



OZI violation and spin alignments at COMPASS

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on behalf of the COMPASS Collaboration

1. Motivation

OZI rule:

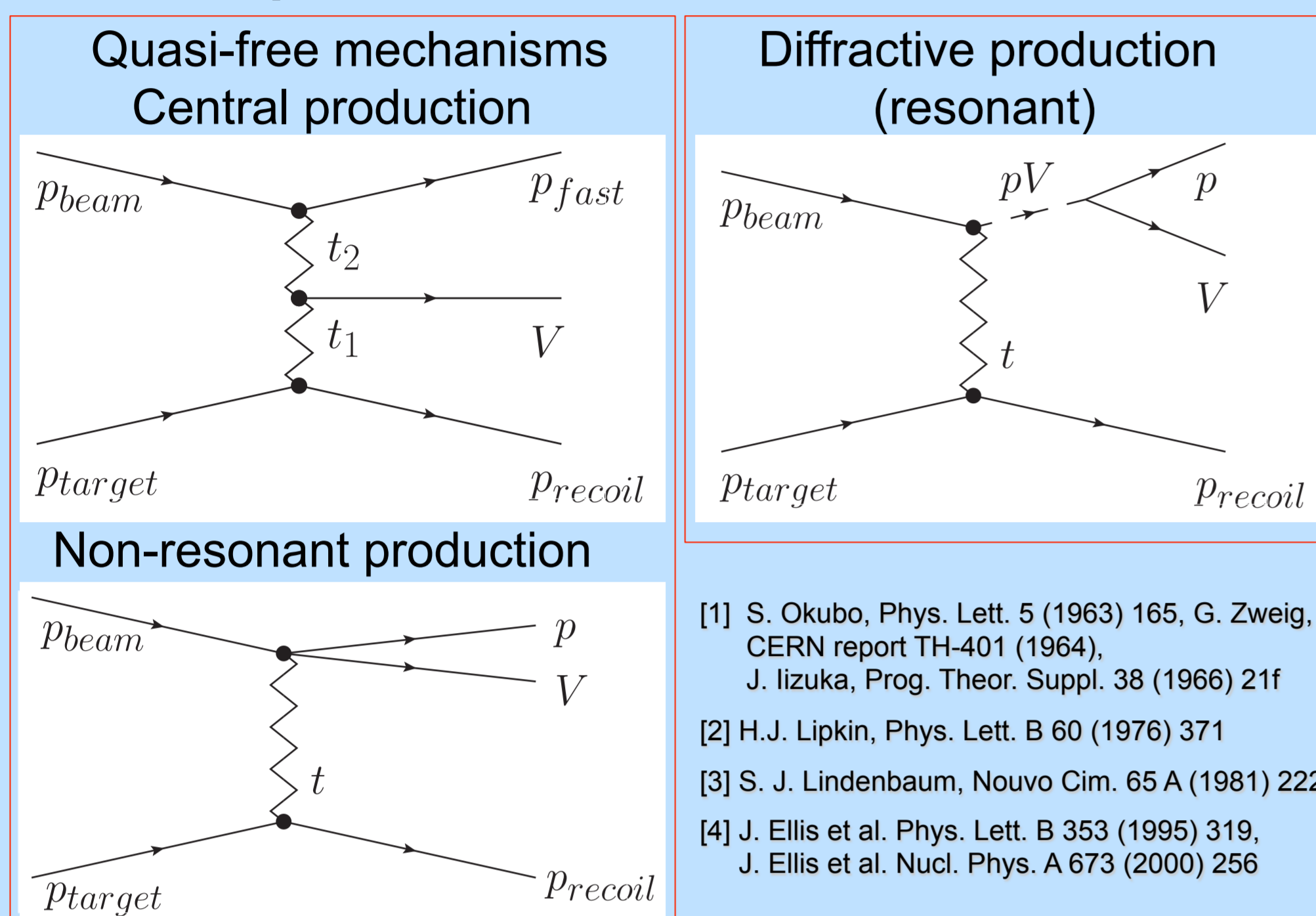
- states processes with disconnected quark lines are forbidden¹
- tool to study production mechanisms by tracing strangeness transfer in vector meson production

