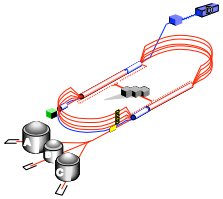
Other facilities - upgraded & new

- Second generation of JLab 12 GeV — Rolf Ent, Or Hen
- Belle II — Carlos Marinas, Hue Ye, Gianluca Inguglia
- PANDA @ FAIR — Marc Pelizeaus
- CBM @ FAIR — Claudia Hoehne
- Mu2e @ FNAL — Luca Morescalchi
- SHiP @ CERN — Annarita Buonaura
- LHC upgrades — Magdalena Slawinska, Tomas Davidek, Thomas Peitzmann



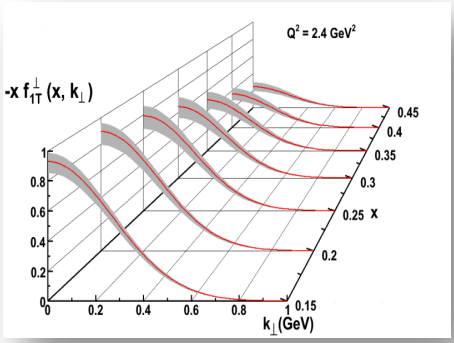
JLab 12 GeV

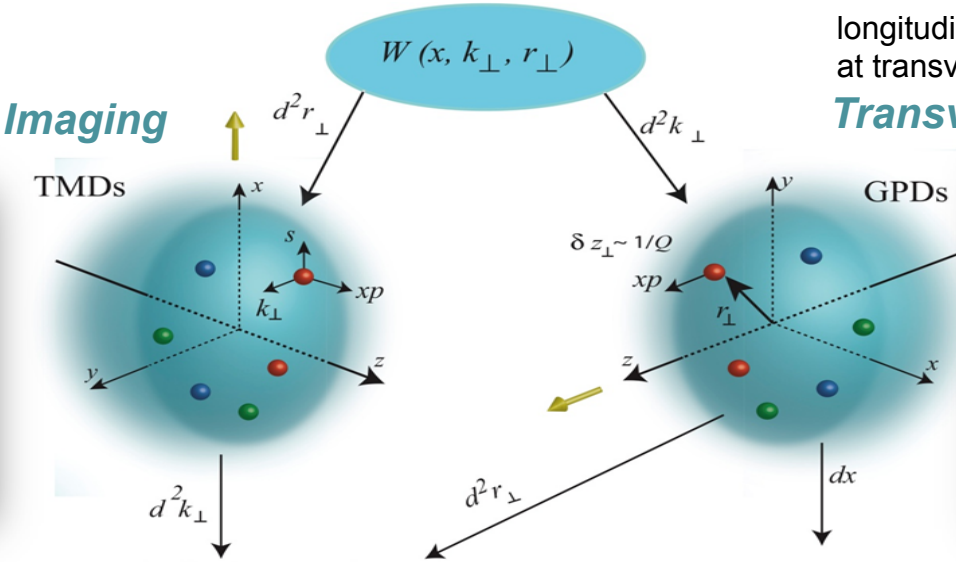
Rolf Ent

A second generation of Jefferson Lab 12 GeV experiments – towards precision spatial and momentum imaging of hadrons

longitudinal momentum fraction *x*
and transverse momentum *k*

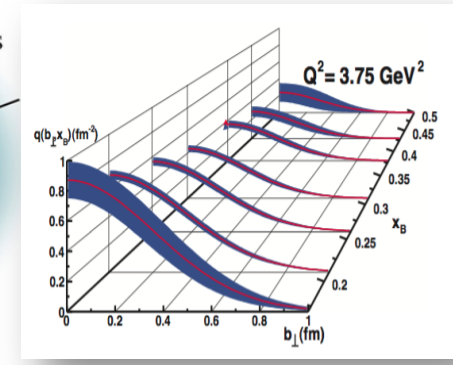
Transverse Momentum Imaging

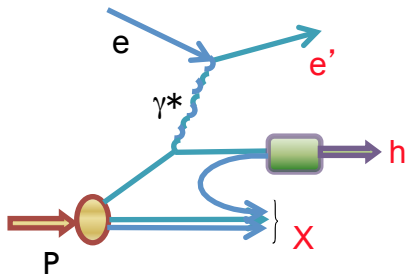




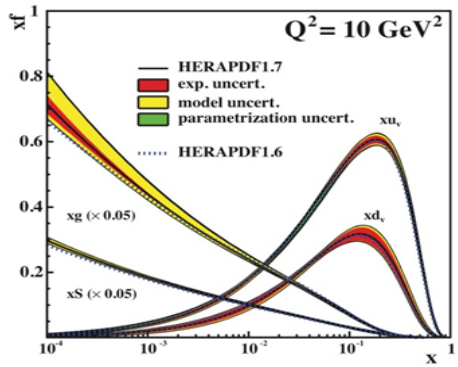
longitudinal momentum fraction *x*
at transverse location *b*

