





...and possibilities for crystal experiments

#### U. Wienands, SLAC Division Head for Linac S0-20





- The primary goal of FACET is proof in principle that plasma acceleration can accelerate a bunch
  - characterize the mechanism under beam loading
  - estimate beam parameters (witness)
  - estimate the efficiency and gradient reachable in practice
  - demonstrate acceleration of a positron bunch
- Beyond that, FACET will provide a facility to explore other accelerator physics issues
  - Wakefield measurements (ILC, CLIC)
  - Matter in extreme fields







- Driven by first  $2/3^{rd}$  of the SLAC 2-mile linac
  - new exp. area in Sec. 19-20.
  - new compressor chicane in Sec. 10 for  $e^+$
  - new compressor chicanes in Sec. 19.
  - $-e^{-}$  and slightly later also  $e^{+}$







#### • Beam Parameters (typical):

Energy	23 GeV
Charge per pulse	$0.5 - 2 \ge 10^{10} e^{-} \text{ or } e^{+}$
Pulse length at IP ( $\sigma_z$ )	15 – 40 μm
Typical spot size at IP $(\sigma_{x,y})$	10 – 20 μm
Repetition rate	1 – 30 Hz
Momentum spread	4 - 0.5%
Momentum dispersion at IP ( $\eta$ and $\eta$ ')	$\eta < 10^{-5}  m$

- many of these can be tuned to match requirements

- 30 Hz repetition rate



## **Staged Bunch Compression**





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### **S20 FACET Installation**







#### **Some of the Beam Diagnostics**









- First beam 13-June 2011
  - "User-assisted commissioning", expt. installed
- Experimental program to begin July 2011
  - 2 Months user run in FY2011
- 8 reviewed and approved experiments
  - for about 20 weeks of total running time
    - several of these can run in parallel
  - plus two letters of intent





Title	Spokesperson(s)			
Multi-GeV Plasma Wakefield Acceleration Experiments	Mark Hogan (SLAC), Chan Joshi (UCLA), Patric Muggli (USC)			
Determination of the time profile of 50fs long bunches by means of coherent Smith-Purcell radiation.	Armin Reichold (Univ. Oxford)			
Study of Ultrafast Processes in Magnetic Solids following Excitations with Electron Beams	Hermann Durr (SLAC)			
Wakefield Acceleration in Dielectric Structures	Mark Hogan (SLAC), James Rosenzweig & Gil Travish (UCLA), Patric Muggli (USC)			
High-gradient Dielectric Wakefield Measurements at FACET	Alexei Kanareykin (Euclid LLC)			
Testing of Metallic Periodic Structures at FACET	Sami Tantawi (SLAC)			
Investigations of Optical Diffraction Radiation as a Non-intercepting Beam-size Monitor at High Energy and Charge Density	Alex Lumpkin (FNAL)			
Afterburner Based on Particle Acceleration by Stimulated Emission of Radiation at FACET	Levi Schächter (Technion)			
Letter of intent for a program of measurements for the CLIC study at the FACET facility	Daniel Schulte (CERN)			
Expression of Intent for THz Program at FACET	Joe Frisch (SLAC)			

# **FACET** Possibilities for Crystal Experiments

- $\approx 10^9...2 \times 10^{10} e^-$  or  $e^+$ /pulse @ up to 30(15) Hz
- $1 \times 10^{-10}$  m-rad y emittance => small divergence
  - $-1 \mu rad at 0.1 mm width quite realistic (rms @ 23 GeV)$ 
    - possibly can lower divergence by another factor 2...5 (?)
  - *x* dimension tuneable (i.e. change particle density)
    - but about 10 times the emittance
- 0.5% -> 1.5% energy spread (approx.)

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- inversely proportional to bunch compression
- will explore if we can lower energy spread further
- low-duty factor pulsed beam
  - cannot easily do particle tracking as we do in H8



UA9 Workshop, 27-Feb-11











- Crystal at or downstream of IP
  - $-1 \mu$ rad beam divergence in *y*, orient crystal horizontally
  - detect channeled beam  $\approx 10$  m downstream
    - $R_{12} \approx 18 \text{ mm/mrad}$ ; 100 µrad => 1800 µm deflection (10  $\sigma$  separation)
  - or detect at  $\approx 5$  m downstream
    - <u>no intervening optics</u>,  $R_{12}$ =5 mm/mrad
- Vertical spectrometer to detect energy loss
  - resolution limited by beam energy spread (0.5%)
    - inherent resolution  $\approx$  factor 10 better







Si (110)  $\rho = 2.5 \text{ m}$  l = 1 mm  $\theta = 400 \mu r$ I.Yazynin code, R. Noble modif's.









 incoming beam size; channeled beam size; energy spectrum of outgoing beam; energy spectrum of γ-rays







- Beam collimation for a linear collider
  - Can only be done at FACET under semi-realistic conditions
  - FACET uniquely may allow us to study intensityrelated effects (vary bunch length, intensity)
  - compare  $e^+$  and  $e^-$  collimation efficiency
  - Effect of γ-ray generation on collimation scheme
  - Fits with overall FACET mission
- Initial round of  $\gamma$ -ray experiments
  - Planar vs Axial channeling radiation
  - VR radiation...





Noble, Ng, Stupakov, Seryi et al.

