



Brief summary on past workshops for a positron beam at JLab

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Timeline - 0

- **< 1999**
 - Low energy positron beams with CW machine
 - Discussions between Jlab staff and physicists
 - Materials science (W. Kossler)



Timeline - 1

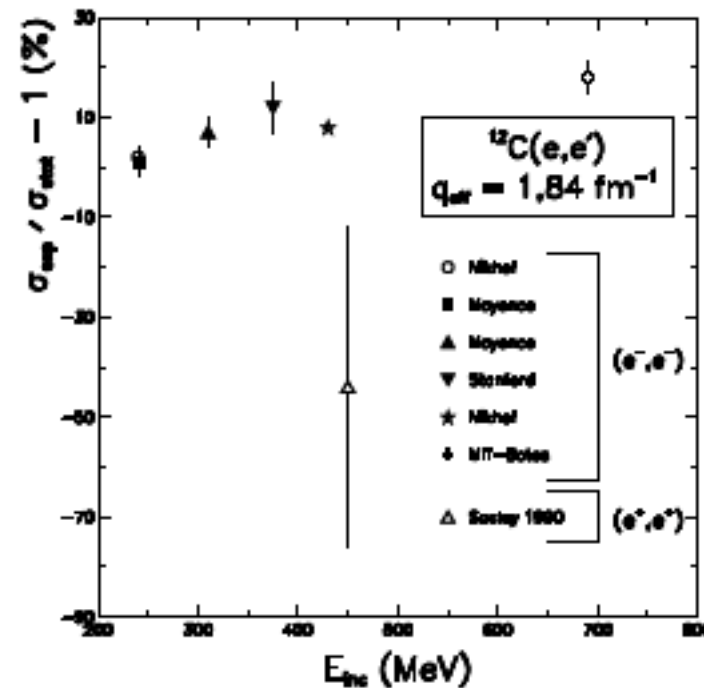
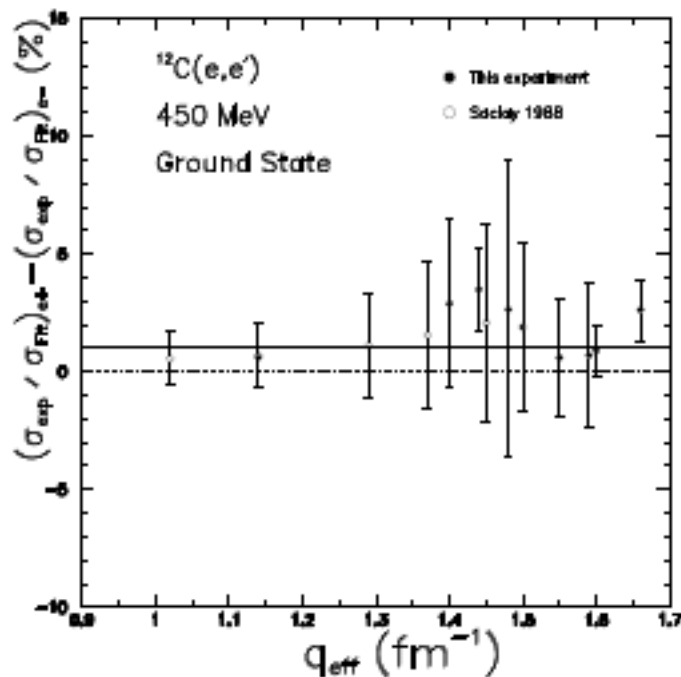
- **1999 @ Jlab**
 - **Mini-workshop on e^+/e^- Physics at Jefferson Lab**
 - 1/2 day (13:00-17:00)
 - 17 participants
 - **Speakers**
 - P. Guèye*: dispersive effects [elastic] & EMA [quasi-elastic]
 - J.-M. Laget: $e^+e^- \rightarrow \gamma\gamma$, 2γ in D_2 form factor, VCS
 - C. Hyde-Wright: hadronic radiative corrections ($e^+p \rightarrow e^+n + \pi^+ + \gamma$), DVCS, weak interaction, materials sciences
 - V. Lebedev: accelerator parameters (new 50 MeV e^+ linac, e^- beam (500 MeV, 1 mA, 0.5 MW beam dump), e^+ (10 μ A)
 - **Cost estimate: \$5M**



