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IFEL driver for IGS

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IFEL (RUBICON) Collaboration:
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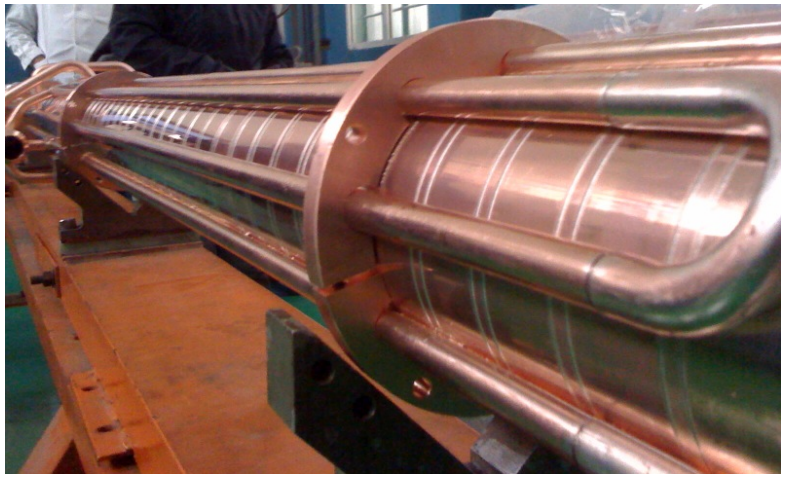
- **Motivation for IFEL IGS driver**
- RUBICON experiment

State-of-the art linac for 700 MeV IGS

Technology	Gradient	Length	Risk	Recurrent Cost Est.
Off-the shelf SLAC-type linac	20 MV/m	35 m	Low	~ $ 5 mm

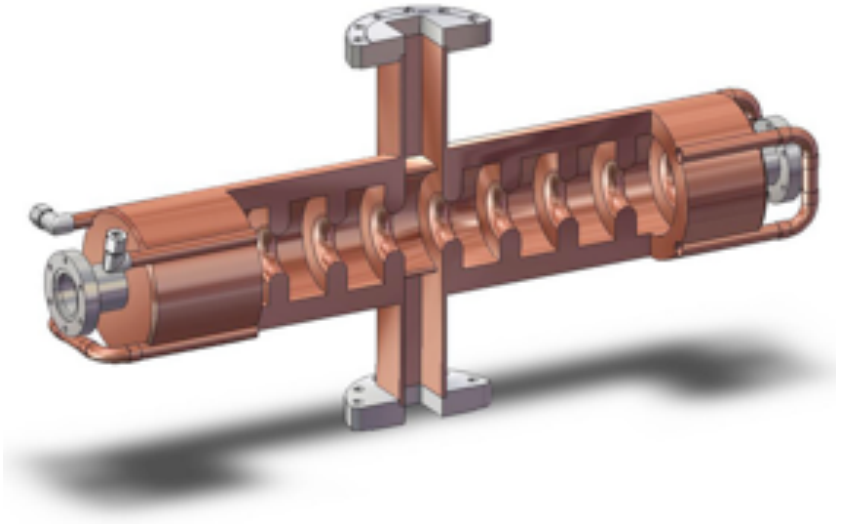
- Proven technology
- Not practical for mobile platform applications
- Not cheap



Novel linac designs

Technology	Gradient	Length	Risk	Recurrent Cost Est.
Off-the shelf SLAC-type linac	20 MV/m	35 m	Low	~ $ 5 mm
High gradient S-band linac	50 MV/m	14 m	Medium	~ $ 4 mm

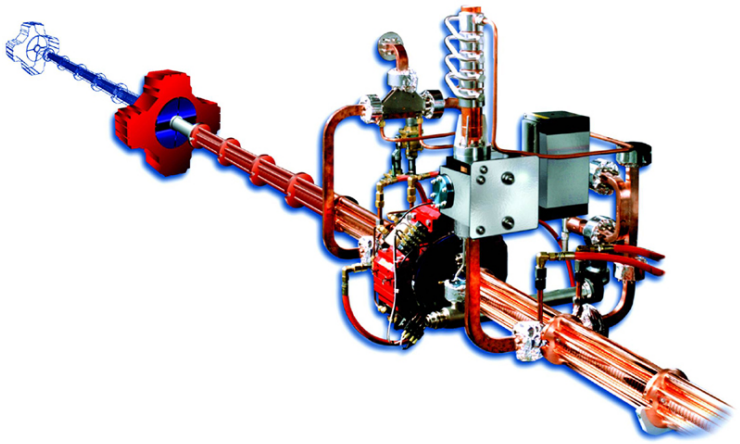
- Higher gradient are possible in S-band
- A prototype is under development



