Super BigBite Project Status

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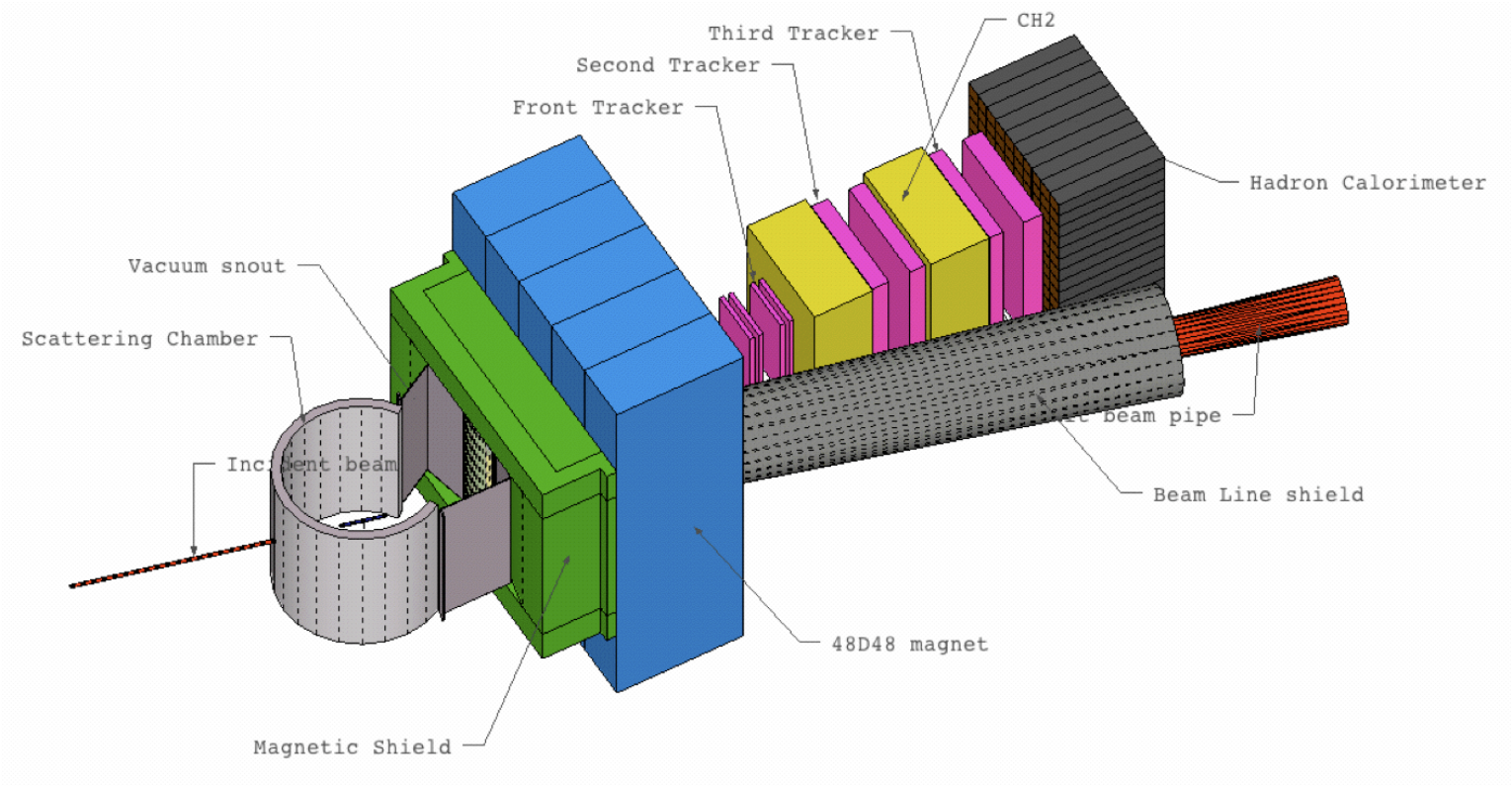
for SBS collaboration

- Concept of the apparatus
- Physics program
- Recent progress
- Near term plans
- Time line of construction

