Round-table –
Instrumentation for AMBER/Dimuons studies

Stephane Platchkov, Apr. 30, 2021
(On behalf of the AMBER collaboration)

Summary slide

- Map out the pion parton structure at large *x*, ($x > 0.1$)
  - 1) DY data : separate valence and sea distributions in the pion
    - Data with BOTH positive and negative pion beams – compare cross sections
  - 2) J/ψ and ψ' data : infer pion valence and gluon distributions
    - Separate J/ψ and ψ' –
- Nuclear dependence at large x
  - Improve our knowledge of the EMC effect – first look at the flavor dependence of the nuclear mean field
    - Data with BOTH positive and negative pion beams – compare cross sections

These three fundamental measurements will be achieved using the same data set

Necessary instrumentation upgrades

- AMBER Phase I
  - Better beam particle identification (partly done, to be continued)
  - Better mass resolution (urgently needed)
  - Better trigger efficiency (future performances should be maximized)
  - Good luminosity measurement (aim at cross sections measurements < 3-5%)

- Remarks on the measurement of charmonium states (other than J/psi)

1) Beam particle identification - CEDARs

- Beam composition CERN/M2 line

Momentum (GeV/c)	π^+	K^+	p	π^-	K^-	$\bar{p}$
	Positive beams			Negative beams		
100	0.618	0.015	0.367	0.958	0.018	0.024
160	0.360	0.017	0.623	0.966	0.023	0.011
190	0.240	0.014	0.746	0.968	0.024	0.008
200	0.205	0.012	0.783	0.969	0.024	0.007

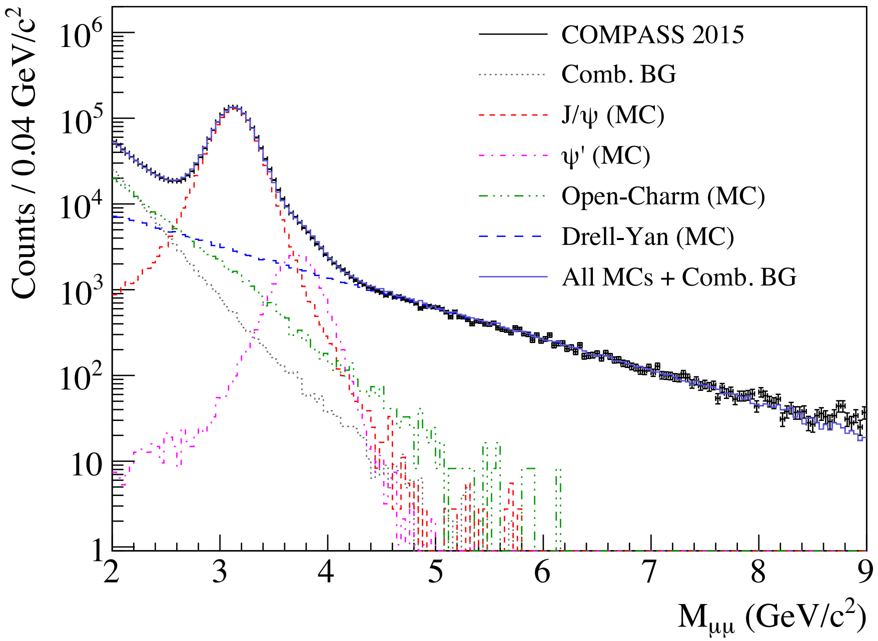
- Secondary beams are not pure beams
  - Two Cerenkov counters identify the beam hadron
  - Need good efficiency (>90%) and good purity (90%)
- Beam trackers (Si?) necessary to reconstruct beam tracks
  - Better definition of the beam trajectory

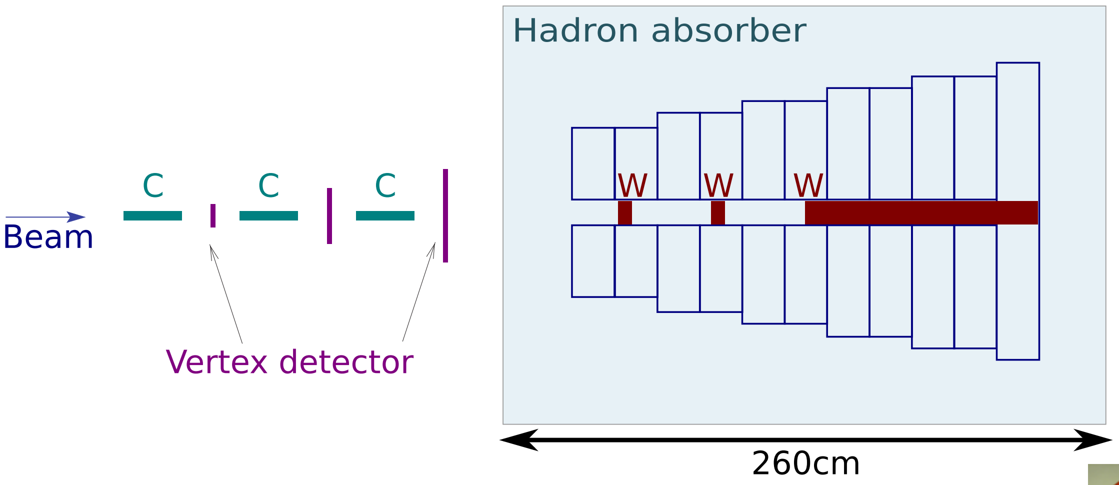
2) Good mass resolution (with an absorber installed)