Timeline – 2/a

- **2000**
 - **Letter-Of-Intent (LOI)** generated for PAC
 - **Physics** (most already discussed at JPOS09!)
 - Nuclear: DVCS, Dispersive effects, radiative corrections, D_2 form factor, fractionally charged partons [sum rule: deep inelastic Bremsstrahlung structure function $V(x)$], parity violating structure functions
 - High energy (upgrade): collider physics (c/τ factory ...)
 - Material: angular correlation of annihilation radiation (ACAR), defects characterization

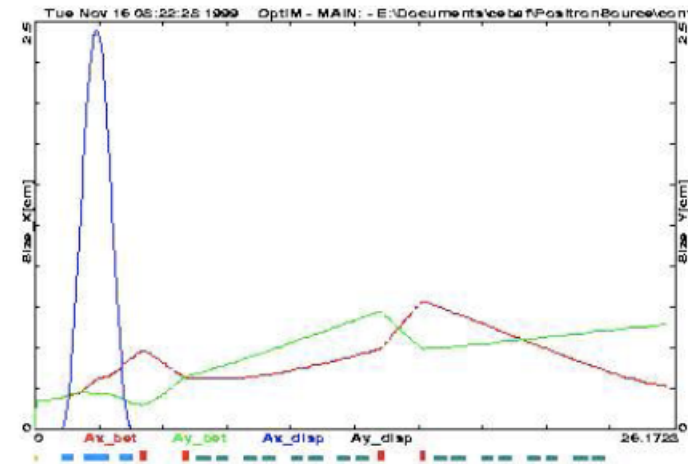
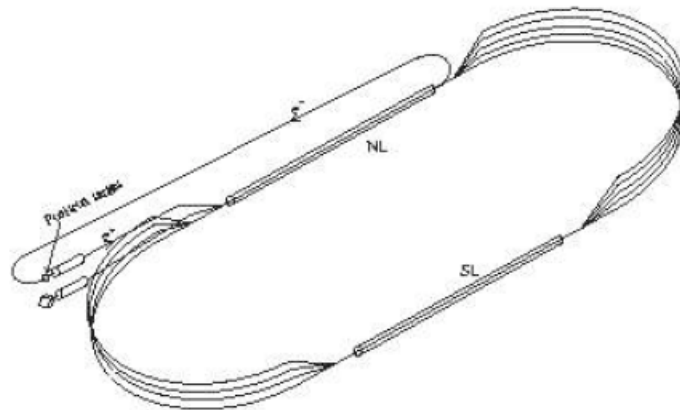
Timeline – 2/b



Guèye *et al.*, Phys. Rev., C57, 2107 1998

- **Dispersive effects**
 - Virtual excitations of the nucleus during elastic scattering process
 - Small at very low Q^2 (≈ 0), $< 1 \text{ GeV}$
 - Energy dependent (10% effect at $\sim 800 \text{ MeV}$)

Timeline – 2/c



Item	Description
Electron beam	
Energy	556 MeV
Current	1 mA
Duty factor	100%
rms size on the target	< 20 μm
rms length on the target	< 80 μm
Positron beam	
Energy range	(56 \pm 4) MeV
Current	1 μA
Duty factor	100%
Normalized acceptance	200 mm.mrad
Relative momentum spread	$\pm 7\%$
Conversion coefficient	0.1%

Item	Relative Gain Factor
Beam Power	40
Acceptance	5
Target Length	6
Relative Momentum Spread	4

Item	Cost Estimation
Beam-line	\$2.0
e^- post-converter cryomodules	\$4.0
e^+/e^- converter	\$3.0
Beam scrapers	\$2.0
Building and Tunnel	\$7.0
Contingency	\$2
Total	\$20.0



Timeline – 3

- **2004 @ Jlab**
 - **Micro-workshop on positron physics**
 - 10 participants
 - Co-Organizers: P. Guèye & J. Arrington
 - **Beam requirements for physics at Jlab**
 - Focus on 2γ exchange & EMA
 - Reactions: ep, eA, quasi-elastic, resonances, ...
 - Physics: Coulomb distortions, dispersive effects, parity violation ...