Transverse Spatial Imaging

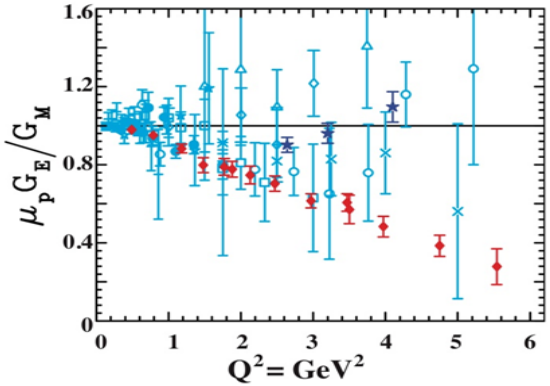


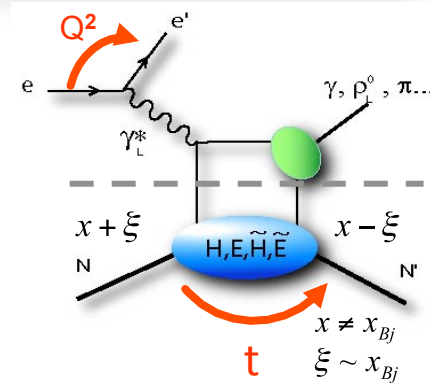


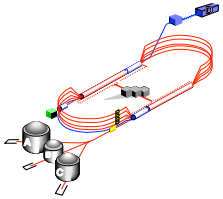
Parton Distribution Functions



Form Factors







JLab 12 GeV

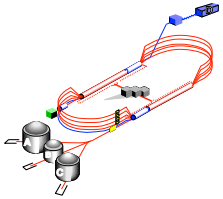
Rolf Ent

A second generation of Jefferson Lab 12 GeV experiments – towards precision spatial and momentum imaging of hadrons

Hall A: Ultimate statistical precision for TMD science: **SBS** and **SoLID**
Hall B: Determining GPDs directly: Double-Deeply Virtual Compton Scattering
Hall C: Precision measurements of (deep) exclusive & SIDIS cross sections with γ, π^0:
Neutral-Particle Spectrometer

Tentative Timeline

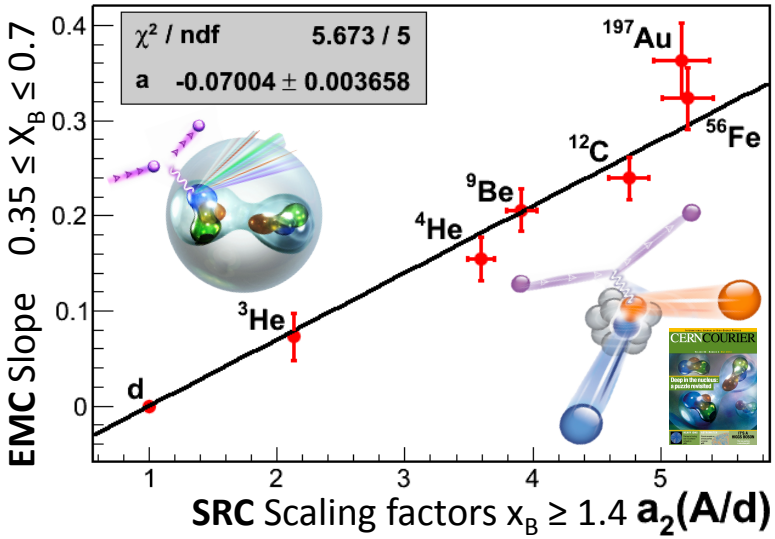
* Up to FY17: 12-GeV Upgrade Project ongoing
* FY16: ongoing program in
  - Hall A: deeply-virtual Compton scattering & *p* magnetic form factor
  - Hall B < 6 GeV science: heavy photon search & *p* radius experiment
  - Hall C: Beam line/dump test
  - Hall D: GlueX engineering run
* FY17: official (DOE) start of 12 GeV science operations
  (typical lifetime of facility science program ~ 15 years)



JLab 12 GeV

Or Hen

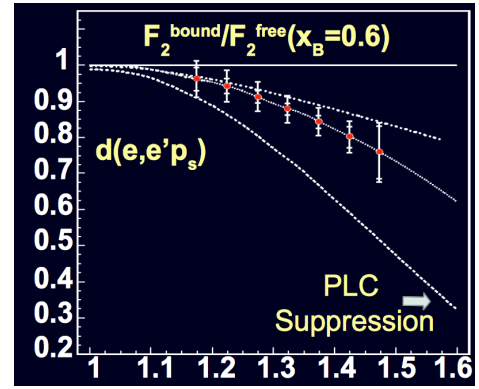
EMC-SRC correlation

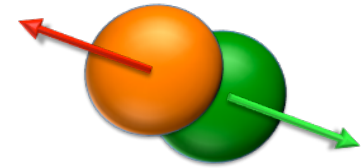


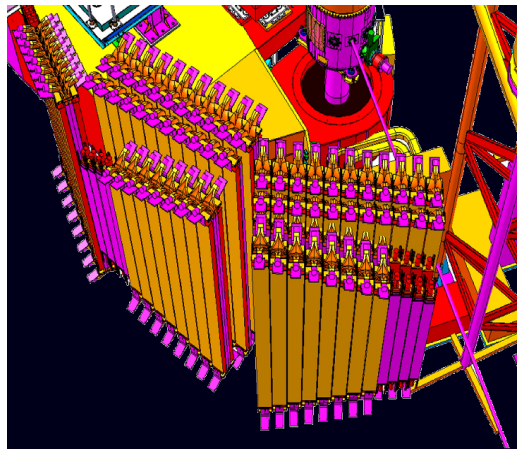
Tagged structure functions

(1) Perform DIS off forward going nucleon.