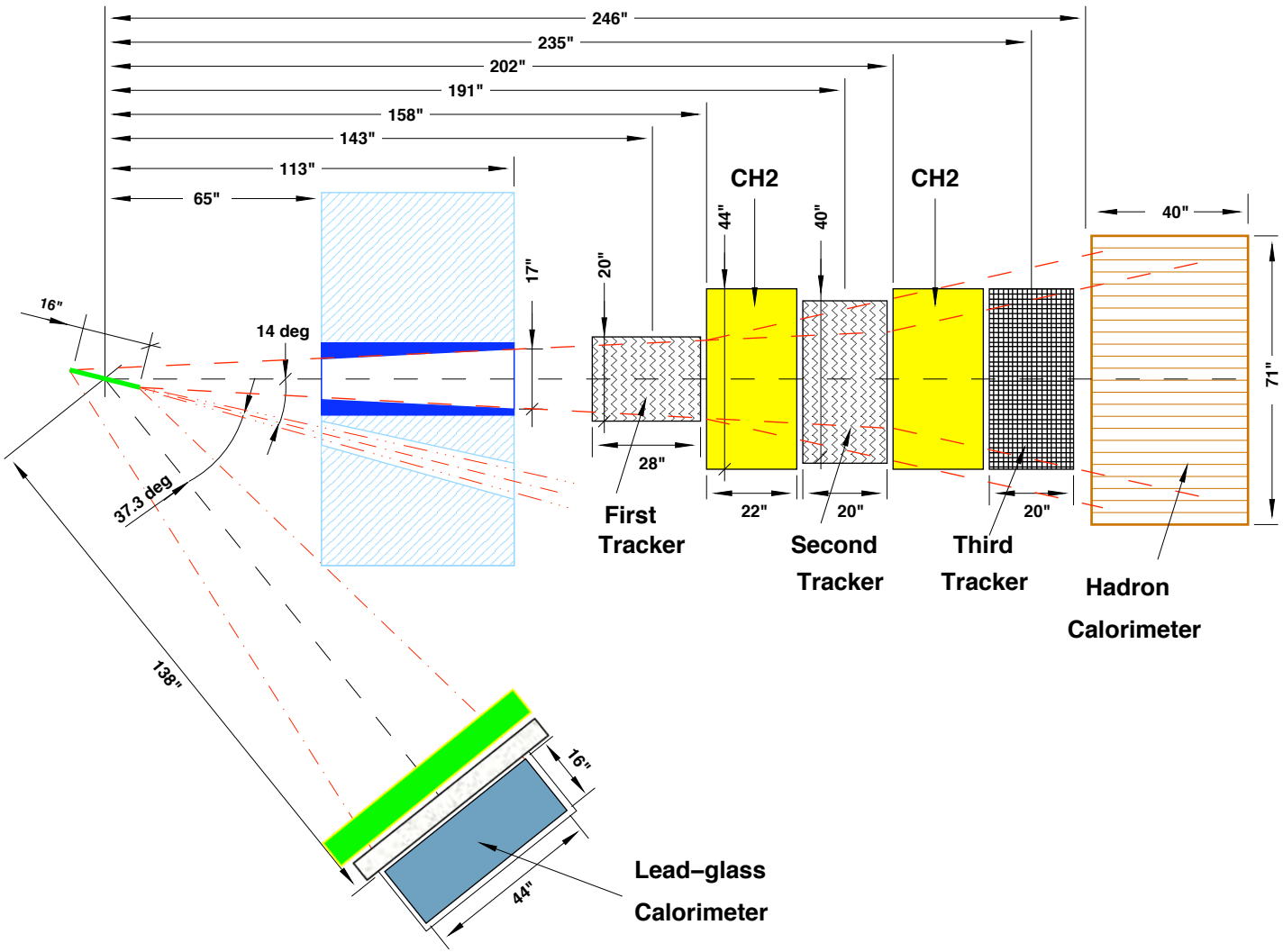
Super Bigbite



SBS Concept

- Vertical bending
- Detector located behind the magnetic field
- Compact beam spot on the target
- Simple dipole for large acceptance
- Field integral vs. detector resolution
- Forward angles vs. solid angle

Layout for GEp(5)



Parameters of SBS

Solid angle

$\theta_{central}$, degree	Ω, msr	D, meter	Hor. range, degree	Vert. range, degree
3.5	5	9.5	$\pm$ 1.3	$\pm$3.3
5.0	12	5.8	$\pm$ 1.9	$\pm$4.9
7.5	30	3.2	$\pm$ 3	$\pm$8
15	72	1.6	$\pm$ 4.8	$\pm$12.2
30	76	1.5	$\pm$ 4.9	$\pm$12.5

Resolution:

Momentum => $\sigma_p/p = (0.03\ p\ [\mathrm{GeV}] + 0.29)\ [\%]$

Angular => $\boldsymbol{\sigma_\theta = 0.2 - 0.3}$ mrad

Momentum acceptance => $\boldsymbol{P}$ range $\mathbf{2 - 10}$ GeV/c

SBS physics program

- **GEP** : reach decisive high 15 GeV^2
- GMN: reach absolute max 14 (18) GeV^2
- GEN: reach 10 GeV^2 (flight to the Moon)
- SSA in nSIDIS: 30,000 gain vs. HERMES

