	0.9906818

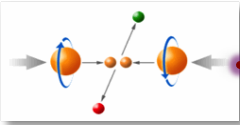
TbT Sy spread: 30pi



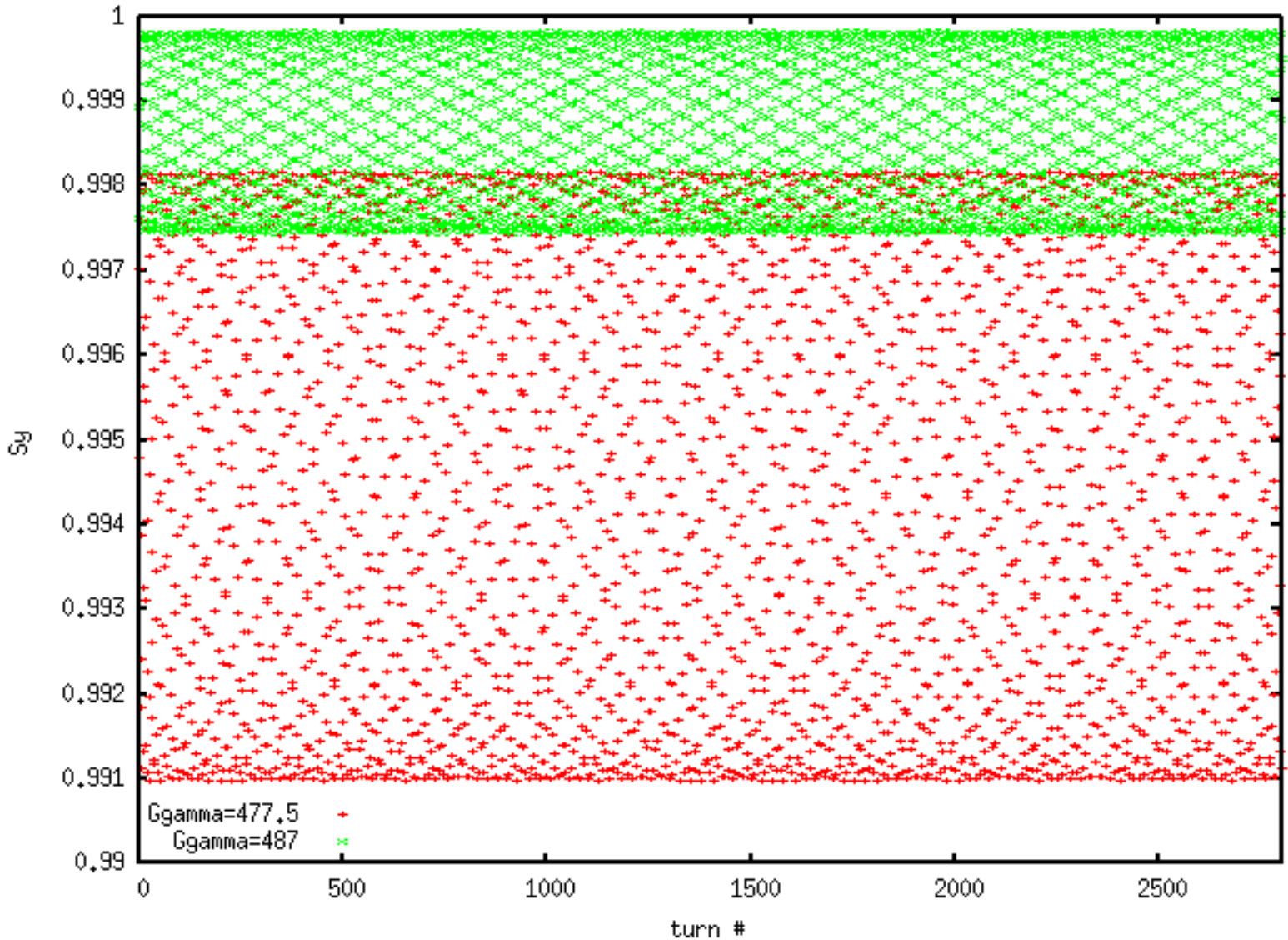
Particle launched with initial spin vector on the calculated stable spin direction