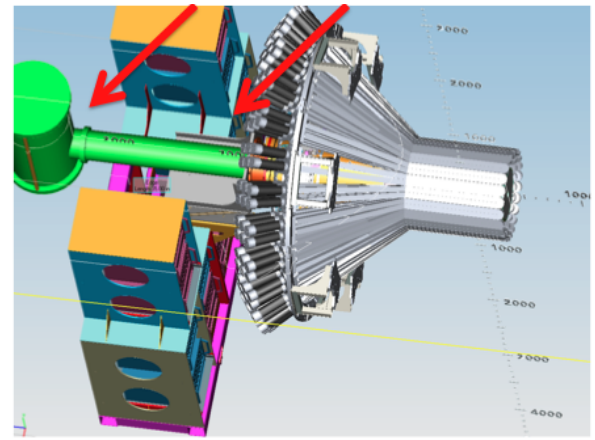
(2) Infer its momentum from the recoil partner.







Large Acceptance Detector
(LAD@Hall-C)

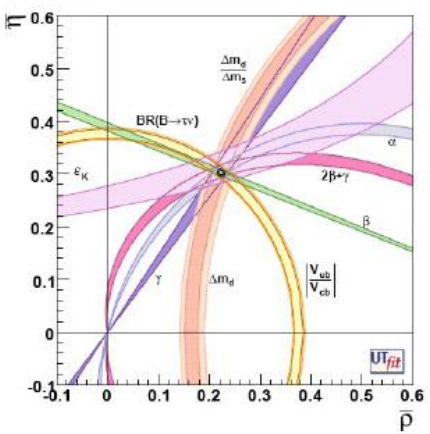


Backward Angle Neutron Detector
(BAND@Hall-B)

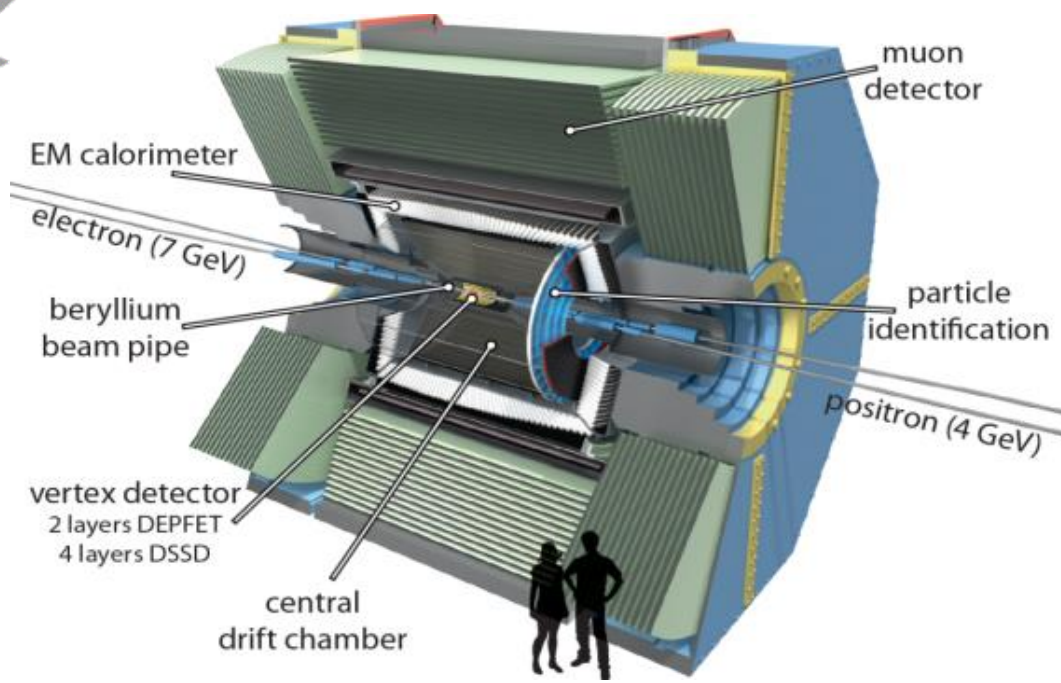
Belle II (KEK)

Carlos Marinas

Belle II



- High-resolution and large-coverage detector



- 40 times larger luminosity than previous Belle
- 50 ab^{-1} by 2025

Ready for physics run in **2018**

Belle II (KEK)

