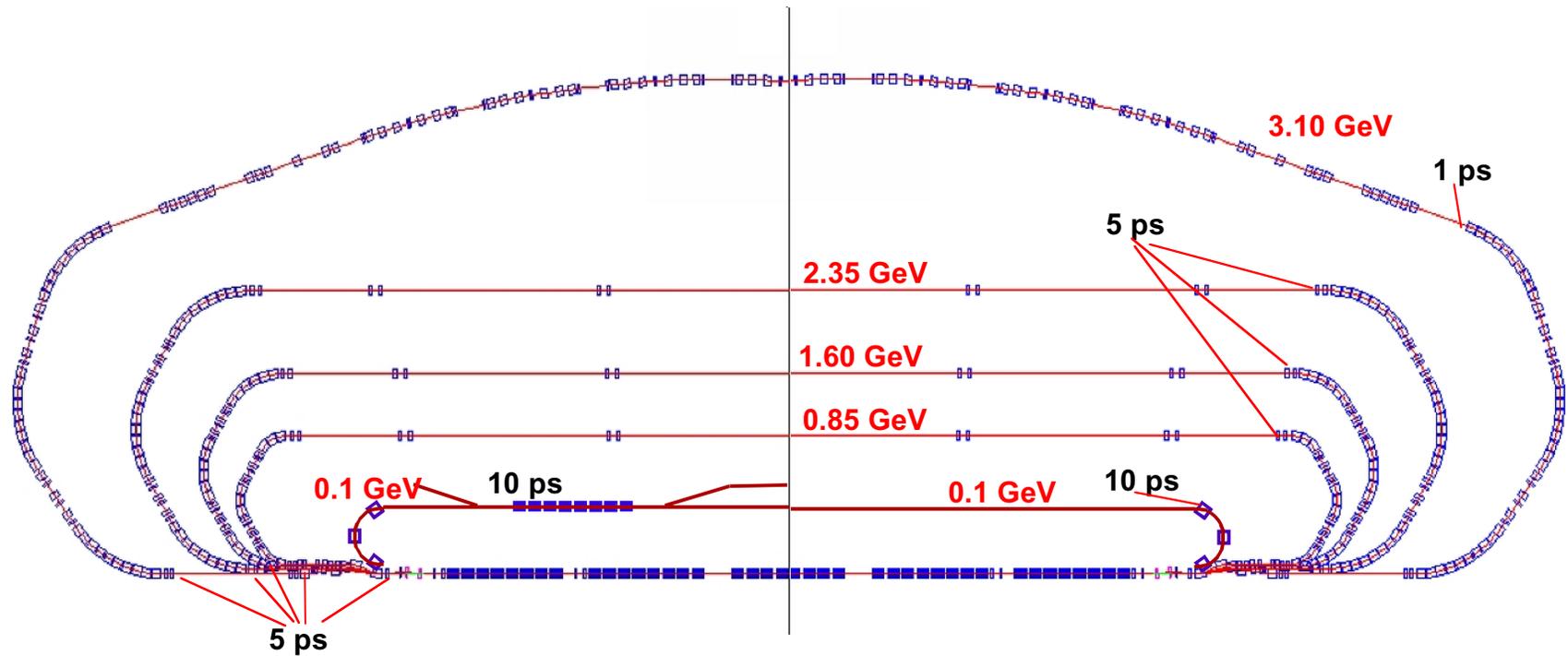


Thoughts On Bunch Length Measurements For the Femtosource

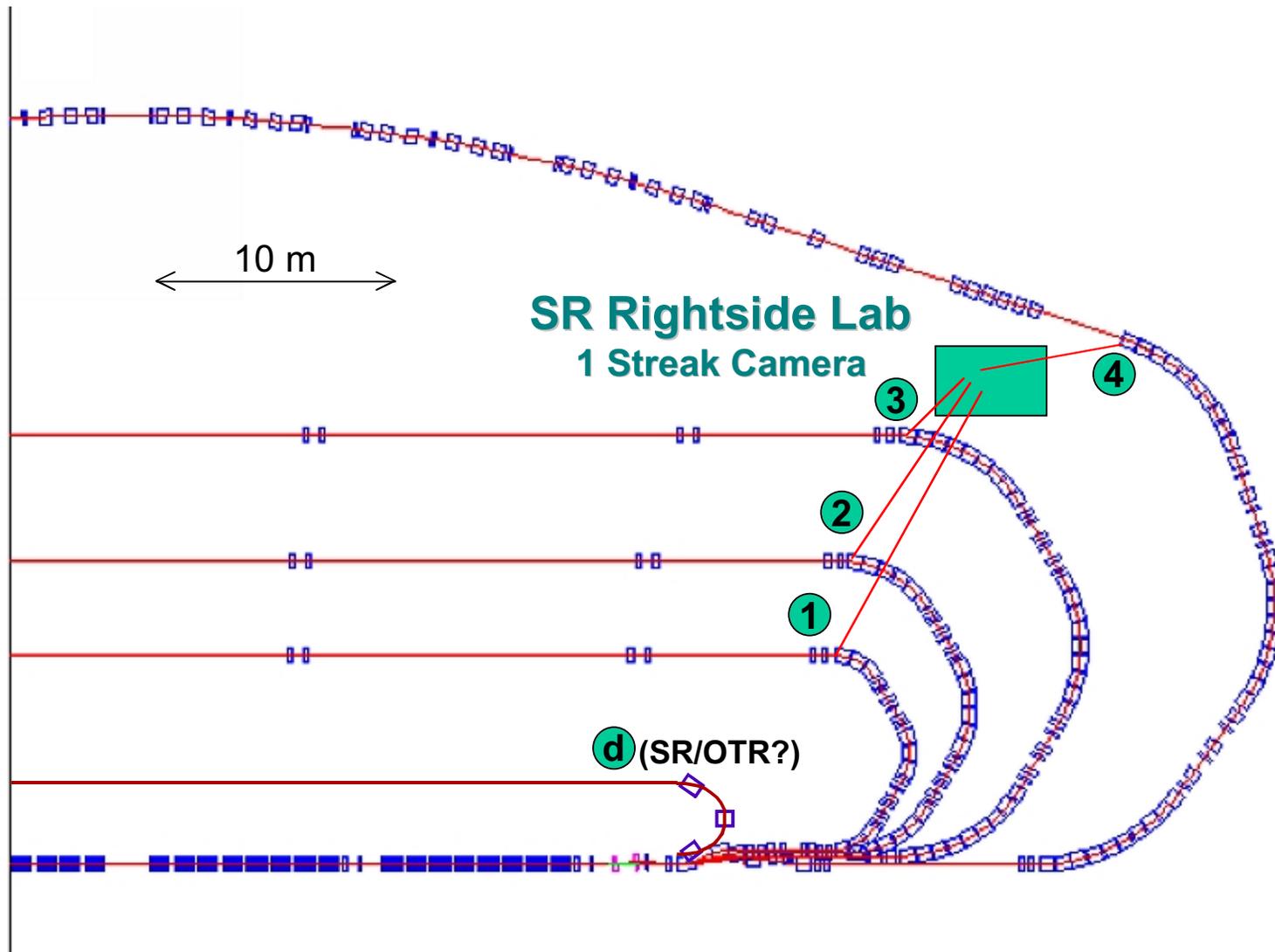
Fernando Sannibale

