A Roadmap for Future Colliders Based on Advanced Accelerators
Contains Key Elements for Experiments and Motivates FACET-II

Key Elements for PWFA over next decade:

- Beam quality – build on 9 GeV high-efficiency FACET results with focus on emittance
- Positrons – use FACET-II positron beam identify optimum regime for positron PWFA
- Injection – ultra-high brightness sources, staging studies with external injectors
- Develop PWFA demonstration facility

FACET-II Project Plan

Timeline:
✓ Nov. 2013, FACET-II proposal, Comparative review
✓ CD-0 Sep. 2015
• CD-3B Sep. 2017
• CD-4 2022

Experimental program (2019-2026)

Key R&D Goals:
• Beam quality preservation, high brightness beam generation, characterization
• e+ acceleration in e- driven wakes
• Staging challenges with witness injector
• Generation of high flux gamma radiation

Three stages:
• Photoinjector (e- beam only) FY17-19
• e+ damping ring (e+ or e- beams) FY18-20
• “Sector 20 Positrons chicane (e+ and e- beams)

FACET-II will operate as a National User Facility with an external program advisory committee reviewing proposals and recommending priorities for the experimental program.
Schedule

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
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<tbody>
<tr>
<td>Quarter</td>
<td>Qtr1</td>
<td>Qtr2</td>
<td>Qtr3</td>
<td>Qtr4</td>
<td>Qtr1</td>
<td>Qtr2</td>
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<tr>
<td>LCLS-1</td>
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<td>S10 Injector AIP</td>
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<tr>
<td>FACET-II Stage 1:</td>
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<tr>
<td>135 MeV e⁻ beam</td>
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<tr>
<td>10 GeV e⁻ beam</td>
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<tr>
<td>S20 e⁻ chicane</td>
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<tr>
<td>FACET-II Stage 2:</td>
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<tr>
<td>10 GeV e⁺ beam</td>
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<tr>
<td>S20 e⁺ chicane</td>
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</tbody>
</table>

FY18: Gun/cathode R&D will start
FY19: 135MeV e⁻ beam
FY20: 10 GeV compressed e⁻ beam
FY22: e⁻ and e⁺ compressed beams
Progress on Sector 10 Injector AIP

Project progressing well

$2,798
$2,360
Progress on AIP

Laser Room: rack anchoring and laser controls installation

Gallery: Electrical circuits for new racks - done
Magnet power supplies ready for cables

S10 Injector vault:
- Waveguide hung, awaiting gun & accelerator structures
- Water manifolds and fittings installed
- PPS installing conduit and terminal cabinets
- LCLS style gun had a successful cold test
- Gun table in shop (drilling new holes)
Planning for FACET-II as a Community Resource

**FACET-II**

- Photo injector (e- beam only) FY17-20
- e+ damping ring (e+ or e- beams) FY21-22

**SLAC Linac in 2025**

- LCLS – II SC LINAC
- FACET-II
- LCLS-I

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V. Yakimenko, FACET-II SCIENCE WORKSHOP, Oct. 17, 2017
<table>
<thead>
<tr>
<th>Electron Beam Parameter</th>
<th>Baseline Design</th>
<th>Operational Ranges</th>
<th>Positron Beam Parameter</th>
<th>Baseline Design</th>
<th>Operational Ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charge per pulse [nC]</td>
<td>2</td>
<td>0.7-5</td>
<td>Charge per pulse [nC]</td>
<td>1</td>
<td>0.7-2</td>
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<tr>
<td>Repetition Rate [Hz]</td>
<td>30</td>
<td>1-30</td>
<td>Repetition Rate [Hz]</td>
<td>5</td>
<td>1-5</td>
</tr>
<tr>
<td>Norm. Emittance γε_{x,y} at S19 [μm]</td>
<td>4.4, 3.2</td>
<td>3-6</td>
<td>Norm. Emittance γε_{x,y} at S19</td>
<td>10, 10</td>
<td>6-20</td>
</tr>
<tr>
<td>Spot Size at IP σ_{x,y} [μm]</td>
<td>18, 12</td>
<td>5-20</td>
<td>Spot Size at IP σ_{x,y} [μm]</td>
<td>16, 16</td>
<td>5-20</td>
</tr>
<tr>
<td>Min. Bunch Length σ_{z} (rms) [μm]</td>
<td>1.8</td>
<td>0.7-20</td>
<td>Min. Bunch Length σ_{z} (rms)</td>
<td>16</td>
<td>8</td>
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<tr>
<td>Max. Peak current I_{pk} [kA]</td>
<td>72</td>
<td>10-200</td>
<td>Max. Peak current I_{pk} [kA]</td>
<td>6</td>
<td>12</td>
</tr>
</tbody>
</table>
Call for proposals