Prediction for ratio of ϕ / ω production²:
 $R = \sigma(pp \rightarrow X\phi) / \sigma(pp \rightarrow X\omega) = 0.0042$

Possible explanations for violations:

- flavour-neutral processes (Pomeron/Reggeon exchange) or gluonic intermediate states³
- polarised hidden strangeness component in the nucleon⁴ / "preformed" mesons

Different production mechanisms:



2. The COMPASS experiment

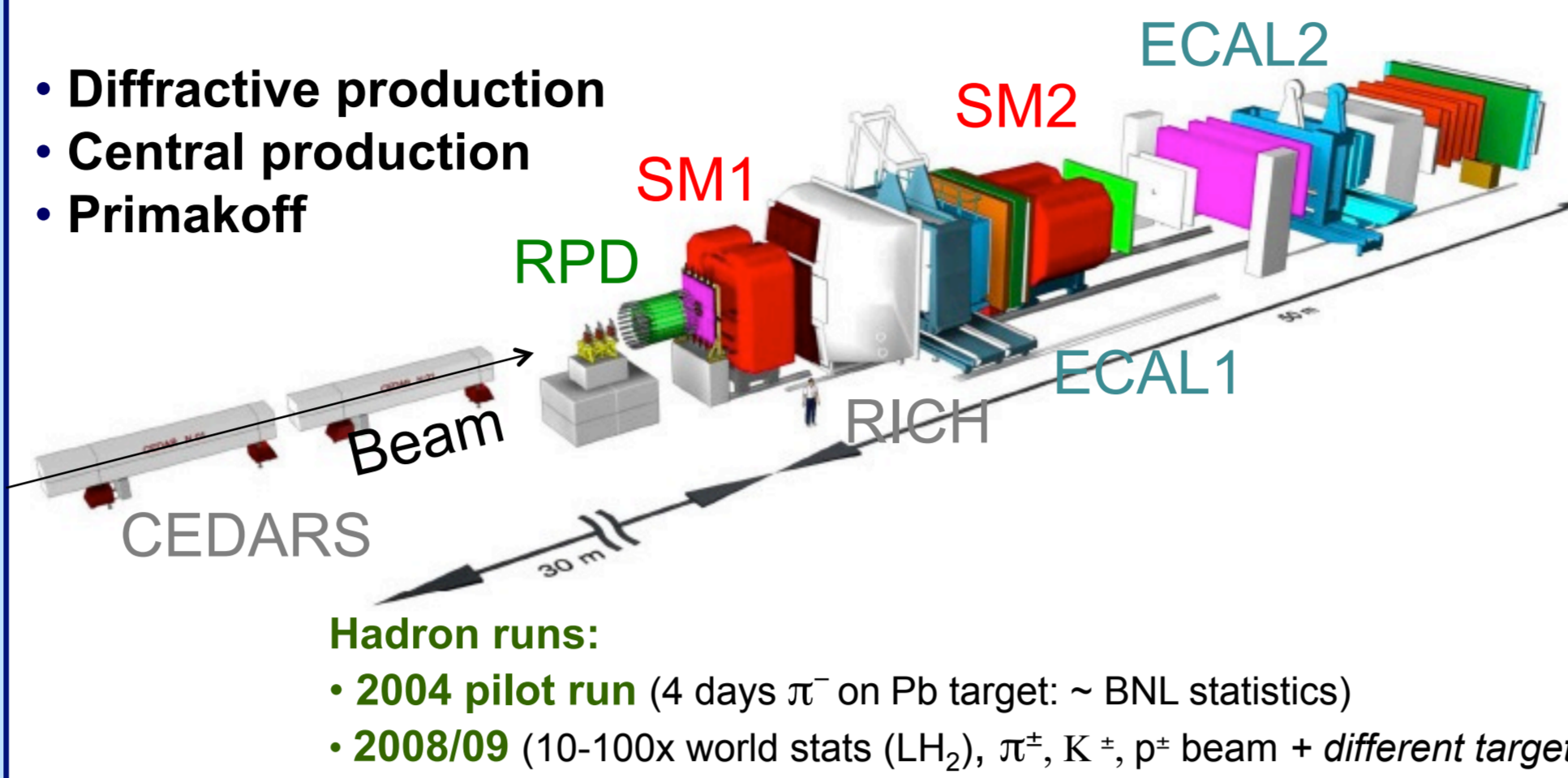
- two stage spectrometer
- high resolution, large acceptance
- ~250 000 read-out channels, ~1 PByte / year