Timeline – 4

- **Jlab management**
 - **Focus on 12 GeV upgrade**
 - Wait for LOI
 - **Alternative?**
 - Laser induced positron beam (US)
 - Accelerator induced positron beam (Africa)



Timeline – 5/a

- **2006 @ National Society of Black Physicists**
 - NSBP annual meeting (San Jose, CA)
 - **1st ultrafast laser applications and positron physics workshop**
 - 40 participants



Timeline – 5/b

- **Universities**

- Cowan, Tom (University of Nevada at Reno) laser simulation
- Drake, Paul (University of Michigan) astrophysics
- Guèye, Paul (Hampton University) – Organizer nuclear physics
- Johnson, Anthony (University of Maryland in Baltimore) comparison of world laser facilities
- Maksmikshuk, Anatoly (University of Michigan) e⁻ acceleration (100 MeV reached!)
- Meziani, Zein-Eddine (Temple University)
- Williams, Quinton (Jackson State University)

- **Laboratories**

- Arrington, John (Argonne National Lab) nuclear physics
- Assamagan, Kétévi (Brookhaven National Lab) high energy physics
- Hamlette, David (Jefferson Lab) safety issues
- Kazimi, Reza (Jefferson Lab) accelerator physics
- Lebedev, Valeri (Fermi National Lab)
- Reed, Kennedy (Lawrence Livermore)
- Shepherd, Ronnie (Lawrence Livermore) plasma physics

- **Industries**

- Black, David (Coherent) ultrafast laser technology 1
- Marquis, Emmanuel (Thales) ultrafast laser technology 2
- Riboulet, Gilles (Amplitude) ultrafast laser technology 3
- Sims, Joey (CSI)
- Willis, Michael (Intel)

(*)Coherent, amplitude & Thales: only companies that can build high power lasers!

Facilities - 1



- **United States (GeV positron machine)**

- **Laser based**

- Ultrafast, high power laser
 - GV/cm accelerating gradient!
 - R&D: worldwide (US – SLAC, UNL, UMich ...), Japan (KEK ...), Europe (LOA ...) ...
As injectors for conventional cavities

- **High energy e^- beam with ultrafast lasers**

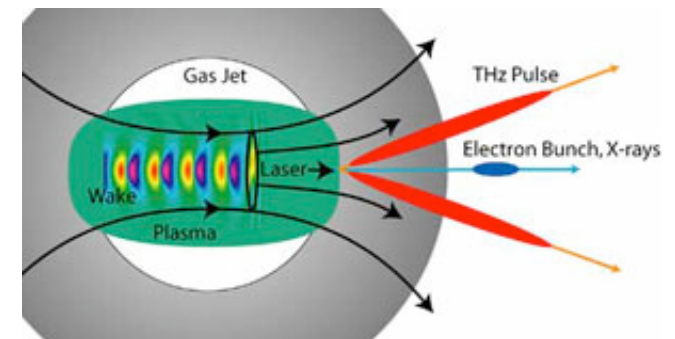
- 1997: $E_e = 70$ MeV, $\Delta E/E = 100\%$, every 10 mins, 3 TW!
 - 2004: $E_e = 200$ MeV, $\Delta E/E = 3\%$, 10 Hz, 1 PW
 - 2006: $E_e = 1$ GeV, $\Delta E/E \approx 1\%$, 10 Hz, 30 TW (in 3.3 cm!)

- **Technological development**

- 2007: 200 TW are commercially available
 - 2008: 500 TW are commercially available
 - 2008: 10 Hz -> 100 Hz for TW lasers

