Brief summary on past workshops for a positron beam at JLab

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National Society of Black Physicists
• <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*
  – ½ day (13:00-17:00)
  – 17 participants
  – **Speakers**
    • P. Guèye*: dispersive effects [elastic] & EMA [quasi-elastic]
    • J.-M. Laget: $e^+e^-\rightarrow\gamma\gamma$, $2\gamma$ 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 µA)
  – **Cost estimate**: $5M
• 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 ($c/\tau$ factory …)

  • **Material**: angular correlation of annihilation radiation (ACAR), defects characterization
• **Dispersive effects**
  – Virtual excitations of the nucleus during elastic scattering process
  – Small at very low $Q^2$ ($\approx 0$), $< 1$ GeV
  – Energy dependent (10% effect at $\approx 800$ MeV)

**Timeline – 2/c**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electron beam</td>
<td></td>
</tr>
<tr>
<td>Energy</td>
<td>556 MeV</td>
</tr>
<tr>
<td>Current</td>
<td>1 mA</td>
</tr>
<tr>
<td>Duty factor</td>
<td>100%</td>
</tr>
<tr>
<td>rms size on the target</td>
<td>&lt; 20 μm</td>
</tr>
<tr>
<td>rms length on the target</td>
<td>&lt; 80 μm</td>
</tr>
<tr>
<td>Positron beam</td>
<td></td>
</tr>
<tr>
<td>Energy range</td>
<td>(56 ± 4) MeV</td>
</tr>
<tr>
<td>Current</td>
<td>1 μA</td>
</tr>
<tr>
<td>Duty factor</td>
<td>100%</td>
</tr>
<tr>
<td>Normalized acceptance</td>
<td>200 mm.mrad</td>
</tr>
<tr>
<td>Relative momentum spread</td>
<td>±7%</td>
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<tr>
<td>Conversion coefficient</td>
<td>0.1%</td>
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<table>
<thead>
<tr>
<th>Item</th>
<th>Relative Gain Factor</th>
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<tbody>
<tr>
<td>Beam Power</td>
<td>40</td>
</tr>
<tr>
<td>Acceptance</td>
<td>5</td>
</tr>
<tr>
<td>Target Length</td>
<td>6</td>
</tr>
<tr>
<td>Relative Momentum Spread</td>
<td>4</td>
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<table>
<thead>
<tr>
<th>Item</th>
<th>Cost Estimation</th>
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<tbody>
<tr>
<td>Beam-line</td>
<td>$2.0</td>
</tr>
<tr>
<td>$e^-$/post-convertor cryomodules</td>
<td>$4.0</td>
</tr>
<tr>
<td>$e^+/e^-$ converter</td>
<td>$3.0</td>
</tr>
<tr>
<td>Beam scrapers</td>
<td>$2.0</td>
</tr>
<tr>
<td>Building and Tunnel</td>
<td>$7.0</td>
</tr>
<tr>
<td>Contingency</td>
<td>$2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$20.0</strong></td>
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</table>
• **2004 @ Jlab**
  – Micro-workshop on positron physics
  – 10 participants
  – Co-Organizers: P. Guèye & J. Arrington
  – **Beam requirements for physics at Jlab**
    • Focus on $2\gamma$ 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!
• 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

Facilities - 2

Tom Katsouleas, Advanced Accelerator Concepts Workshop, July 208
• **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