[hep-ex/0703049, NIM A 577, 455 (2007)]

Common Muon Proton Apparatus for Structure and Spectroscopy
 (~270 physicists, 25 institutes, 12 countries)

Baryon & meson spectroscopy

- Diffractive production
- Central production
- Primakoff



Experimental setup 2008/09:

- 190 GeV/c beam (π^\pm , K^\pm , p), liquid H₂ target
- new trigger system
- new pixelised tracking detectors
- new recoil proton detector (RPD)
- 2 CEDARs (beam particle PID)
- Calorimetry in both stages – upgraded 2008/09
- RICH in 1st stage – upgraded in 2006

[Hadron set-up 08/09, NIM A, in preparation (2013)]

3. Event selection and signal extraction

Event selection, common cuts for ϕ / ω :

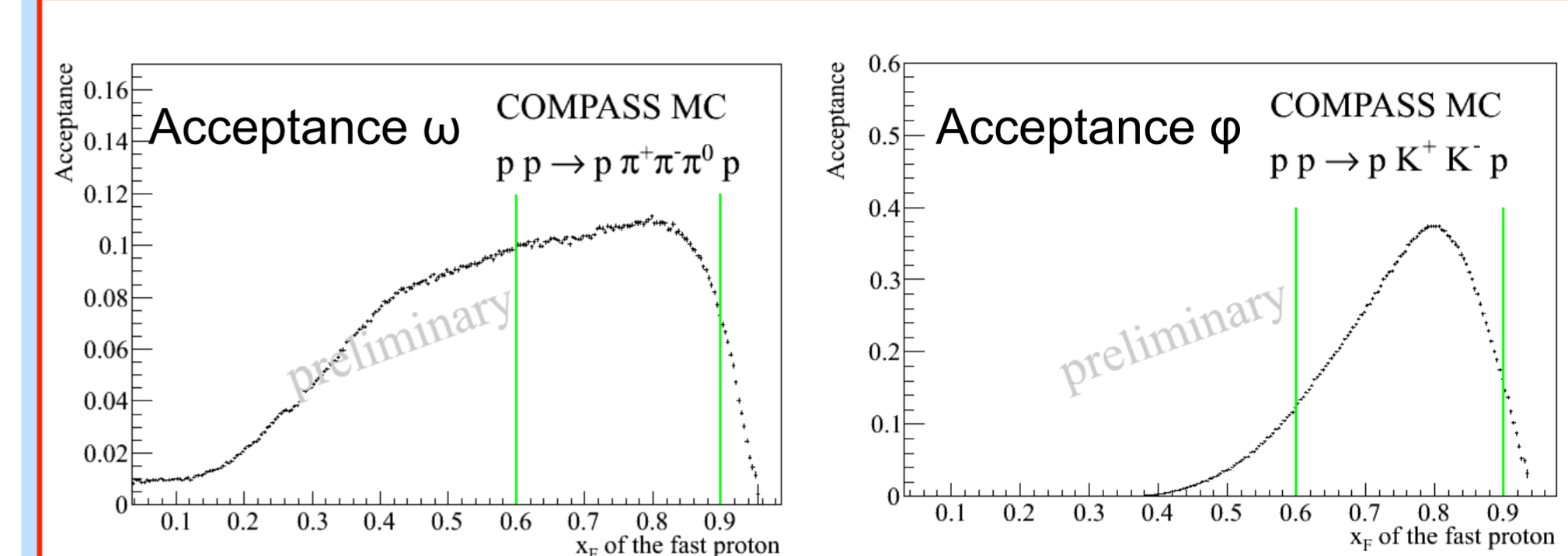
- primary vertex in target volume
- three charged tracks, charge conservation
- beam proton (tagged with CEDARs)
- recoil proton (tagged by RPD)
- exclusive events (energy of final state = beam energy)

