A Cascaded Optical Klystron on an Energy Recovery Linac – Race Track Microtron

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In the next 15 minutes…

Studies in progress for a light source:

- 1-10 Å
- Coherent
- Continuos
- Tunable
- Stable
- Low-electron energy
- ”Compact”

- Problems and challenges

Background

- Sweden has 3 SR sources (MAX I, II, III)
- Rumours of ESS to Sweden
- MAX IV
  - 3 GeV storage ring
  - Full energy injector

More than just inject….

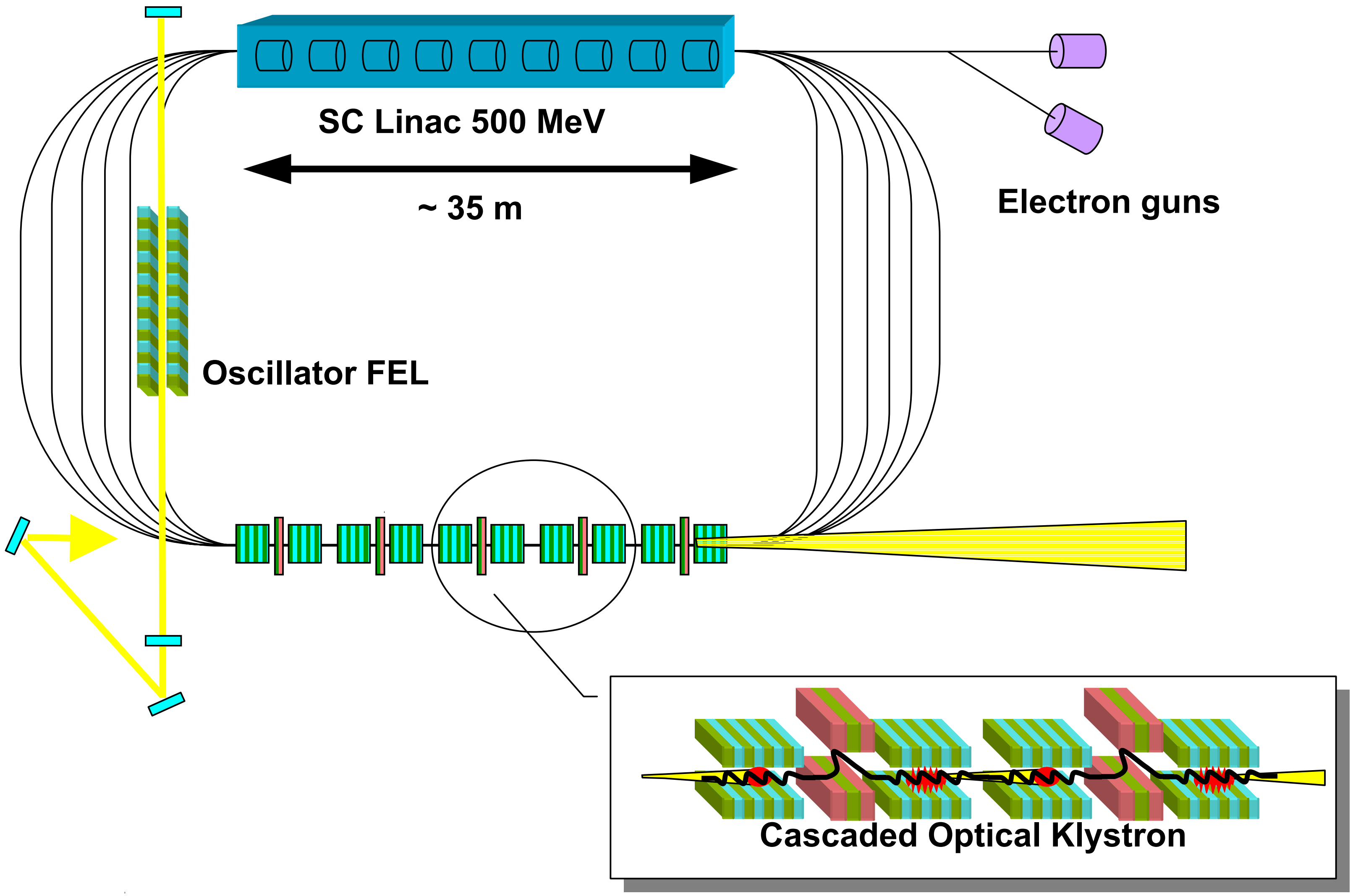
+

RTM experience

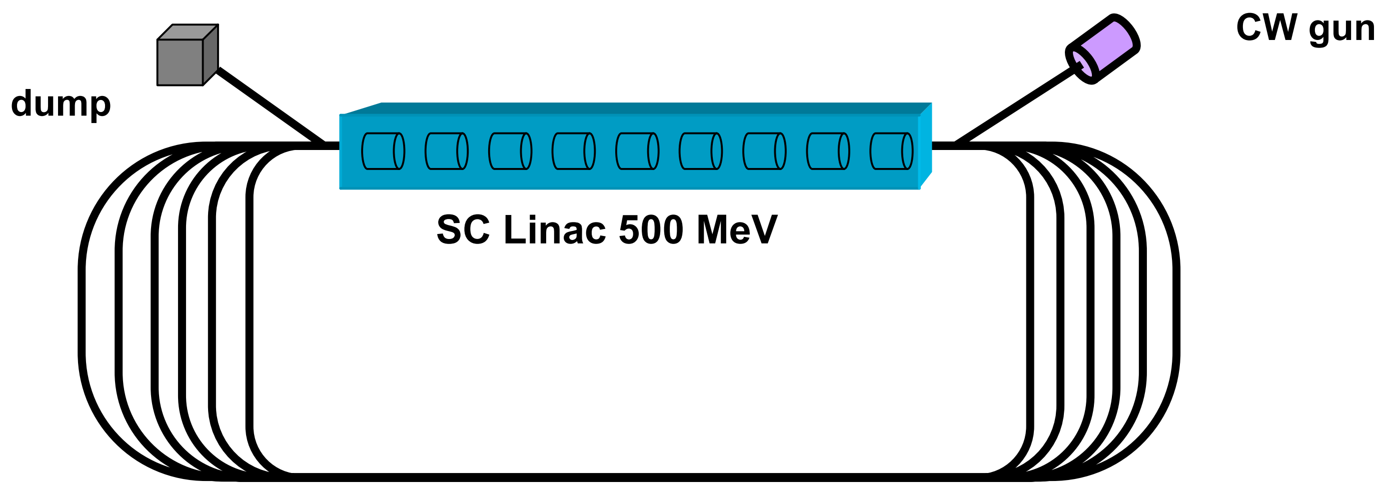
HG history

Input

3 GeV Energy Recovery RTM



Energy recovery RTM

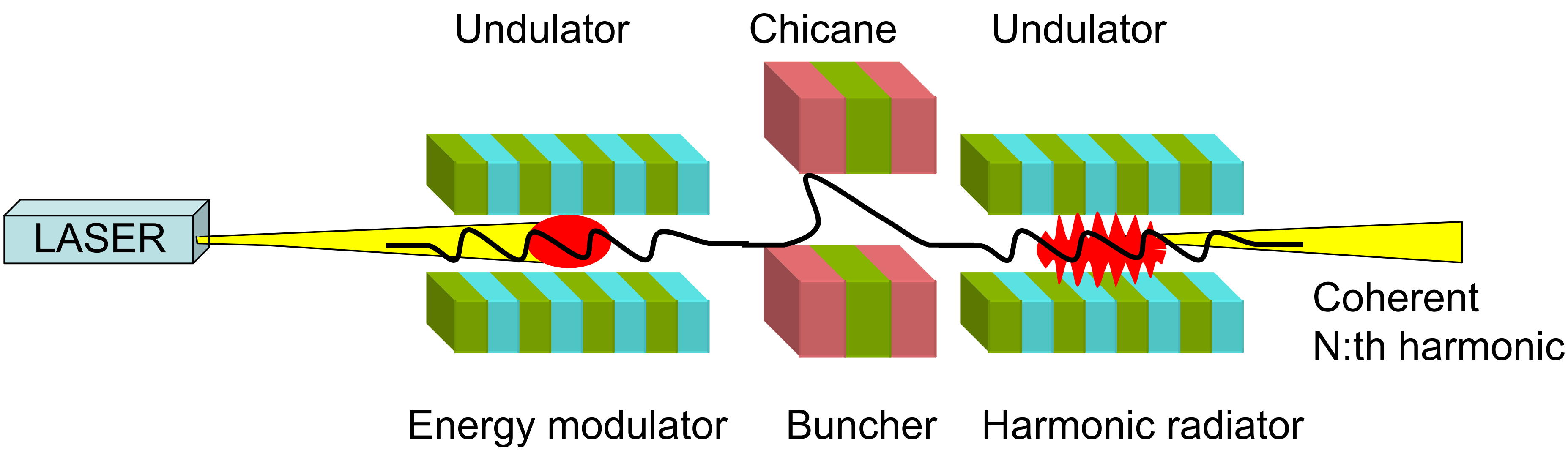


- 3 GeV
- 6 turns
- Common return path
- CW

MARS, G.N. Kulipanov et.al. NIM A 467-468(2001)16

Cornell ERL, Gruner and Tigner, Chess technical memo 01-003 (2001)

