Time-like Form Factors of Hadrons

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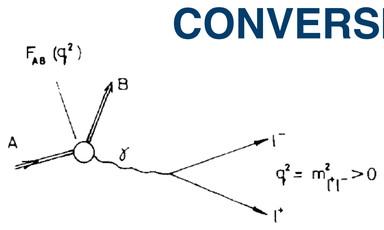
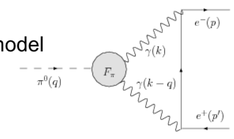
light mesons

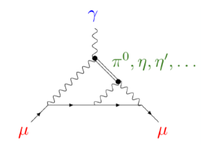
form factors: fundamental properties of hadrons

CONVERSION DECAYS OF MESONS

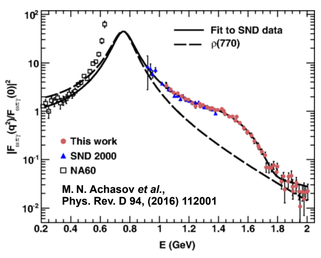


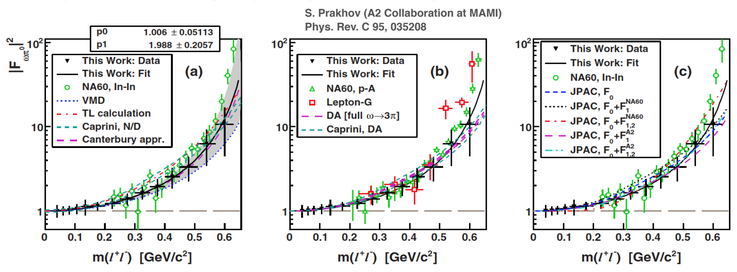
- intrinsic structure of hadrons
  - transition form factors
  - validity of vector meson dominance
- background for physics beyond the standard model
  - rare decays
    - eg $\pi \to ee$
  - g-2 anomalous magnetic moment of the muon
    - light-by-light scattering