Selection for ω :

- π^0 candidate from ECALs

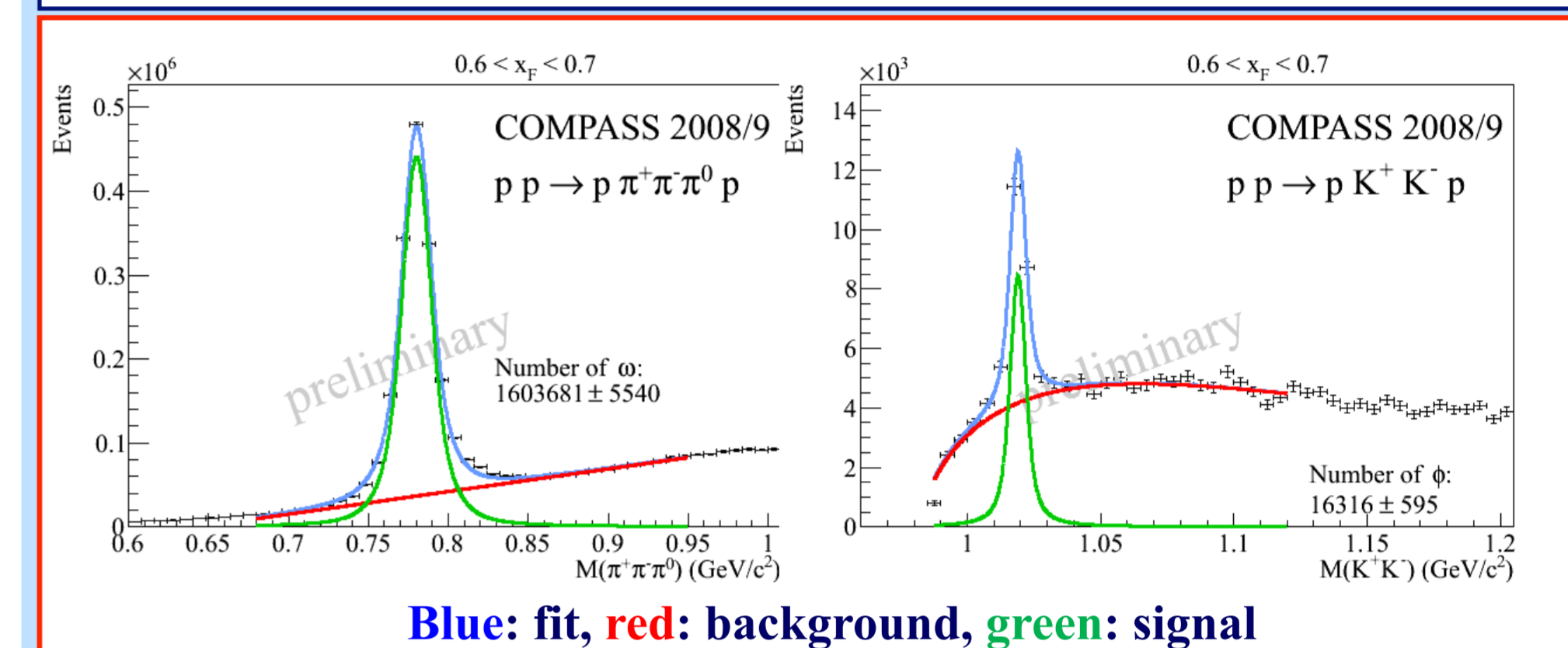
Selection for ϕ :