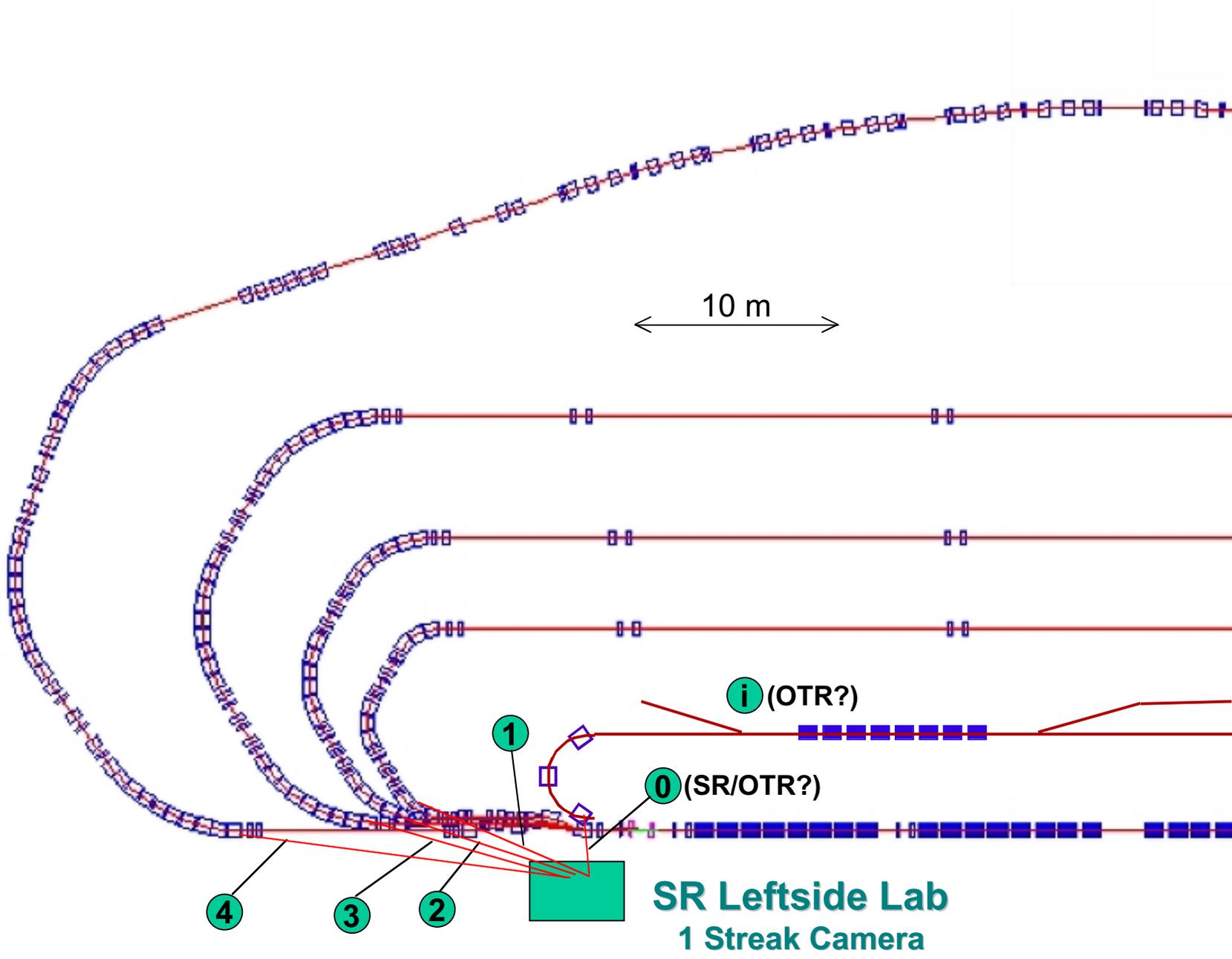
Femtosource Meeting — January 23, 2002

Points of Interest



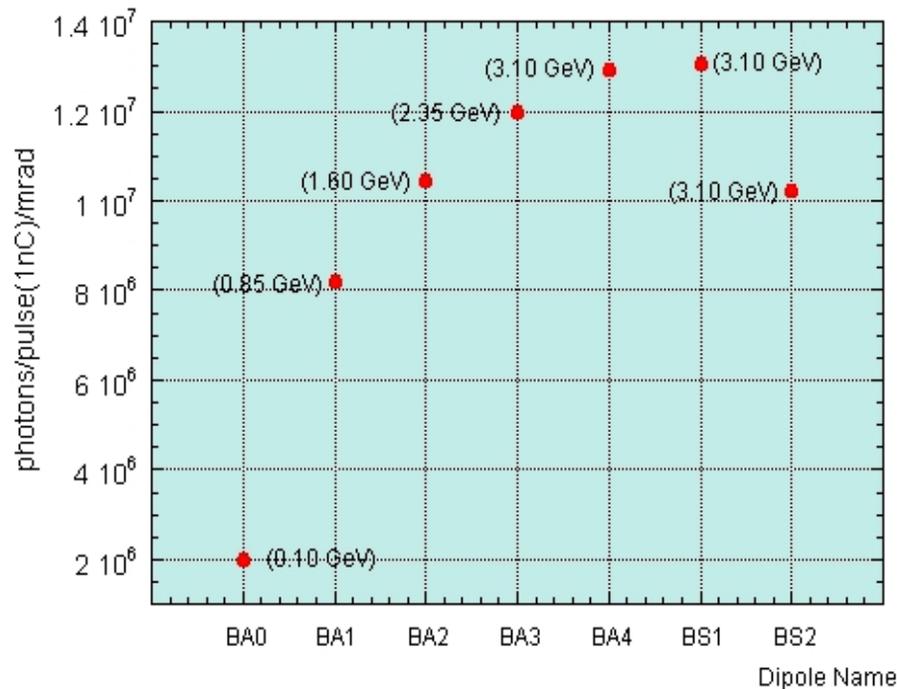
Rightside SR Station