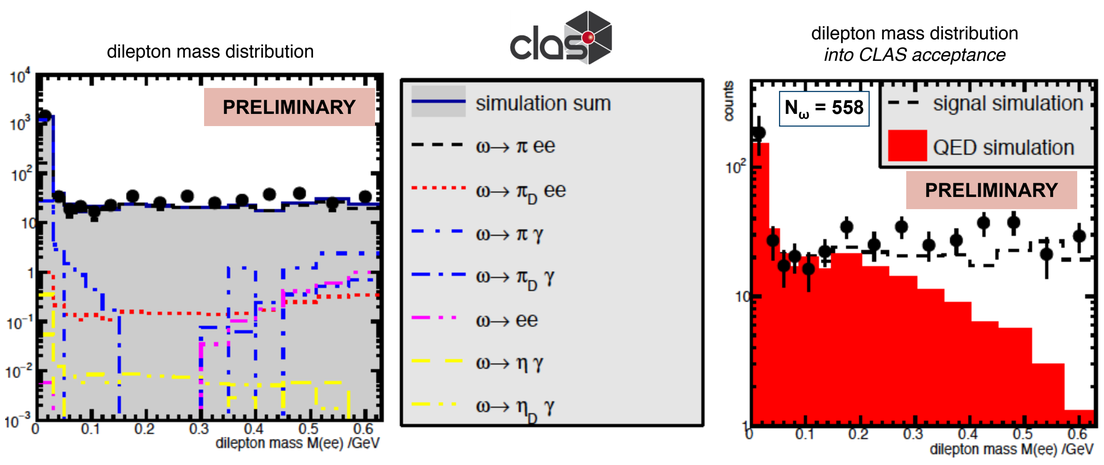


status of the ω-π transition form factor





ω-π⁰ TRANSITION FORM FACTOR WITH CLAS

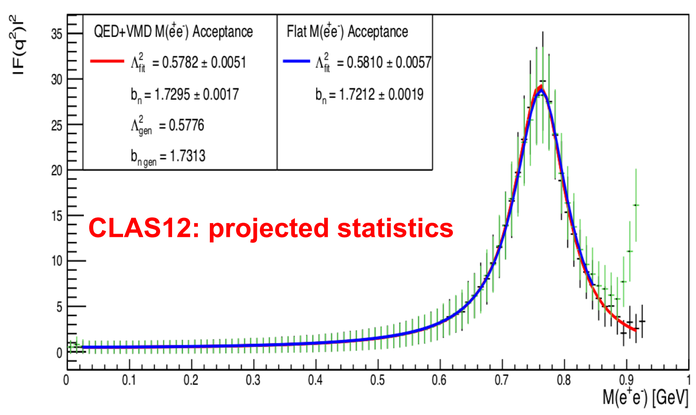


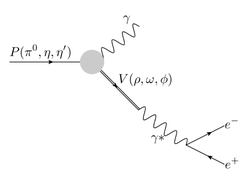
trend: no extreme excess beyond VMD

further: data mining WASA-at-COSY

search for double Dalitz decays of pseudoscalars in pp reactions

$\eta' \to \gamma ee$ with CLAS12

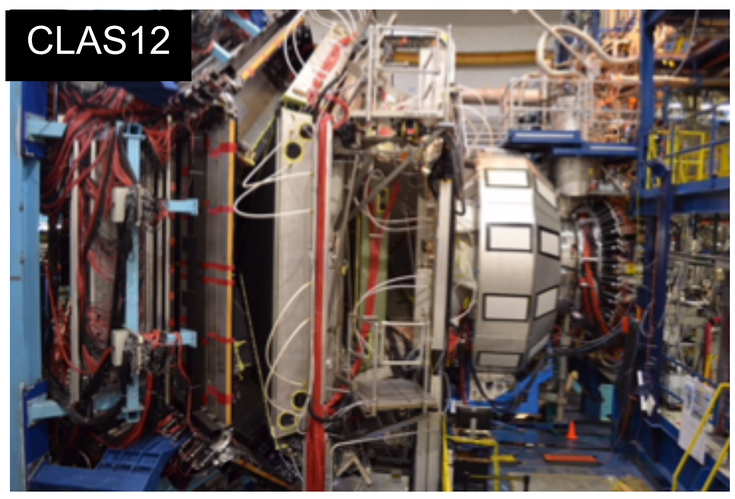




- internal structure of η' by measuring $\eta' \to e^+ e^- \gamma$
- test theoretical models
- high statistics needed

  → upcoming CLAS12 measurement

CLAS UPGRADE

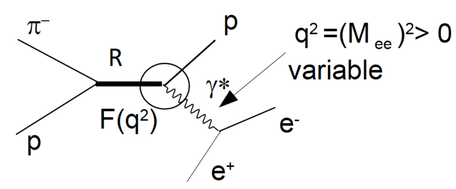


excited baryons

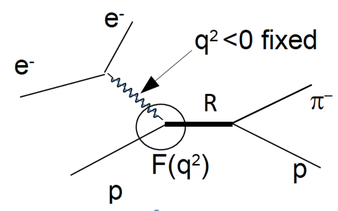
RADIATIVE DECAYS OF EXCITED BARYONS

time-like ($G_M(q^2)$, $G_E(q^2)$) complementary to space-like kinematic region

Time-like electromagnetic form factors



Space-like electromagnetic form factors

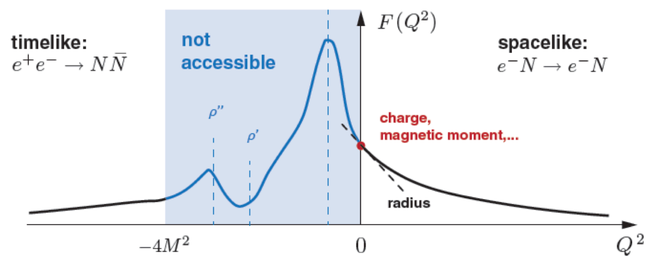


access to kinematically forbidden region (for annihilation)