- COMPASS-type resolution (MC estimates)
  - NH_3 : 143 MeV
  - Al : 223 MeV
  - W : 351 MeV

These numbers are too large and not enough to separate J/ψ and ψ'

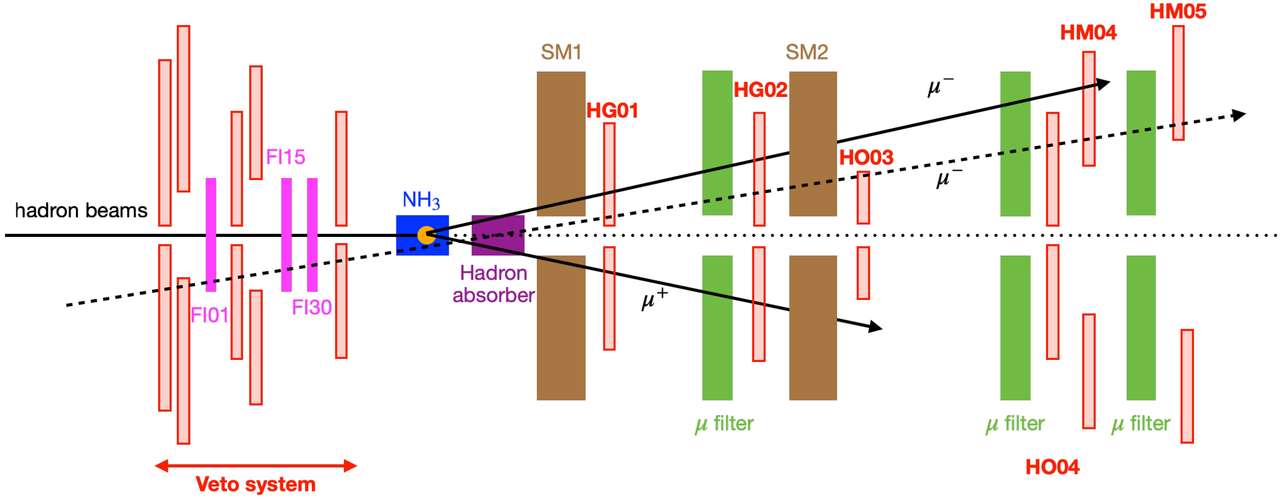
- A vertex detector (nb of stations?) should improve the resolution by at least a factor of 2:
  - high counting rate capability
  - good time resolution ($\lesssim$ 10 ns)
  - good spatial resolution (< 100 μm)



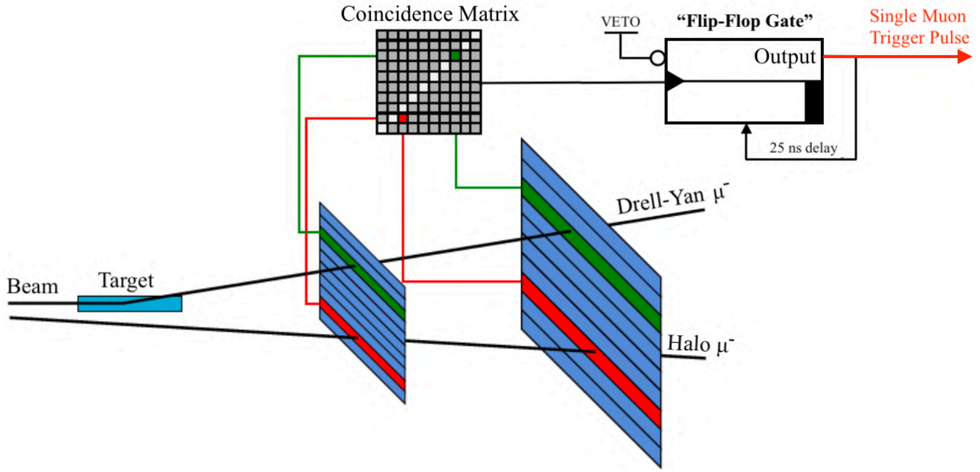


Improved trigger and veto system

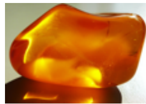
- Trigger efficiency
  - Optimal scintillator efficiency: > 95%
  - Optimized coincidence: > 95%
  - Total efficiency: aim at > 90%