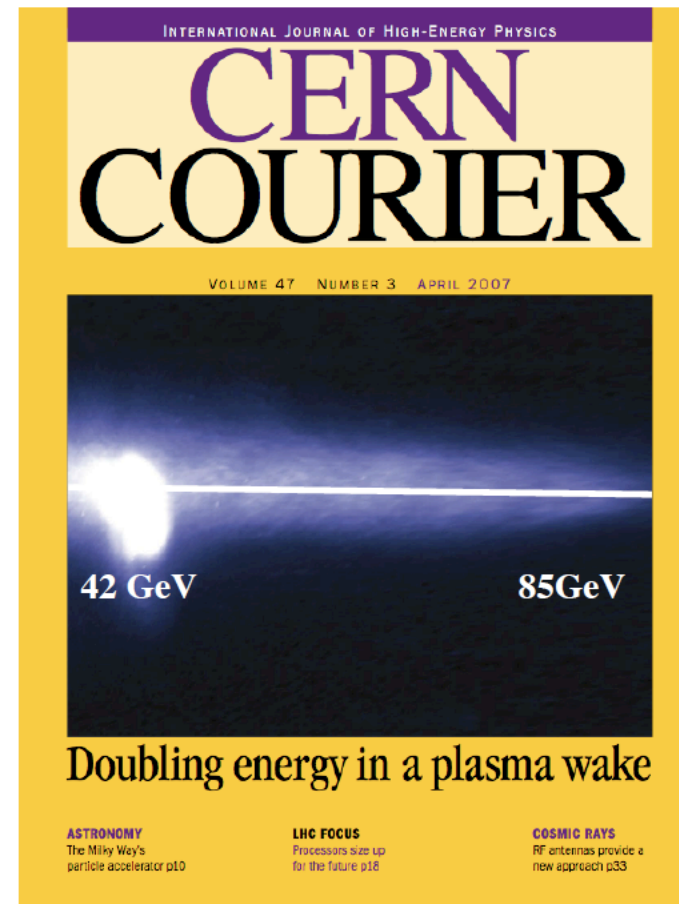
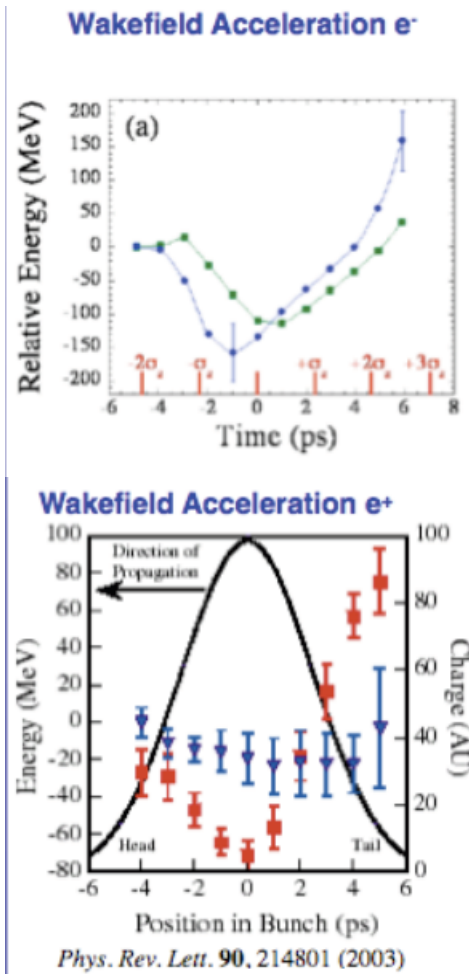
- **Relevant laser parameters**

- 10-400 fs pulse
 - mJ-few Joules
 - Microns spot size



W.P. Leemans, B. Nagler, A.J. Gonsalves, Cs. Toth, K. Nakamura, C.G.R. Geddes, E. Esarey, C.B. Schroeder, and S.M. Hooker, "GeV electron beams from a centimetre-scale accelerator," **Nature Phys.** **2**, 696-699 (Oct 2006), LBNL-60105.

Facilities - 2



Nature V, 445, p. 471 (2007)

Tom Katsouleas, Advanced Accelerator Concepts Workshop, July 208



Facilities - 3

- ***Africa (up to 100s MeV machine)***
 - **Accelerator based**
 - Conventional 10-50 MeV injector
 - Radiator for pair production
 - Pulsed beam (50 Hz)
 - **Phase 1**
 - Low energy physics & applications
 - Benchmarking for simulation (Geant4 ...)
 - Research & education
 - **Phase 2**
 - Upgrade to 100s MeV



Thanks!

- ***US-laser & Africa facilities***
 - Complementary to Jlab
- **Jlab facility**
 - Great progress since 1999!!
 - Looking forward doing physics with e^+ beams