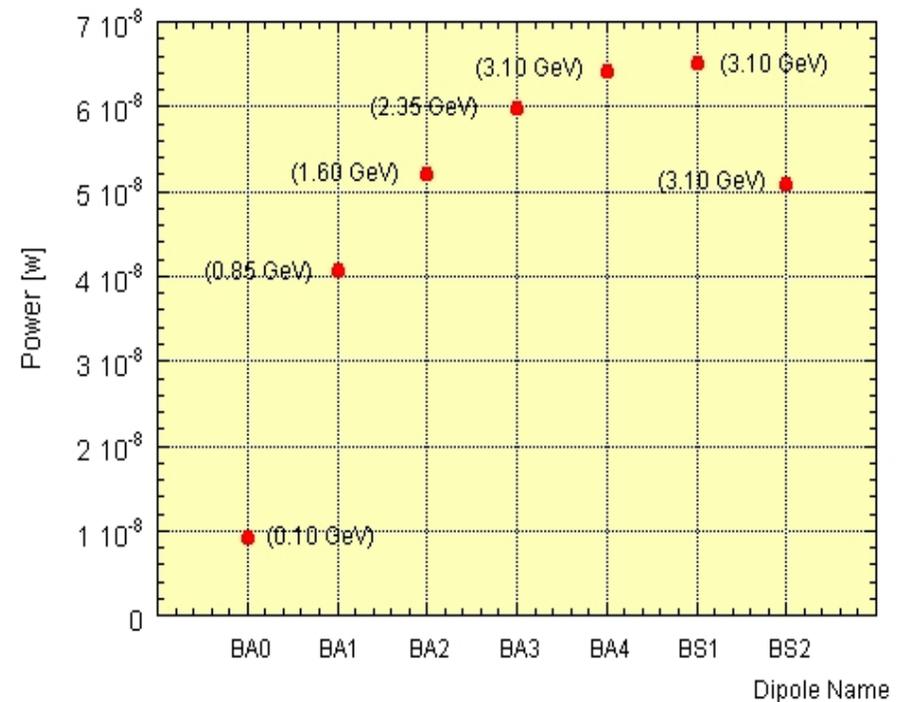


SR Flux & Power from Bending Magnets

Number of Photons per Pulse (250 - 750 nm)



Power/mrad/nC (10 kHz) (250 nm - 750 nm)