• The FACET-II science research program has been under development through a series of events that span several years (from 2012). Events include community workshops and collaboration meetings.

• Community engagement will continue with annual FACET-II science workshops. Development of individual high profile FACET-II experiments is expected to be coordinated through numerous collaborations meetings.

The call for proposals is expected after the project is baselined and will be followed by the first FACET-II external advisory committee meeting (expected in FY18).
FACET-II operation modes

- 6 months/year operations with target operational efficiency of 85%
- Simplified injector system and LCLS operations experience allows to consider different patterns (Cost analyses shows very similar cost of operations):
  - 1 week on - 1 week off
  - 2 weeks on - 2 weeks off
  - ...
  - 6 months on - 6 months off

- Access:
  - 12 hours every 2 weeks
  - ~2 months summer
  - 3 weeks winter shutdowns
Improvements and discussion on agenda:

- FACET-II new Beam Capabilities: Glen White
- Accelerator Diagnostics: Nate Lipkowitz
- Experimental area diagnostics: Brendan O’Shea and Mike Litos (tomorrow)
- Differential pumping: Christine Clark
- Experimental laser upgrade: Alan Fry (Friday)

Tonight at 6pm
Baseline FACET-II Electron Single-Bunch Design Parameters

4.3 MeV
σ_z = 0.85 mm
σ_δ = 400 keV

135 MeV
σ_z = 0.85 mm
σ_δ = 0.1 %

335 MeV
σ_z = 400-500 µm
σ_δ = 1-1.5 %

4.5 GeV
σ_z = 80-100 µm
σ_δ = 1-1.5 %

10 GeV
σ_z = 1.5-20 µm
σ_x,y = 10-20 µm
σ_δ = 1-1.5 %

I_pk = 30-70 kA

Q=2nC

SLAC Linac Tunnel (Sectors 10 – 19)

W-chicane & Final Focus (S20)
Baseline FACET-II Positron Parameters

- RF gun
- Linac-0: $L=6\text{m}$, $R_{56}=-48\text{ mm}$
- Linac-1: $L=12\text{m}$, $R_{56}=6.3\text{ mm}$
- Linac-2: $L=322\text{m}$
- Linac-3: $L=471\text{m}$
- S14 e$^+$ booster Linac: $L=12\text{m}$
- BC11: $L=6\text{m}$, $R_{56}=-48\text{ mm}$
- BC14: $L=22\text{m}$, $R_{56}=-36\text{ mm}$
- BC20: $R_{56}=5\text{ mm}$, $L=39\text{m}$
- Final Focus: $(\beta_{x,y}=0.5\text{ m})$
- $Q=4\text{nC}$
- $Q=1\text{nC}$

Parameters:
- $\gamma_{x/y}=9/10\text{ mm-rad}$
- $335\text{ MeV}$
- $\sigma_z = 276\text{ mm}$, $\sigma_\delta = 1.2\%$
- $4.5\text{ GeV}$
- $\sigma_z = 97\text{ mm}$, $\sigma_\delta = 1.1\%$
- $10\text{ GeV}$
- $\sigma_z = 16.4\text{ mm}$, $\sigma_\delta = 0.7\%$
- $I_{pk} = 6\text{kA}$

$\sigma_z = 3.9\text{ mm}$, $\sigma_\delta = 0.084\%$
$\gamma_{x/y} = 6.7\text{ mm-rad}$
$E=335\text{ MeV}$

SLAC Linac Tunnel (Sectors 10 – 19)
W-chicane & Final Focus (S20)

V. Yakimenko, ExHILP, September 5, 2017