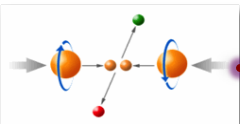
TbT Sy spread: 5pi



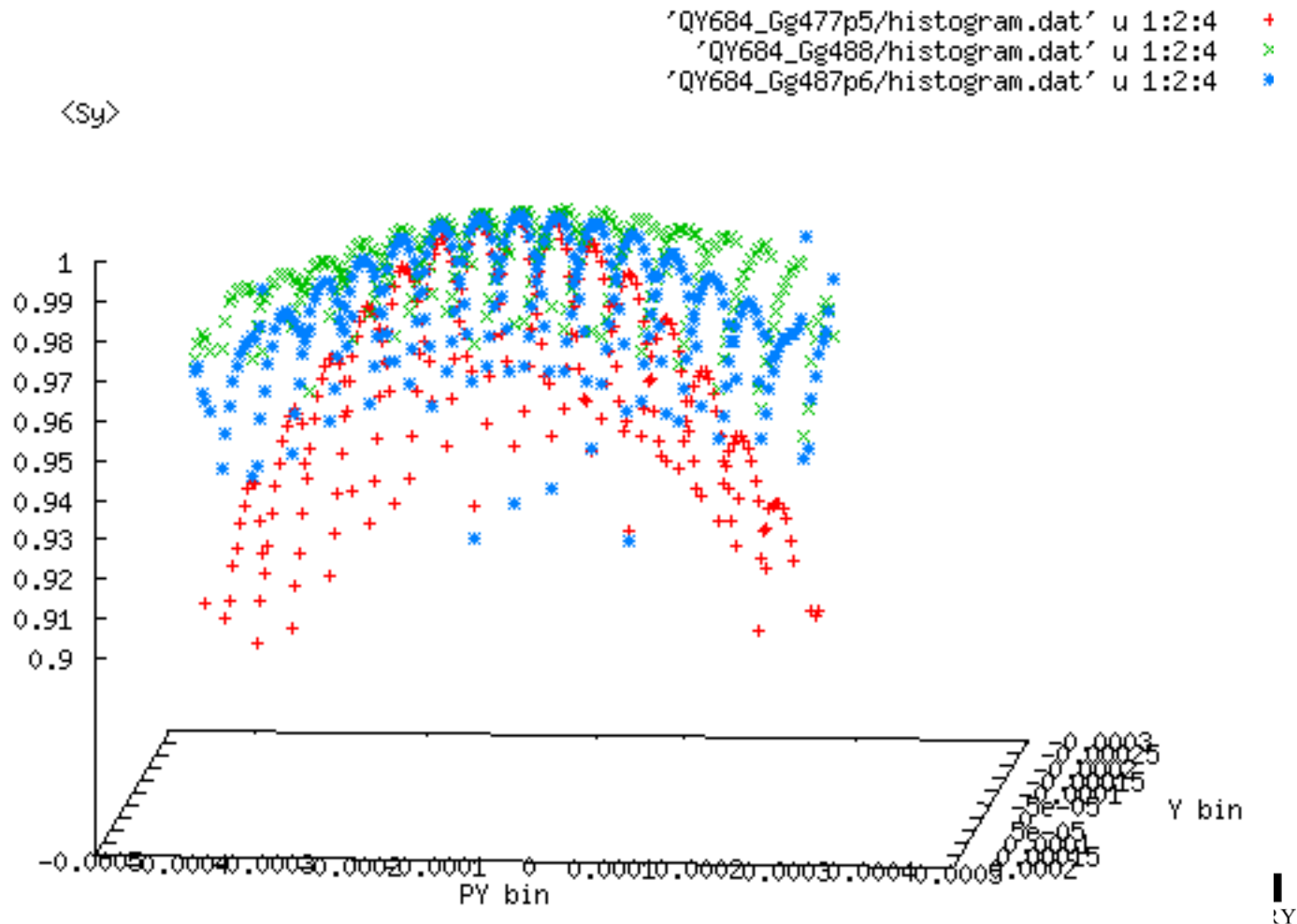
Particle launched with initial spin vector on the calculated stable spin direction