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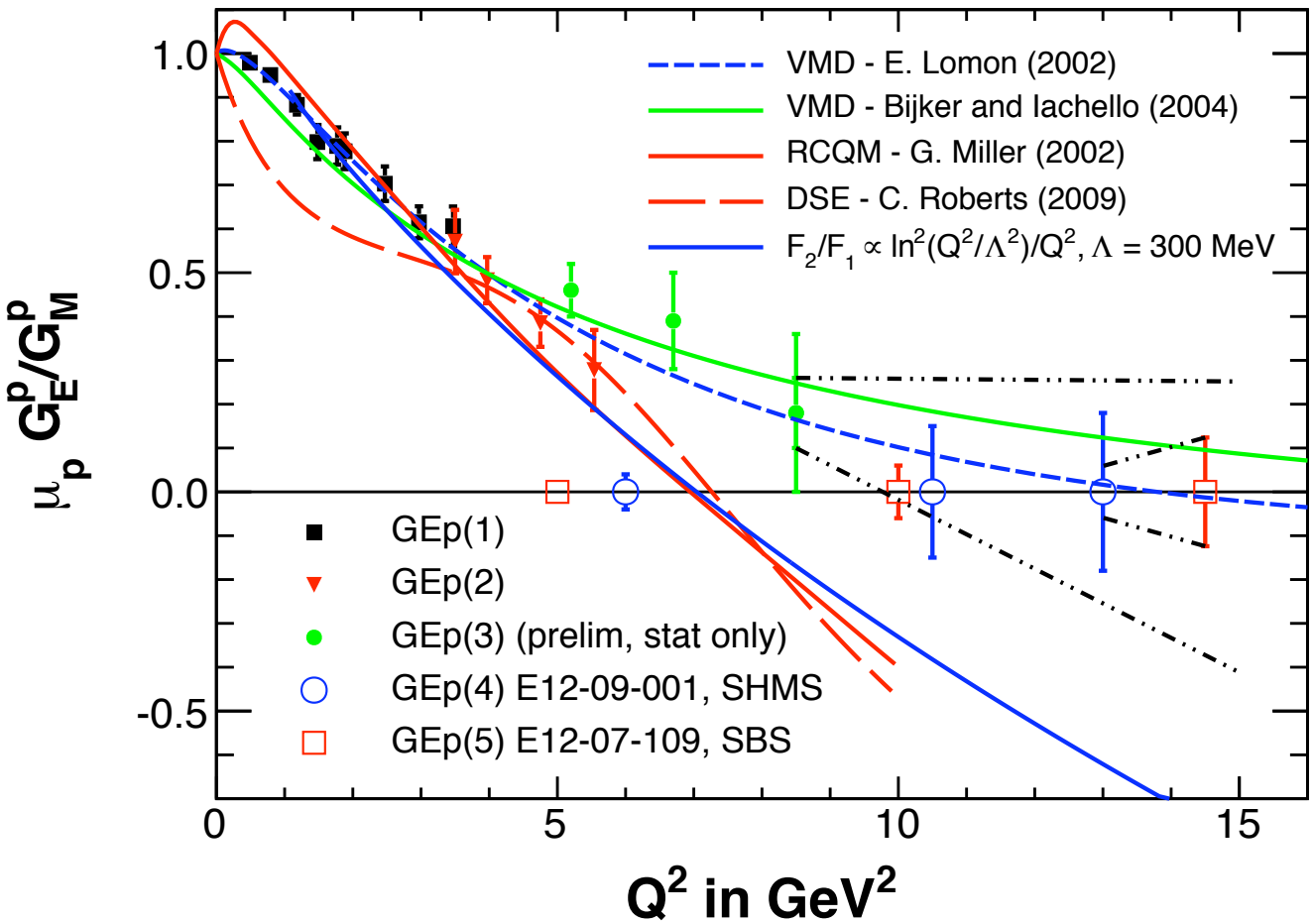
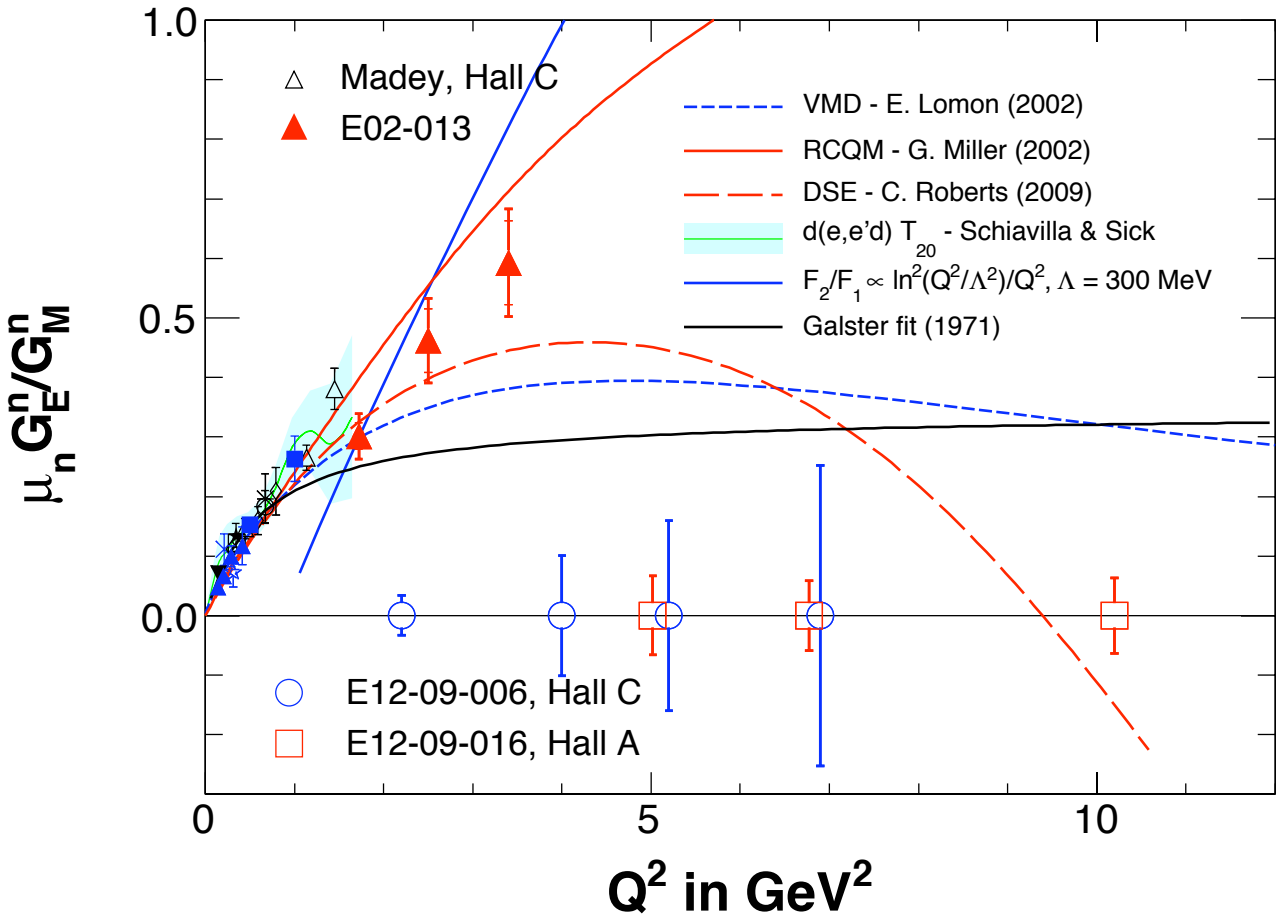
- **A1n**/d2n – gain ~ 20-30 compared with HMS/SHMS
- A(e,e'ϕ)X – in DIS regime
- D(e,e'p) – proton FFs ratio and Resonances
- D(e,e'd) event rate gain ~ 50 at 6 GeV^2
- T/^{3}He(e,e') : 0.1 g of T in the target = 0.6% of Bates
- RCS $d\sigma/dt, K_{LL}, A_{LL}$ \ L= 4 10^{36}
- SRC: e'(HRS) + p(SBS) + N(BB)
- PVDIS – gain by 10-15 compared with two HRS
- A(e,e'p/n), A(e,e'$\pi^{+/-}$) – modification, CT