Moving to higher frequency (X-band)

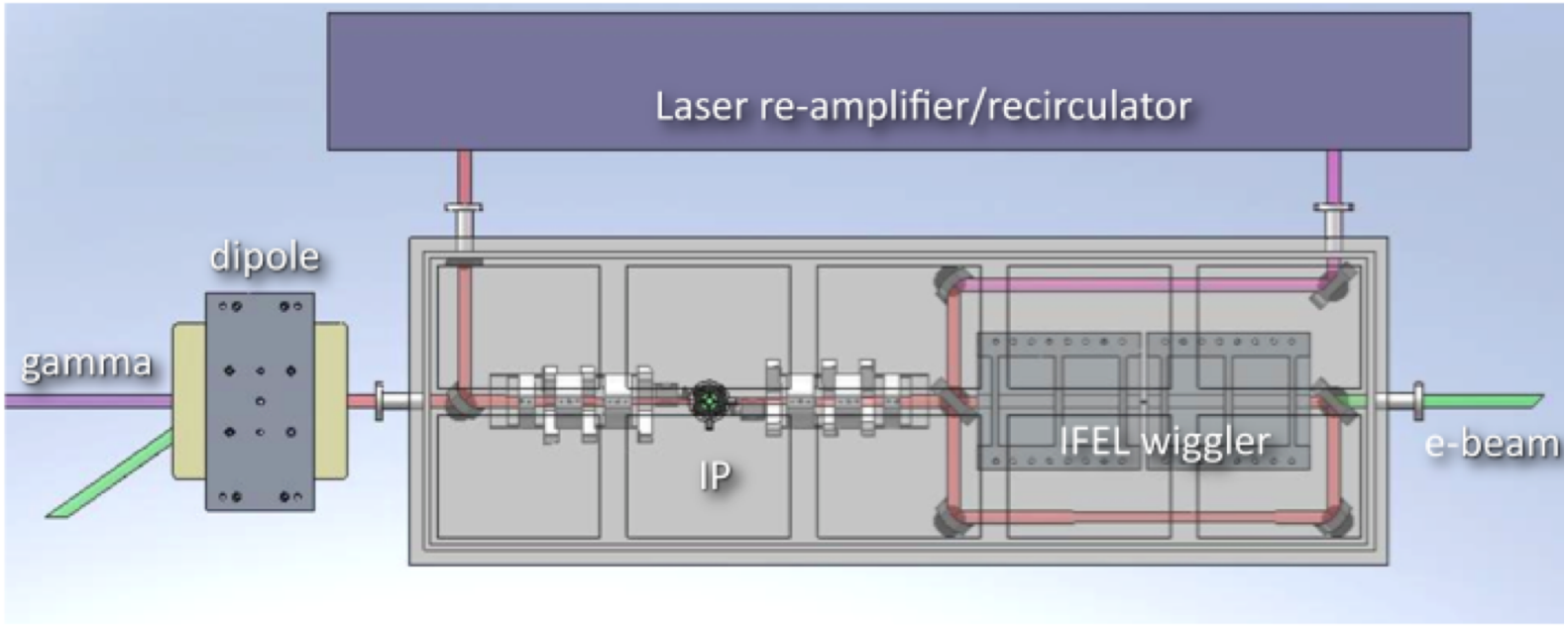
Technology	Gradient	Length	Risk	Recurrent Cost Est.
Off-the shelf SLAC-type linac	20 MV/m	35 m	Low	~ $ 5 mm
High gradient S-band linac	50 MV/m	14 m	Medium	~ $ 4 mm
High gradient X-band linac	90 MV/m	8 m	Medium	~ $ 7 mm

- Very promising technology
- Based on years of research and optimization for NLC
- A major risk and cost driver is a poor industrial participation in X-band klystron development