Harmonic generation

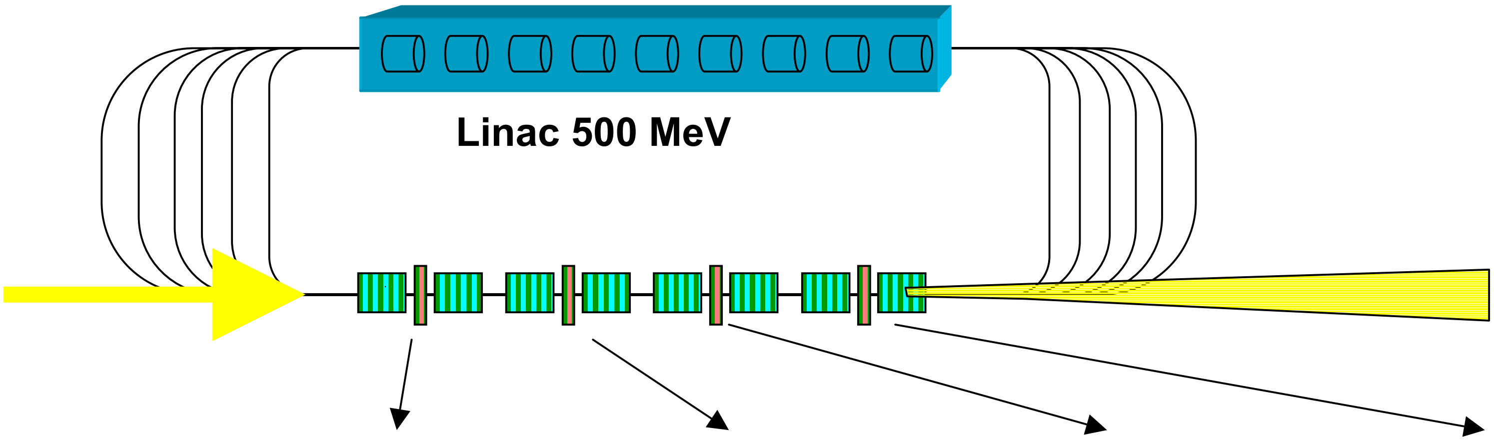


Do this 4 times:
Ex: 7^4=2401 st harmonic of 266 nm = 1.1 Å

BUT….

Each step needs new e- of higher energy!

Cascaded optical klystron*)



	Stage 1		Stage 2		Stage 3		Stage 4	
e- energy	500 MeV		1.5 GeV		2.5 GeV		3.0 GeV	
U period	0.06	0.025	0.06	0.025	0.05	0.015	0.015	0.015
K	3.916	1.98	4.5	2.37	2.93	1.75	2.3	2.3
$\lambda 1$ (nm)	260	37	37	5.3	5.3	0.76	0.76	0.76