Comparing Power and Photon Flux

Power/mrad

Equivalent to 10 μA in ALS

and to 15 μA in DAΦNE

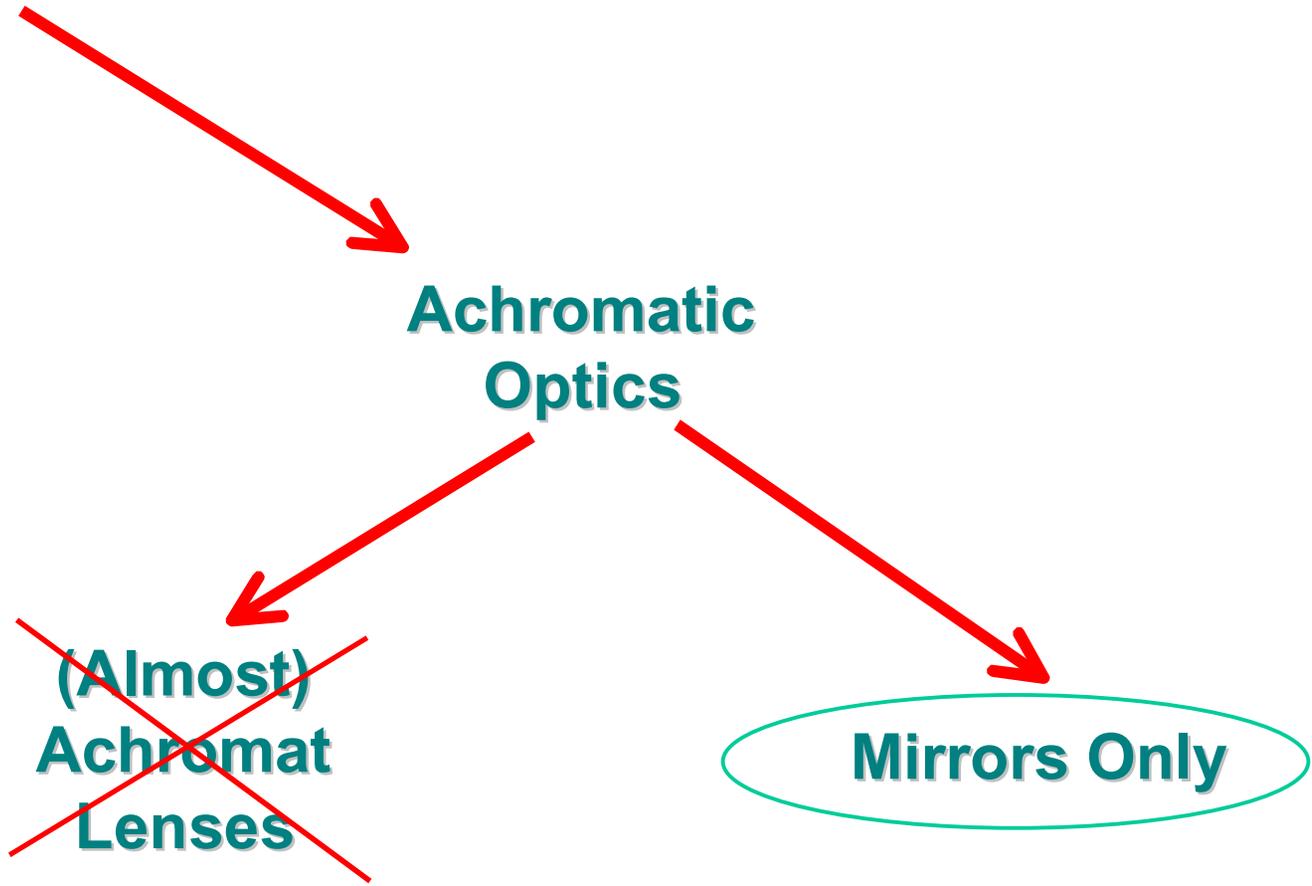
Photons/pulse (1 nC)/mrad

Equivalent to 1.5 mA single bunch in ALS