- Veto dead time
  - Optimized veto dead time (< 10%)



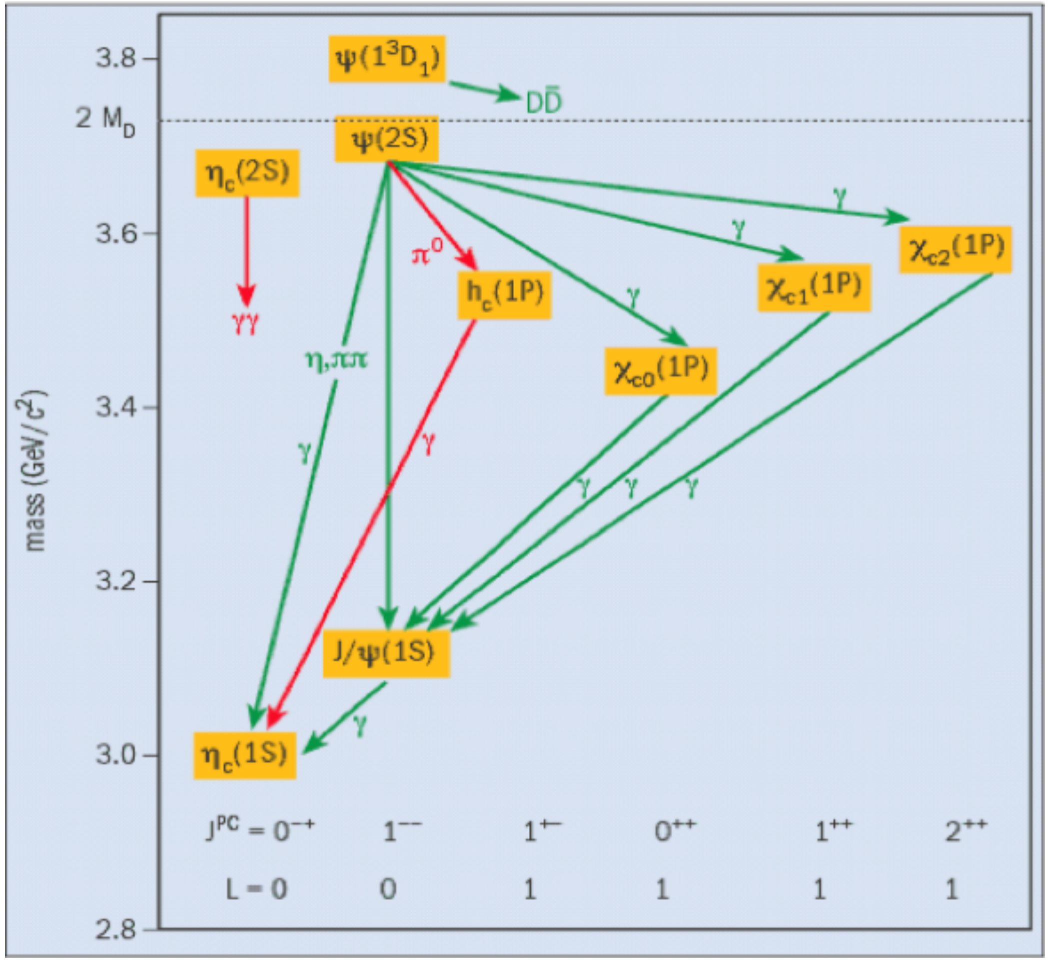
Improved trigger and veto life time means improved statistical accuracy



Charmonium states identification

- ψ': Amber Phase-1
  - can be measured simultaneously with J/psi
  - $\Delta E \simeq 100$ MeV
    - requires a vertex detector

- χ_c states: Amber Phase-2
  - detect photon and J/psi in coincidence
  - very good resolution needed, $\Delta E \simeq 15$ MeV
    - no absorber
- η_c state: Amber Phase-2
  - e.g.: detect p and $\bar{p}$ $(\mathrm{BR} = 1.5\ 10^{-3})$
    - no absorber



HERA-B experiment