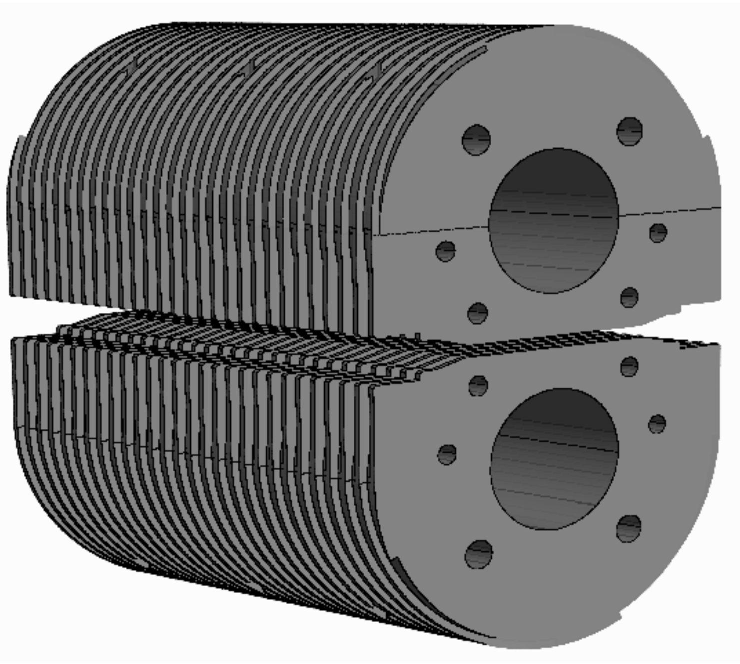
7th=1.1 Å

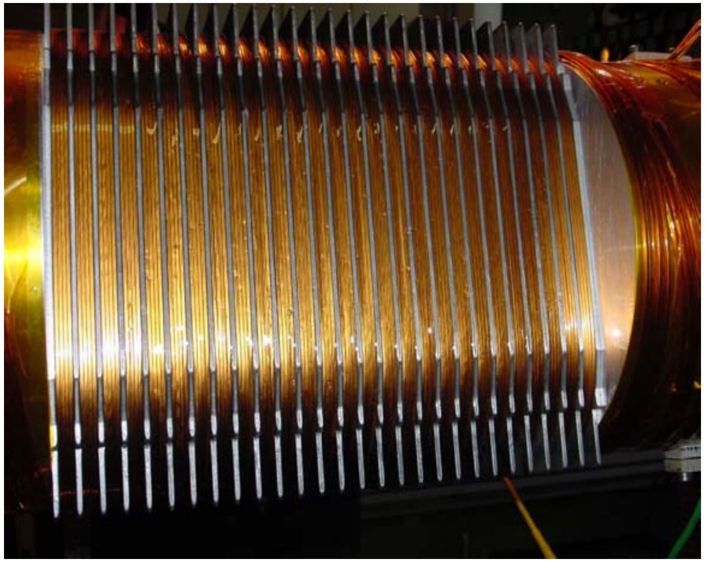
*) J. Wu et.al., NIM A 475(2001)104

Additional key technologies - 1

Undulators

Periods	14-30 mm
K-values	0-2
Gap	5 mm



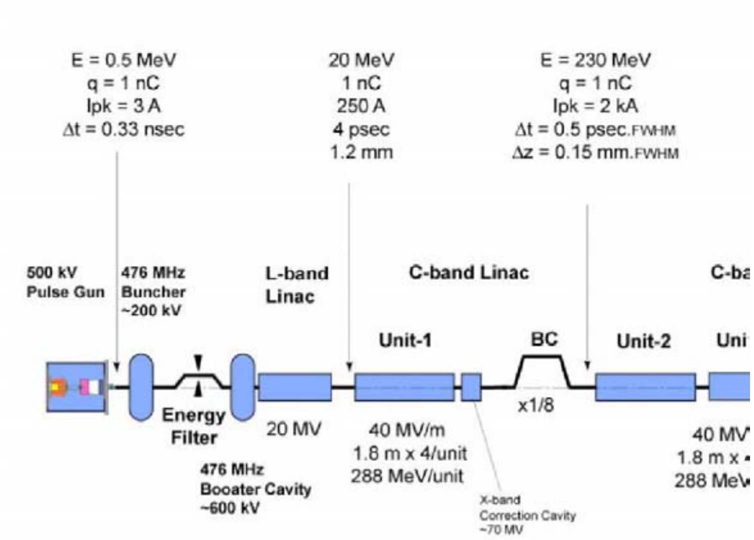


R. Rossmanith, H.O. Moser, EPAC 2000, Vienna, June 2000.

Additional key technologies - 2

CW guns

Non RF (Spring8, Jefferson…)