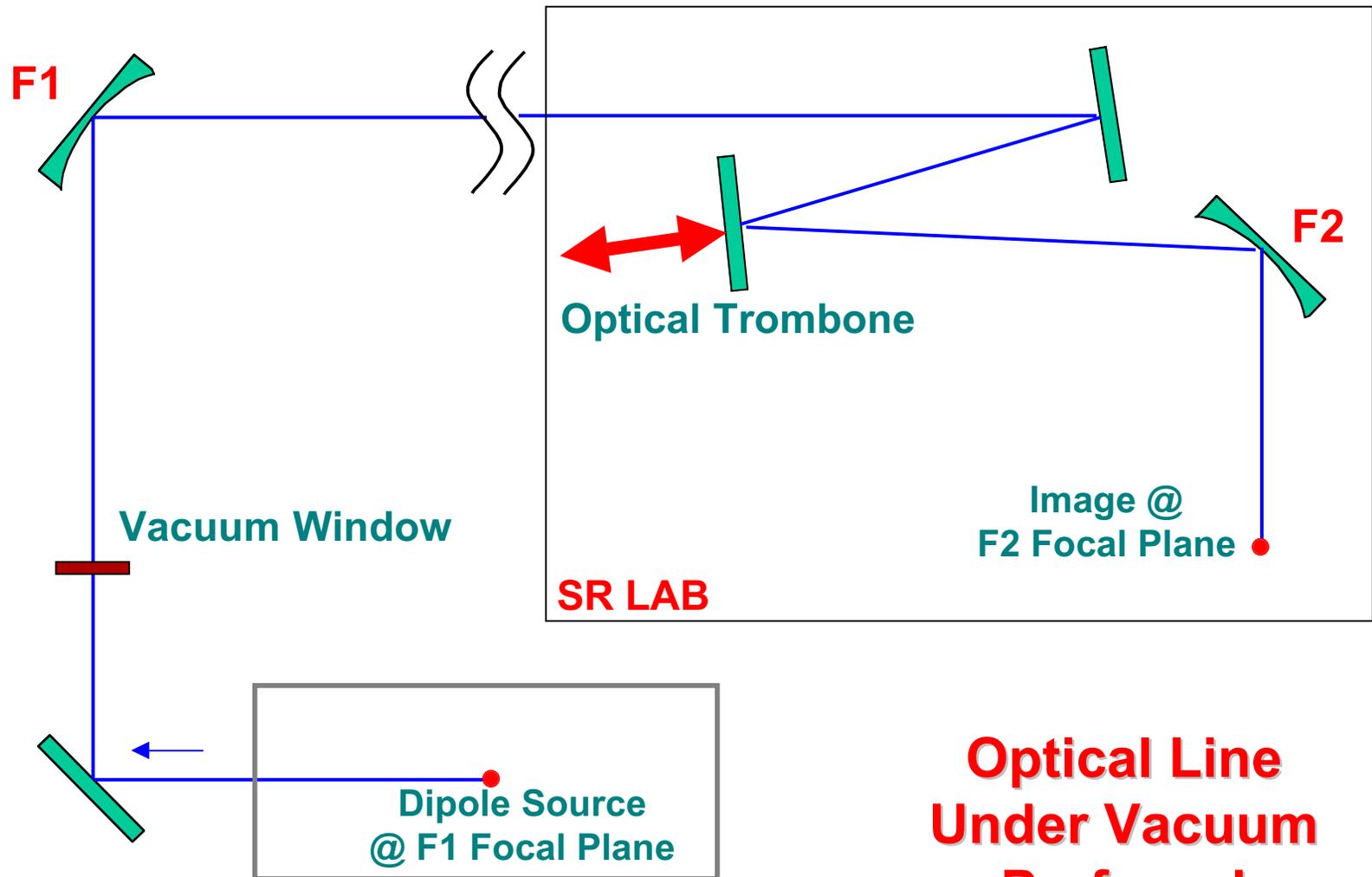
and to 5 mA single bunch in DAΦNE

Chromatic Aberration

250 nm $< \lambda <$ 750 nm

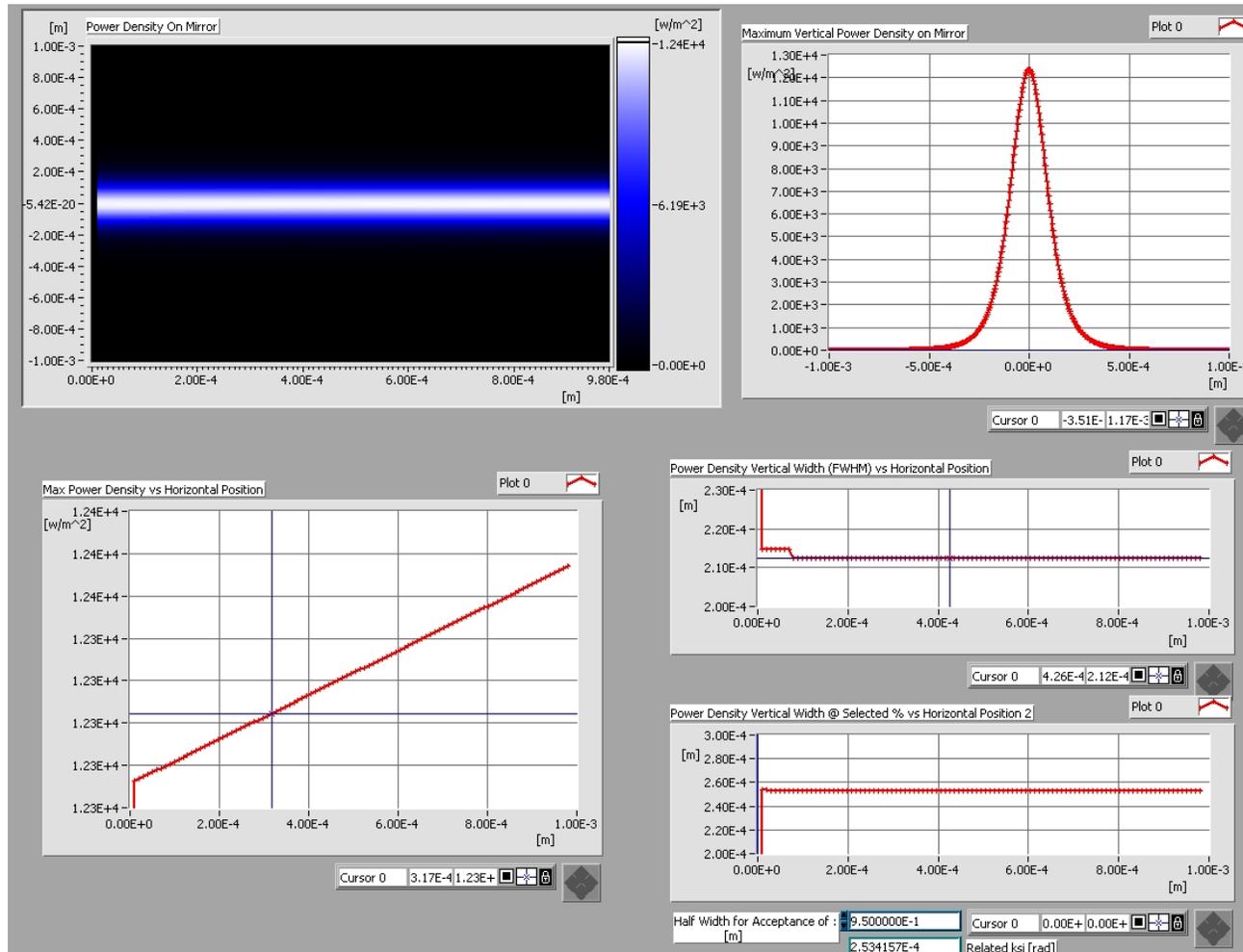


Typical Optical Line Schematics



**Optical Line
Under Vacuum
Preferred**

Max Power on Mirrors



**Mirror @
Source Area
Bending**

**Heat Load:
3 mw/mrad**

**Max Power
Density @ 1 m:
12.4 mw/mm²**

Small Values!