IFEL alternative to RF accelerators

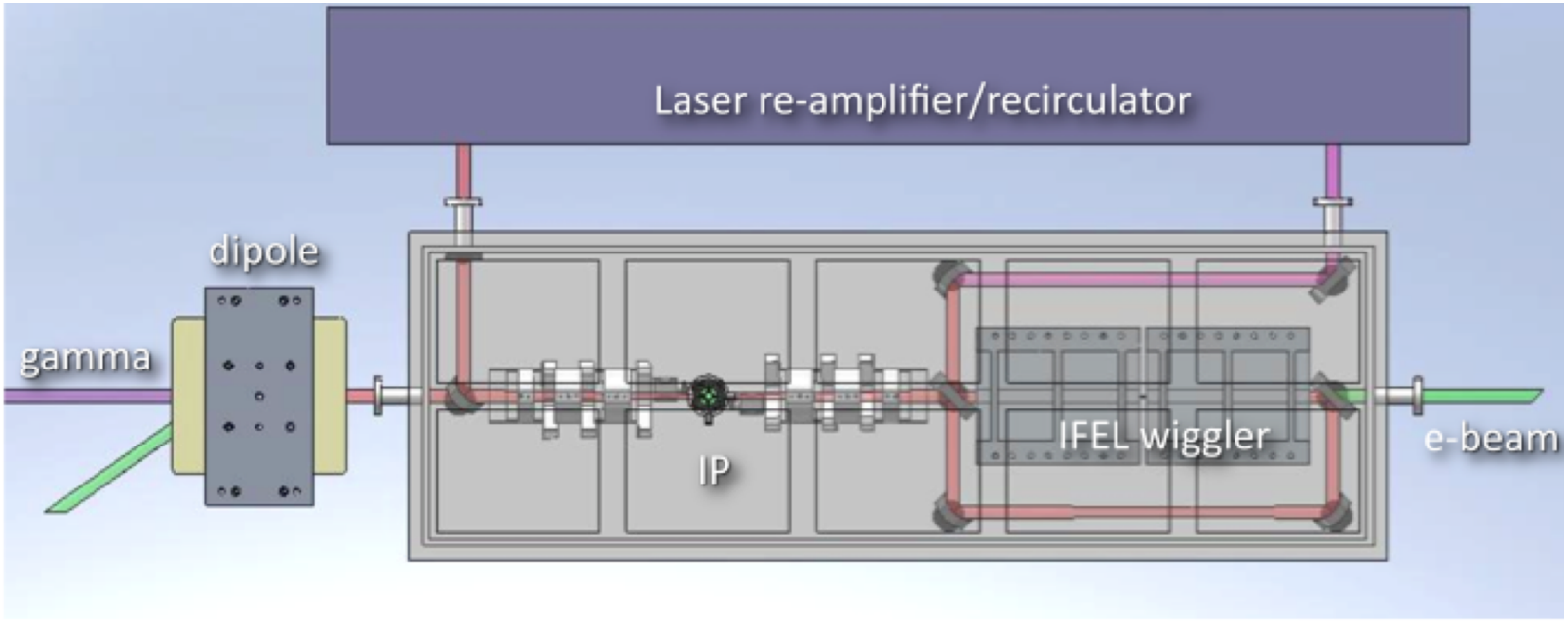
Technology	Gradient	Length	Risk	Recurrent Cost Est.
Off-the shelf SLAC-type linac	20 MV/m	35 m	Low	~ $ 5 mm
High gradient S-band linac	50 MV/m	14 m	Medium	~ $ 4 mm
High gradient X-band linac	90 MV/m	8 m	Medium	~ $ 7 mm
Inverse Free Electron Laser (IFEL)	**700 MV/m**	**1 m**	**High**	**~ $ 1 mm**