The Proton Form Factor

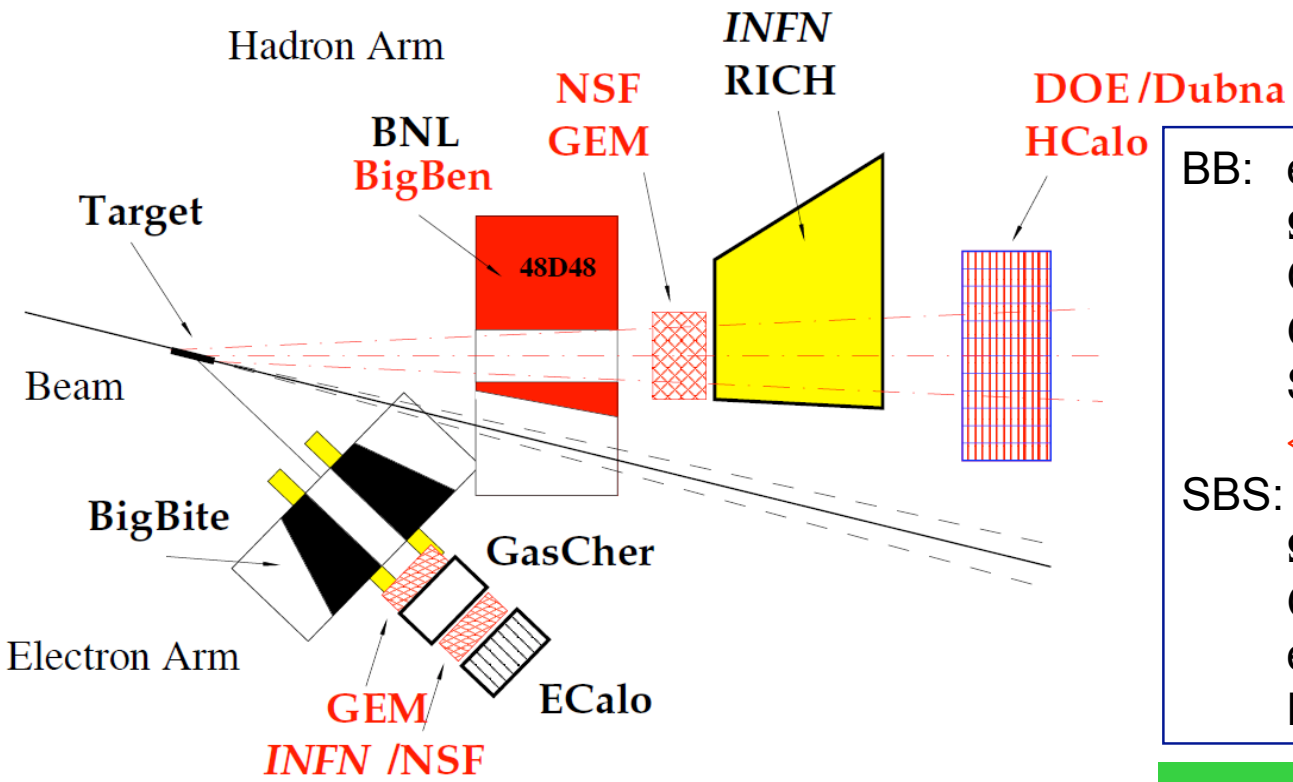


The Neutron Form Factor



SIDIS experiment (conditionally approved)

$$e + {}^3He^{\uparrow} \rightarrow e' + \pi(K)^{\pm} + X$$



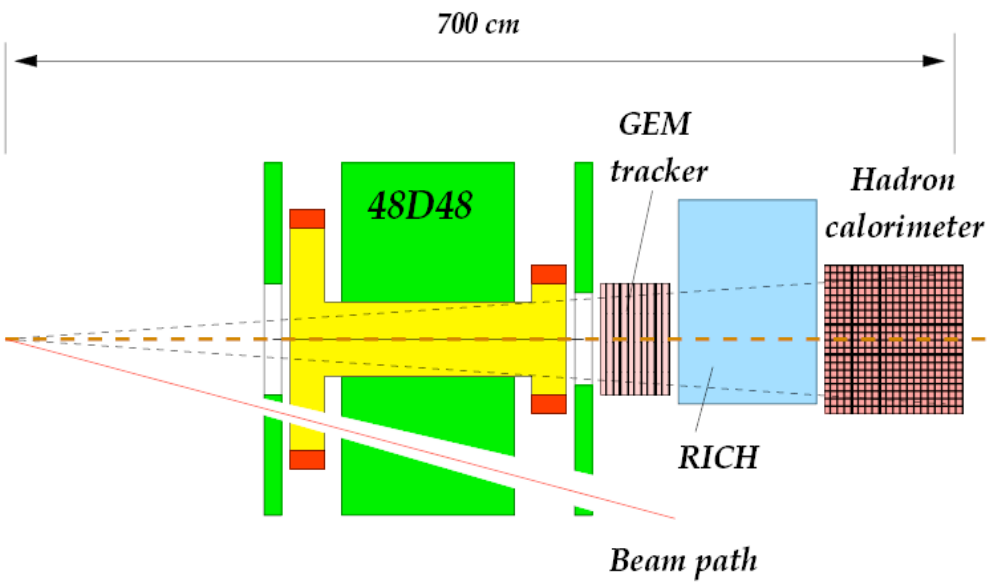
BB: e-arm at 30°
Ω = 45 msr
GEM Tracker
Gas Cherenkov
Shower
⇐ GMn/PR-09-019

SBS: h-arm at 14°
Ω = 50 msr
GEM tracker
excellent PID / RICH
Hadron CALO

Beam: 50 μA, E=8.8 and 11 GeV (80% long. Pol.)
Target: 65% polarized 3He ⇐ GEn(2)/PR-09-016
⇨ Luminosity: 1.4×10^{37} cm^{-2}s^{-1} , 0.05 sr

Event rate: ~$10^4\times$HERMES
60 days of production
expected stat. accuracy:
1/10 of proton HERMES