Streak Cameras

Hamamatsu		Spectral Response Characteristics	Sweep Unit (Plug-in type)	Max. sweep repetition frequency	Temporal Resolution
Model No.	Features				
C6860 (Synchroscan Fesca)	The newly developed Synchroscan FESCA achieves an ultra-high temporal resolution at a high repetition frequency of 75 to 100 MHz synchronizing with repetitive optical phenomena. The integration of such repetitive phenomena makes it possible to detect and measure extremely weak signals in the IR region of up to 1600 nm using an S-1 streak tube.	200 to 850 nm (S-20)	M6863	2 MHz	<50 ps
		300 to 1600 nm (S-1)	M6866	75 to 100 MHz	500 fs
C6138 (FESCA-200)	The FESCA-200 is an ultrafast streak camera with a temporal resolution of 200 femtoseconds (typ.). It is designed for use with single-shot or slow-repetitive phenomena. It can analyze the process of energy relaxation and dynamics of chemical reaction in the femtosecond region in combination with femtosecond pulse laser.	280 to 850 nm (S-20)	built-in the main body	1 KHz	<200 fs
C5680	This is the streak camera which is most ideal for general purposes. By selecting the appropriate sweep units and additional function units, this can be configured to cover an extremely wide range of times from 200 ps to 1 ns. In addition, it is capable of measuring anything from a single event phenomenon to high-repetition phenomena in the GHz range. The appropriate streak tube (photocathode) can be selected to accommodate light ranging from X-rays to the near infrared rays. Operation can be handled very simply using a computer.	200 to 850 nm (N5716, N5864)	M5676	10 KHz	<2 ps
		300 to 1600 nm (N5716-02)	M5677	2 MHz	<50 ps
		115 to 850 nm (N5716-01) 400 to 900 nm (N5716-03) X-ray region (10 eV to 10 keV)	M5675	75 to 165 MHz	<2 ps
C4334	The C4334 ("Streakscope") is a compact streak camera primarily dedicated for time-resolved as an alternative to conventional detector system.	200 to 850 nm (C4334-01) 400 to 900 nm (C4334-02) 300 to 1500 nm (C4334-04)	built-in the main body	2 MHz	< 15ps
C2830	This streak camera is designed for single-sweep operations, and offers a maximum temporal resolution of 10 ps.	200 to 850 nm (S-20)	M2547	1 KHz	< 10 ps
			M2548	10 KHz	< 100 ps
C7700	The C7700 is a wide dynamic range streak camera for single shot measurement	200 to 850 nm (S-20) 300 to 1600 nm (S-1)	built-in the main body	1 KHz	< 5 ps
C4187	This is a large format streak camera with 18 mm effective photocathode width (three times that of the C5680 model). In addition to high and low speed sweep operations, framing operation is possible.	200 to 850 nm (S-20)	M4190	500 Hz	< 100 ps
			M4191	500 Hz	< 10 ps
C4575-01	The C4575-01 X-ray Streak Camera offers extremely high temporal resolution of only 1.5 picoseconds, while maintaining good spatial resolution. This is made possible by using the latest achievements in streak tube technology.	X-ray region (10 eV to 10 keV)	built-in the main body	50 Hz	<1.5 ps

~ 220 k\$ (complete system)

Sweep Units

M5675 Synchroscan Unit



Temporal resolution	Better than 2 ps	
Sweep range	Video output type	150 ps to 1/6 fs (fs: synchroscan frequency)
	Lens output type	200 ps to 1/6 fs
Sweep range	4 selectable range	
Synchroscan frequency	Factory set within a range of 75 to 165 MHz	
Synchronous frequency range	fs \pm 0.2 MHz (fs = synchroscan frequency)	
Trigger jitter	Better than temporal resolution	
Trigger signal input	-3 dBm to 17 dBm / 50 Ω	

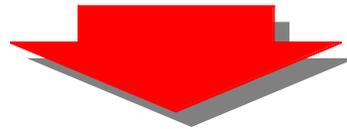
M5676 Fast Single Sweep Unit



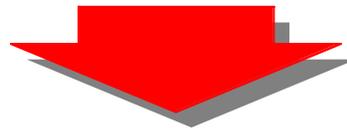
Temporal resolution	Better than 2 ps (1.5 ps typ.)	
Sweep time	Video output type	0.15, 0.5, 1, 2, 5, 10, 20, 50 ns/full screen
	Lens output type	0.2, 0.5, 1, 2, 5, 10, 20, 50 ns/full screen
Trigger jitter	Better than 20 ps	
Trigger delay	Approx. 13 ns (fastest range)	
Maximum sweep repetition frequency	10 kHz max.	
Trigger signal input	\pm 5 V/50 Ω	

A Possible Configuration for Our Case

130 MHz Synchroscan Frequency
Locked
with the 1.3 GHz LINA V RF and with 10 kHz RepRate Trigger



Only 1 pulse every $\sim 10^4$ with real signal!



Noise Integration Can Be Avoided
by Using the
Built-in Streak Camera Gating

Dual Sweep Possibility (Single Bunch Measurements)

M5679 Dual Time Base Extender Unit

This unit can be used in conjunction with all sweep units.