- Kaon ID with RICH

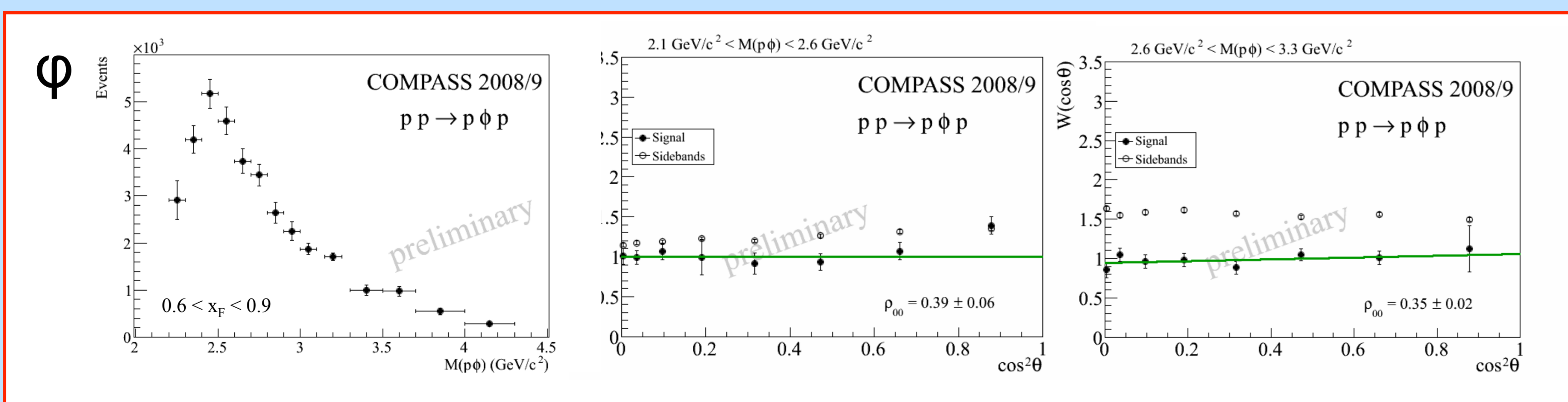