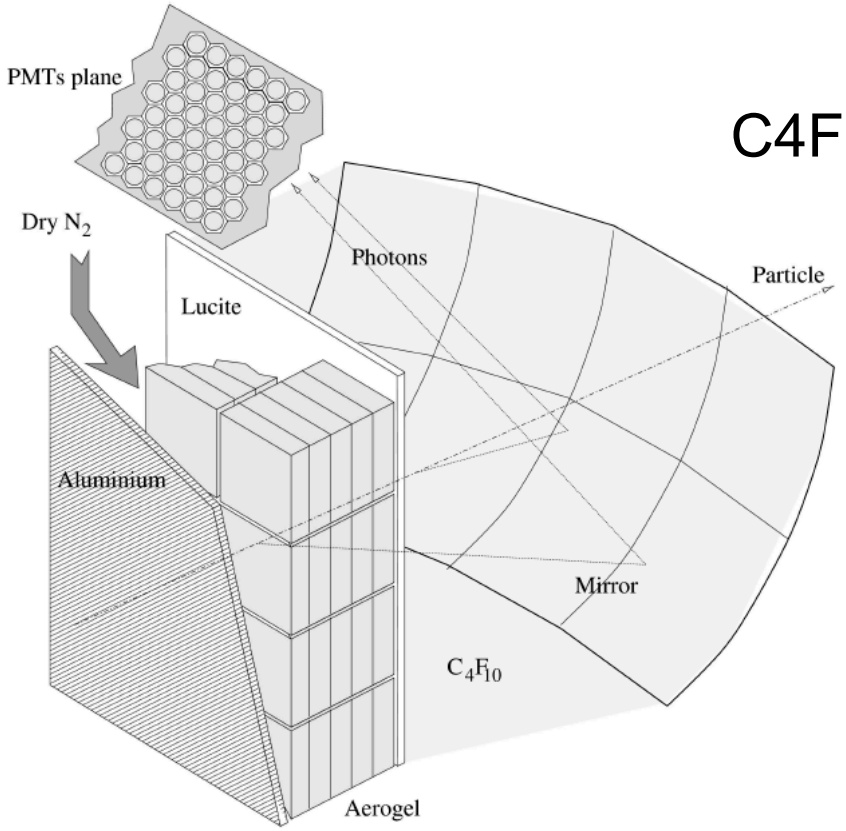
Hadron Arm: SBS



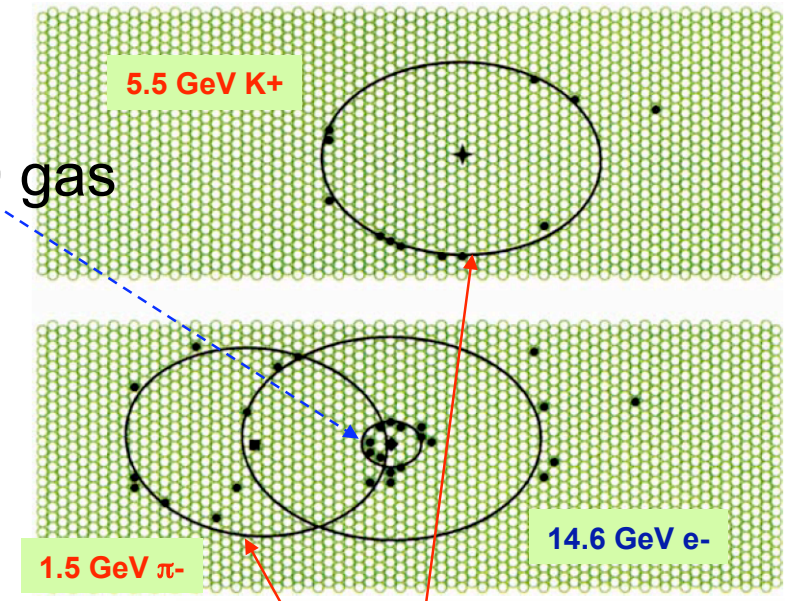
- Magnet: 48D48 - 46 cm gap
  2 Tm field integral -100 ton
  Insert for beam pipe
- GEM chambers for tracking
  with 70 μm resolution
- HERMES RICH for hadron-ID
- Segmented Hadron CALO
  (15x15 cm^2 blocks)

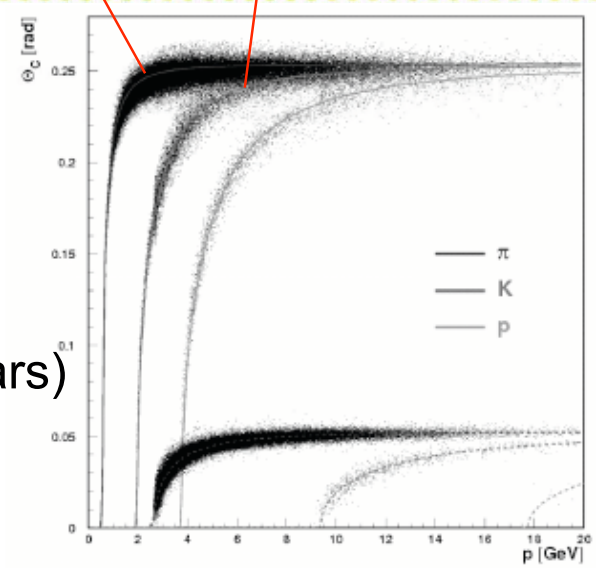
- Angular Resolution: (p = 4 GeV)
  σ_{ϑ_h} = 0.09+0.59/p [mrad] (0.3 mrad)
  σ_{ϑ_v} = 0.14+1.34/p [mrad] (0.4 mrad)
- Vertex Resolution: 0.53+4.49/p [mm] (0.2 cm/$\sin\vartheta_{central}$)
- Momentum resolution σ_p/p = (0.03 p+0.29) % (~0.4 %)
- CALO Trigger Threshold: 1.5 GeV (online), 2.0 (offline)

Hadron PID: HERMES RICH on SBS



C4F10 gas





Very stable performance ($\delta n/(n_{aerogel}-1)$= 1%, 9 years)
Stored at UVa under safe/controlled conditions
(also additional wall of spare Aerogel)