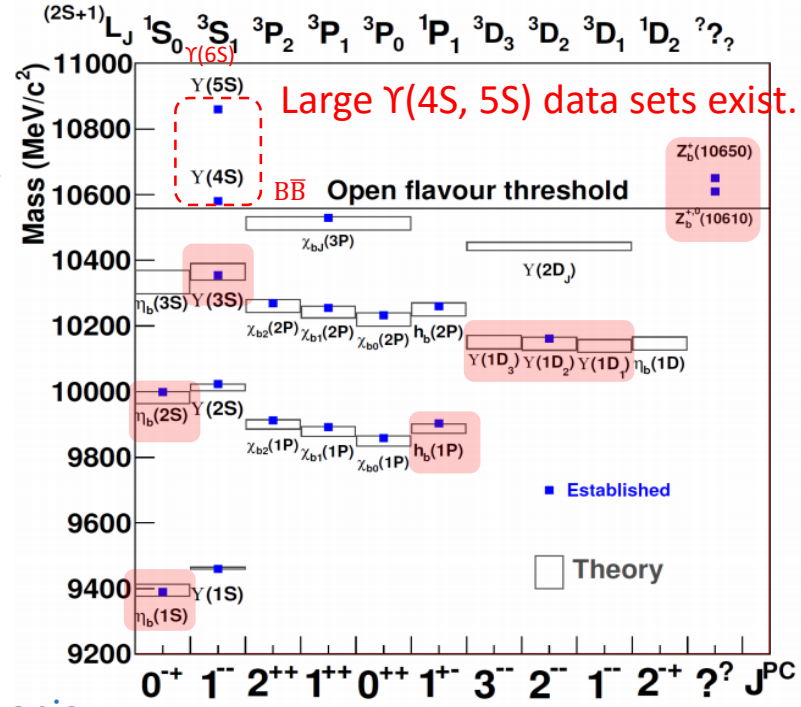
Hue Ye

Belle II early physics program of bottomonia spectroscopy

Physics at B-factory

- CP Violation
  - CKM matrix elements: V_{ub}, V_{cb}.
  - CPV in charm sector
- Bottomonium spectroscopy
- Unanticipated New Particles
  - XYZ hadrons.
- Beyond the SM
  - $B \to X_s l^+ l^-$ probe the FCNC
  - Lepton flavor violating.
  - $B \to \tau\nu$, $D^{(*)}\tau\nu$ probe the charged Higgs.
  - Light dark matter particles and dark photon
  - ……

Early Physics: physics program in the early data taking period of Belle II



Potential of Belle II early physics on bottomonia

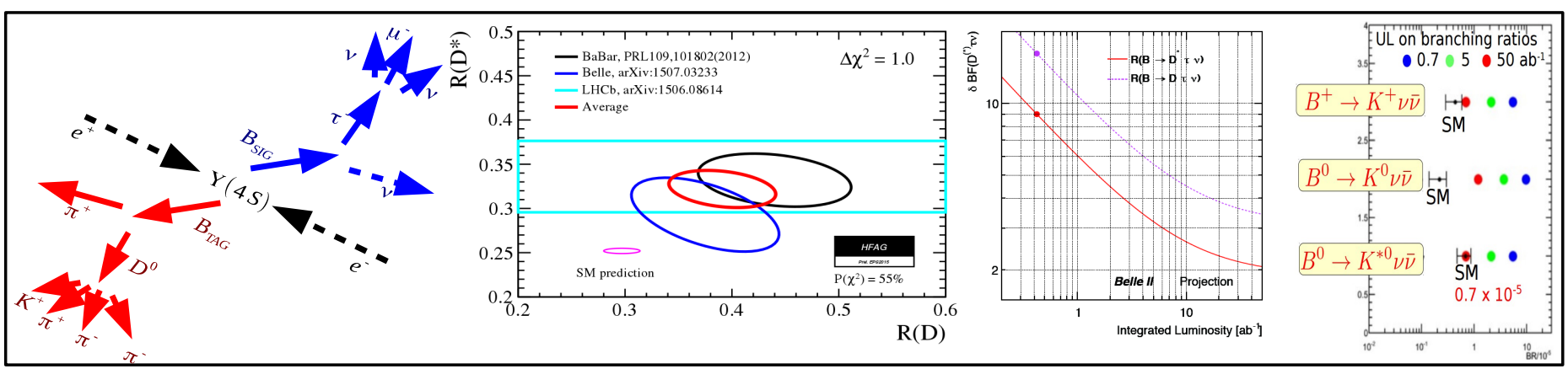
- Bellow Υ(4S): The Υ(3S) offers greatest access to lower bottomonium states, 200fb^{-1} data set will give significant potential
  - Study of η_b(1S,2S), h_b(1P) and $\Upsilon(n^3D_1)$ Studies
  - Analyses with converted photons to improve resolution.
  - Hadronic/Radiative transitions.
- Above Υ(5S)
  - Charged bottomonium-like states: $Z_b^{\pm}$

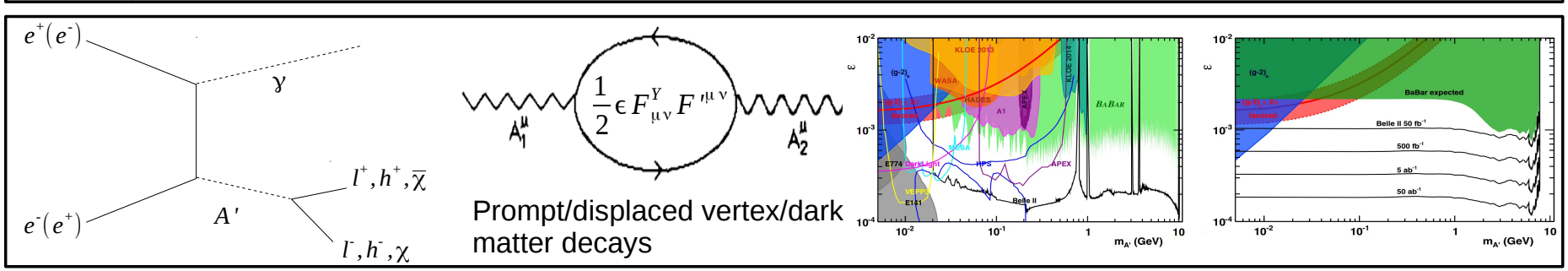
Belle II (KEK)

Gianluca Inguglia

Belle II studies of missing energy decays and searches for dark photon production

- Leptonic and semileptonic B decays can be used to probe new physics at tree level and in loops
  - Anomalies already observed in data
- The dark photon is proposed in many BSM theories to introduce possible interactions between dark matter particles
  - Can explain many anomalies observed in astrophysical if the mass in the few MeV- few GeV range
- With 50 ab-1 collected at Belle II experiment one should be able to resolve the observed anomalies and measure rare decays with missing energy. In addition one will have a high discovery potential in searches for the dark photon.