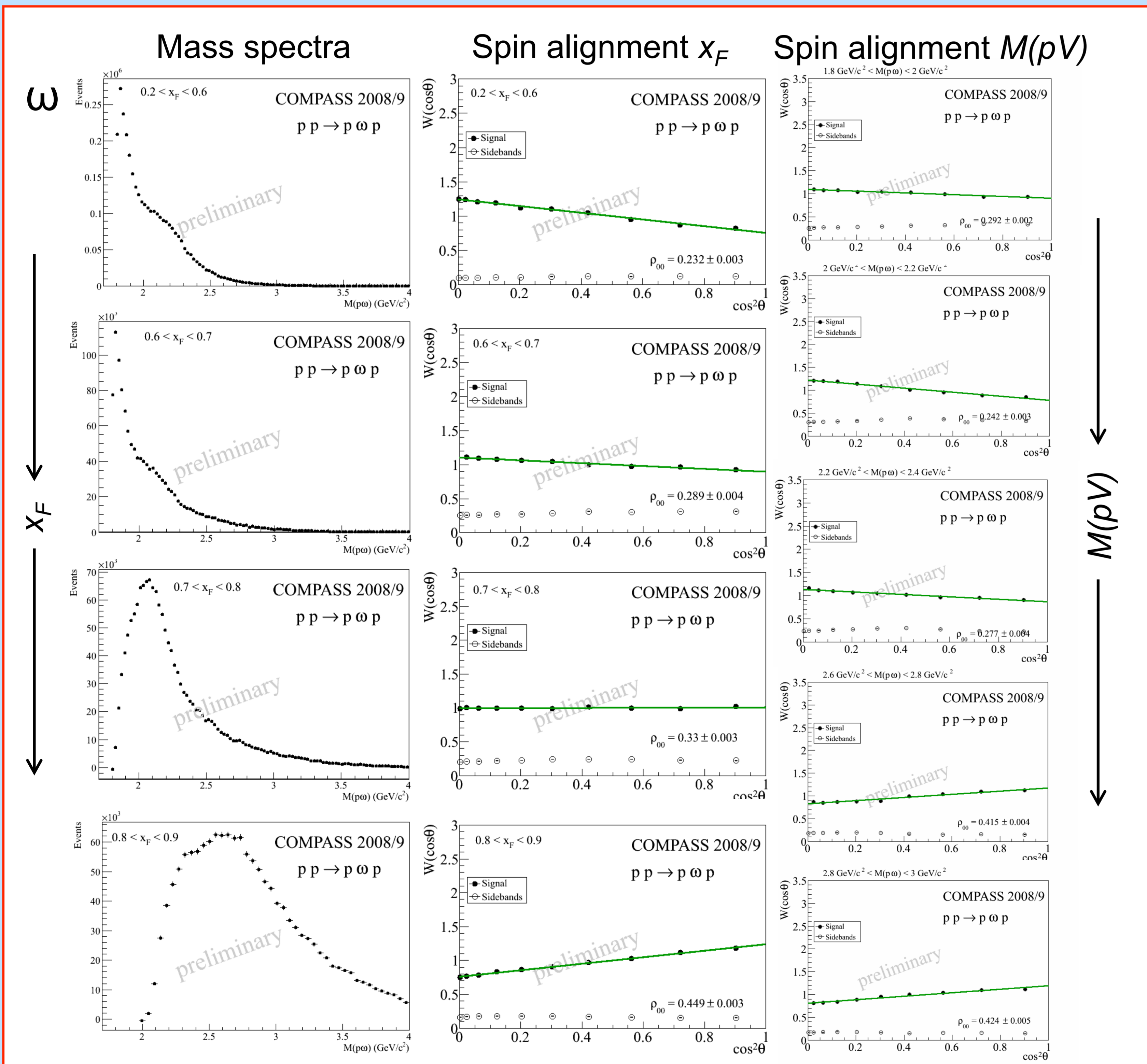