Figure of Merit

Parameter Target		Unit	HERMES H	CLAS12 HD (×60 days)	Proposed Exp. ^{3}He (×40 days)
Dilution factor	f		1	0.20	0.20
Nucleon Polarization	P	%	80	85	56
Cross Section $\sim s/Q^2$	σ	a.u.	4	1	1
Angular Acceptance	$\Delta\Omega$	sr	0.14	1	0.05
Integrated Luminosity	$\int L$	10^{38} cm^{-2}	1.5	260	4.6×10^5
FOM $= f^2 P^2 \sigma \Delta\Omega \int L$			0.54	7.5	280

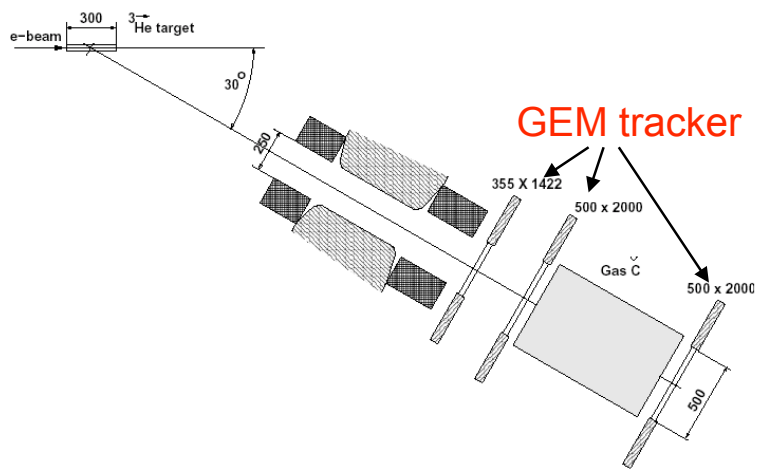
Two beam energy runs for Q^2 dependence studies:

E_{beam} GeV	Time days	Integrated Lumi 10^{43} cm^{-2}
8.8	20	2.4
11.0	40	4.6

Polarized DIS with SBS

Cates, Liyanage, Meziani, Rosner, Zheng, and BW

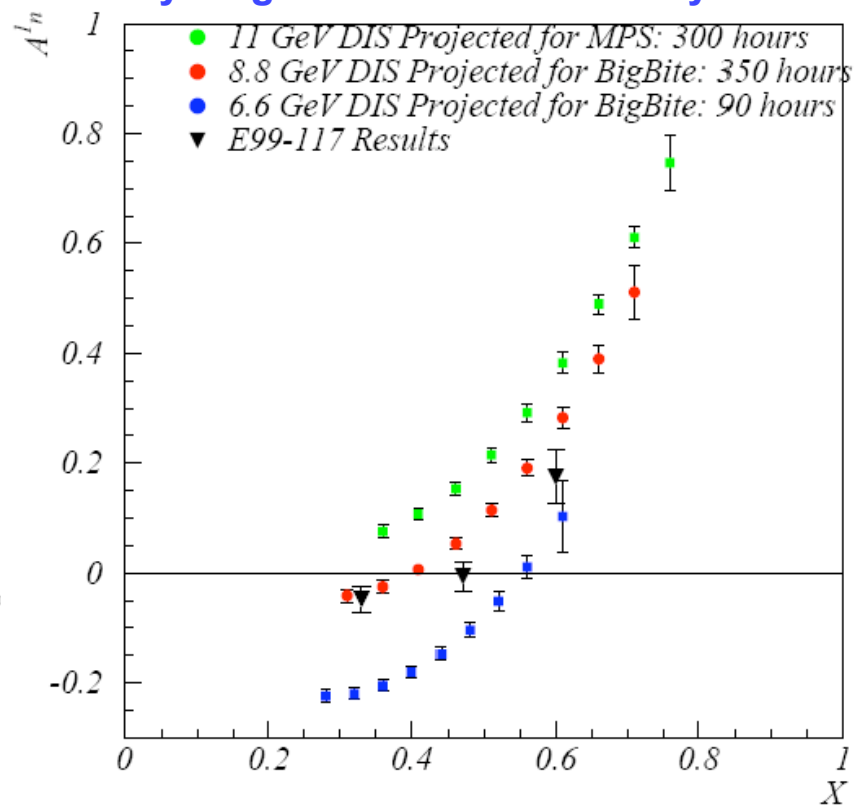
$$^3\vec{H}e(\vec{e}, e')X$$



SBS advantage over HMS+SHMS ~ 12

SBS advantage over BigBite ~ 6

Liyanage: Total ~1000 h in May Now 1/6



very good accuracy, x up to 0.75
first test of Q^2 dependence

Detector configurations in SBS program

	Front GEM	Polar GEM	Had Calo	Elec Calo	Big Ben	Big Bite	RICH a/gas	BB Calo
GEP	X	X	X	X	X			
GEN	X(BB)	X(BB)	X		X	X		X
GMN	X(BB)	X(BB)	X		X	X		X
SIDIS	X (BB)	X	X		X	X	X,a	X
A1n	X (BB)	X	X		X	X	X,gas	X
A(Q^2)	X (BB)	X	X		X	X	X,gas	X
RCS	X	X	X	X	X			
e,e'p	X (BB)	X	X		X	X	*X,a	X
T:u/d	X (BB)	X	X		X	X	X,gas	X
SRC	X (BB)	X	X		X	X		
e,e'ϕ	X (BB)	X	X		X	X	X,a	X