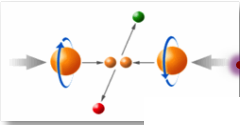
UAL SPINK Stable Spin Axes: V. Ranjbar



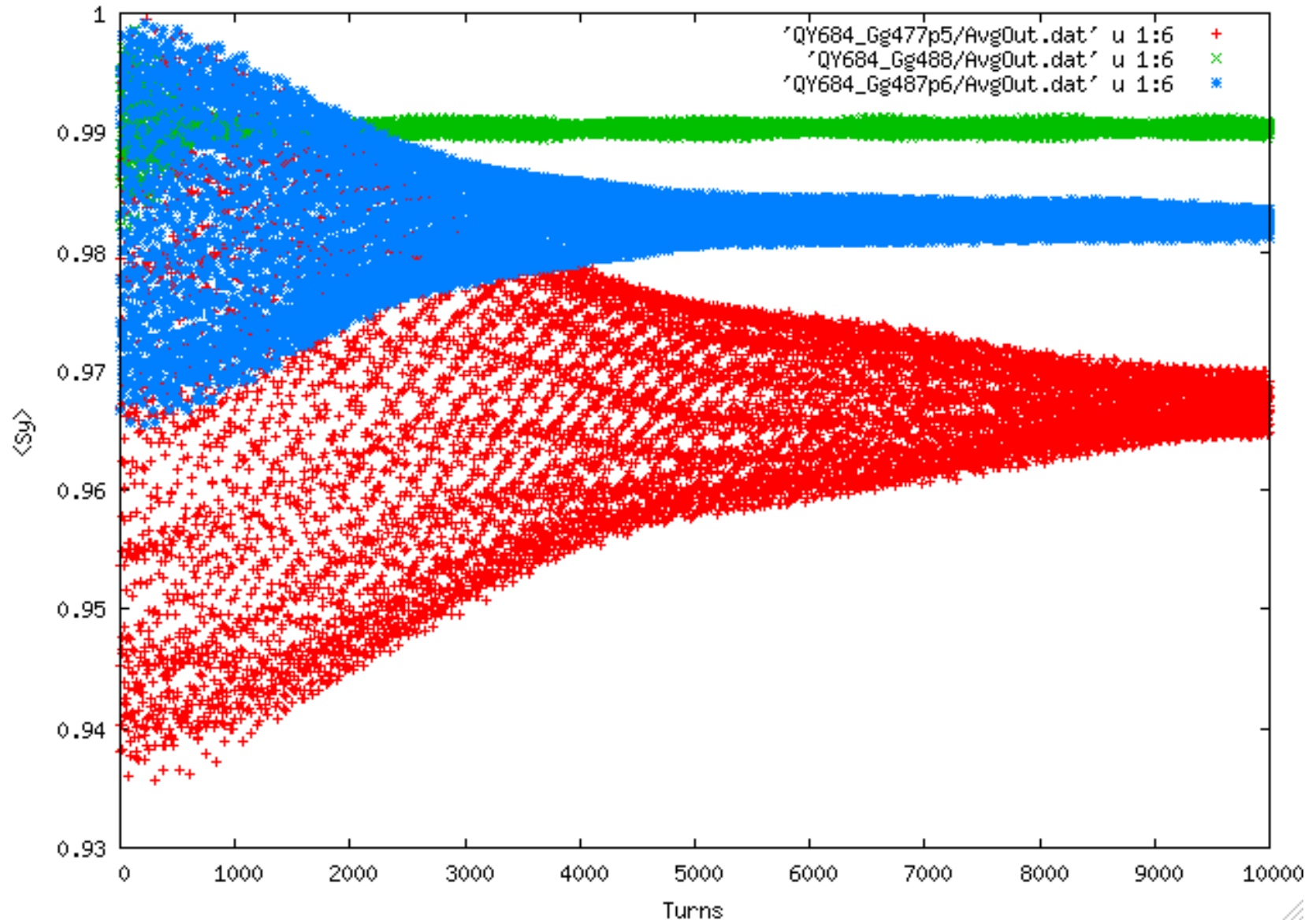
- Launched 1024 pts in 4D
- For a phase space bin, average the spin vectors for all particles



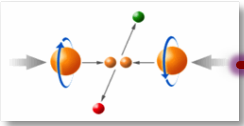
UAL SPINK Result: V. Ranjbar



Sy average for 1024 particles distributed on 3.33 pi mm-mrad sigma gaussian distribution in 4D



Summary and Plan



- Summary
 - 250 GeV simulation yields at $G_{\text{gamma}}=487$, stable spin direction is closest to vertical, and less open
 - 100 GeV simulation yields current store energy $G_{\text{gamma}}=191.5$ is close to optimized ($G_{\text{gamma}} = 192.5$)
- Suggestion for the run
 - Raise 100 GeV store energy to $G_{\text{gamma}}=192.5$ if no significant effort
 - Similar polarization lifetime issues from CNI polarimetry group
 - Raise 250 GeV store energy to $G_{\text{gamma}}=487$. Scan store energy nearby if no improvement on polarization lifetime
- Plan
 - Map out stable spin direction for the phase space
 - Ideal lattice
 - Lattice with closed orbit distortions