Spring8, Shintake et.al. EPAC 2002, Paris

Superconducting RF
Nb structure

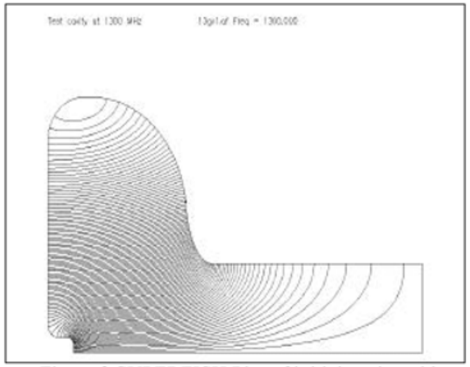


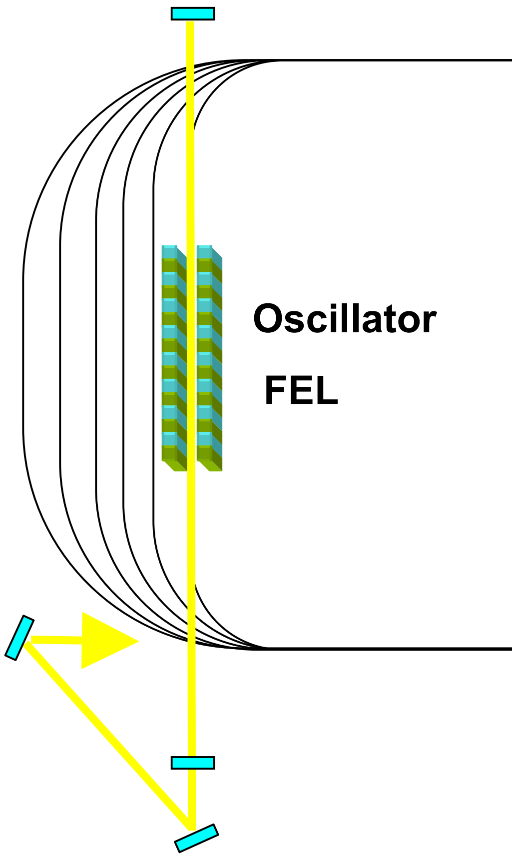
Figure 2 SUPERFISH Plot of initial cavity with protruding cathode

BNL-AES, Ben-Zvi et.al. XX Intl. Linac Conf, Monterrey, 2000

Additional key technologies - 3

Oscillator FEL

- Modelocking – coherence length
- Tunability
- Power – still to be shown
- Linewidth



Does it work?

Charge	1 nC
Pulse length	1 ps
Emittance (norm)	$1*10^{-6}$ π m Rad
Undulator length	3 m
Energy spread	$1*10^{-4}$
Starting wavelength	266 nm

1.1 Å

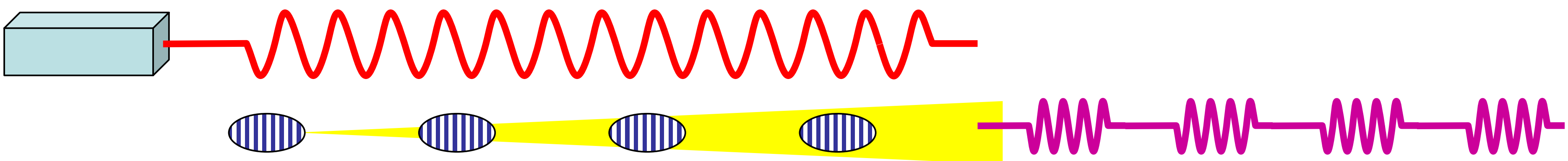
Calculations, not simulations.

Very sensitive to parameter choices.