Signal Extraction:

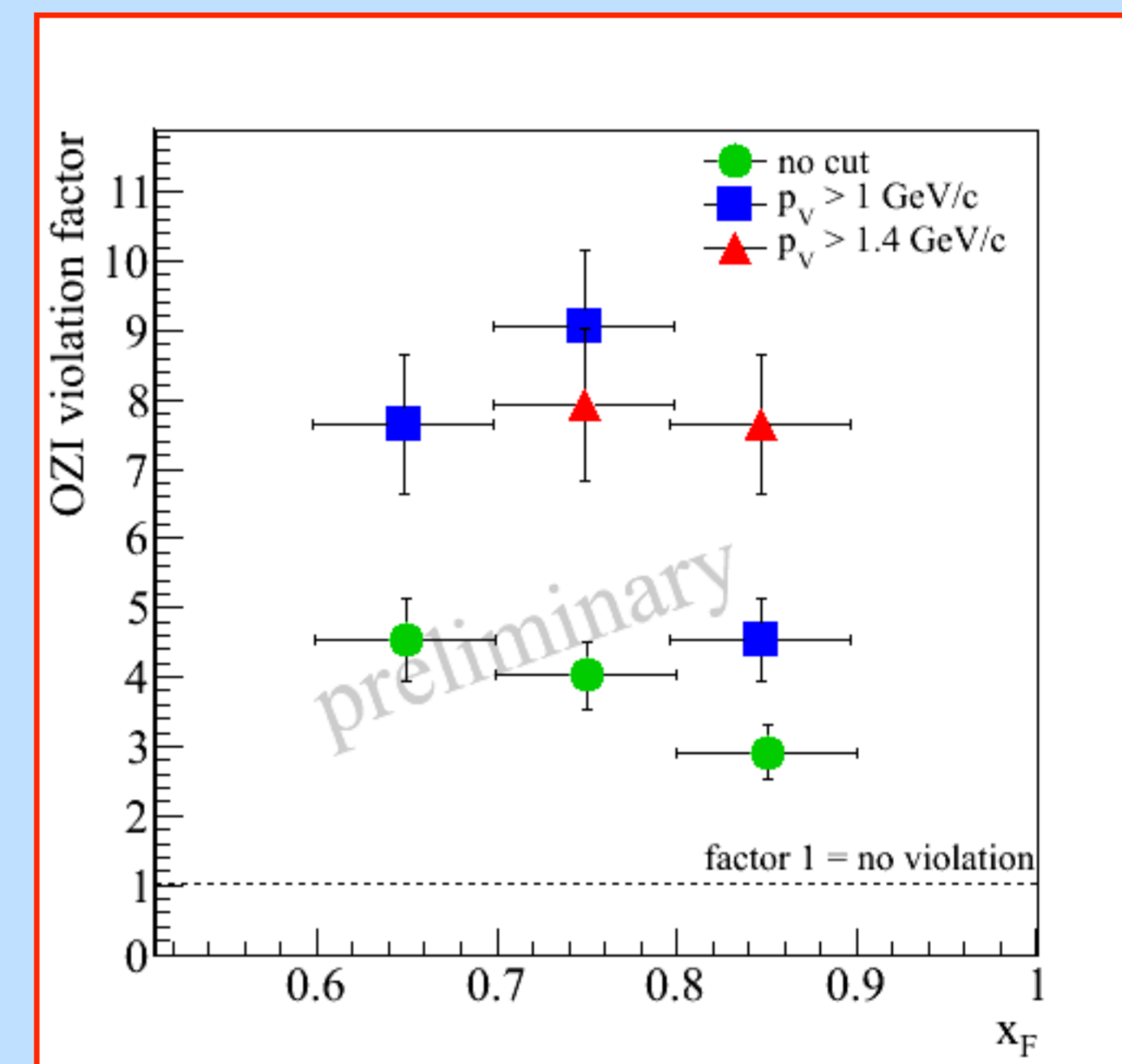
- 3D acceptance correction (x_F , $M(pV)$, t')
- Fit corrected mass distributions with Breit-Wigner/ Gaussian convolution + polynomial background