- Study of volume reflection of  $e^+$  and  $e^-$ 
  - test continuum model of VR for light particles
  - study effect of multiple scattering on VR
  - possible application for halo cleaning in lin. colliders
- Physics of volume-reflection radiation by  $e^+ \& e^-$ 
  - test radiation models for channeled light particles in region of undulator parameter  $K = E/m^* \Theta \approx 1$ .
  - possible application as new photon source







- Simulations to better define setup & crystal parms

   I will try to get a (summer-) student to start this
- Find a suitable  $\gamma$ -ray detector
  - issue is the high multiplicity due to pulsed radiation
  - Clive Field (SLAC) will look into this
- Goniometer
  - needs to be vacuum compatible
  - other groups at SLAC have used motorized stages etc; maybe we can benefit form their experience...
  - help will be needed here
- Design of hardware
  - Applied for an "LDRD" grant from SLAC
    - success not guaranteed.
- Definition of a crisp initial experimental program





- Preliminary planning is for 2 running periods of 2 months each/fiscal year.
  - this FY it is 2 months only, + 2 weeks commissioning
  - running time is funding and demand driven
- Scheduling of experiments depends on possibility of parallel running.
  - if crystal expt. hardware can co-exist with the PWFA tank, can likely have multiple relatively short running periods.
  - if hardware requires PWFA to deinstall, likely have to use relatively long blocks of time.





- The 2<sup>nd</sup> FACET Users Meeting is presently planned for September 2011.
  - Chance to see the facility, discuss special requirements, etc.
- The next Call for Proposals will go out after that
  - October or November deadline
  - 3-12 pages typical for the first round
- This year, proposals were reviewed in January.
  - Internal pre-review for completeness and to ask for specifics or clarifications
  - External review meeting ("SAREC")



# **SLAC Operating Schedule**



	Fiscal	Month	SPEAR-3	LCLS	FACET	NLCTA	ESA-TB		
	year								
	FY2011	January	On Jan 2, Run	On Jan 3, Users Jan 13	Off	Run about 50%	tbd		
	FY2011	February	Run	Run 120 Hz	Off	Run about 50%	tbd		
	FY2011	March	Run	Run, Off Mar 8	Off	Run about 50%	tbd		
	FY2011	April	Run	Off Sept 1	Off	Run about 50%	tbc		
	FY2011	May	Run	Turn on May 13	Off	Run about 50%	tbd		
	FY2011	June	Run	Run IV, Users June 9	Commis	Run about 50%	tbd		
	FY2011	July	Run	Run IV	Run	Run about 50%	tbd		
	FY2011	August	Off	Run IV	Run	Run about 50%	tbc		
	FY2011	September	Off	Run IV	Off	Run about 50%	tbc	>	
	FY2012	October	Turn on, Run	Run IV ends Oct 25	Off	Run about 50%	tbd		re-commissio
	FY2012	November	Run	Run Run	Ť.	Run about 50%	tbd		<i>e</i> <sup>+</sup>
	FY2012	December	Run, Off Dec 16	Run V, Off ec to	9	Run about 50%	tbd		-
-	FY2012	January	On Jan 2, Run	Off, Turn on an 30	Ōff	Run about 50%	tbd		
	FY2012	February	Run	ers Feb 9	Run	Run about 50%	tbd	)	
	FY2012	March	Run	Run	Run	Run about 50%	tbd		
	FY2012	April	Run	Rup v	Off	Run about 50%	tbd		
	FY2012	May	R' I	Fun V	Off	Run about 50%	tbd		
	FY2012	June	R	Fun V	Run	Run about 50%	tbd		
	FY2012	July	Run	Fan V	Run	Run about 50%	tbd		
	FY2012	August	Off Au 1	Off Aug 1	Off	Run about 50%	tbc		
	FY2012	sptember		Off	Off	Run about 50%	tbc		
	FY2013	Octoper	T m on, Run	On Oct 3, Users Oct 13	Off	Run about 50%	tbd		
	FY2013	Novener	Kun	Run VI	Off	Run about 50%	tbd		
	FY2013	December	Run, Off Dec 19	Run VI, Off Dec 19	Off	Run about 50%	tbd		
	FY2013	January	On Jan 2, Run	On Jan 2, Users Jan 10	Off	Run about 50%	tbd		
	FY2013	February	Run	Run VI	Run	Run about 50%	tbd		
	FY2013	March	Run	Run VI	Run	Run about 50%	tbd		
	FY2013	April	Run	Run VI	Off	Run about 50%	tbd		
	FY2013	May	Run	Run VI	Off	Run about 50%	tbd		
	FY2013	June	Run	Run VI	Run	Run about 50%	tbd		
U. Wienands, SLAC	FY2013	July	Run	Run VI	Run	Run about 50%	tbd		
1140 Workshop 27	FY2013	August	Off Aug 1	Off	Off	Run about 50%	tbc		
UA9 WORKShop, 27-1	FY2013	September	Off	Off	Off	Run about 50%	tbc		
U. Wienands, SLAC UA9 Workshop, 27-1	FY2013 FY2013 FY2013	July August September	Run Off Aug 1 Off	Run VI Off Off	Run Off Off	Run about 50% Run about 50% Run about 50%	tbd tbd tbc tbc		