Coherent radiation		
Peak brilliance	$2*10^{30}$	ph/s*mm2*mRad2*0.1%BW
Peak flux	$2*10^{24}$	ph/s*0.1%BW
Peak power	$7*10^{8}$	W/0.1%BW
Average brilliance	$5*10^{26}$	ph/s*mm2*mRad2*0.1%BW (500 MHz, 0.5 ps)

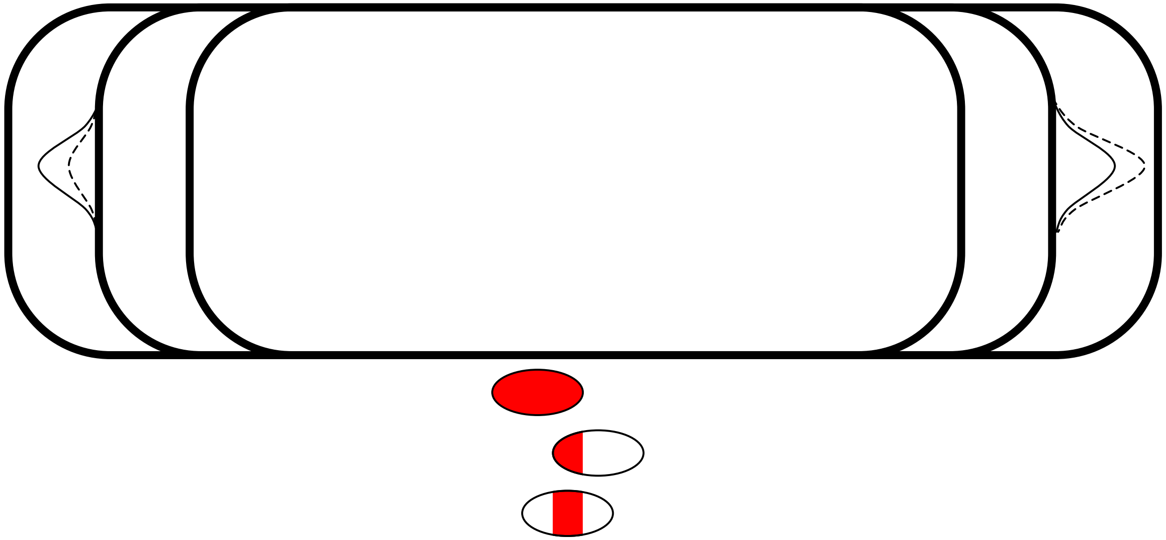
Is anything else good?

- **Stable** – defined by the drive laser.
- **Coherence length** – defined by the laser.
- **Linewidth** – small due to laser coherence length.



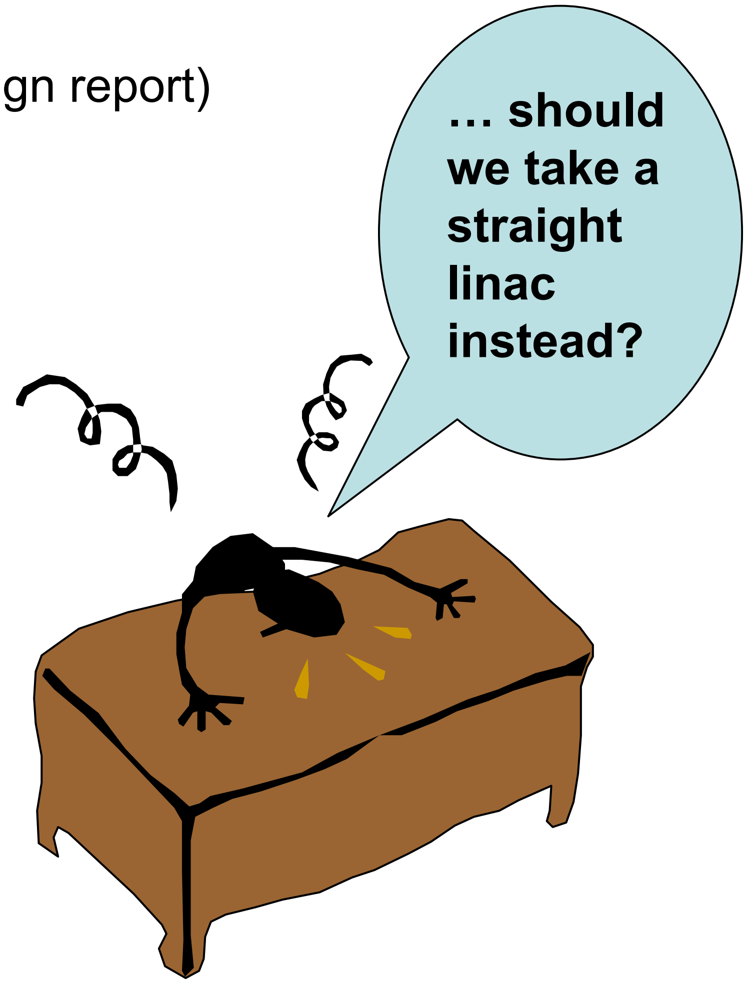
… good too

- **Tunable** – 5-10 % oscillator FEL.
- **CW**
- **Pulse length** – tunable by overlap between orbits (<50 fs ?)