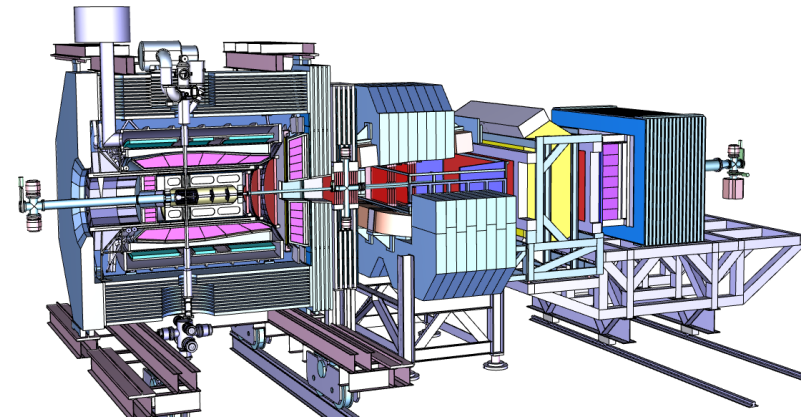


PANDA (FAIR)

Marc Pelizeaus

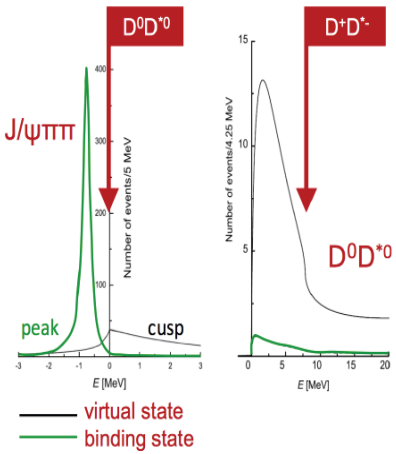
$\bar{p}p$ annihilation

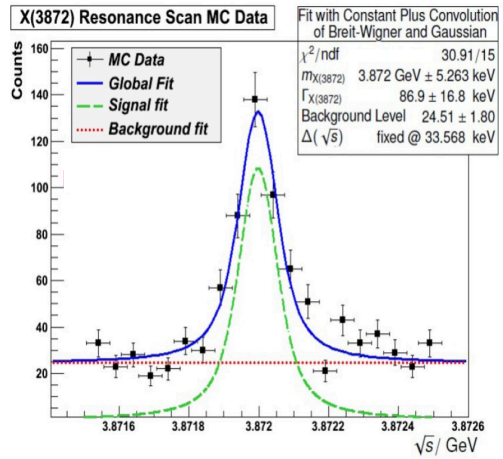
- Gluon-rich environment
- Uniqueness of antiproton probe (no other facility in the corresponding energy range in the world)
- Versatility of physics program (if coupled with universal PANDA detector) addressing
  - hadron spectroscopy
  - nucleon structure
  - hadron interactions



charmonium spectroscopy

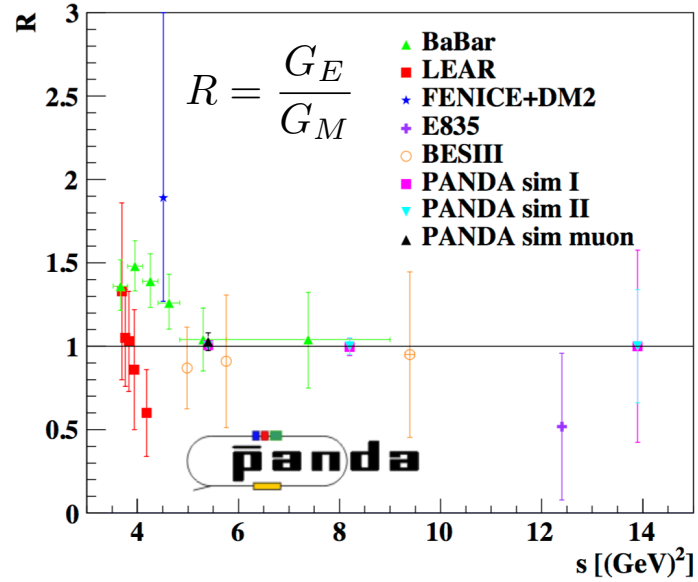
e.g. lineshape of X(3872)





timelike e.m. *p* form factors

$$p\bar{p} \to e^+e^-,\ \mu^+\mu^-$$



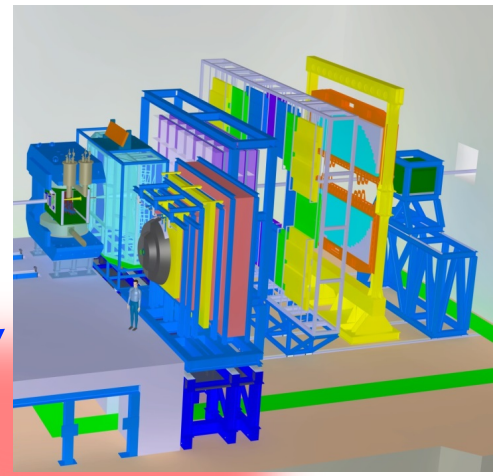
CBM (FAIR)
(Compressed Baryonic Matter)