- Motivation for IFEL IGS driver
- **RUBICON experiment**

RUBICON is a pilot experiment

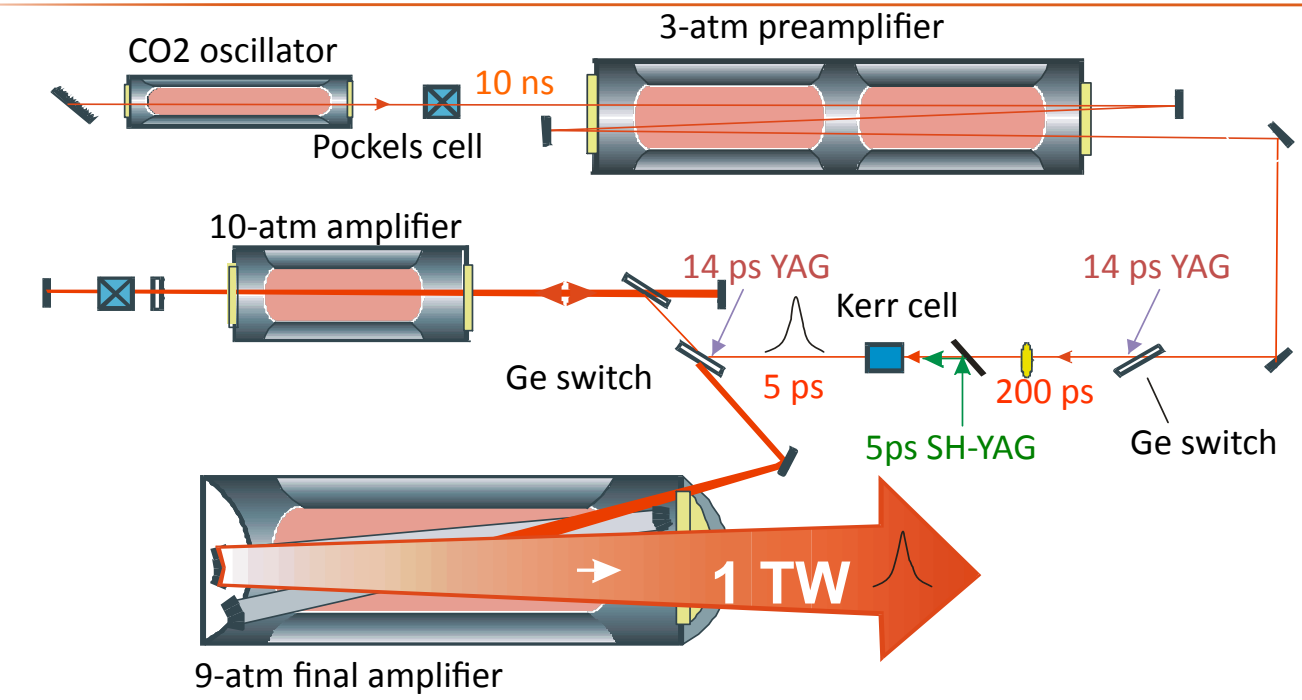
Input beam energy	Future IFEL/ICS	RUBICON
Input electron beam energy	75 MeV	50 MeV
Final electron beam energy	700 MeV	150 MeV
Laser wavelength	0.8 μm	10.6 μm
Average accelerating gradient	> 600 MV/m	~ 200 MeV/m
Laser seed power	5 TW	0.5 TW