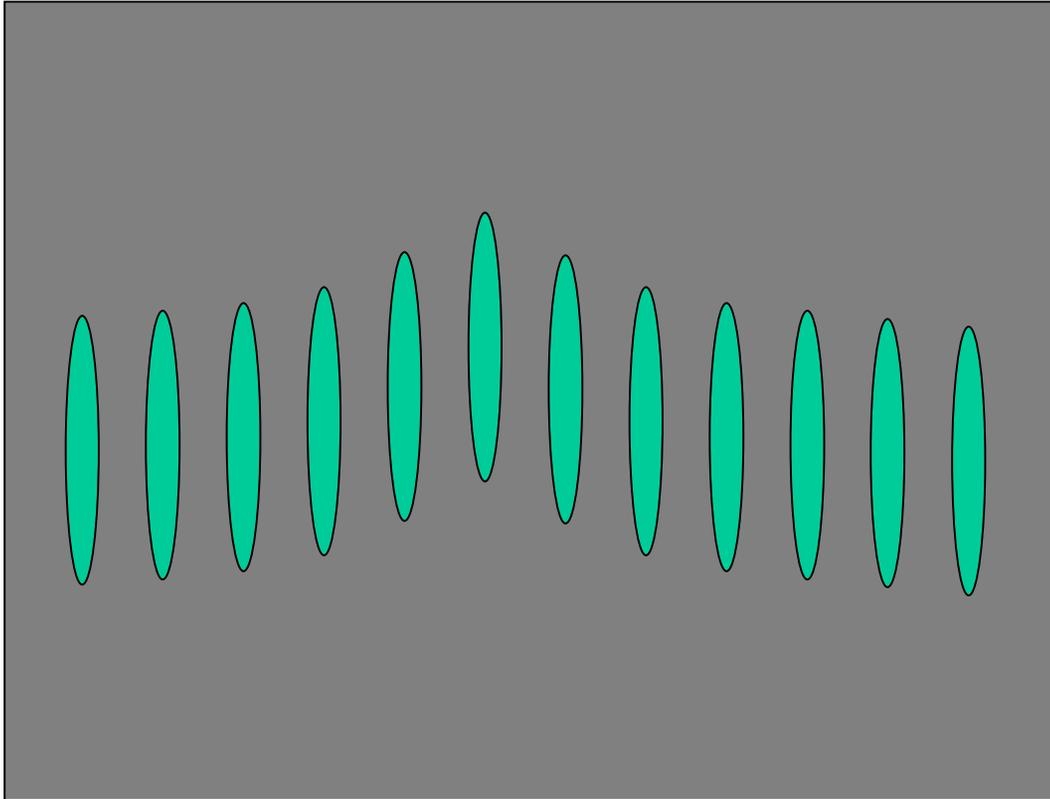
Sweep time	100 ns to 100 ms/full screen
Maximum sweep repetition frequency	10 Hz max
Trigger signal input	± 5 V/50 Ω

5 μ s Full Screen:
Same Bunch @ All the Arc Ports
in a Single Sweep

110 μ s to 100 ms Full Screen:
2 to 1000 Bunches @ a Selected Arc Port
in a Single Sweep

If the Number of Photons per Single Bunch is Sufficient!

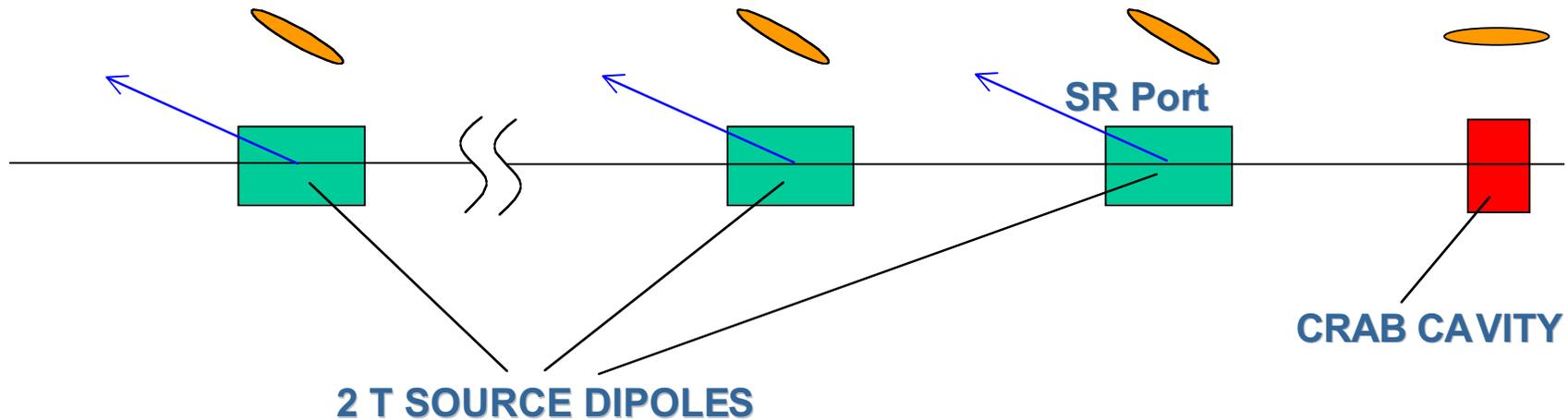
Dual Sweep Principle



Vertical (Fast) Sweep:
Bunch Length

Horizontal (Slow) Sweep:
Different Bunches Or Same Bunch at Different Ports

Transverse Measurements @ the 2 T Dipoles



Streak Camera-like Configuration

**Transverse Measurement at the SR Ports Could Allow:
Betatron Phase Advance Optimization Between Dipoles
Crab Cavity Optimization**

Resolution Effect

1.5 ps rms Resolution Effect