Claudia Hoehne

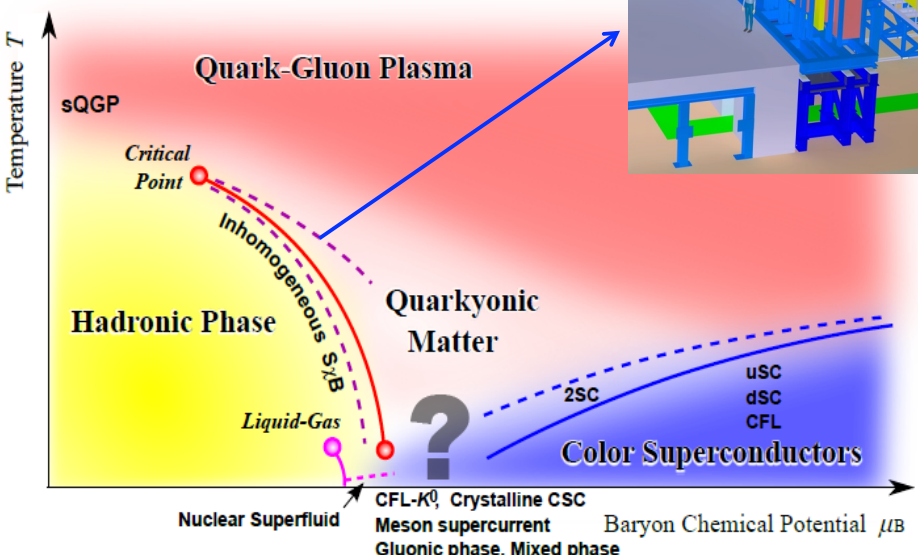
Explore & characterize high-baryon density matter in A+A collisions
- equation of state
- new forms of matter (quarkyonic, strange, hypernuclei …)
- phase transitions?

High precision experiment, high interaction rates, rare probes!

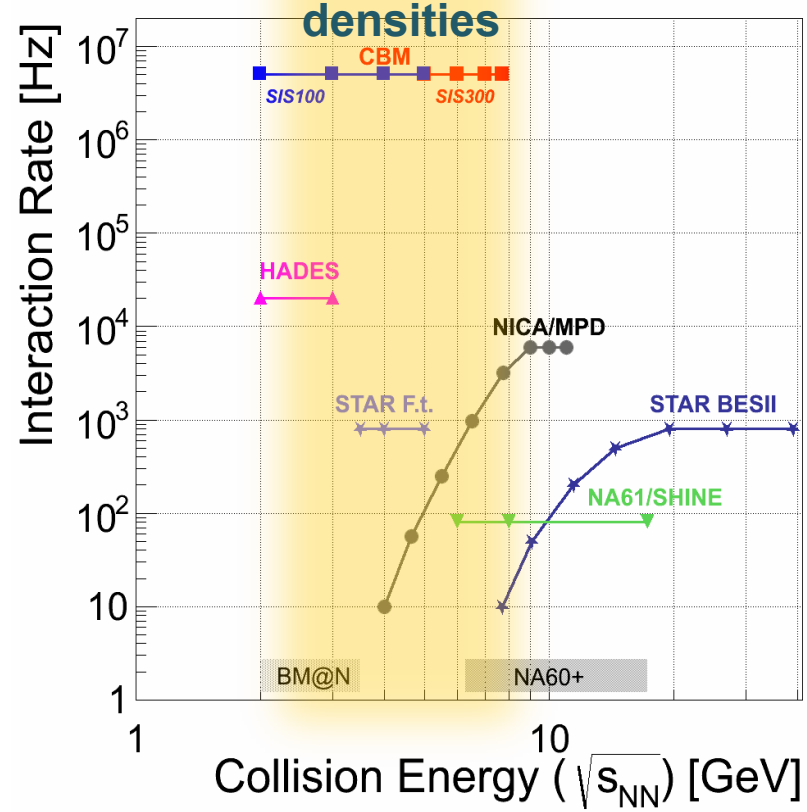
Complementary to heavy-ion experiments at LHC



K. Fukushima, T. Hatsuda,
Rept. Prog. Phys.74, 014001 (2011)



high net-baryon densities



FAIR "phase 0" prior to 2022

Install, commission and use CBM detector components in ongoing physics campaigns:
- BM@N (Dubna)
- HADES at GSI
- STAR at BNL

Mu2e (Fermilab)

Luca Morescalchi

- Mu2e will search for the CLFV process:

$$\mu^- Al \rightarrow e^- Al$$

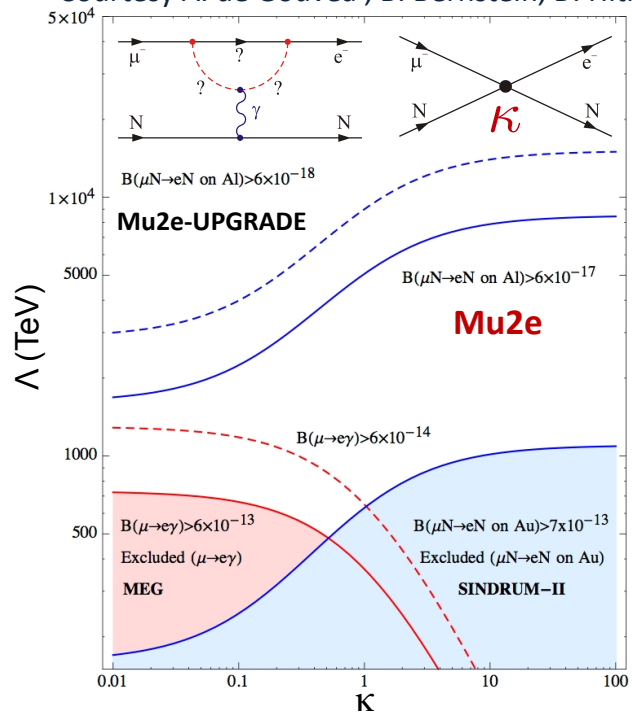
(where the resulting e has an energy of 104.96 MeV)