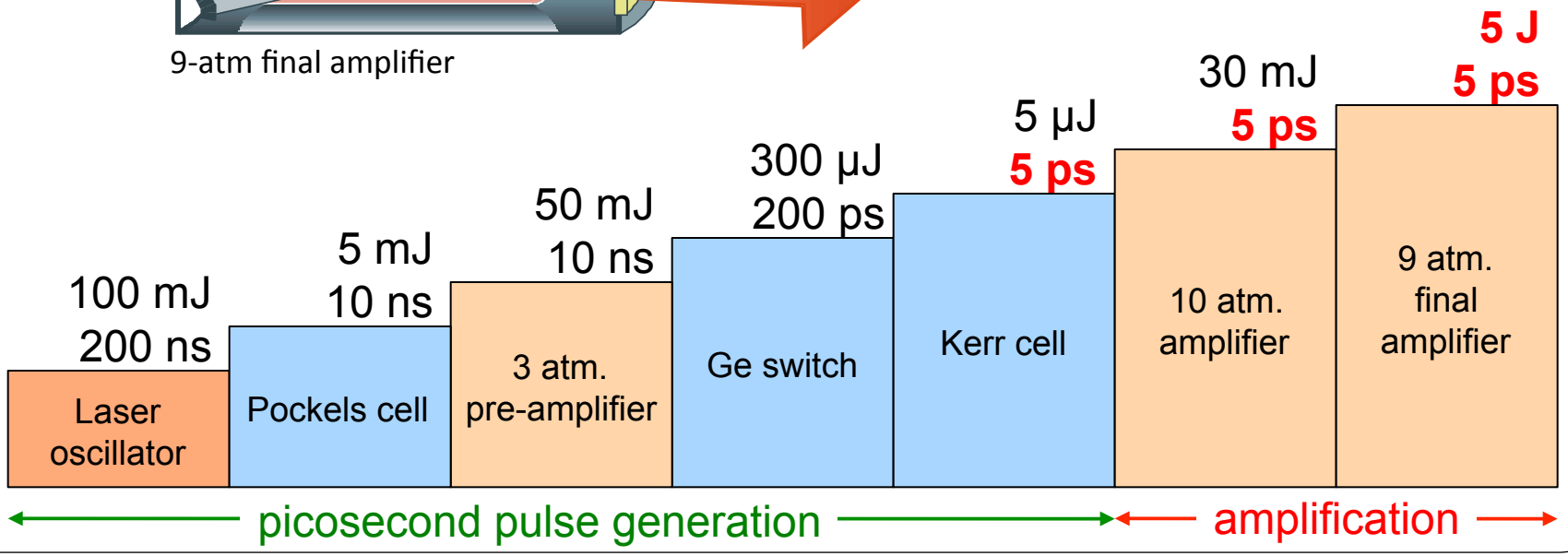


RUBICON goals

- An IFEL pilot project for IFEL-ICS concept
- Achieving record high gradient and good beam capture with the CO2 driven IFEL:
  - > 200 MV/m;
  - > 50 % capture.
- Demonstrating recirculation and re-amplification of the laser beam to achieve high average power IFEL,
  - up to 100 CO2 pulses, 12 ns apart per each RF pulse.
- Experimental investigation of IFEL physics in re-circulation regime
  - Stability, transverse mode structure, acceleration/capture fluctuations, etc.