Project status/progress

1) All trackers with GEM chambers
2) HCalo for detection of all hadrons
3) ECalo with one-coordinate GEM
4) INFN: full approval of the front tracker $1.1M
5) EMFF funding proposal (DOE) $2.5M + $1.3M
6) Second technical review in 30-40 days
7) Detailed physics design, prototyping:

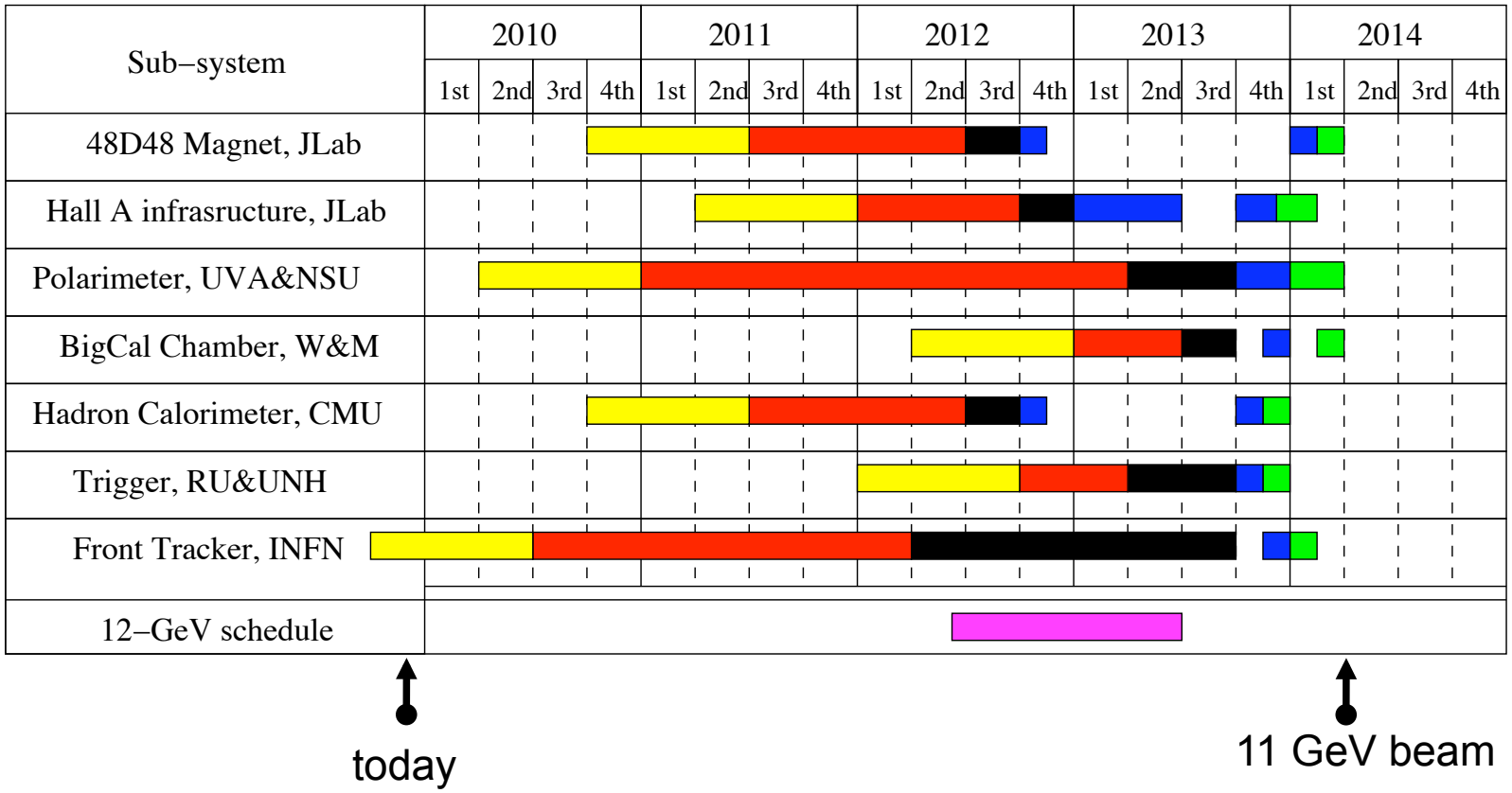
    a) Magnet calculations/design
    b) HCalo components
    c) GEANT simulations
    d) GEM electronics
    e) GEM chamber module
    f) He-3 target gold-plated cell

Near term schedule

DOE review (physics) - ongoing
GMN-18 proposal to PAC35
DeepPhi – LOI to PAC35

Technical review 1/18 (or 2/1)

INFN electronics test – March-June

A1n+ will be resubmit PAC36
SIDIS will be resubmit PAC36
Deep Phi will be submit PAC36
T/He-3; A(Q2) likely will be submit PAC36

Project time line