$B_1 \to B_2 e^+ e^- \quad q^2 < (m_1 - m_2)^2$

$\bar{B}B \to M e^+ e^-$

$\bar{B}B \to e^+ e^- \quad q^2 > (m_1 + m_2)^2)$



Δ(1232) DALITZ DECAY WITH HADES AT T = 1.25 GEV

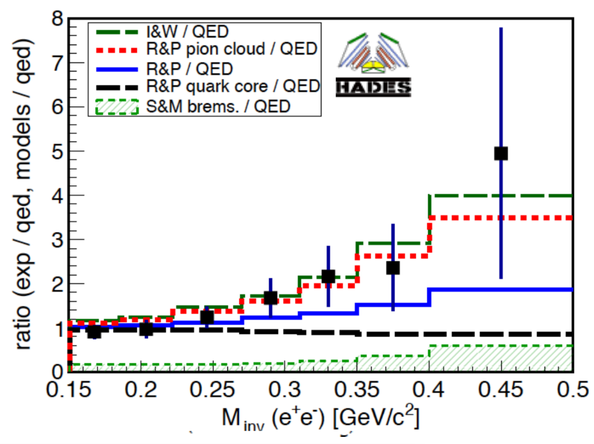
Phys. Rev. C 95, 065205

- Ratio of data (after subtraction of bremsstrahlung) to simulated Δ contributions with pointlike coupling (QED)
- Dashed green:

  F. Iachello and Q. Wan, Phys. Rev. C 69 (2004) 055204.
- Blue: Δ Dalitz

  G. Ramalho et al., Phys. Rev. D 93 (2016) 033004.
- Red/Black: components of Ramalho-Peña

form factor



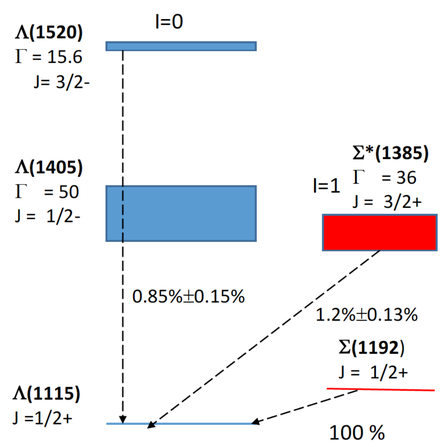
Δ Dalitz decay measured for first time

further: pion beams at HADES

Goal: scan N(1520) region to improve $\pi^+\pi^-$ database and investigate R→Ne^+e^- (no data available)

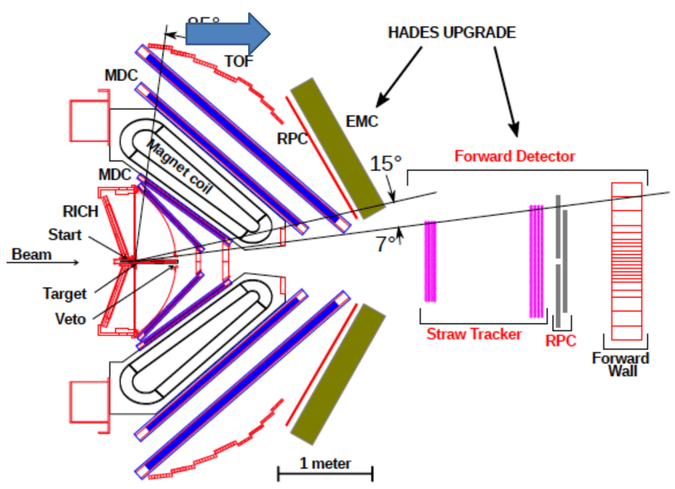
RADIATIVE HYPERON DECAYS

Dalitz decay of excited hyperons with proton beam



- Decays to real and virtual photons sensitive to baryon structure:
- Hyperon →Λee not measured at all: strong effects of vector mesons (VDM) expected
- Only few γ transitions measured

HADES UPGRADE



New:

RICH photon-detector & Readout
e^+e^- eff. gain x 5

ECAL (Pb-glass)
g, e^+, e^-
$\sigma(E) / \sqrt{(E)} \sim 5.5\%$

Forward Detector:
PANDA Straws
$\sigma(x) \sim 140$ micron

RPC TOF
$\sigma(t) \sim 70$ ps