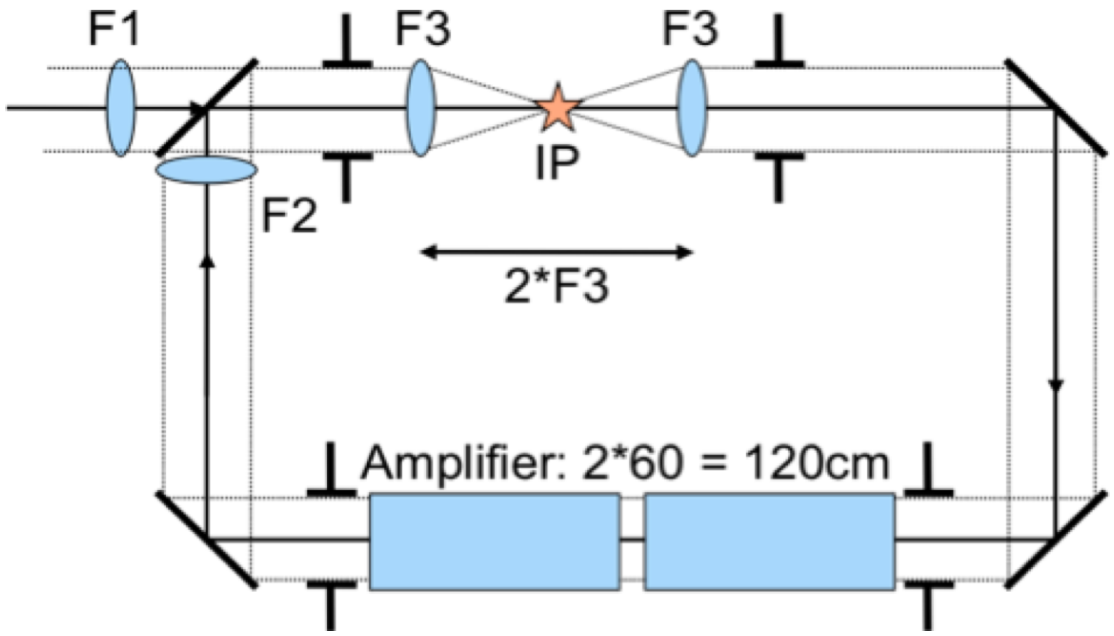
ATF-BNL CO2 Laser





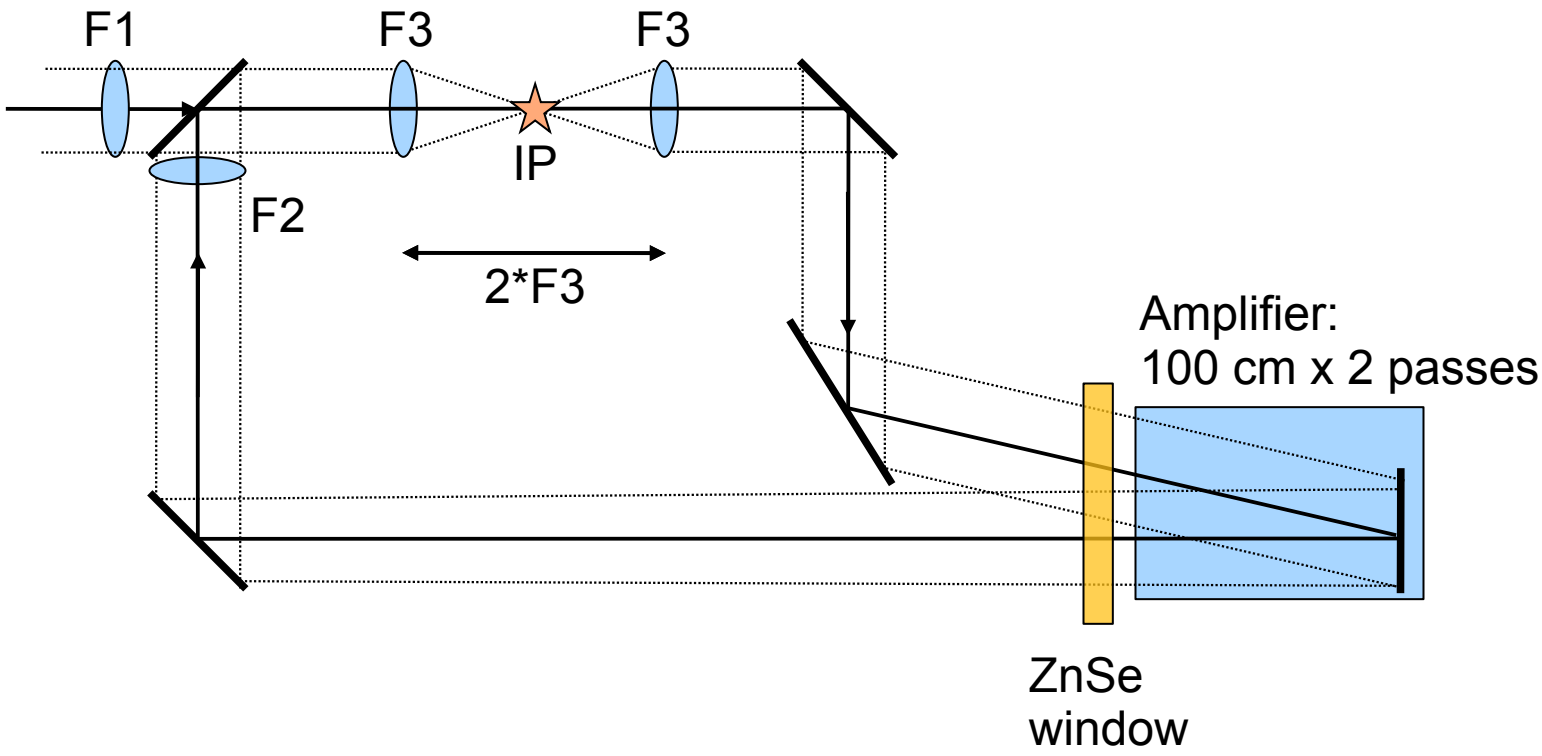
CO2 Laser Re-Circulation (Approach #1)

- A 22-m reamplification loop will carry 6 pulses (12 ns apart), to achieve RUBICON goal of pulse train IFEL acceleration.