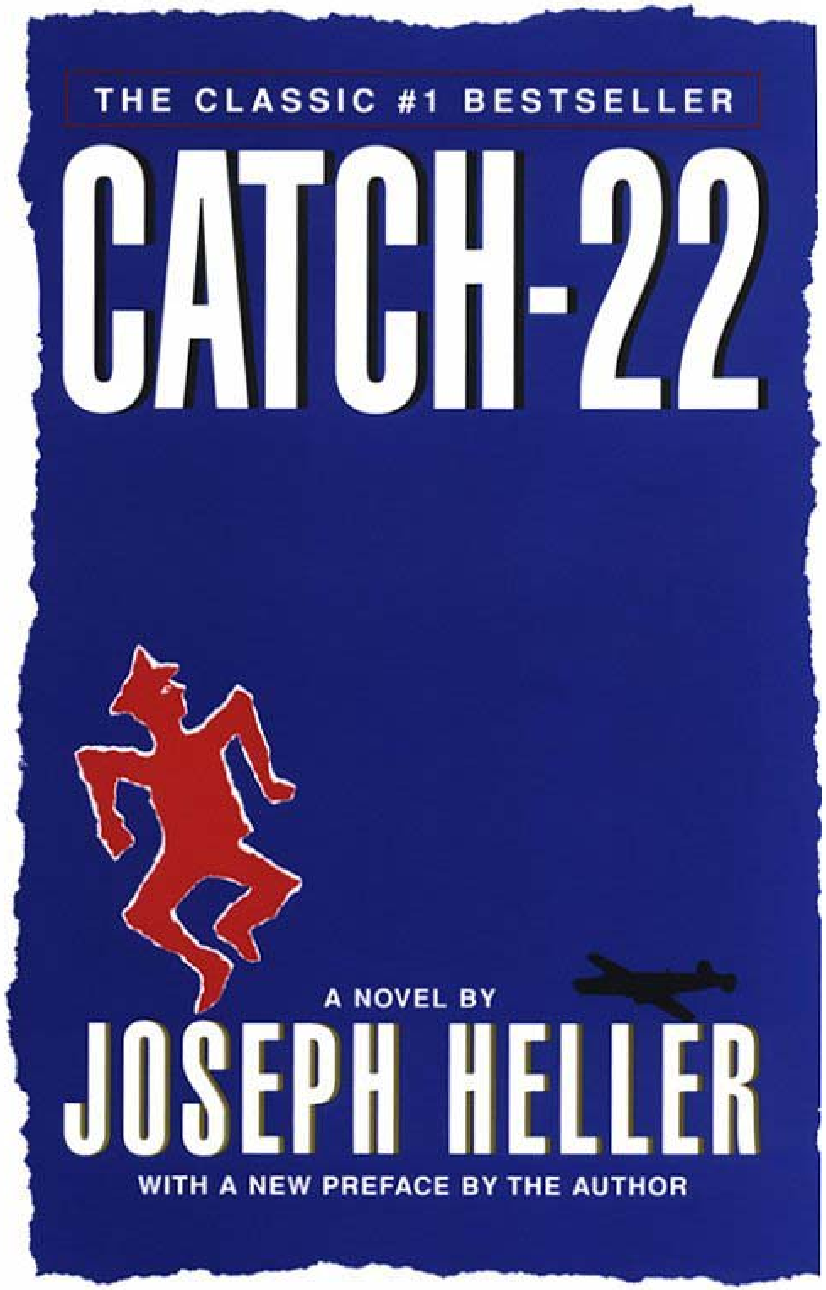


Problems / challenges

- **Noise** – amplified (Brefeld et.al., FEL 2001, Darmstadt)
- **Coherent SR** – Shielding (LCLS design report)
- **RTM optics**
- **Focusing / optical mode overlap**
- **CW guns**
- **Simulations**



There is always a catch…



end!