- In 3 years of data taking we expect **10^{18}** stopped muons, to put an upper limit on

$$R_{\mu e} = \frac{\Gamma\left(\mu^- + \mathrm{N(A,Z)}\right) \rightarrow e^- + \mathrm{N(A,Z)}}{\Gamma\left(\mu^- + \mathrm{N(A,Z)}\right) \rightarrow \text{all muon captures}}$$

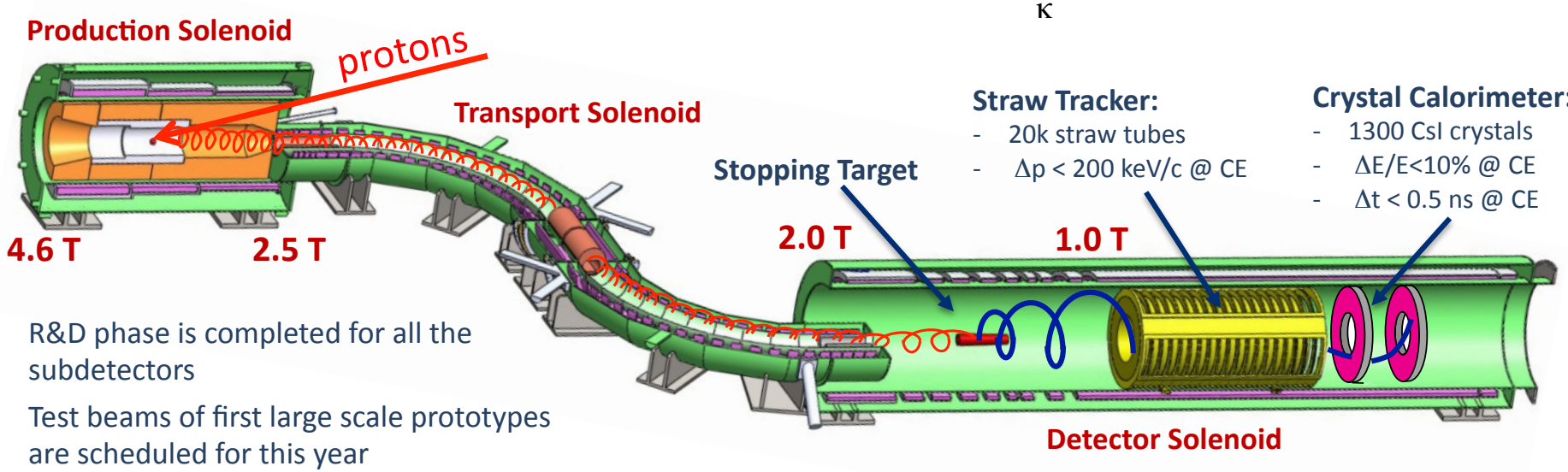
$< 6 \times 10^{-17}$ @ 90% C.L

Courtesy A. de Gouvea , B. Bernstein, D. Hitlin



✓If signal is found, it will be proof of new Physics and it will provide data complementar to LHC and to the other CLFV experiments

✓If no signal is found, it will set constrains on mass scale up to thousands of TeV



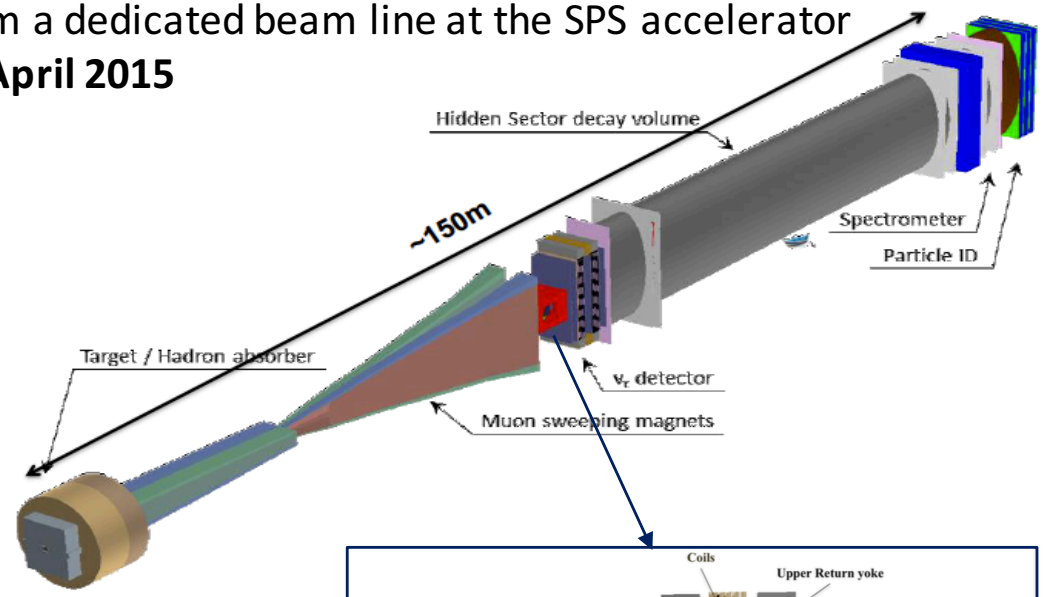
- ✓ R&D phase is completed for all the subdetectors
- ✓ Test beams of first large scale prototypes are scheduled for this year