4. Resonances / spin alignment in helicity reference frame



5. OZI violation



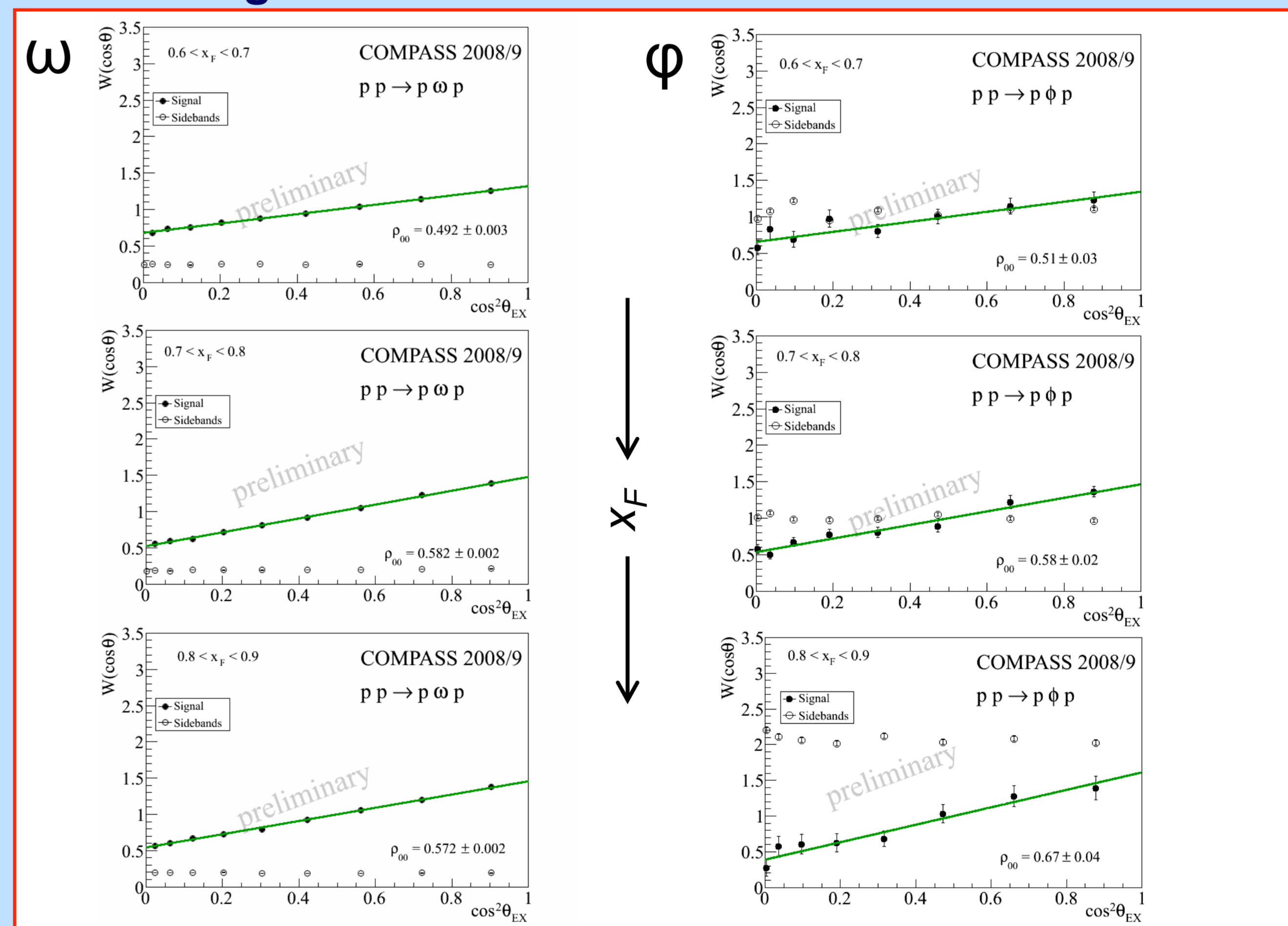
Study deviation from prediction of cross section ratio $R(\phi/\omega) = 0.0042$

- Additional cut on vector meson momentum p_V in pV rest frame to remove resonance contribution

Observations:

- without p_V restriction: dep. on x_F
- violation of factor 8 indep. on x_F with tight p_V cut (resonance contribution removed)

6. Exchange reference frame



Reference axis with respect to exchange particle (sensitive to central production)

Observations:

- strong alignments for both ω and ϕ
- no alignments with tight p_V cut (not shown)

7. Summary & Outlook

OZI rule & spin alignments @ COMPASS:

- high statistics and precision
- measurement of ϕ / ω with the same setup at the same time
- measure at higher energies compared to former experiments
- violation of OZI rule + spin alignments draw picture of interplay between production mechanisms

Outlook: publication in preparation

Spin alignment yields additional information on production mechanism

Parameterisation of cross section's angular dependence⁵: $W(\cos\theta) = \frac{3}{4}(1 - \rho_{00} + (3\rho_{00} - 1)\cos^2\theta)$
 no alignment at $\rho_{00} = 0.33$

[5] K.Schilling, P.Seyboth, G.Wolf, Nucl.Phys.B 15 (1970) 397

Observations:

- resonant structures in $p\omega$ mass distributions linked to alignment of ω in helicity frame
- alignment changes with higher masses when resonances are crossed
- no structures and no alignment visible for $p\phi$ (OZI suppressed)