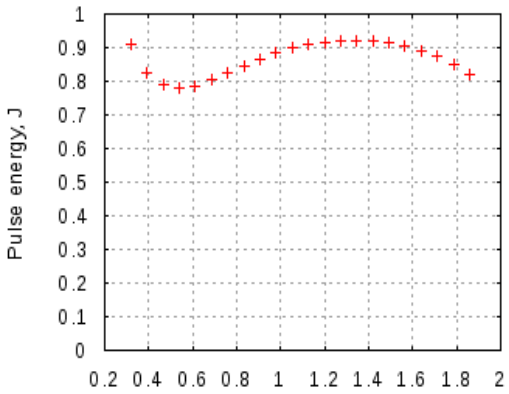
CO2 Laser Re-Circulation (Approach #2)

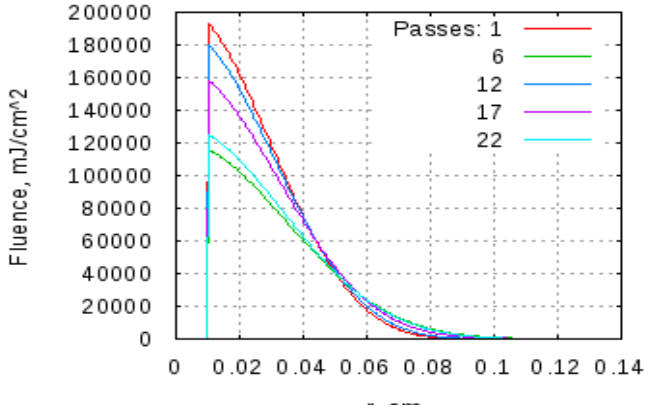
- A 22-m reamplification loop will carry 6 pulses (12 ns apart), to achieve RUBICON goal of pulse train IFEL acceleration.

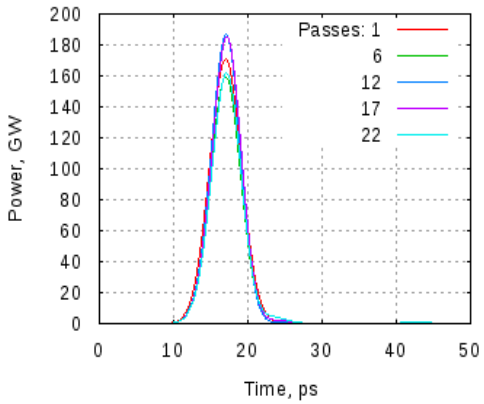


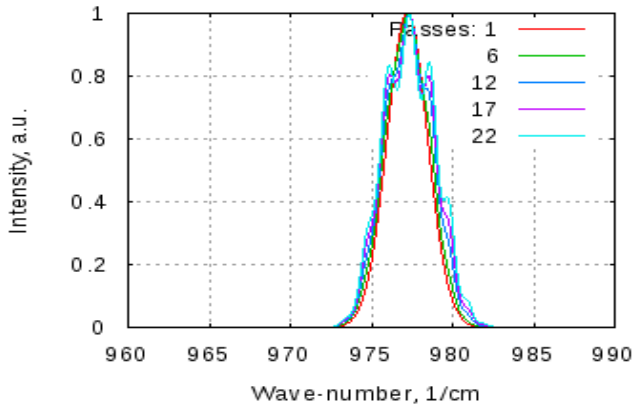
CO2 Laser Re-Circulation

- Simulations demonstrate good beam quality preservation for a re-amplified laser pulse over the duration of the macro-bunch.









Conclusions

- IFEL is a promising technology to fundamentally reduce cost and footprint of the ICS gamma sources.
- RUBICON is a pilot project initiated specifically in the context of ICS application.
- RUBICON is a 5 years program:
  - 2010-2011 to demonstrate record high gain (lead by UCLA);
  - 2011-2012 to demonstrate and characterized multi-bunch IFEL acceleration (pending Phase II SBIR grant);
  - 2013-2014 to combine IFEL with the ICS;
- A success of this project would enable development of a practical stand-alone high average power IFEL-ICS system in a 5 year horizon.
- This work was supported by DTRA (DOD) Phase I SBIR Contract # HDTRA1-10-P-0021