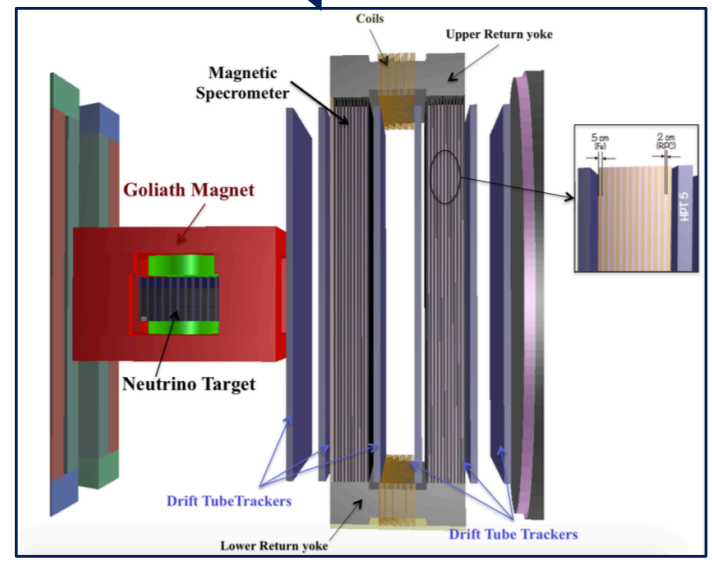
SHiP (CERN)
(Search for Hidden Particles)

Annarita Buonaura

- New experiment proposed @ CERN SPS
  - 400 GeV proton spills (4 x 10^{13} p.o.t.) from a dedicated beam line at the SPS accelerator
- **Technical and Physics Proposal submitted in April 2015**

- Decay volume 50m long equipped with detectors at the far end to explores **Hidden Portals** searching for *long-lived and very weakly interacting particles*
  - Vector portal (dark, hidden, para-photons)
  - Scalar portal
  - Neutrino portal





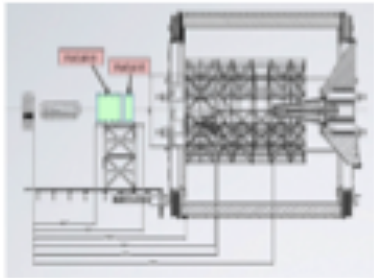
- **Neutrino physics with emulsion-based active neutrino target** (µm resolution) in a magnetic field.
- Particular focus on identifying and distinguish ν_τ and anti-ν_τ
- High statistics never reached before(8k ν_τ CC + 4k anti-ν_τ CC) to:
  - Study ν_τ and anti-ν_τ cross sections
  - Estimate structure functions (F_4 and F_5) from CC DIS of neutrino on nucleon
- Study ν-induced charm events
- Study s-quark content of the nucleon

Positive recommendation from CERN SPS Committee

LHC upgrades (CERN)

Magdalena Slawinska
Tomas Davidek
Thomas Peitzmann

- **High luminosity LHC physics prospects with the upgraded ATLAS detector** (M. Slawinska, Thurs AM)
- **ATLAS Tile Calorimeter, its performance at 13 TeV pp collisions, and its upgrades for the high luminosity LHC** (T. Davidek, Thurs AM)
- **Measurement of forward direct photon production in pA at the LHC with ALICE – a probe for nuclear PDFs and saturation** (T. Peitzmann, Tues PM) (FoCal upgrade to ALICE)



LHC upgrades (CERN)

Magdalena Slawinska
Tomas Davidek
Thomas Peitzmann

HL-LHC upgrade

Much extended physics capabilities in EG. EWSB, BSM, ...

Scoping Document (https://cds.cern.ch/record/2055248, 2015)

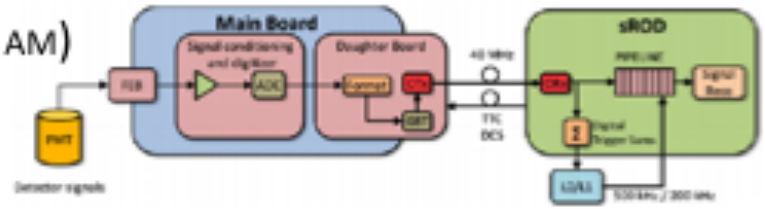
ATLAS detector upgrades (M. Slawinska, Thurs AM)

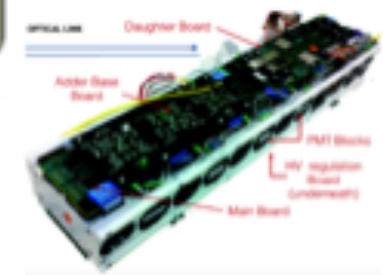
- **Trigger and Data Acquisition**
  - Two-Level hardware trigger with L0 up to 1MHz and L1up to 400 KHz
  - High-Level Trigger with 10 kHz output (permanently recorded data)
  - "Custom hardware" triggers for data streaming at rates 1-40 MHz
  - New Inner Tracker, Calorimeters and Muon Triggers
- **Inner Tracker**
  - Completely new, all-silicon tracker
  - Extending Pixel Detector to $|\eta| < 4$
- **Calorimeters**
  - LAr forward electromagnetic calorimeter replaced with high-granularity
  - High Granularity Timing Detector installed in front of LAr Cal end-caps, $2.4 \lesssim |\eta| \lesssim 4.3$
  - Readout electronics of LAr and Tile Calorimeters replaced
- **Muon Spectrometer**
  - Addition of RPCs in the barrel, $|\eta| < 1$

NSW in the end-cap at Phase 1

ATLAS TileCal upgrade (T. Davidek, Thurs AM)

Major electronics upgrade for HL-LHC 2023 upgrade with higher radiation tolerance, faster and more modern electronics





DEMONSTRATOR prototype built and tested in labs and testbeam; could be inserted in ATLAS by end of year